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Andrea Camilli and Marta Giagheddu

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Public Debt and Crowding-out: The Role of Housing Wealth*

Andrea Camilli† Marta Giagheddu ‡

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WORKING PAPER

Abstract

We investigate the link between housing wealth concentration and the macroeconomic effects of a rise in domestic banks' exposure to sovereign securities. We build a general equilibrium model with housing and heterogeneous agents who differ in their investment opportunities. Banks, optimizing their portfolio between mortgages and sovereign securities, are characterized by financial frictions as households' collateralized debt links government debt with the real economy, through interest rates and housing prices. A country willing to lower the financing cost of the domestic debt in a time of dry out of financial markets has in *moral suasion* a viable option. We find a trade-off between real estate wealth concentration, household lending and consumption inequality. However, under binding financial regulation, moral suasion can help reducing wealth inequality while persistently rising consumption inequality. This comes at the cost of generating worse losses for savers and banks, while failing to reduce financing costs of government.

JEL classification: E32, E44, G11, G18, R21.

Keywords: Sovereign risk, housing, lending crowding-out, regulation, liquidity, heterogeneity.

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†University of Milano-Bicocca. E-mail: andrea.camilli@unimib.it

‡Johns Hopkins University - SAIS. E-mail: mgiaghe1@jhu.edu

1 Introduction

The real estate share of wealth is above 70% for a large number of European economies, partially financed by mortgages.[1] The exposure to the real estate market represents both a vulnerability and a source of resilience from the macroeconomic perspective. On the one hand, a large share of the population is heavily exposed to a potentially illiquid asset, on the other hand lenders accumulate wealth and provide savings to the financial system. In periods of high sovereign debt rollover needs governments can adopt formal and informal financial control on domestic banks inducing a high level of sovereign exposure in financial institutions. The role of population's housing exposure for banks facing a trade off between lending to private sector or to the government has not yet been analyzed. This paper fills this gap examining the effect of government pressure on banks to allocate sovereign security on household lending under different real estate wealth concentration scenarios, with and without regulation. We in particular, find that the private lending crowding out can be dampened in countries with higher wealth concentration.

The mechanism we propose is of relevance in principle for several economies. In particular, the European sovereign debt crisis of 2011 highlighted the vulnerability of several economies to their high levels of public debt and to spikes in the sovereign default risk, in particular distressed macroeconomic conditions following the financial crisis. Moreover, the increased government yield volatility induced higher costs of financing government expenditures conditioning the behavior of international as well as domestic investors (see Corsetti et al. (2013), Bocola (2016), Brunnermeier et al. (2016), Farhi and Tirole (2017), Faria e Castro (2018), Sosa-Padilla (2018)).

Banks provide a key role to finance economic activity and are essential for policy transmission, since they can absorb sovereign securities (see Ferrero et al. (2018), Greenwald (2018), D'Erasmo et al. (2019)). Besides risk shifting and regulatory arbitrage behavior, a motivation for the increased share of domestic bonds purchases out of total assets is represented by formal and informal financial repression as shown in Ongena et al. (2019). During the European sovereign crisis, domestic banks purchased large quantities of rolled over and newly issued national government debt when international investors reduced their share of financing (see Albertazzi et al. (2014), Broner et al. (2014) and Saka (2019)). In addition, due to dried out inter-bank lending market, financial institutions ended up significantly constrained.[2]

In circumstances where access to foreign liquidity is limited, sovereign debt refinancing can puts pressure on the domestic financial sector through *moral suasion* i.e. when the government pressure domestic financial institutions to finance sovereign securities allocation. Moral suasion affects borrowers and lenders in the economy differently, affect-

[1] Household Finance and Consumption Survey Data (HFCS).

[2] Moved by this background, the ECB introduced policy intervention as the Long Term Refinancing Operations (LTRO) to restore liquidity and functional lending conditions.

ing lending and housing demand from borrowers as well saving allocation from savers. We provide empirical evidence that for lower levels of sovereign debt, a higher level of real estate wealth concentration is associated to less lending towards households. When instead the level of sovereign debt is relatively high, lending to households is even lower than the little government indebtedness case, with fewer differences among real estate concentration levels.

Our paper provides a framework to analyze relevant trade-offs for financial institutions and governments in terms of financial stability concerns with a particular focus on the role of real estate wealth concentration and regulation. To this aim, we build a general equilibrium model with housing and heterogeneous agents who differ in their saving and investment opportunities. Savers can save in real estate or in bank's deposits, while borrowers face an endogenous borrowing limit proportional to the value of real estate owned. The financial institution receives deposits from savers and optimally chooses the allocation of assets between loans to borrowers and long-term government securities.

A *moral suasion* shock in this model increases the sovereign bonds demand by banks lowering the cost of debt financing for the government, thus increasing the borrowing cost for households. Private lending drops by 15% and, as borrowers reduce their demand for housing, real estate prices decrease while savers substitute deposits holdings with an increase in their housing stock. If the share of borrowers is higher in the economy, real estate wealth is more concentrated among a smaller group of savers. Since in this situation savers are wealth richer, the aggregate amount of bank's deposits is higher. Moreover, for larger initial deposits' stock a smaller reduction in deposits is needed to accommodate the higher debt demand arising from the shock. This dampens the previous crowding out mechanism in magnitude. With higher real estate wealth concentration, deposits drop less in reaction to a shock and so does lending to household allowing borrowers keeping more of their housing stock. Hence, moral suasion is a viable option for governments to lower debt financing cost. In addition, the more concentrated is the real estate wealth, the smaller it will be the consumption inequality drop and the smaller it will be the wealth inequality rise.

We also examine how our results change if the economy is subject to an always binding regulatory constraint imposing that the bank's assets are composed by a constant share of sovereign bonds. This constraint can be seen as a macroprudential policy tool available to the policy maker. In this context, a moral suasion shock rising the banks' sovereign bonds holdings will have to be accompanied by a higher supply of private credit in order to keep the share of bond holdings unchanged. This calls for a rise in deposits demand, beneficiary for household borrowing conditions, while it generates higher debt financing costs for the government. Even though worsening consumption for savers and worth of financial institutions, and failing to reduce government debt financing costs, moral suasion under this type of regulation can help reducing wealth inequality. This

comes at the cost of temporarily higher, but persistent consumption inequality, with a larger impact the more concentrated is the real estate wealth.

Finally, we investigate the sensitivity of our findings depending to the tightness of loan to value ratio and of the regulatory constraint. Our result highlights an interaction between macroprudential regulation and moral suasion which can give rise to counterproductive increases in the financing cost of public debt given strict regulation realizing high level of sovereign securities in banks' balance sheet in condition of stringent loan-to-value conditions. For the sake of allocating sovereign debt via suasion on banks we highlight the concrete risk of higher indebtedness for the government. The upside of this is both a higher consumption for households and financial institutions incomes and a temporary lower inequality.

The sovereign-bank nexus is key to understand the transmission of country risk to lending to private sector. While existing literature highlights the effects of government bonds' volatility on firm lending (see Gertler et al. (2012), Buera and Moll (2015)), private loans and the mortgage market are also affected by financial institutions balance sheet consideration. The housing and mortgages markets are heavily affected by financial frictions and this can generate spillover effects on the rest of the economy (see Iacoviello (2004), Bostic et al. (2009), Iacoviello and Neri (2010), Baldini and Poggio (2014), Barrell et al. (2015), Favilukis et al. (2017)) having implication also on wealth inequality (see Fernandez-Villaverde et al. (2018)). A large share of the home buyers has a mortgage and households often use housing as collateral for additional consumption. A large set of work analyzes the transmission from housing prices to consumption (see Berger et al. (2018), Mian et al. (2019), Kaplan et al. (2017)). The literature has not incorporated the amplification role played by household wealth inequality in the context of financially repressed banking institutions.

Our model merges elements from household housing choice, as in Iacoviello (2015) with sovereign debt risk transmission mechanism and a financial system featuring elements of *financial repression* as in Chari et al. (2019). This paper contributes to the existing literature on the link between inequality and credit provision (see Aiyagari and McGrattan (1998), Mian et al. (2019), Garriga and Hedlund (2017)): (i) it proposes a theoretical model that includes banks' portfolio choice and sovereign debt with a financial friction which operates as a transmission mechanism: collateralized debt links sovereign debt with real economy, through interest rate and housing prices; (ii) it analyzes the risks connected with high sovereign debt and households' wealth invested mainly in housing; (iii) it addresses the distributional implications of selected macroprudential policy tools.

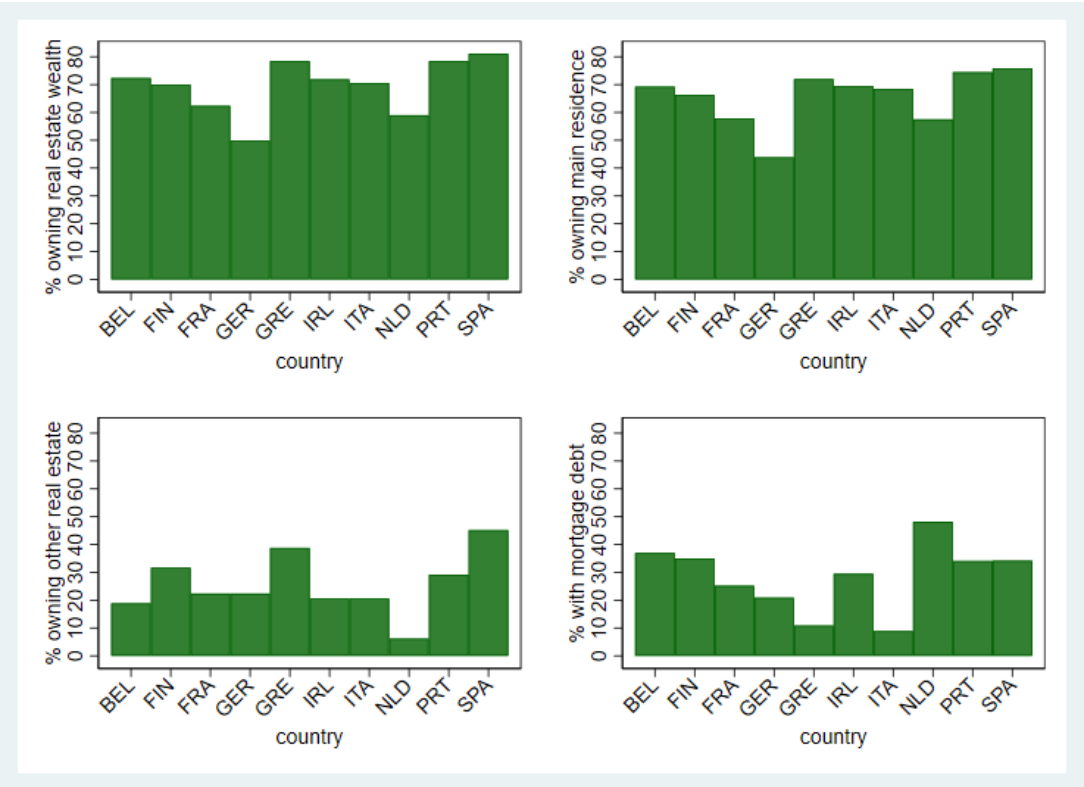
The rest of the paper is organized as follows: Section 2 describes motivating facts, Section 3 illustrates the model and Section 4 the calibration. In Section 5 we describe the numerical results. In Section 6 we discuss a macroprudential application. Finally, Section 7 concludes the paper.

2 Motivating evidence & background facts

Across countries in Europe, most households are characterized by the presence of real estate in their portfolio.[3] Real assets account for more than 75% out of total assets held by households, whereas financial assets are usually below 20%.

As seen in the first panel of Figure 1, real estate exposure characterizes more than 60% of the respondents in countries as Belgium, Spain, Greece, France, Ireland, Italy, Portugal and never for less than 50% of the population. The second panel in Figure 1 shows that this is mostly due to main residence ownership. However, real estate is also an investment good. Panel three reveals a considerable share of the population (averaging at about 20%) owning real estate other than their main residence. Panel four shows that a variable share of the population is also characterized by mortgage debt ranging between 10% in countries as Italy and Greece and 40% in Finland, Portugal and Belgium. The data presented so far suggest that real estate plays a relevant role in household's portfolio choice and that the demand and supply of mortgages can have a large impact on the housing market.

Figure 1: Real estate ownership and mortgage exposure



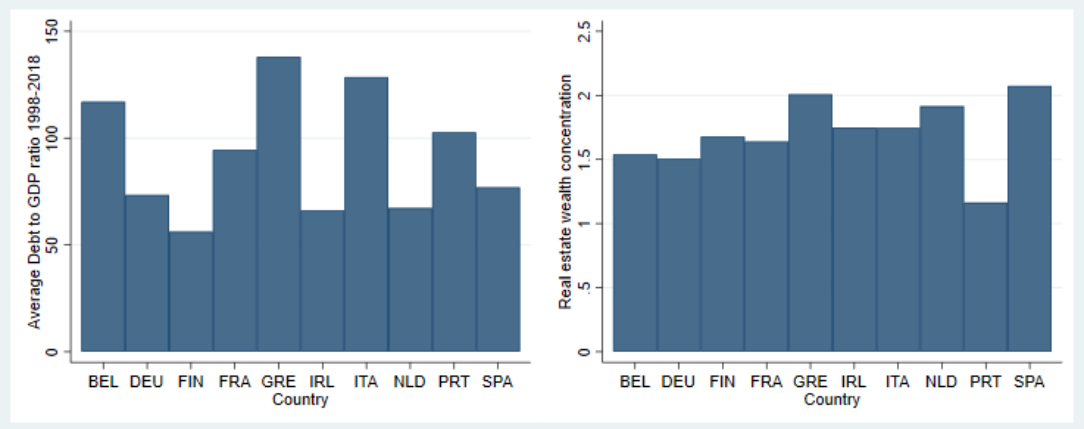
Note: *First panel: % of the population owning real estate wealth. Second panel: % of the population that owns the household main residence. Third panel: percentage of population owning other real estate. Fourth panel: percentage of population with mortgage debt. Source: HCFS*

[3]We use the survey data in the harmonized aggregate version of the third wave, available in the HFCN (2016) survey results publication. The third wave data has been collected in 2017 for 18 Euro area countries for more than 84,000 households.

Not only countries in the HCFS sample show high exposure to real estate, but they are also heterogeneous in terms of real estate wealth concentration. The right panel of Figure 2 shows the average real estate value owned by the wealthiest 8th-9th decile over the average real estate value of the population. We observe that countries as Belgium, France, Germany and Portugal are characterized by lower concentration in housing wealth, while countries as Finland, Italy, Ireland, Greece, Netherlands and Spain have a higher level of concentration. Exposure and concentration to the real estate are likely to impact the investment decisions of households and of the banks.

From Figure 2, we can also observe that among the countries characterized by high real estate exposure, and in some instance concentration, several have also been affected by high government debt levels (see Greece, Italy, Spain) during the period 1998-2018.

Figure 2: Government debt and Real estate wealth concentration



Note: *Left panel: General government debt to GDP ratio. Average of yearly values between 1998 and 2018. Data Source: OECD. Right panel: Real estate value owned by the 80-90 percentile of net wealth population over the average real estate value of the entire population. A value equal to one in the right panel indicates that the real estate wealth share of the second richest decile of the population is equal to the population average. Data source: HFCS waves 2014 (see Appendix A.1 for details).*

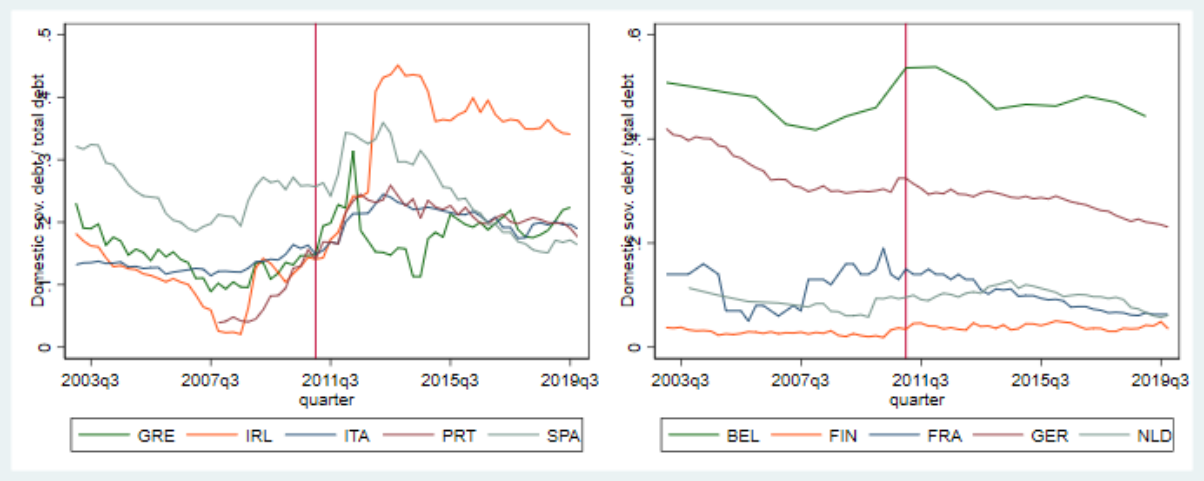
These facts motivated us to investigate how does real estate exposure and concentration affect the link between rise in public debt stock, household lending and macroeconomic outcomes. In particular, the linkage between debt, lending conditions and housing market is even more apparent in specific circumstances. During the Euro debt crisis the financial sector in southern Europe was characterized by a drying up of the wholesale liquidity[4] limiting banks' lending ability. In addition, the sovereign securities market was also characterized by repatriation tendencies (see Acharya and Steffen (2015)) and this could crowd out the household lending market, leading to a drop in housing demand and hence in housing prices making some categories more vulnerable.

Figure 3 shows the share of domestic sovereign debt as a share of the total sovereign

[4]See Figure 13 on banks' liquidity in the Appendix.

debt exposure of the domestic banking sector.[5] Most high debt countries experienced a rise in *home bias* in domestic banks' balance sheet holdings of sovereign debt, during a period of drier wholesale markets and less favorable international financing conditions for debt allocation. As highlighted in the literature (see Ongena et al. (2019)), these circumstances were also the outcome of moral suasion efforts made by the governments.

Figure 3: Domestic sovereign debt in domestic banks (total debt ratio)



Note: *Share of domestic sovereign debt in domestic banks over total debt. Source: Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012)*

To gather more complete motivating evidence, we examine in a reduced form model how the link between a rise in relative domestic sovereign debt exposure and household lending is affected by different levels of real estate wealth concentration.[6] We consider 9 European countries over the period that spans between the first quarter of 2003 until the fourth quarter of 2019. The time period includes the European sovereign debt crisis of 2011, and the countries included in our analysis represent nations both directly and indirectly affected by this.

Our dependent variable is *aggregate household lending* (in billions of Euro). Our variable of interest is the interaction between domestic sovereign debt exposure of domestic banks as a ratio to total debt holdings and a variable capturing real estate wealth concentration (i.e. the average value of real estate wealth owned by the 80-90 percentile of net wealth households as a ratio to average real estate wealth).[7] We include a broad set of controls suggested by the literature to explain lending to households. We can divide our controls into two groups: (i) *economy-wide controls* that control for economy-wide economic conditions and lending demand (GDP growth, average real estate wealth, consumer confidence index, volatility index, short and long-term interest rates, borrowing

[5]Bruegel dataset, Merler and Pisani-Ferry (2012)

[6]For a detailed description of variables and data see A.1.

[7]See appendix for results in which we adopt an alternative dependent variable, *aggregate mortgage lending*, and an alternative measure of real estate concentration, using real estate wealth owned by the 90-100 percentile of net wealth.

cost and housing price) and (ii) *banking sector specific controls* (including measures as leverage, liquidity and profitability of banks as accounted for by banks' balance sheet variables, see Appendix A.1 for further details). We also include country fixed effects and time fixed effects to account for specific economic events potentially affecting the lending market. Our baseline regression reads:

$$\begin{aligned} hh\ lending_{i,t} = \alpha + \beta' Real\ estate\#Sov.\ debt_{i,t} + \\ + \beta_1' Real\ estate_{i,t} + \beta_2' Sov.\ debt_{i,t} + \gamma' \mathbf{X}_{i,t} + \mu_i + \nu_t + \varepsilon_{i,t} \end{aligned}$$

where $hh\ lending_{i,t}$ is lending towards households at time t in country i. α is a constant, $Real\ estate\#Sov.\ debt_{i,t}$ is our regressor of interest: i.e. the interaction between a measure of real estate concentration and the share of sovereign debt held by domestic banks at time t in country i. $\mathbf{X}_{i,t}$ is a vector representing the set of economy-wide and banking specific controls. Finally, μ_i are country fixed effects, ν_t are time fixed effects.

Table 1 reports our empirical evidence. In column (1), a panel regression with only country fixed effect reveals a negative impact on households' lending of rise in sovereign debt holdings by domestic banks. This result is in line with the 2011 Euro debt crisis events (Becker and Ivashina (2018) and Ongena et al. (2019)) and the need of banks to reallocate their portfolio. In column (2) we introduce our coefficient of interest and its interaction components, still controlling for country fixed effects. While both higher domestic sovereign debt exposure and real estate wealth inequality have negative coefficients, their interaction is positively correlated with an increase in household credit. Columns (3), (4) and (5) introduce respectively banking related controls, economy-wide controls and the full model without time fixed effects. Finally, column (6) presents our baseline model, including all controls, country and time fixed effects. The coefficient β' associated to our regressor of interest is always statistically significant, with a value quite stable across different model's specifications. The Appendix presents a series of robustness checks, which include the use of an alternative dependent variable, the use of an alternative measure of real estate concentration and the combination of these alternatives. Our coefficient of interest remains of similar magnitude and significant.

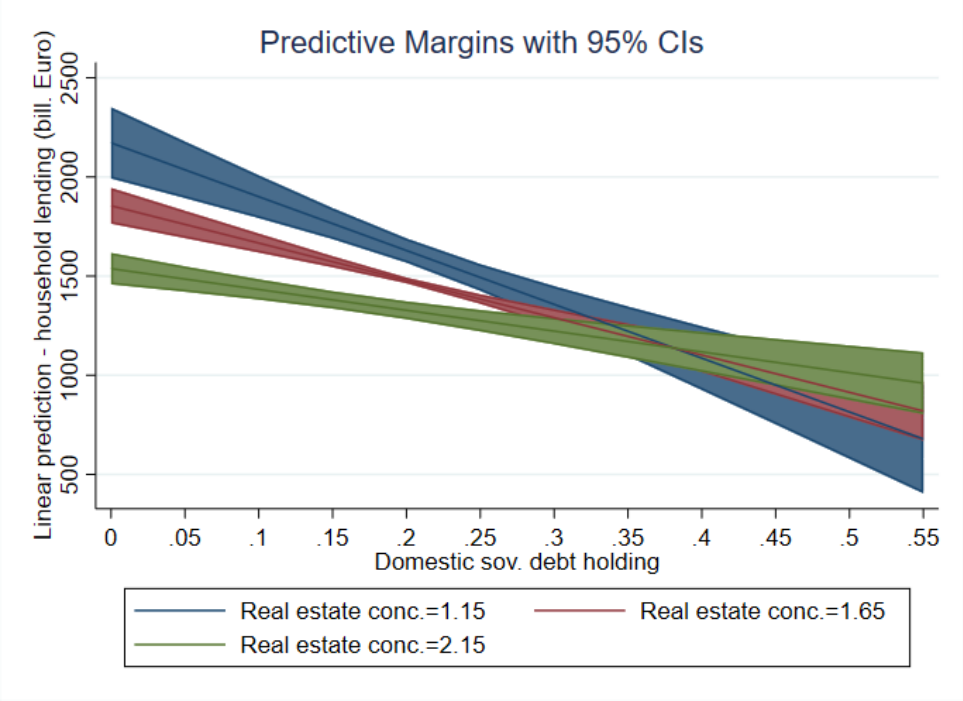
To get a direct interpretation of our results on the impact of the interaction between sovereign debt holding and real estate concentration on household lending, Figure 4 shows the marginal effect of our regressor of interest on the dependent variable. As we can see, when the share of domestic sovereign debt is relatively low a higher real estate concentration is associated with lower household lending. Moreover, the higher is sovereign debt share held by domestic banks, the lower is lending to households for any different level of real estate concentration. Finally, it is worth to highlight that the size of these results are economically significant, considering that the average quarterly amount of lending to household is 1455 billions of Euro for the countries considered in the sample.

Table 1: Panel regression results

VARIABLES	(1) HH lending	(2) HH lending	(3) HH lending	(4) HH lending	(5) HH lending	(6) HH lending
Real estate conc.#Domestic sov. debt		4,310***	1,040*	1,971***	1,781***	1,665***
		(701.5)	(555.3)	(549.2)	(450.2)	(462.2)
Domestic sov. debt	-428.4*	-8,674***	-1,538	-4,397***	-4,151***	-4,629***
	(257.5)	(1,332)	(1,080)	(1,040)	(892.6)	(913.3)
Real estate wealth concentration		-1,119***	-595.7***	-646.6***	-722.2***	-634.3***
		(175.0)	(124.9)	(133.5)	(101.1)	(107.4)
Average real estate wealth				-5.262***	-3.518***	-2.696***
				(0.474)	(0.351)	(0.386)
GDP growth				-2.964	1.406	12.62
				(14.54)	(10.04)	(11.13)
Consumer confidence index				-57.96***	-26.84***	-9.932
				(9.242)	(6.515)	(7.179)
VIX index				-0.502	-2.663***	-10.00
				(1.338)	(0.936)	(30.40)
Short term int. rate				-1.180	-17.16*	-185.1
				(13.09)	(9.353)	(202.3)
Long term int. rate				-15.90***	-4.221	13.21***
				(5.152)	(3.653)	(3.915)
Borrowing cost				-151.4***	-85.89***	25.20
				(17.03)	(12.17)	(16.04)
Real house prices				7.689***	2.615***	3.628***
				(0.843)	(0.631)	(0.686)
Banks leverage			-1.930***		3.096***	5.349***
			(0.658)		(0.616)	(0.583)
Banks liquidity			0.000471***		0.000354***	0.000302***
			(1.64e-05)		(1.53e-05)	(1.49e-05)
Banks profitability			-0.00136**		0.00202***	0.00510***
			(0.000614)		(0.000545)	(0.000552)
Constant	1,538***	3,655***	1,715***	9,265***	5,705***	3,801***
	(50.93)	(335.3)	(244.9)	(965.2)	(683.9)	(850.6)
Observations	612	612	612	612	612	612
R-squared	0.005	0.072	0.614	0.495	0.761	0.833
Controls			✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Time FE						✓

Note: *The dependent variable HH lending represents the quarterly lending to households in billions of Euro. The regressor of interest is the interaction between a measure of real estate concentration and the share of public debt held by domestic banks. A more detailed description of the controls used for this panel regression can be found in the Appendix. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*

Figure 4: Margins plot



Note: *The y-axis indicates the predicted change in lending to households (in billions of Euro). The x-axis represents the share of sovereign debt held by domestic banks. The three colored lines indicate three different levels of real estate concentration and the colored shadows are the 95% confidence interval of the estimates.*

This result stems from various mechanisms at play. Therefore, in the next section we present a general equilibrium theoretical model that is functional to understand the mechanisms behind the interaction between real estate concentration and domestic sovereign debt holdings of banks with household lending.

3 Model description

Our model environment features heterogeneous households, a domestic banking sector and the government. We assume a closed economy in financial autarky, representing an absence of demand for domestic debt from foreign institutions.[8]. We consider heterogeneous agents, *savers* and *borrowers*, who ex-ante differ in their personal discount factor ($\beta^b < \beta^s$), their investment opportunities and their preferences weights for housing and leisure. Savers work, save in deposits or in housing stock, consume a final good and get utility from housing services. Borrowers work, save only in housing stock, consume a final good and get utility from housing services. Due to financial frictions, they are credit constrained and can borrow from the banks up to a certain proportion of the value of the

[8]This can be seen as an extreme case of the dry out of foreign investments in sovereign debt, which took place in some European countries (as Italy, Greece and Spain) during the sovereign debt crisis of 2011.

housing stock they own. Banks maximize their net income and dividends and can invest in private or long term public debt. The interest rate on government bonds depends only on the domestic bond markets. Finally, the government finances its expenditures through taxation and sovereign debt and we assume that government bonds are only held by domestic banks.

3.1 Households & production

A share ν of the population is composed by borrowers and a share $1-\nu$ is composed by savers.

Savers. Savers maximize utility from consumption, housing and leisure:

$$U(C_t^s, H_t^s, N_t^s, d_t) = E_0 \sum_{t=0}^{\infty} \beta_s^t \left\{ \log(C_t^s) + j_h^s \log(H_t^s) + \xi^s \log(1 - N_t^s) \right\} \tag{1}$$

where j_h and ξ represent the utility weight of housing and leisure respectively, subject to the budget constraint:

$$(1+\tau_c)C_t^s + P_t H_t^s + d_t = P_t H_{t-1}^s + R_{dt} d_{t-1} + (1-\tau_N) N_t^s w_t^s + \delta \frac{C_t^b}{(1-\nu)} \tag{2}$$

where d_t denotes deposits in the bank, w_t^s denotes the savers' wage, P_t is the price of housing and C_t^b represents the aggregate bank wealth which is rebated in share δ to the savers as dividends. The terms τ_c and τ_N are consumption and labor income tax rates respectively.

Borrowers. Borrowers maximize utility consumption, housing and leisure:

$$U(C_t^e, H_t^e, N_t^e, m_t) = E_0 \sum_{t=0}^{\infty} \beta_e^t \left\{ \log(C_t^e) + j_h^e \log(H_t^e) + \xi^e \log(1 - N_t^e) \right\} \tag{3}$$

subject to the budget constraint:

$$(1+\tau_c)C_t^e + P_t H_t^e + m_{t-1} R_{m,t-1} = P_t H_{t-1}^e + m_t + (1-\tau_N) N_t^e w_t^e \tag{4}$$

where m_t denotes the mortgage of an individual borrower, $R_{m,t}$ the cost of mortgage. Borrowers are also subject to a credit constraint which depends proportionally on the value of the owned housing stock:

$$R_{m,t} m_t \leq \chi P_t H_t^e \tag{5}$$

where χ represents the exogenous loan-to-value (LTV) ratio.

Firms. Labor supply of borrowers and savers is combined to produce output, under perfect competition. The production technology reads:

$$Y_t = z\{\gamma(\nu N_t^e)^\sigma + (1-\gamma)((1-\nu)N_t^s)^\sigma\}^{\frac{1}{\sigma}} \tag{6}$$

where z represents total factor productivity, σ denotes the inverse of output elasticity to each type of labor and γ is the share of labor from borrowers used in the production.

3.2 Banks

Banks receives aggregate deposits D_t from savers, which pay a gross return $R_{d,t}$ and lend to borrowers at a gross return $R_{m,t}$, through a mortgage contract. Banks can also invest in long-term government bonds, B_t. Each period banks choose government debt, B_t, deposits, d_t, mortgages, m_t. The banks' problem reads:

$$\max_{\{C_t^b, B_t, D_t, M_t, R_{Bt}\}} \sum_{t=0}^{\infty} \beta_b^t \log(C_t^b) + s_t \Theta \log(B_t^n) \tag{7}$$

C_t^b is the residual income of the banker after depositors have been repaid and loans have been issued as well as income from expiring sovereign debt has been received. A share of this income equal to δ is redistributed as dividends. The term s_t represents a *moral suasion shock* in the spirit of Smets and Wouters (2007) and Fisher (2015) risk premium shock. Our shock consists in a increase in sovereign bonds demand by banks, induced by the government and it follows the AR(1) process:

$$s_t = (1-\rho_s) + \rho_s s_{t-1} + \varepsilon_s \tag{8}$$

Banks are subject to the budget constraint:

$$(1+\tau_C)C_t^b + R_{d,t}D_{t-1} + M_t + B_t^n = D_t + R_{mt-1}M_{t-1} + (R_{Bt-1} - 1 + \alpha)B_{t-1} \tag{9}$$

where M_t represents the aggregate mortgage, D_t aggregate deposits and B_t the stock of long-term sovereign bonds and B_t^n is the stock of newly issued bonds. Banks are constrained so that the liquidity they can invest in government bonds and mortgage loans is limited by the amount of deposits received by the savers. The banks' collateral constraint reads:

$$D_t \leq \psi[M_t + B_t] \tag{10}$$

where ψ regulates the ratio between banks assets (mortgages and sovereign securities) and liabilities (deposits), Banks face also a *regulatory constraint* (omitted in the baseline

results and re-introduced later on):

$$B_t \geq \phi(M_t + B_t) \tag{11}$$

where ϕ regulates the ratio of government bonds on total assets. The financial repression constraint represents all those explicit or implicit policies that require banks to hold a certain proportion of their assets as government bonds.[9]

3.3 Government & sovereign debt

The government finances an exogenous stream of public spending $\bar{G}$ with taxes on labor and consumption, and by selling government debt to the banks. The government can issue a long-term stochastic bond expiring with probability α and average maturity $1/\alpha$, with gross return of R_{Bt} and balances the following budget constraint:

$$\bar{G} + (R_{Bt-1} - 1 + \alpha)B_{t-1} = B_t^n + T_t \tag{12}$$

The long-term government debt held in portfolio by domestic banks is denoted with B_t. The total stock of bonds evolves according to:

$$B_t = (1 - \alpha)B_{t-1} + B_t^n \tag{13}$$

where B_t^n represents the new issuance of debt. As in Krause and Moyen (2016) the average bond return can be written in the following recursive form:

$$(R_{Bt} - 1)B_t = (1 - \alpha)(R_{B,t-1} - 1)B_{t-1} + (R_{B,t-1}^n - 1)B_t^n \tag{14}$$

where the return on newly issued bonds is denoted as $R_{B,t-1}^n$ and it is determined by the optimality conditions in relation to the other banks' investment opportunities.
The tax revenues are defined as:

$$T_t = \tau_N[(1 - \nu)w_t^s N_t^s + \nu(w_t^e N_t^e)] + \tau_C C_t \tag{15}$$

and consumption tax is paid by all agents including banks before dividends redistribution.

[9] Evidences of financial repression in practice have been discussed by Chari et al. (2019).

3.4 Aggregation and clearing.

Finally, aggregates of consumption, housing stock, deposits and loans are:

$$C_t = (1-\nu)C_t^s + \nu C_t^e + C_t^b$$
$$H_t = (1-\nu)H_t^s + \nu H_t^e$$
$$D_t = (1-\nu)d_t$$
$$M_t = \nu \times m_t$$

Note that the housing stock is exogenous and constant in every period $H_t = \bar{H}$. The resource constraint of the economy reads:

$$Y_t = (1-\nu)C_t^s + \nu C_t^e + (1-\delta)C_t^b + \bar{G} \tag{16}$$

4 Parametrization

We solve the model using second-order perturbation method.[10] As baseline calibration we consider the case when borrowers' borrowing constraint is always binding and the regulatory constraint for banks does not bind. We later consider the case with both constraints always binding to extend our analysis to macroprudential regulation. Our parametrization is based mainly on European countries and USA, reflecting the empirical evidence provided in the motivation section.[11] The parameter values and descriptions are summarized in Table 3. The model is quarterly and the discount factors for savers, borrowers and banks are set such that the yield between returns from deposits and returns from mortgages is about two percentage points in the long-run, as in Iacoviello (2015). To obtain this result in steady state, we set β_s (discounting factor for savers) at 0.9832, β_e (discounting factor for borrowers) at 0.94 and β_b (discounting factor for banks) at 0.9456.

With respect to the households' part of the model, the parameter related to preference for housing, j_h is set equal to 1.2 for savers and 0.07 borrowers, to obtain a household debt to GDP ratio of 0.58 in steady state, in line with the IMF's estimates for the European countries considered in the empirical motivation. Housing depreciation is set to 0, following Iacoviello (2005). The parameter ξ regulates the disutility from working and it is set to 4.15 for savers and 2.4 for borrowers, implying about 7/24 hours spent at work by the borrowers and about 5/24 hours spent by the savers, in line with the empirical evidence reported by Bluwstein et al. (2018), which suggests that borrowers work more hours than savers. The baseline share of borrowers is set equal to 45%, similar to the value indicated by Elenev et al. (2016). To study the role of housing in the sovereign risk

[10] The model is solved using DYNARE version 4.5.7.

[11] As shown by Ongena et al. (2019) and Reinhart and Sbrancia (2015), the phenomenon of moral suasion from governments towards domestic banks is not limited to only one region or country.

transmission we consider also a scenario with a lower share of borrower, with ν equal to 0.25, closer to southern European countries (see HFCN (2016)) and a case with a higher share of borrowers and ν set to 0.6, closer to US, as shown by Justiniano et al. (2015). The loan to value ratio is set to 0.8, in line with with existing literature (see Iacoviello (2005), Iacoviello and Pavan (2013)). We set an inverse elasticity of labor supply equal to 0.99, that is an average value in macroeconomic models, given the absence of any sort of labor market frictions or wage rigidities. Finally, we set the total factor productivity z to obtain an households consumption to GDP ratio of 0.67, in line with the OECD estimates for Europe.

With respect to the banking sector, we set the parameter regulating banks' preference for government bonds equal to 0.05 to obtain a debt to GDP ratio of 1.08 in steady state, which is in line with the average level of government debt to GDP ratio in the European Union, according to the OECD, during the sovereign debt crisis. The dividends paid every period from banks to the savers are equal to the 35% of bank's wealth, considering a 75% of operative costs for the financial sector. The parameter which governs the level of collateral constraint of banks, ψ is set to 0.6, to obtain a capital asset ratio for bank of 0.8, in line with the evidence from World Bank data for Europe. Finally, ϕ, the parameter which determines the level of financial repression is set to 0.6, to represent a not negligible distortion imposed by the regulation.

The parameters related to the government sector are calibrated to match specific ratios in steady state or are based on data evidence. In particular, the parameter regulating unproductive government expenses is set to 0.045, leading to a government expenditure in steady state of 31% of GDP. Tax rate on consumption is set equal 20%, in line with the average VAT rate in Europe. Tax rate on labor income is also set to 20% similar to Asimakopoulos and Asimakopoulos (2019), based on data from European Commission ECFIN. Finally, the percentage of sovereign debt maturing every period, α, is set to 0.116, corresponding to an average maturity of 8.6 years, in line with the estimates of Krause and Moyen (2016) for Europe.

Table 2 reports relevant ratios produced using different calibrations for the share of borrowers: 0.45 for the baseline, 0.25 for the low and 0.6 for the high one.

Table 2: Notable ratios - With different shares of borrowers

Ratios	***Share=0.45***	*Share=0.25*	*Share=0.6*
Government debt to GDP ratio	1.08	0.54	1.47
Household debt to GDP ratio	0.58	0.34	0.75
Household consumption to GDP ratio	0.67	0.67	0.67
Government expenditure to GDP ratio	0.31	0.32	0.3

Table 3: Parameter Values - baseline calibration

Param.	Value	Description
Households and production		
β^s	0.9832	Time discount factor - savers
β^e	0.94	Time discount factor - borrowers
β^b	0.9456	Time discount factor - banks
ξ^h	4.15	Disutility weight of labor - savers
ξ^e	2.4	Disutility weight of labor - borrowers
j_h^s	1.2	Utility weight for housing services - saver
j_h^e	0.07	Utility weight for housing services - borrower
ν	0.45	Baseline share of borrowers in the economy
χ	0.8	Loan to value ratio
γ	0.4543	Share of borrowers' labor in production
σ	0.99	Inv. elasticity of labor substitution
z	1.25	Total factor productivity
Banks		
Θ	0.05	Banks' preference for bonds
δ	0.35	Share of net worth redistributed/dividend
ψ	0.6	Liabilities to assets ratio for banks
ϕ	0.6	Financial repression parameter
Government		
α	0.116	% of sovereign debt maturing each period
τ_N	0.2	Tax on labor
τ_C	0.2	Tax on consumption
$\bar{G}$	0.045	Exogenous government expenditure
Exogenous shock		
σ_s	0.046	Std. deviation of moral suasion shock
ρ_s	0.85	Persistence of moral suasion shock

5 Results

5.1 Baseline experiment

Our baseline experiment considers the impact of a sovereign bond preference shock of 2.5pp, which correspond to an increase of 0.7% in terms of demand for government bond, in an economy populated by the 45% of borrowers and the 55% of savers. This shock generates a rise in the ratio of domestic sovereign bonds on banks' total asset by about 5.6% in the first quarter after the shock.[12] This demand shock represents all the informal types of pressure that a government can make to its domestic banks to ensure the allocation of sovereign debt.[13] The aim of this intervention is to increase the demand

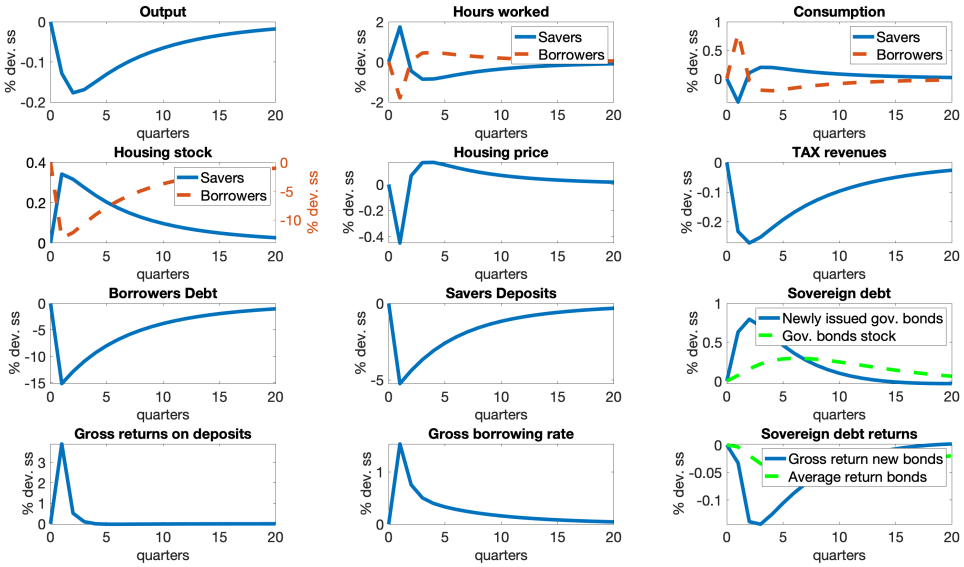
[12]This is in line with the about 5% increase in the average holdings of domestic sovereign securities over total assets for 47 domestic banks in five Euro area countries (Greece, Ireland, Italy, Portugal, and Spain) between September 2010 and January 2011 as per Figure 3 in Ongena et al. (2019)

[13]Moral suasion denotes the pressure of governments on domestic financial institutions to guarantee sovereign securities allocations: example of this behavior are fiscally stressed countries during the European sovereign debt crisis in the Euro periphery (see Ongena et al. (2019)), but also in other countries (see Dotsis (2019)).

for public debt to limit the increases in the risk premium. We constructed this shock following the interpretation of Smets and Wouters (2003) shock made by Fisher (2015), as a positive demand shock for government securities.

Figure 5, shows that the shock on impact induces an increase in the demand of newly issued government bonds higher than the increase in supply, which lowers the gross return on public debt.[14] As banks reallocate their portfolio towards public debt borrowers' loans decrease by about 15%. This crowding out of banks' household lending limits the housing demand of borrowers, whose housing stock drops 10% lowering housing prices by 0.4% on impact. Lower housing in borrowers' utility is compensated by an initial increase in consumption and reduction in labor supply. The investment opportunity created by low housing prices induces savers to increase their housing demand. Savers reduce their deposits by 5% to invest in housing stock inducing banks to increase deposits' return by about 3.5%, to stimulate deposits' provision. Deposits are in fact the main source of liquidity for the financial sector, giving savers' investment decisions a pivotal role for the credit provision in the economy. The movement in deposits' return is associated with a co-movement of mortgages' rate, due to the collateral constraint of banks. This phenomenon increases the cost of borrowing for borrowers by 1.5%, further decreasing their housing demand. The changes in labor supply indirectly lower tax revenues and output, with the latter falling by 0.18%.

Figure 5: Model dynamics under baseline calibration



Note: *Impulse response functions for the main variables of interest of the model, given a suasion shock of 2.5pp. The share of borrowers is equal to the baseline case (0.45) and the collateral constraint of banks is binding while the regulatory constraint is not binding.*

[14]The newly issued sovereign bond return to fall by 0.15%.

5.2 The role of housing wealth

To evaluate the role of housing wealth concentration, we compare the impact of the same shock analyzed in the previous section on economies with different shares of borrowers. We consider our baseline calibration with 45% of borrower, which is representative of the Euro Area, a case with 25% of borrowers that is consistent with southern European countries, and a case with 60% of borrowers which is closer to what the literature has found for USA.

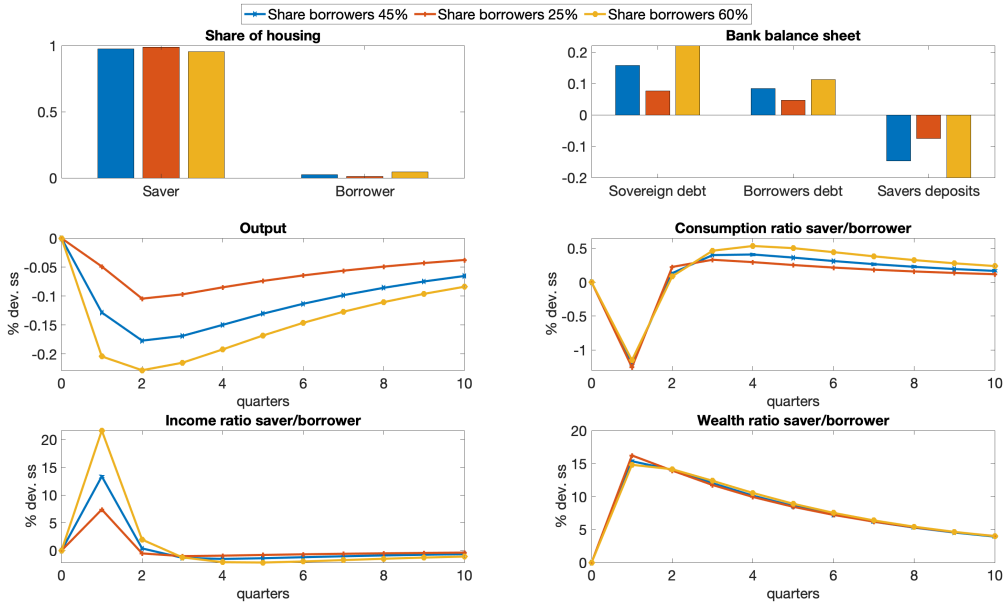
The first panel of Figure 6 shows, with reference to the steady state, that an economy with more borrower and less savers is characterized by more concentration in real estate wealth and therefore a higher degree of wealth inequality. Fewer savers translates (as shown in the top right panel) into larger banks' deposits. Since deposits constitute the source of liquidity of the financial sector, the way savers' investments changes with housing wealth concentration has an impact on banks' balance sheets and on lending to borrowers. However, with lower real estate concentration and hence deposits the borrowing possibilities of the credit constrained households are reduced, limiting their possibility to smooth consumption over the business cycle. In a way, the economy is characterized by trade-off forces between the lending liquidity granted by the presence of a certain degree of inequality in real estate and a more equitable distribution of illiquid wealth.

We now abandon the static perspective and look at when the moral suasion shock occurs in Figure 7. With less savers and more wealth concentration the initial deposit stock of is larger and hence a smaller reduction in deposits is needed to accommodate the higher debt demand arising from the shock with consequent smaller increase in the deposits returns. Richer (fewer) savers reduce their deposits less and their consumption more while they increase their housing ownership more. Also as more credit is available borrowers reduce less their housing stock at the expenses of smaller increases in consumption.

As a consequence, in the second panel of Figure 6 we see that a suasion shock increases income inequality more (due to higher exposure to deposits returns for savers) which translates into persistent wealth inequality rather than consumption inequality, that is instead temporarily lowered. The temporary rise in overall wealth inequality is weaker the more concentrated the real estate wealth is.

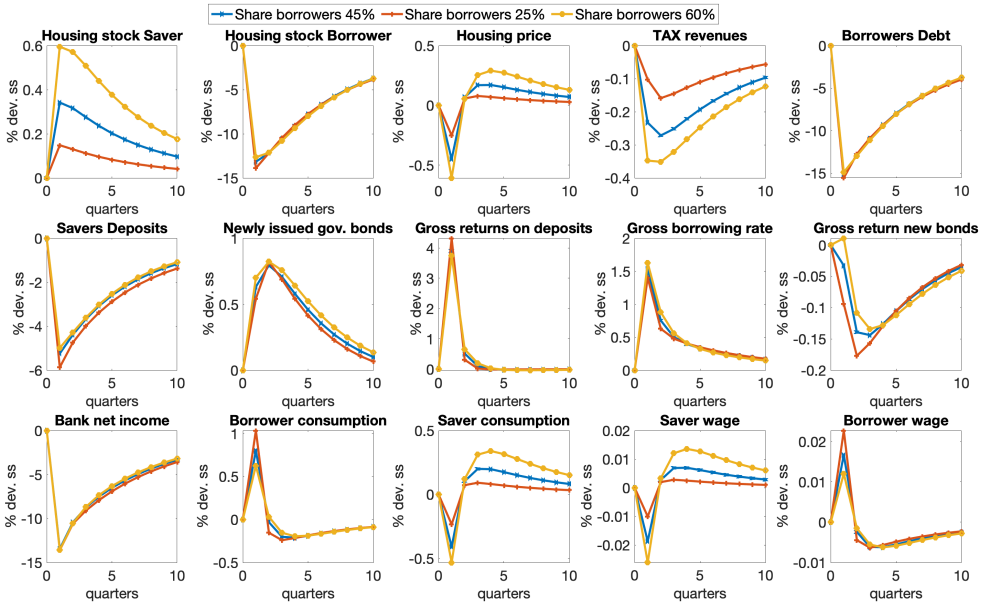
A country characterized by high debt to GDP ratio wanting to lower the financing cost of the domestic debt in a time of dry out of international financial markets has in moral suasion a viable option that lowers consumption inequality while increasing wealth inequality. However, at higher level of concentration of the real estate wealth the consumption inequality will diminish less while overall wealth inequality will increase less.

Figure 6: Model dynamics under baseline calibration



Note: *The first two panels show steady state properties for different shares of borrower: the first panel represents the housing share held by each type of agent. The second panel represents banks' asset side (government and private debt) and liabilities side (deposits). The other panels represents model's outcome variables for different shares of borrowers: output; the ratio savers/borrowers consumption (measuring consumption inequality), the ratio savers/borrowers income (saver's income is composed by dividend income, return from deposits and labor income net of taxes; borrower's income is composed by labor income net of taxes); the ratio savers/borrowers wealth (saver's wealth includes housing wealth and deposits; borrowers' wealth includes housing wealth). The regulatory constraint is not binding.*

Figure 7: Model dynamics with different shares of borrowers



Note: *Comparison of impulse response functions, with different shares of borrowers, for the main variables of interest of the model, given a suasion shock of 2.5pp. The collateral constraint of banks is binding and the regulatory constraint is not binding.*

6 The role of macroprudential policy

6.1 A regulatory constraint on banks' assets

There are several motivations behind banks' holding of sovereign debt (including home-bias, moral suasion and regulatory arbitrage[15]). While moral suasion in our framework is modeled as a shock that does not have permanent character, the regulatory aspect is permanent and modeled as an always binding constraint.[16] Financial institutions have increasingly been subject to capital requirements and regulation with the purpose of lowering dangerous risk build-ups. The regulatory arbitrage motive is generated in response to regulation since Basel II, featuring a zero-risk weight for sovereign debt holdings (see Hannoun (2011)).

In this section, we look at the case of a moral suasion shock occurring in an economy subject to an always binding regulatory constraint represented by equation (11). This constraint's tightness depends on the parameter ϕ and imposes that the bank's assets are composed by a ϕ ratio of sovereign bonds. As this constraint binds, a shock increasing the banks' sovereign bonds holdings will have to be accompanied by a higher supply of private credit in order to keep the share of sovereign bond holdings unchanged.[17] From Figure 8,

[15] See Acharya and Steffen (2015), with particular reference to the European case

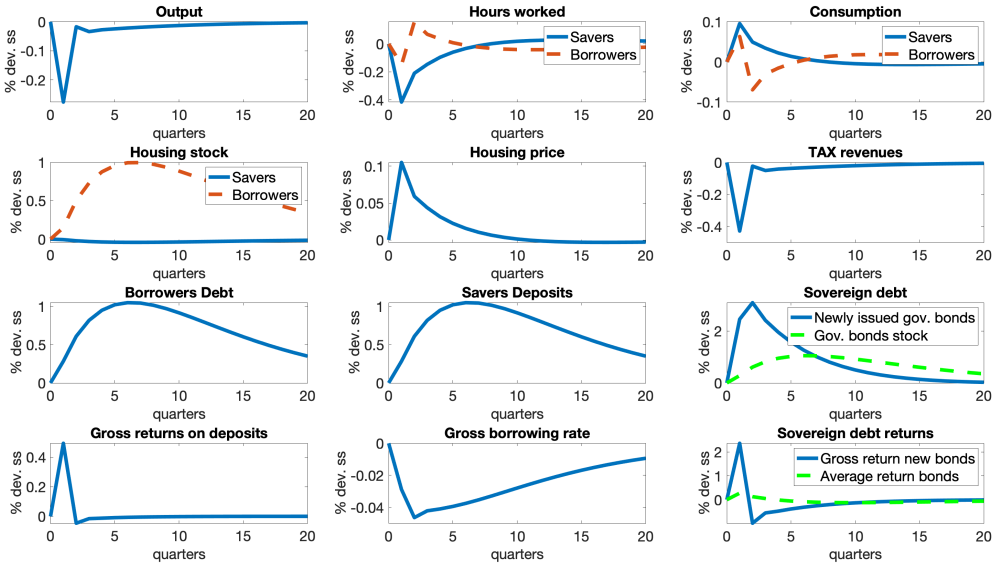
[16] This constraint is designed in the fashion of Chari et al. (2019), while it is worth mentioning that via implementing a separate suasion shock we distinguish between a temporary and a permanent dimension.

[17] In the context of our model the regulatory constraint is always binding. This is in line with the case

we observe a persistently higher supply of household debt by 1% associated with a lower cost of borrowing by 0.04% and an increased demand for housing from the borrowers by 1% and a rise in housing prices by 0.1%. This increased size of the bank's balance sheet comes with a raised demand for deposits followed by higher deposits' returns for the savers. Savers will work less and consume more. Borrowers initially also work less and consume more, but this reverses as their indebtedness rises. It is worth noticing that, differently from a moral suasion shock in absence of regulation, the pubic debt issued is now higher (rising by about almost 3%) as well as the return on newly issued bonds that rises by more than 2%. The rise in supply of sovereign debt is higher than the rise in demand due to lower tax revenues and deeper (but shorter) recession than in the case without regulation (with output dropping by 0.3%). The worse recession is induced in turn by a worse drop in banks residual income, that reduces both the bank consumption and the savers' dividends.

In presence of regulation, moral suasion generates crowding in of household borrowing, while it generates higher financing costs for the government as well as worse aggregate recession due to savers' and banks' losses.

Figure 8: Model dynamics under baseline calibration



Note: *Impulse response functions for the main variables of interest of the model, given a suasion shock of 2.5pp. The share of borrowers is equal to the baseline case (0.45) and the collateral constraint of banks is binding as well as the regulatory constraint.*

We now discuss alternative scenarios for the population composition under regulation. An economy with a higher share of borrowers is characterized by larger individual

in which the bank complies with regulation, and does not hold a higher share of bonds. Regulation on banks holdings of sovereign debt as ratio of total asset have been a largely discussed part of the debate around regulation and a worrisome dimension in light of the deterioration of some Euro area periphery countries positions in the past decade. We offer sensitivity analysis to this parameter in section 6.2.

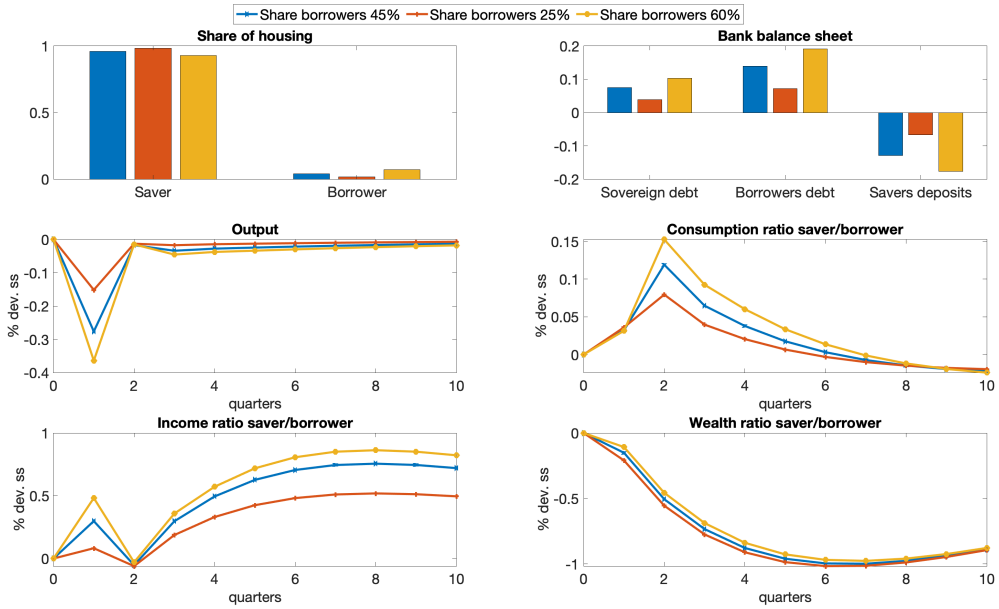
deposits in steady state which accounts for a larger amount of aggregate deposits (see second panel of Figure 9). The impact of the shock in this context, co-moving bank's assets in both bond and, due to regulation, mortgages and demanding for higher deposits, require less pressure on returns deposits in a world with a smaller share of savers and lowers further the cost of borrowing (see Figure 14 in Appendix B.2). furthermore, the economy experiences a higher rise in housing prices due to that a higher share of borrowers will be demanding housing.[18] This rise is possible due to the increased credit supply imposed by the regulation constraint that prevents a fall in deposits. In addition, while the share of savers is lower their overall saving in deposits will be higher and hence the economy will be able to accommodate the higher demand of sovereign debt without a rise in the once government debt returns (see Figure 14 in Appendix B.2).

From the lower panels of Figure 9, higher housing wealth concentration (with less savers) in the initial steady state is associated with increased income inequality and consumption inequality. This is explained by reduced labor income for borrower and increased deposit return income for savers. On the other hand, the increased borrowing opportunity will temporarily reduce the wealth inequality in real estate rising the relative housing stock of borrowers as compared to savers.

While generating losses for financial institutions and failing to reduce government financing costs, moral suasion under regulation can help reducing wealth inequality, however, rising consumption inequality for several periods the more concentrated is the housing wealth.

[18]Even though individual housing of borrower will have to adjust to be slightly lower due to their larger number.

Figure 9: Model dynamics with financial constraint



Note: *The first two panels highlight the steady state properties for different shares of borrower: the first panel represents the housing share held by each type of agent. The second panel represents the composition of the asset side (government and private debt) and liabilities side (deposits) of banks. The rest of the panels represents outcome variables of the model for different shares of borrowers: output; the ratio of savers' consumption to borrowers' (measuring consumption inequality), the ratio of savers to borrowers income (the saver income is composed by dividend income, return from deposits and labor income net of taxes while the borrower income is composed by labor income net of taxes); the ratio savers wealth to borrowers' wealth (where saver wealth include housing wealth and deposits and borrowers' wealth includes housing wealth). In this case the regulatory constraint is binding.*

6.2 Interactions among policy instruments

Our framework highlights the role of real estate concentration for the effect of moral suasion on private lending with temporary implications that feed back into changes consumption, income and wealth inequality both in the case with and without regulation affecting banks' balance sheet. Regulation of the loan-to-value ratio (LTV) is another policy instrument available for controlling borrowing conditions and the level of risk taken by financial institutions. The impact of shocks to LTV ratio or regulation on it has been largely studied by the literature[19], but the interaction with other policy instruments can have relevant implications. In this section, we look at how much the tightness, both in regulation on banks and in the loan-to-value ratio requirement imposed on borrowers, matters for the results.

In Figure 10 a higher value of the parameter ϕ (labeled phib in the figure) implies a higher share of banks' asset that needs to be allocated to sovereign debt. For a given

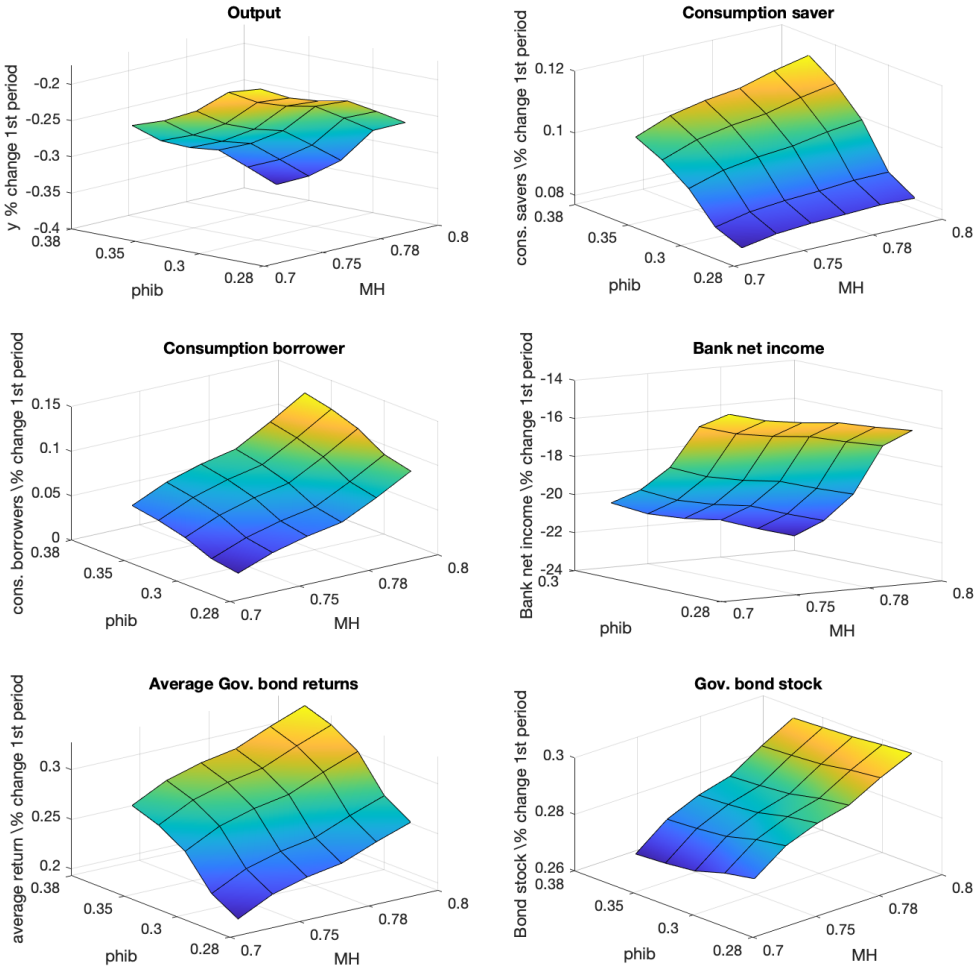
[19]See Iacoviello and Pavan (2013), Buera and Moll (2015), Favilukis et al. (2017).

value of LTV, a moral suasion shock comes with more access to private credit and housing to borrowers and hence higher consumption and slightly lower financial sector worth. In addition the rise in government debt is lower and the return higher at high level of regulation signaling that the constraint's tightness, while ensuring the allocation of debt, also controls its financing cost in the form of returns with higher rise in public borrowing costs the higher values of regulation. The more debt banks have to hold by regulation the smaller the demand hence the more the return on public debt needs to rise to facilitate the allocation.

A higher value of the parameter χ (labeled MH in the figure) is associated with a higher possibility to borrow upfront the value of housing collateral and hence it is associated with a significantly higher consumption for borrowers dampening the output reduction and the consumption inequality. A higher value of LTV is also associated with more household debt demand that due to regulation requires higher amount of debt, hence associated with higher rise in debt stock and hence slightly higher return.

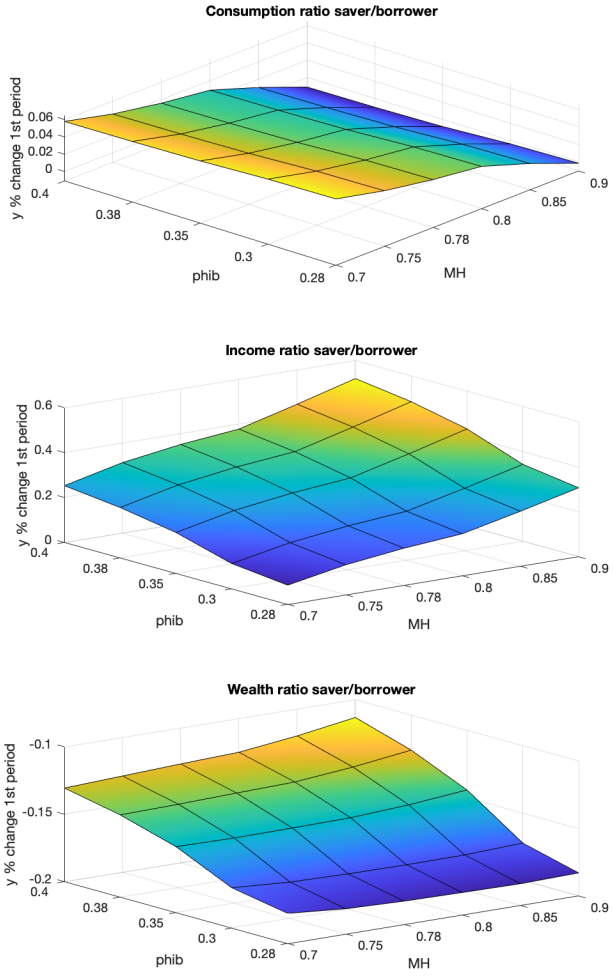
Interestingly, while both savers and borrowers consumption increases more in response to the suasion shock with high regulation, but high LTV parameter, the economy also experiences the biggest drop in output due to the large drop in banks net income. In addition a tighter regulation and more generous LTV that allows indebtedness of households is also associated with more temporary income inequality as shown in Figure 11.

Figure 10: Percentage change after shock with different level of regulation and LTV



Note: *"MH" stands for the model parameter χ LTV ratio: low values of this parameter mean smaller mortgages in relation to collateral. "Phib" stands for the model parameter ϕ: low level of this parameter mean smaller ratio of bonds on total assets.*

Figure 11: Percentage change after shock with different level of regulation and LTV



Note: *"MH" stands for the model parameter χ LTV ratio: low values of this parameter mean smaller mortgages in relation to collateral. "Phib" stands for the model parameter ϕ: low level of this parameter mean smaller ratio of bonds on total assets.*

Our results highlight an interaction between macroprudential regulation and moral suasion which can give rise to counterproductive increases in the financing cost of debt in presence of strict regulation realizing high level of sovereign securities in banks' balance sheet in condition of stringent LTV conditions. For the sake of allocating sovereign debt via suasion on banks we highlight the concrete risk of higher indebtedness for the government. The upside of this is both a higher consumption for households and financial institutions incomes and a temporary lower inequality.

7 Conclusions

In this paper we study the link between housing wealth concentration and the macroeconomic effects of a rise in sovereign debt holding by domestic banks. Using data between 2003 and 2019 for nine European countries, we provide empirical evidence on the relevance of real estate concentration and sovereign debt holding for household lending.

To investigate the mechanism that links government debt and wealth inequality, we build a general equilibrium model with housing and heterogeneous households who differ in their access to investments opportunities. Savers can invest in real estate or save through bank's deposits. The more impatient households instead face an endogenous borrowing constraint proportional to the housing stock owned. The financial sector collects deposits from a part of the population and faces a portfolio decision problem, choosing between investing in sovereign bonds or providing mortgage loans to the borrowers. In this framework, financial frictions operate as transmission mechanism since collateralized debt links sovereign debt with real economy through interest rate and housing prices.

The mechanism of our model speaks to circumstances in which access to foreign liquidity is limited and sovereign debt refinancing puts pressure on the domestic financial sector through *moral suasion*. This situation affects borrowers and lenders in the economy differently, as the more constrained share of the population is pushed towards the *hand to mouth* limit, impacting lending and housing demand from borrowers. A country characterized by high debt to GDP ratio, willing to lower the financing cost of the domestic debt in a time of dry out of international financial markets has in moral suasion a viable option.

We find that the less concentrated is the real estate wealth in the initial steady state, the bigger the consumption inequality drop and the larger the rise in wealth inequality. As we increase the real estate wealth concentration in the economy rising the number of borrowers in the model we observe that with reference to the initial steady state the economy is characterized by larger banks' deposits and the economy is characterized by trade-off forces between liquidity granted by the presence of a certain degree of inequality in real estate and a more equitable distribution of illiquid wealth.

However, under binding capital regulation, moral suasion can help reducing wealth inequality while persistently rising consumption inequality, more the more concentrated is housing wealth. This comes at the cost of generating worse losses for savers and banks, while failing to reduce government financing costs. In this case we also highlight the concrete risk of higher indebtedness for the government, associated with the upside of higher consumption for households and financial institutions incomes and a temporary lower inequality.

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Appendix

The appendix is structured as follows. Section A contains the empirical appendix. Section B is the model appendix. Subsection B.1 describes model's maximization and first-order conditions. Subsection B.2 presents additional result tables and figures from the model.

A Empirical appendix

A.1 Data description

For the panel regression analysis we consider the following countries: *Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Portugal and Spain.* We exclude Ireland from the estimation, due to lack of data. The data used in the empirical motivation section are described below:

- Real estate variables: "Real assets include the value of the household main residence for homeowners, other real estate property, vehicles, valuables (such as jewelry, works of art, antiques, etc.) and value of self-employment businesses. Real estate wealth includes household main residence and other real estate property."

Percentage of households owning real estate assets, *Percentage of households owning households main residence* obtained from Table B1. *Distribution of the value of household main residence* from table B4. Real estate concentration variable used in the regression is obtained from Table B5, Real estate assets' conditional medians breakdown by percentile of the net wealth. In particular, the real estate asset median value (in thousands of Euro) of the 80-90 percentile of the net wealth distribution is divided by the overall median value. Sensitivity is done for the 90-100 percentile. All the previously listed variable are obtained from the Household Finance and Consumer Survey, HFCN (2016) 2017 wave. *Real Housing prices* statistics are obtained from OECD data ("HOUSECOST" series) "The real house price is given by the ratio of nominal price to the consumers' expenditure deflator in each country, both seasonally adjusted, from the OECD national accounts database."

- Domestic sovereign debt. This variable denotes the ratio of domestic sovereign debt in resident banks over the total debt as created in the "Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012)".

- GDP growth: from OECD statistics indicator "QGDP". It represent the quarter-on-quarter growth of real GDP seasonally adjusted.

- Government debt to GDP ratio: from OECD statistics is the ratio between Debt and GDP. As highlighted in OECD (2020), General government debt (indicator). doi: 10.1787/a0528cc2-en "Debt is calculated as the sum of the following liability categories (as applicable): currency and deposits; debt securities, loans; insurance, pensions and standardized guarantee schemes, and other accounts payable."

- Consumer confidence index: this indicator reflects "future developments of households' consumption and saving, based upon answers regarding their expected financial situation, their sentiment about the general economic situation, unemployment and capability of savings. An indicator above 100 signals a boost in the consumers' confidence towards the future economic situation, as a consequence of which they are less prone to save, and more inclined to spend money on major purchases in the next 12 months. Values below 100 indicate a pessimistic attitude towards future developments in the economy, possibly resulting in a tendency to save more and consume less." OECD (2020), Consumer confidence index (CCI) (indicator). doi: 10.1787/46434d78-en

- VIX indicator: Source is CBOE S&P 100 volatility index historical Data. For comparability reasons the old methodology data are used (VXO). The monthly data have been averaged at the quarter level. This variable is real-time market

index that represents the volatility expectations prevailing on the market over the upcoming month. This is a proxy for the level of risk and stress in the market.

- Short-term interest rate: this data is obtained from OECD statistics and refers to the "money market interest rate" i.e. the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government bonds are traded or issued. OECD (2020), Short-term interest rates (indicator). doi: 10.1787/2cc37d77-en

- Long-term interest rate: this data is obtained from the OECD statistics and refers to government bonds maturing in ten years. As the statistic description highlights: "These interest rates are implied by the prices at which the government bonds are traded on financial markets, not the interest rates at which the loans were issued." OECD (2020), Long-term interest rates (indicator). doi: 10.1787/662d712c-en (Accessed on 07 September 2020)

- Cost of borrowing: data source is ECB Statistics "Cost of borrowing for households for house purchase" (excluding revolving loans and overdrafts, convenience and extended credit card debt, Total calculated by weighting the volumes with a moving average (defined for cost of borrowing purposes), New business coverage, Households and non-profit institutions serving households). Monthly data aggregated taking quarterly average.

- Banks liquidity, profitability and leverage: Data source for these variables is ECB Statistics. The measure chosen for *bank profitability* is the "return on asset" for the full sample (All banking groups / stand-alone banks irrespective of their accounting / supervisory reporting framework). The measure chosen to represent *bank liquidity* is the stock of interbank loans in millions Euro from monetary and financial institutions counterparts. The banking sector leverage is obtained from the average of leverage ratio (Total assets / Total equity) observation over the period in aggregate from consolidated banking data.

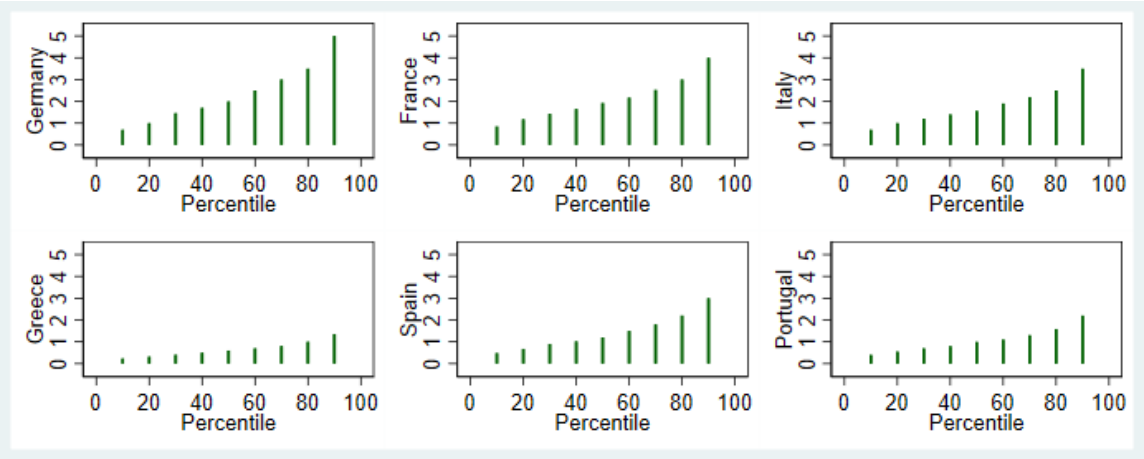
- Bank lending data: obtained from ECB statistics. *Household lending*: includes the monetary and financial institutions stock of credit (loans + debt securities) granted to (domestic) households. *Household lending for housing purchase* includes the monetary and financial institutions stock of loans for house purchase granted to domestic households.

A.2 Additional evidence and robustness checks

Figure 12 shows that households belonging to the top part of the wealth distribution are those with a higher value for the main residence owned. 13 instead,shows how banks'

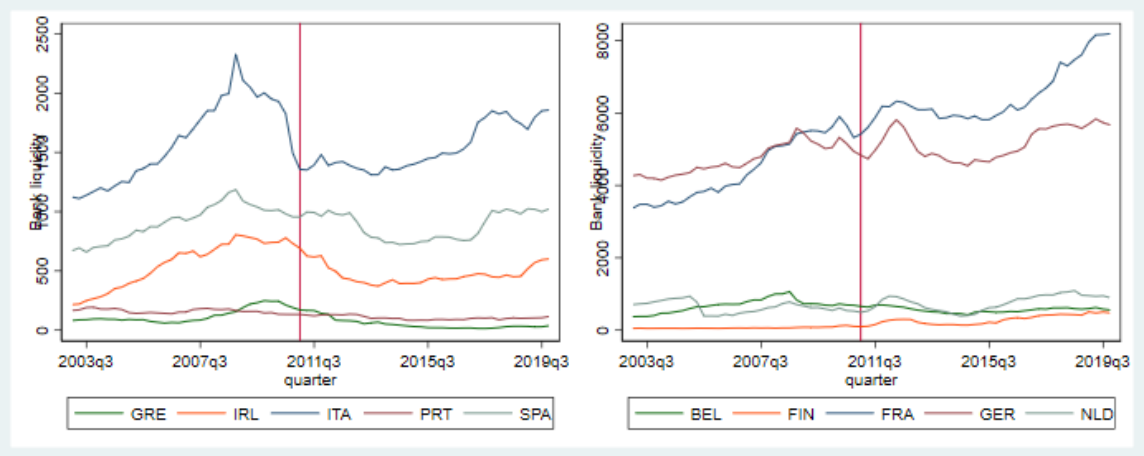
liquidity of selected European countries changed during the sovereign debt crisis of 2011. As we can see, those country directly affected by an increase in government financing cost during the crisis, such as Ireland, Italy and Greece, experienced also a reduction in domestic banks' liquidity. Moreover, also countries not directly affected by the sovereign debt crisis, such as France and Germany, but heavenly financially exposed with the affected countries, experienced a dry out of banks' liquidity.

Figure 12: Distribution of main residence values (by percentile of net wealth)



Note: *Distribution of main household residence value (in thousand of Euro). Source: HFCS*

Figure 13: Bank liquidity measure



Note: *Interbank loans volume (in millions of Euro). Source: ECB - Macroprudential database.*

Table 4: Panel regression results with alternative dependent variable

VARIABLES	(1) Mortgages	(2) Mortgages	(3) Mortgages	(4) Mortgages	(5) Mortgages	(6) Mortgages
Real estate conc.#Domestic sov. debt		4,588***	1,106**	3,023***	1,676***	1,889***
		(648.2)	(486.7)	(492.0)	(407.1)	(436.8)
Domestic sov. debt	-557.0**	-9,307***	-1,759*	-5,983***	-3,150***	-3,904***
	(240.2)	(1,231)	(946.6)	(931.4)	(807.1)	(863.1)
Real estate wealth concentration		-1,160***	-598.7***	-791.7***	-652.2***	-648.3***
		(161.7)	(109.5)	(119.6)	(91.37)	(101.5)
Average real estate wealth				-5.266***	-3.245***	-2.809***
				(0.425)	(0.317)	(0.365)
GDP growth				-16.46	-12.37	-15.73
				(13.03)	(9.079)	(10.51)
Consumer confidence index				-71.98***	-47.36***	-46.90***
				(8.279)	(5.891)	(6.784)
VIX index				-0.811	-3.093***	-10.36
				(1.199)	(0.846)	(28.73)
Short term int. rate				1.379	-1.837	-95.89
				(11.73)	(8.457)	(191.2)
Long term int. rate				-19.06***	-8.793***	6.017
				(4.616)	(3.303)	(3.700)
Borrowing cost				-130.0***	-71.60***	19.02
				(15.26)	(11.01)	(15.16)
Real house prices				10.75***	6.222***	7.676***
				(0.756)	(0.570)	(0.649)
Banks leverage			-2.684***		-0.298	0.866
			(0.577)		(0.557)	(0.551)
Banks liquidity			0.000450***		0.000338***	0.000312***
			(1.44e-05)		(1.39e-05)	(1.41e-05)
Banks profitability			-0.00170***		0.000731	0.00247***
			(0.000539)		(0.000492)	(0.000522)
Constant	1,216***	3,410***	1,444***	10,140***	6,730***	6,523***
	(47.51)	(309.8)	(214.7)	(864.7)	(618.3)	(803.8)
Observations	612	612	612	612	612	612
R-squared	0.009	0.094	0.661	0.536	0.776	0.829
Controls			✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Time FE						✓

Note: *The dependent variable represents the total lending to households for housing in billions of Euro. The regressor of interest is the interaction between real estate concentration and the share of public debt held by domestic banks. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*

Table 5: Panel regression results with alternative real estate distribution measure

VARIABLES	(1) HH lending	(2) HH lending	(3) HH lending	(4) HH lending	(5) HH lending
Real estate conc.#Domestic sov. debt		1,413***	346.5	741.8***	673.4***
		(305.2)	(237.2)	(246.2)	(201.4)
Domestic sov. debt	-428.4*	-4,988***	-501.5	-3,143***	-3,184***
	(257.5)	(1,120)	(880.7)	(911.7)	(777.0)
Real estate wealth concentration		-118.4	-69.38	-125.1**	-203.9***
		(81.91)	(56.30)	(62.56)	(47.10)
Average real estate wealth				-4.914***	-3.195***
				(0.486)	(0.364)
GDP growth				-4.363	-1.300
				(14.77)	(10.46)
Consumer confidence index				-66.85***	-37.61***
				(9.183)	(6.617)
VIX index				-0.452	-2.688***
				(1.352)	(0.970)
Short term int. rate				-5.284	-21.82**
				(13.43)	(9.983)
Long term int. rate				-18.97***	-7.687**
				(5.177)	(3.777)
Borrowing cost				-148.4***	-83.34***
				(17.53)	(12.86)
Real house prices				7.491***	2.468***
				(0.854)	(0.655)
Banks leverage			-1.813***		2.998***
			(0.650)		(0.618)
Banks liquidity			0.000468***		0.000353***
			(1.69e-05)		(1.58e-05)
Banks profitability			-0.00171***		0.00189***
			(0.000637)		(0.000576)
Constant	1,538***	1,957***	837.5***	9,347***	6,125***
	(50.93)	(299.0)	(208.2)	(980.3)	(707.6)
Observations	612	612	612	612	612
R-squared	0.005	0.048	0.590	0.483	0.743
Controls			✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Time FE					✓

Note: *The dependent variable represents the total lending to households in billions of Euro. The regressor of interest is the interaction between an alternative real estate concentration and the share of public debt held by domestic banks. The alternative concentration measure is obtained using the 90-100 percentile for real estate wealth value, instead of the 80-90 percentile. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*

Table 6: Panel regression with alternative dependent variable real estate distribution measure

VARIABLES	(1) Mortgages	(2) Mortgages	(3) Mortgages	(4) Mortgages	(5) Mortgages	(6) Mortgages
Real estate conc.#Domestic sov. debt		1,616***	480.7**	1,323***	834.7***	890.7***
		(282.0)	(208.4)	(219.1)	(180.0)	(183.2)
Domestic sov. debt	-555.2**	-5,896***	-1,145	-4,882***	-2,989***	-3,525***
	(240.0)	(1,035)	(774.4)	(812.2)	(694.9)	(718.4)
Real estate wealth concentration		-176.7**	-111.7**	-221.7***	-218.8***	-198.7***
		(75.75)	(49.54)	(55.75)	(42.15)	(44.78)
Average real estate wealth				-4.825***	-2.928***	-2.206***
				(0.433)	(0.326)	(0.357)
GDP growth				-19.80	-15.62*	-18.25*
				(13.17)	(9.362)	(10.77)
Consumer confidence index				-81.17***	-57.63***	-55.65***
				(8.187)	(5.924)	(6.804)
VIX index				-0.789	-3.179***	-9.280
				(1.205)	(0.869)	(29.31)
Short term int. rate				-7.368	-8.617	-108.7
				(11.98)	(8.938)	(195.0)
Long term int. rate				-22.05***	-12.37***	1.575
				(4.616)	(3.382)	(3.758)
Borrowing cost				-122.1***	-66.13***	20.02
				(15.63)	(11.52)	(15.50)
Real house prices				10.57***	6.080***	7.067***
				(0.761)	(0.586)	(0.653)
Banks leverage			-2.460***		-0.133	1.105**
			(0.572)		(0.553)	(0.551)
Banks liquidity			0.000447***		0.000334***	0.000307***
			(1.49e-05)		(1.41e-05)	(1.42e-05)
Banks profitability			-0.00200***		0.000620	0.00254***
			(0.000561)		(0.000516)	(0.000540)
Constant	1,216***	1,845***	713.0***	10,305***	7,289***	6,844***
	(47.47)	(276.6)	(183.3)	(874.0)	(633.5)	(803.7)
Observations	612	612	612	612	612	612
R-squared	0.009	0.068	0.637	0.530	0.764	0.822
Controls			✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Time FE						✓

Note: *The dependent variable represents the total lending to households for housing in billions of Euro. The regressor of interest is the interaction between an alternative real estate concentration and the share of public debt held by domestic banks. The alternative concentration measure is obtained using the 90-100 percentile for real estate wealth value, instead of the 80-90 percentile. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*

B Model appendix

B.1 Maximization and first-order conditions

The maximization problem for the savers reads:

$$\max_{\{C_t^s, H_t^s, N_t^s, d_t\}} \mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta_s^t \log(C_t^s) + j_h \log(H_t^s) + \xi_s \log(1 - N_t^s)$$

$$+\lambda_t [P_t H_{t-1}^s + R_{dt} d_{t-1} + (1 - \tau_N) N_t^s w_t^s - (1 + \tau_C) C_t^s - P_t H_t^s - d_t + \delta C_t^b$$

The first-order conditions are:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial C_t^s} &\equiv \lambda_t^s = \frac{1}{C_t^s(1+\tau_C)} \\
\frac{\partial \mathcal{L}}{\partial H_t^s} &\equiv \frac{j_h}{H_t^s} - \lambda_t^s P_t + \beta_s^t \lambda_{t+1}^s P_{t+1} = 0 \\
\frac{\partial \mathcal{L}}{\partial N_t^s} &\equiv -\frac{\xi_s}{1-N_t^s} + \lambda_t^s (1-\tau_N) w_t^s = 0 \\
\frac{\partial \mathcal{L}}{\partial d_t} &\equiv \lambda_{t+1}^s \beta_s^t R_{d,t+1} - \lambda_t^s = 0
\end{aligned}$$

The maximization problem for the borrowers/entrepreneurs reads:

$$\max_{\{C_t^e, H_t^e, N_t^e, m_t\}} \mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta_e^t \{\log(C_t^e) + j_h \log(H_{et}) + \xi_e \log(1-N_t^e)$$

$$+\lambda_t^e [P_t H_{t-1}^e + (s_t) + (1-\tau_N) N_t^e w_t^e - (1+\tau_C) C_t^e - P_t H_t^e - s_{t-1}(R_{M,t-1})]$$

$$+\mu_t^{e1} [\chi P_{t+1} \frac{H_t^e}{R_{Mt+1}} - s_t]\}$$

The first-order conditions are:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial C_t^e} &\equiv \lambda_t^e = \frac{1}{C_{et}(1+\tau_C)} \\
\frac{\partial \mathcal{L}}{\partial H_{et}} &\equiv \frac{j_h}{H_t^e} - \lambda_t^e P_t + \frac{\mu_t^{e1} \chi P_{t+1}}{R_{Mt+1}} + \beta_e^t \lambda_{t+1}^e P_{t+1} = 0 \\
\frac{\partial \mathcal{L}}{\partial N_t^e} &\equiv -\frac{\xi_e}{1-N_t^e} + \lambda_t (1-\tau_N) w_t = 0 \\
\frac{\partial \mathcal{L}}{\partial m_t} &\equiv \lambda_t^e - \mu_t^{e1} - \beta_e^t \lambda_{t+1}^e (R_{M,t}) = 0
\end{aligned}$$

The maximization problem for the bank, reads:

$$\max_{\{C_t^b, B_t, d_t, M_t, R_{Bt}\}} \mathcal{L} = \sum_{t=0}^{\infty} \beta_b^t \{\log(C_t^b) + \Theta s_t \log(B_t^n)$$

$$+\lambda_t^b [D_t + (R_{M,t-1}) M_{t-1} + (\alpha + R_{Bt-1} - 1) B_{t-1} - (1+\tau_C)(1-\delta) C_{bt} - R_{dt} D_{t-1} - (M_t) - (B_t - (1-\alpha) B_{t-1})]$$

$$+\mu_t^{b1} [\psi(M_t + B_t) - D_t] + \mu_t^{b2} [B_t - \phi(S_t + B_t)]$$

$$+\mu_t^{b3} [(1-\alpha)(R_{Bt-1} - 1) B_{t-1} + (R_t^n - 1)(B_t - (1-\alpha) B_{t-1}) - (R_{Bt} - 1) B_t]$$

The first-order conditions are:

$$\frac{\partial \mathcal{L}}{\partial C_t^b} \equiv \lambda_t^b = \frac{1}{C_t^b(1+\tau_C)(1-\delta)}$$

$$\frac{\partial \mathcal{L}}{\partial B_t} \equiv \frac{\Theta\sigma_t}{((B_t-(1-\alpha)B_{t-1})} - \beta_t^b \frac{\Theta\sigma_{t+1}(1-\alpha)}{((B_{t+1}-(1-\alpha)B_t)} - \lambda_t^b$$
$$+ \lambda_{t+1}^b \beta_t^b (R_{B,t}) + \mu_t^{b1}\psi + \mu_t^{b2}(1-\phi)$$
$$+ \mu_t^{b3}(i_t^n - R_{B,t} + 1) + \beta_t^b \mu_{t+1}^{b3}((1-\alpha)(R_{B,t}-1) - (R_{t+1}^n - 1)(1-\alpha)) = 0$$

$$\frac{\partial \mathcal{L}}{\partial D_t} \equiv \lambda_t^b - \beta_b^t R_{dt+1} \lambda_{t+1}^b - \mu_t^{b1} = 0$$

$$\frac{\partial \mathcal{L}}{\partial M_t} \equiv -\lambda_t^b + \lambda_{t+1}^b \beta_b^t (R_{M,t}) + \mu_t^{b1}\psi - \mu_t^{b2}(\phi) = 0$$

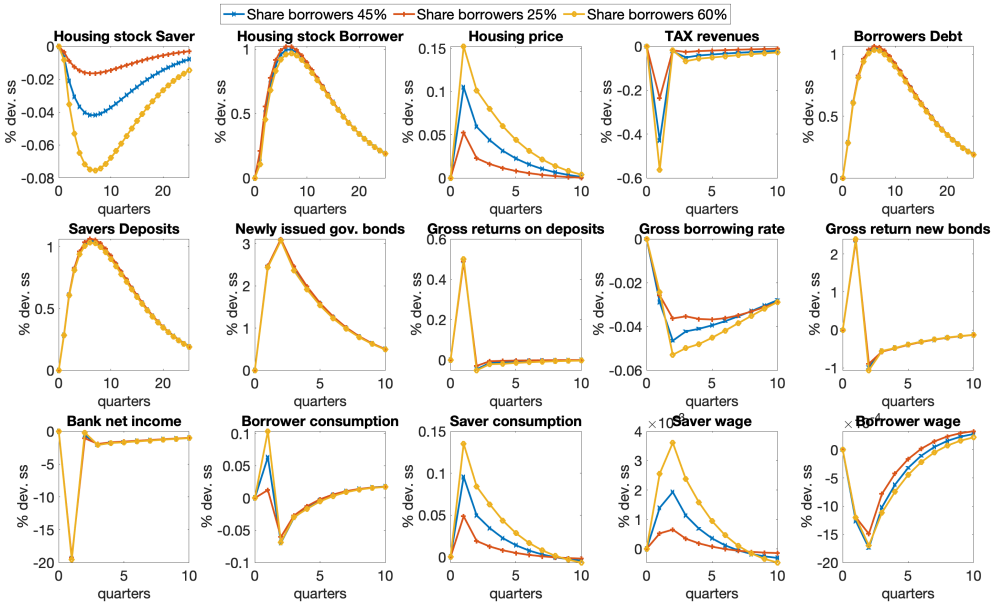
$$\frac{\partial \mathcal{L}}{\partial R_{Bt}} \equiv \beta^b \lambda_{t+1} B_t - \mu_t^{b3} B_t + \beta^b \mu_{t+1}^{b3}(1-\alpha)B_t = 0$$

B.2 Additional result tables and figures

Table 7: Steady state values under alternative borrowers' shares with and without regulation

		No regulation			**Regulation**		
		Low	Baseline	High	Low	Baseline	High
cb	*Bank net income*	0.0022	0.0043	0.006	0.002	0.0038	0.0052
ce	*Consumption borrower*	0.1097	0.1096	0.1097	0.1101	0.1101	0.1102
ch	*Consumption saver*	0.0889	0.0896	0.0908	0.0888	0.0895	0.0905
he	*Housing borrower*	0.0423	0.0563	0.0749	0.0633	0.0895	0.1206
hh	*Housing saver*	1.3192	1.7721	2.3876	1.3122	1.745	2.3191
loe	*Debt borrower*	0.189	0.1889	0.189	0.2893	0.3101	0.3183
LA	*Aggregate borrower debt*	0.0472	0.085	0.1134	0.0723	0.1395	0.191
q	*Housing price*	5.7755	4.3344	3.2589	5.8032	4.3947	3.3445
re	*Cost of borrowing*	1.0333	1.0333	1.0333	1.0167	1.0146	1.0139
rh	*Deposits' return*	1.0171	1.0171	1.0171	1.0171	1.0171	1.0171
rb	*Average bond return*	1.0307	1.0308	1.0308	1.0594	1.0634	1.0647
Rn	*Newly issued bonds return*	1.0307	1.0308	1.0308	1.0594	1.0634	1.0647
wh	*Wage savers*	0.6833	0.6831	0.684	0.6832	0.6831	0.6839
we	*Wage borrowers*	0.5673	0.567	0.5674	0.5674	0.5671	0.5675
nh	*Labor individual saver*	0.1901	0.1834	0.1738	0.1906	0.1847	0.1763
ne	*Labor individual borrower*	0.3039	0.3039	0.3039	0.3016	0.3012	0.301
y	*Output*	0.1405	0.1464	0.151	0.1404	0.1462	0.1507
d	*Deposit saver*	0.0996	0.2657	0.5022	0.089	0.2342	0.4407
B	*Government bond stock*	0.0773	0.1585	0.2214	0.0389	0.0751	0.1028
Bn	*Newly issued government bonds*	0.009	0.0184	0.0257	0.0045	0.0087	0.0119
DAG	*Aggregate deposits*	0.0747	0.1461	0.2009	0.0668	0.1288	0.1763
TAX	*Tax revenues*	0.0474	0.0499	0.0518	0.0473	0.0498	0.0517

Figure 14: Model dynamics with regulatory constraint & different shares of borrowers



Note: Comparison of impulse response functions, with different shares of borrowers, for the main variables of interest of the model, given a suasion shock of 2.5pp. The collateral constraint of banks is binding as well as the regulatory constraint.