Differential Effects of Macroprudential Policy*

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Abstract

We explore the differential effects of lender-based macroprudential policies on new mortgage borrowing for households of different income using a comprehensive dataset that links macroprudential policy actions with household survey data for European Union countries. The main results suggest that higher-income households on average experience a larger reduction in mortgage loan size than lower-income households when regulation targeting total lenders' assets tightens. In contrast, lower-income households on average experience a larger reduction in mortgage loan size than higher-income households when regulation targeting lenders' risk-weighted assets tightens. We also provide evidence of the different channels through which these policies operate.

JEL Classification: G5, E60

Keywords: Household borrowing, macroprudential policy, income distribution

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1 Introduction

Following the Global Financial Crisis (GFC), macroprudential policy has increasingly been advocated by both academics and policymakers as a policy tool to preserve the resilience of the financial system by managing aggregate bank credit and reducing risks to individual financial institutions. As countries started to use macroprudential policy more frequently, interest in its effectiveness has grown. An important open question is whether macroprudential policy affects some segments of the population more than others and if so through what channel. Despite its policy relevance, the literature on this topic is still in its infancy. Recent work by Acharya et al. (2022) and Peydró and Rodriguez-Tous (2020) suggests that lower-income households tend to be affected more by borrower-based macroprudential policy instruments such as limits on loan-to-value (LTV) and loan-to-income (LTI) ratios. But little is known about the differential effects of other types of instruments.

This paper aims to fill this gap by providing one of the first empirical evidence of the differential effects of lender-based macroprudential instruments. Specifically, we examine whether the effect on new mortgage credit varies with household income for two commonly used lender-based instruments: (i) levies/taxes on financial institutions, and (ii) minimum capital requirements.

To do this, we use a comprehensive dataset that links macroprudential policy actions with detailed household survey data on a large sample of European Union (EU) countries. Data for macroprudential policy instruments are from the Macroprudential Policies Evaluation Database (MaPPED), which provides detailed information on macroprudential policy actions in EU countries during 1995-2018.[1] The source of the household survey data is the Household Finance and Consumption Survey (HFCS), coordinated by the European Central Bank (ECB).[2] These two datasets are uniquely suited for our analysis for several reasons. First, the HFCS is the only cross-country household survey with detailed information on household income, assets, liabilities, as well as sociodemographic characteristics, thus allowing us to examine the effects of macroprudential policies on borrowing

[1]The source of the MaPPED dataset is: https://www.ecb.europa.eu/pub/research/working-papers/html/mapped.en.html .

[2]We obtained access to HFCS by following these steps: https://www.ecb.europa.eu/pub/economic-research/research-networks/html/researcher_hfcn.en.html.

outcomes while accounting for a rich set of household characteristics. Second, both the macroprudential policy and household survey datasets are harmonized across countries, thus allowing us to draw evidence from a large sample of countries rather than focusing on a single policy action that took place in one country. Last but not least, the MaPPED dataset provides information on detailed macroprudential policy instruments, thus allowing us to examine the effect of individual instruments and the channels through which they operate.

Examining the effect of individual macroprudential policy instruments as opposed to that of an overarching macroprudential policy index—one that measures macroprudential policy stance comprising all instruments available in a given country at a given time—is preferable because different instruments could operate through different channels, with possibly offsetting effects. As a result, the effect of an overarching macroprudential policy index may disguise the actual effect of individual instruments.

A comparison of the two instruments in our analysis serves to illustrate this point. Let's consider first levies/taxes imposed on financial institutions, which is an instrument that targets the asset size of lenders without explicitly accounting for the risk profiles of the loans in the portfolio. The effect of higher levies/taxes is likely to increase the cost of lending, which lenders may pass on through a higher loan rate. Hence, one channel through which this policy can affect new borrowing is the "cost of lending/borrowing" channel. When borrowing costs increase for all borrowers across the board due to higher levies/taxes, higher-income household may be better able to hedge against higher borrowing costs by getting smaller loans and providing a larger down payment.

On the contrary, the second instrument that we consider, minimum capital requirement, imposes a minimum capital level based on lenders risk-weighted assets. Under Basel III requirements, risk weights for mortgage assets depend on the risk profile of the mortgage loan (measured by LTV).[3] To the extent that a minimum capital requirement is binding, a tightening in the requirement incentivizes lenders to reduce the risk profile

[3]The Basel framework allows banks to choose between two broad methodologies for calculating their risk-based capital requirements for credit risk. One option is to follow the so-called standardized approach (SA), which uses prescribed risk weights to assess bank portfolio risk. An alternative is to use the internal ratings-based (IRB) approach, which allows banks to use their internal rating systems for credit risk. Both approaches use the LTV ratio as an indicator to assess bank asset portfolio risk. In most of the advanced European countries, banks use the IRB method (https://www.bis.org/bcbs/publ/d424_hlsummary.pdf).

of their portfolio by contracting the amount of riskier loans. As a result, this policy could affect new borrowing through the "flight to quality" channel as lenders limit their exposures to risky loans. When minimum capital requirement tightens, the riskier segment of the loan pool, typically held by borrowers with lower income, is likely to obtain smaller loans.

We find that levies/taxes and minimum capital requirement have differential effects on households with different income, consistent with the channels discussed above. We report two main findings. First, higher-income households on average experience a larger mortgage loan reduction than lower-income households when levies/taxes imposed on financial institutions are tightened. This differential effect is driven by higher-income households being able to hedge the increase in the borrowing costs with a larger down payment. Second, lower-income households experience a larger mortgage loan reduction than higher-income households when minimum capital requirement are tightened, consistent with a "flight to quality" channel when lenders limit their exposures to riskier borrowers.

Taken together, our results indicate that these lender-based macroprudential policy instruments could have implications for the households' access to credit across the income distribution and the effects crucially depend on the nature of the instrument. Instruments that limit credit supply without differentiating across borrowers' risk profile could have stronger effects on higher-income households; whereas instruments that take into account borrowers risk profiles could have stronger effects on lower-income households. These results have important policy implications. Evidence on the differential effects of macroprudential policy on households could inform the policy debate surrounding the distributional effects of macroprudential policy. This is related more broadly to ongoing efforts of policymakers in advocating for equitable policy making.

Related literature—Our paper contributes to a nascent literature on the differential effects of macroprudential policy. To the best of our knowledge, we are one of the first to study the differential effect of macroprudential policy across households with different income.

Prior literature on macroprudential policy has mostly focused on its aggregate effects.

Evidence on differential effects is scarce and is often derived indirectly from implications across market segments. One example is Peydró and Rodriguez-Tous (2020), who analyze the effect of a new LTI limit imposed on lenders in the UK in 2014. They find more-constrained lenders issue fewer high-LTI mortgages. Partial substitution by less-constrained lenders leads to overall credit contraction to low-income borrowers in areas that are more exposed to constrained lenders. Another example is Acharya et al. (2022), who study LTV and LTI limits imposed on residential mortgage borrowers in Ireland in 2015. They similarly find a reallocation effect: mortgage loans are reallocated from low- to high-income households and from areas closer to the regulatory limits (typically urban areas) to areas further from the regulatory limits.

These two papers, although closely related, differ from ours in important ways. First, both papers study borrower-based macroprudential policy instruments whereas we focus on lender-based instruments. Second, they examine the differential effects of a one-off macroprudential policy action that takes place in one country. By contrast, we provide systemic evidence of a comprehensive set of macroprudential policy instruments across EU countries. The richness of our sample offers useful evidence on the validity of results spanning across countries and over time. Lastly, both papers offer evidence on an aggregate level (by market and borrower income group) whereas we provide evidence at the household level. The advantage of our approach is that it allows us to distinguish a wide range of household financial conditions and sociodemographic characteristics.

A separate strand of the literature focuses on the effect of macroprudential policy on inequality. Carpantier et al. (2018) and Frost and Stralen (2017) find that LTV requirements are likely to increase wealth inequality. Similarly, GeorgescuDiego and Martín (2021) find that LTV and debt-service-to-income (DSTI) ratios contribute positively to wealth inequality because borrower-based limits exclude some household from the housing market thus affecting their housing wealth. Our paper complements this literature by studying the extent to which the effectiveness of macroprudential policy varies with household income.

More broadly, a growing literature since the GFC examines the effectiveness of macroprudential policy. The main focus of this literature has been the overall effect of macropru-

dential policy as well as heterogeneity across instruments and countries. As summarized by Biljanovska et al. (2022) in an extensive overview of the literature on the effectiveness of macroprudential policies, existing evidence suggest that borrower-based and sectoral instruments (e.g., those targeting lending standards in the housing market) are effective in containing the growth of credit and house prices. . Our paper adds to this literature by showing that the overall effect of macroprudential policy may mask important differential effects across the population. We also provide new micro evidence on the potential channels through which lender-based instruments may affect mortgage credit.

Finally, our paper also relates to the literature studying the distributional effects of monetary policy (Coibion et al. (2017), Kaplan et al. (2018), Auclert (2019), among others). Most of this literature focuses on consumption outcomes and suggests that monetary policy can affect households differently depending on the composition of their balance sheet and employment status. A few papers study credit outcomes. For example, Mian and Sufi (2014)assess the effects of a monetary policy easing on households marginal propensity to borrow home equity loans. They find that households in the lowest quartile of the income distribution benefit more compared to their top 10% counterparts. Dias and Duarte (2022)show that monetary policy affects households homeownership decision and housing tenure.. Our paper complements this literature by providing evidence from macroprudential policies.

The rest of the paper is organized as follows. Section 2 describes our data, measurements, and stylized facts. Section 3 presents our empirical model and results. Section 4 discusses the robustness analysis. Section 5 concludes.

2 Data and measurements

Our analyses links macroprudential policy actions at the country level with household survey data for 21 EU countries. This section discusses the characteristics and challenges of both of these datasets and how we address them.

2.1 Household survey data

Our source of household data is the Household Finance and Consumption Survey (HFCS), coordinated by the ECB. The survey provides rich information on households financial conditions as well as their socioeconomic and demographic characteristics. Data on three survey waves are available. The fieldwork for the first wave took place for most countries in 2010 and 2011 and, for the second wave, between 2013 and the first half of 2015, and for the third wave, in 2017.

We are interested in how macroprudential policy affects newly issued mortgage loans to households. The survey asks each household about the year a mortgage loan was taken (or refinanced) and its amount. The answers to these questions allow us to construct an annual chronology of new mortgage loans for each household. The choice of which years to include in our analysis comes with a trade of sample size and potential measurement error. This is because information on household characteristics, such as household income and household size, are only available for the year of the survey. If we use all the years for which information on new mortgages is available, we need to infer household characteristics for years during which households were not surveyed. If we restrict the analysis to only the year a household was surveyed, we avoid inferring household characteristics, but we will end up with a small sample because only about 3% of households obtained new mortgage loans in each survey wave. We choose a balanced approach by restricting our analysis within three years of a survey. For example, if a household was surveyed in 2015, we only include mortgage loans taken by this household during the period 2012-2015 and use other household characteristics as measured in 2015 throughout this period. The assumption is that household characteristics are unlikely to change in a short period of time. This approach allows us to build a repeated cross-section database with a reasonable size while minimizing potential measurement errors by inferring household characteristics.

2.1.1 Summary statistics

Table 1 provides summary statistics on mortgage loan and household socioeconomic characteristics. Our sample consists of 4,582 observations. The average household income is about 51,000 Euros. The average size of new loans issued to households is about 111,000

Euros. On average, mortgage loan maturity is 19 years; interest rate is 2.8%; and the LTV and down payment are 68.6 and 31.4 percent of property value, respectively. Moreover, 31% of the loans are issued with a variable interest rate; and 27% of the loans in the sample are refinanced loans.

Table 1: Summary Statistics

	Mean	SD
Household Characteristics		
Age	41.49	0.25
No Economically Active in HH	1.71	0.02
HH Gross Income	51040.66	925.43
Gender:		
Male	0.72	
Education:		
At Least some College	0.51	
Employment Status:		
Employed/Self-employed	0.93	
Loan Characteristics		
Initial Amount Borrowed	110564.52	1703.79
Loan-to-Value Ratio	68.55	0.68
Length of Loan at Origination	19.04	0.25
Current Interest Rate	2.78	0.04
Downpayment as % of House Value	31.35	0.72
Rate Type:		
Adjustable	0.33	
Loan Type:		
Refinanced	0.27	0.00
No Obs	4582.00	4582.00

Note: The number of observations is restricted to the regression sample.

Table 2 summarizes the average household income and wealth in each income decile of a country. It is worthwhile noting that higher-income households are over-represented in the HFCS. In our sample, a disproportionately larger proportion of households fall in the 61-100 percentile of the income distribution. In our analysis, survey weights are used to correct for the oversampling of high-income households.

Table 3 summarizes the average LTV, LTI, and DSTI ratios in each income decile. As expected, lower-income households have on average higher LTV, LTI, and DSTI ratios than high-income households. Moreover, all three ratios monotonically increase with households' income.

Table 2: Income and Wealth Distribution

	Gross Income Distribution	Net Wealth Distribution
0% - 10%	0.02	0.03
11% - 20%	0.01	0.03
21% - 30%	0.04	0.07
31% - 40%	0.05	0.13
41% - 50%	0.07	0.13
51% - 60%	0.10	0.17
61% - 70%	0.14	0.13
71% - 80%	0.17	0.11
81% - 90%	0.22	0.11
91% - 100%	0.19	0.08
No Obs	4582.00	4582.00

Note: The number of observations is restricted to the regression sample.

Table 3: Average Ratios by Income Quintile

	LTV	LTI	DSTI
0%-20%	72.2	492.0	27.9
21%-40%	72.2	393.5	23.4
41%-60%	71.6	301.8	18.6
61%-80%	68.3	231.0	14.9
81%-100%	61.6	170.6	11.7
No Obs	4582.0	4480.0	4148.0

Note: The number of observations is restricted to the regression sample.
LTV is the ratio of the mortgage loan amount to the value of the collateral property at the time the mortgage was taken.
LTI is the ratio of the mortgage loan amount to the household's current annual income.
DSTI is the ratio of current yearly payments on the mortgage to current annual income.

2.2 Macroprudential policy data

Many EU countries adopted a wide range of macroprudential measures after the GFC. Unlike monetary policy, which is centralized in the EU, macroprudential measures are introduced at the country level and show much heterogeneity across countries.

Our source for macroprudential policy is the ECBs MaPPED dataset, which provides comprehensive information on macroprudential policy for 28 European Union countries over the period 1995-2018. It includes 11 categories and 53 subcategories of policy instruments. The dataset tracks policy instruments over their "life cycles, with information on the dates of introduction, recalibration, and termination. The direction of each measure is interpreted as tightening, loosening, or ambiguous.[4] In our analysis, we define the measure for macroprudential policy as the number of tightening actions minus loosening actions for each country-year in our sample and for each of the 11 policy categories. Hence, a larger number reflects a tighter macroprudential policy.

2.2.1 Zooming into specific macroprudential policy categories

Now we turn to the specific categories of macroprudential policy instruments available in the MaPPED database. Table 4 presents the total number of loosening (< 0), tightening (> 0), and neutral or no policy action (0) for each category.[5] Similarly, Table 5 shows the shares for each action within the policy category. Table 5 shows that two categories of policy in our sample exhibit most variation: levies/taxes on financial institutions and minimum capital requirement. These two categories account for 40% and 30% percent non-zero actions. Other categories have much less variation, accounting for only about 10% loosening and tightening actions combined.

Our main analysis focuses on these two most commonly used categories—levies/taxes on financial institutions and minimum capital requirements. Studying these two policy categories allows us to compare the channels through which they operate. As we discussed in the introduction, levy/tax on financial institution and minimum capital requirement have different targets. The focuses targets a lenders total assets whereas the latter focuses

[4] In the dataset, about 19 percent of the policy actions are denoted as "ambiguous," which we exclude from our analysis.

[5] The table shows 10 (instead of 11) categories of macroprudential policies because there is no observation for the category "leverage ratio" in our sample.

Table 4: Number of macroprudential policy (MaPP) actions by instrument

	Liqu	Levy	Risk	Capi	Lend	Lcred	Lexp	LL	MinC	Other
<0	21	975	185	53	105	34	122	46	0	91
0	4274	2738	4238	4052	4067	4556	4185	4492	3225	3869
>0	295	877	167	485	418	0	283	52	1365	630
Total	4590	4590	4590	4590	4590	4590	4590	4590	4590	4590

(1) Liqu: Liquidity req. and limits (2) Levy: Levy/tax on financial inst.
(3) Risk: Risk weights (4) Capi: Capital buffers (5) Lend: Lending standards restr.
(6) Lcred: Limits on credit growth and vol. (7) Lexp: Limits on large exp. and concent.
(8) LL: Loan-loss prov. (9) MinC: Minimium cap. req. (10) Other: Other measures

Table 5: Share of macroprudential policy (MaPP) actions by instrument

	Liqu	Levy	Risk	Capi	Lend	Lcred	Lexp	LL	MinC	Other
<0	0.00	0.21	0.04	0.01	0.02	0.01	0.03	0.01	0.00	0.02
0	0.93	0.60	0.92	0.88	0.89	0.99	0.91	0.98	0.70	0.84
>0	0.06	0.19	0.04	0.11	0.09	0.00	0.06	0.01	0.30	0.14
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(1) Liqu: Liquidity req. and limits (2) Levy: Levy/tax on financial inst.
(3) Risk: Risk weights (4) Capi: Capital buffers (5) Lend: Lending standards restr.
(6) Lcred: Limits on credit growth and vol. (7) Lexp: Limits on large exp. and concent.
(8) LL: Loan-loss prov. (9) MinC: Minimium cap. req. (10) Other: Other measures

risk-weighted assets. [6]

Our analysis abstract from other categories of macroprudential instruments for several reasons. First, there is lack of variability in our sample as shown in Table 5. Second, the LTV and LTI limits in the MaPPED dataset do not necessarily target only residential loans of households for house purchases, but they also include regulatory limits for commercial real estate loans and auto loans. Finally, some countries introduced soft while others hard LTV and LTI limits, which, as argued by Tzur-Ilan (2020), affect lending differently.

[6] In the MaPPED dataset, the specific regulations under the same category may vary across time and countries. For example, the following two regulations were introduced in Austria and Cyprus in 2011 and 2013, respectively, both falling under the category of levy/tax on financial institutions: (i) a bank levy was imposed on the total unconsolidated assets less some liability items (Austria),[7] and (ii) a bank levy was imposed on the total amount of deposits (Cyprus).[8] Despite their differences, what these two regulations have in common is that they both target total as opposed to risk-weighted assets. The following two regulations fall under the category of minimal capital requirements in the MaPPED dataset: (i) fully-phased Tier 1 capital ratio of 6% (Portugal, 2014); (ii) the deactivation of the minimum Core Tier 1 ratio of 9% (Greece, 2014). Again, these two regulations are different, but what they have in common is that they both impact the Tier 1 capital ratio, against which banks' risk-weighted assets are compared.

3 Empirical Framework and Results

In this section, we present our empirical framework and discuss the main results.

3.1 Loan amount

We start by examining the size of newly obtained mortgage loans across households. We estimate regression model of the following form

$$Y_{lict} = \alpha H_{ict} + \beta MaPP_{ct} \times IncomeDecile_{it} + \gamma L_l + \lambda_{ct} + \epsilon_{lict}, \quad (1)$$

where l, i, c, and t index loan, household, country, and year, respectively. Our outcome variable of interest, Y, is the amount of newly obtained mortgage credit deflated to 2015 euro.[9] We measure newly obtained mortgage loans based on responses to survey questions on the year the mortgage loan was taken (or refinanced) and its amount. Moreover, we restrict our loan sample to mortgages that are taken to purchase a household's primary residence, using the same property as collateral.[10]

The independent variable H_{ict} is a vector of household socioeconomic and demographic characteristics, including household income (measured by the decile it falls in within a country's income distribution), net wealth (measured by the decile it falls within a country's net wealth distribution), household size (measured by the number of working household members), and the gender, age (in linear and quadratic terms), education, and employment status of the households reference person.[11] (Table 1 and Table 2 provide the summary statistics of these variables). $MaPP_{ct}$ is macroprudential policy action on levy/tax on financial institutions or minimum capital requirements defined in section 2.2. We also control for loan characteristics, L_{ict}, including the loan maturity, and dummy variables for the type of rate (adjustable versus fixed), refinancing (refinanced versus new loan), and high LTV loans (LTV>80). Finally, we include fixed effects, λ_{ct}, at the country×year level. This control accounts for observed and unobserved time varying

[9] We focus on newly obtained credit rather than the stock of mortgage credit because a change in macroprudential policy does not have a direct effect on a household's existing mortgage loans.

[10] We exclude loans that use several properties as collateral because the data do not allow us to track the exact number and value of the properties that were used as collateral. We also exclude loans on second or third properties for two reasons. First, only a few households in our sample own mortgages on properties other than the primary residence. Second, more stringent regulation may apply for second- and/or third- home buyers.

[11] The reference person is either specified by the respondent during the survey, or in case multiple persons are specified, identified at the person owns or rents the home and closest to age 45.

factors at the country level. With this control, our main coefficient of interest is β—the coefficient of the interaction term $MaPP_{ct} \times IncomeDecile_{ict}$—captures the differential effect of macroprudential policy depending on household income. Our identification comes from variations across households within the same country and same year.[12] The sign of β has an intuitive interpretation. If $\beta < 0$, then higher-income households on average experience a larger reduction in mortgage loan size than lower-income households when macroprudential policy tightens ($MaPP_{ct} > 0$). If $\beta > 0$, then lower-income households have on average a larger reduction in mortgage loan size than high-income households when macroprudential policy tightens.

Finally, following the HFCS statistical guidance, we estimate bootstrap standard errors with 1,000 replications using the datasets replicate weight.[13] While this is a computationally intensive exercise, it should provide consistent variance estimates in case of non-smooth statistics such as distribution quantiles.[14]

3.1.1 Results

Table 6 reports the results from regression (1). We only show the coefficient on our main variable of interest β here and report the full regression output in Appendix Table 12. Column 1 reports the result when macroprudential policy is measured by levy/tax on financial institutions; similarly, column 2 reports the results when macroprudential policy is measured by minimum capital requirement.

Table 6: Loans Regression

	(1) New Loan (ln)	(2) New Loan (ln)
Levy/Tax X HH Income	-0.00181**	
	(0.000719)	
Min. Cap. X HH Income		0.00112**
		(0.000488)
Country X Time FE	Yes	Yes
Obs	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[12] Note that the standalone term of $MaPP$ is absorbed by country×year fixed effects. Therefore, we do not estimate the average effect of macroprudential policy on the outcome variable Y.

[13] In the bootstrap procedure, a with-replacement sample of primary sampling units from each stratum is selected. The bootstrap variant is the rescaling bootstrap of Rao and Wu (1988) as specified by Rao, Wu, and Yue (1992).

[14] For detailed discussion, see HFCS User Guide.

We find a significantly negative coefficient on the interaction of levy/tax on financial institutions and household income. This result suggests that higher-income households on average experience a larger reduction in mortgage loan size than lower-income households when the regulation on levy/tax on financial institutions tightens. The magnitude of the coefficient suggests that an increase in household income by one decile is associated with a decrease in the mortgage loan amount by about 0.2 percent when the regulation on levy/tax on financial institutions tightens.

In the case of minimum capital requirements, the coefficient is significantly positive. This result suggests that lower-income households on average experience a larger reduction in mortgage loan size than higher-income households when the minimum capital requirement tightens. The magnitude of the coefficient suggests that an increase in the income of households by one decile is associated with an increase in the mortgage loan amount by about 0.1 percent when the minimum capital requirement tightens.

These results suggest that the two macroprudential policy instruments likely operate through different channels, which we turn to in the next subsection.

As shown in Appendix Table 12, which reports the full regression output, all controls have the expected sign, with the majority of them being statistically significant. Among household controls, loan amount increases with age (although with a hump shape), income, net wealth, and the level of education. Among loan controls, mortgage loan size increases with the maturity of the loan; it is also higher if the loan is used to purchase a new house rather than for refinancing an existing one. The dummy indicating LTV>80 is also positive and significant, which, as expected, suggests that larger loans are characterized by higher LTV ratios.

3.2 Testing the channels

We now turn to testing the potential channels through which the differential effects may operate. We first discuss the channel for levy/tax on financial institutions. We then provide some suggestive evidence for the minimum capital requirement.

3.2.1 Borrowing cost channel

We hypothesize that one channel through which the differential effects operate is by increasing the borrowing cost. In particular, a macroprudential policy tightening that increases the levy/tax on financial institutions makes a large loan portfolio more costly for lenders, which can be passed through as higher loan rates to borrowers. To the extent that higher-income households have more liquidity than lower-income household, they can hedge the higher borrowing costs by substituting a larger loan with a larger down payment.

We test this channel in two steps. First, we estimate the following regression

$$Rate_{lict} = \alpha H_{ict} + \beta MaPP_{ct} + \gamma L_l + \delta GDP_{ct} + \sigma_c + \tau_t + \epsilon_{lict} \tag{2}$$

where $Rate_{lict}$ denotes the loan rate at issuance, GDP_{ct} denotes country level real GDP growth, and σ_c and τ_t denote country and time fixed effects, respectively. Equation (2) differs from (1) in three ways. First, the main variable of interest is levy/tax on financial institution because we would like to understand whether a tightening in this measure is associated with an increase in the overall borrowing costs.[15] Second, because our main variable of interest in this regression is macroprudential instrument at the country level, we introduce time and country fixed effects separately instead of country$\times$ time fixed effects. Finally, we include real GDP growth to control for the potential effect of macroeconomic condition on borrowing cost.

The results from this regression can shed light on whether an increase in the levy/tax on financial institution may affect borrowing costs. To investigate how high borrowing costs may affect households of different income, in the second step, we test whether higher-income households put a larger down payment to hedge the higher costs.

To this end, we run regression (1) with down payment (in percent of collateral value) as the dependent variable. If $\beta > 0$, it suggests that higher-income households on average increase down payment compared to low-income households when the regulation on levy/tax on financial institutions tightens.

Results. Table 7 reports the results from the two regressions. As before, we only

[15]We focus on the average loan rate rather than the differential rates across households. The latter would indicate potential discrimination based on household income, which is beyond the scope of our paper.

show the coefficient of interest here and report the full regression results in Appendix Table 13. The first column reports the β coefficient from regression (2), and the second column in the table reports the β coefficient on the interaction term on macroprudential policy and household income in (1).

The result in column 1 suggests that a tightening regulation on the levy/tax on financial institutions is associated with a higher mortgage loan rate on average. In terms of the magnitude, a one unit increase in the net tightening measure is associated with an increase the cost of borrowing by 14 basis points. Column 2 shows a positive and significant coefficient on the interaction term on macroprudential policy and household income. This suggests that higher-income households on average experience a larger increase in their down payment than lower-income households when the regulation on levy/tax on financial institutions tightens. This is consistent with the hedging channel discussed above.

Table 7: Loan Rate & Down payment Regression

	(1) Current rate	(2) Downpayment
Levy/Tax	0.140**	
	(0.0569)	
Levy/Tax X HH Income		0.0541***
		(0.0204)
Country FE	Yes	No
Time FE	Yes	No
Country X Time FE	No	Yes
Obs	4402	4426

Standard errors in parentheses
* Downpayment is measured as a percentage of property value
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Although we test the cost of borrowing channel primarily for the differential effects of levies/taxes on financial institutions, the same channel may be at play for the effects of minimum capital requirements. In other words, to comply with tighter capital requirements, lenders may either decrease the riskiness of their portfolio by decreasing their risk-weighted assets (as discussed in section 3.2.3 below) or increase their capital by raising more equity.[16] Because equity financing tends to be costlier than debt financing, a tighter capital requirement may pass on the higher cost to borrowers.[17] Therefore, we run

[16]For a sample of EU countries, Andrle et al. (2017) finds that, following the implementation of the Basel-III requirements related to the GFC, banks raised capital adequacy ratios mainly through retained earnings. In countries where the banking sector struggled with profitability, banks resorted to equity issuance to meet the requirements.

[17]Cohen and Scatigna (2016) find that lower dividend payouts and (for advanced economy banks) wider

regression (2) also using minimum capital requirements as a measure of macroprudential policy. Although the coefficient is positive, it is not statistically significant, suggesting no evidence that a tightening in minimum capital requirements raises the overall costs of borrowing for households in the sample of countries and time period we consider.

Table 8: Interest Rate Regression

	(1) Current rate
Min. Cap.	0.0124
	(0.0538)
Country FE	Yes
Time FE	Yes
Obs	4402

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.2.2 Risk-taking channel

The previous section documents that a tightening in levies/taxes has a stronger effect on high-income households as their new borrowing reduces on average more than that of low-income households. Our analysis suggests that this could be due to higher borrowing costs, against which high-income borrowers can hedge by substituting larger loans with larger down payments, providing evidence for the existence of the borrowing cost channel.

However, the stronger effect on high-income households could also be due to other factors. One possibility could be that banks react to higher lending costs induced by a tighter macroprudential regulation by increasing risk exposure. To the extent that loans to low-income households are considered riskier as they tend to have higher LTV ratios, in response to the tighter regulation, banks may reallocate credit from higher-income to lower-income households.[18] While this hypothesis still suggests a negative sign on the coefficient of the interaction term between levies/taxes and household income (β in equation (1)), the differential effects in this case are likely to be driven by the households in the lower end of the income distribution. We refer to this as the *risk-taking channel*.

lending spreads have contributed to banks ability to use retained earnings to build capital following the GFC.

[18]See for example Delis and Kouretas (2011), which analyzes empirically the extent to which a negative relationship exists between the level of interest rates and bank risk-taking in the euro area over the period 2001-2008. See Keeley (1990) and Dell'Ariccia and Marquez (2006) for the theoretical exposition of the link.

To check whether this channel operates in our sample, we perform three tests, which we discuss below.

Test 1: Intensive margin of credit reallocation. In this exercise, we test if the stronger negative effect on new borrowing of high-income households from a tightening in levies/taxes is driven by low-income households receiving larger loans and providing lower down payments on average as banks engage in risk-taking. To do this, we split the sample to two income groups—households belonging to 0-40th (low-income) and 41-100th (medium-/high-income) percentile of the income distribution—and estimate the impact of a tightening in levies/taxes on the size of the down payment provided by running a regression specification similar to (2) for each income group[19]

$$Downpayment_{lict} = \alpha H_{ict} + \beta MaPP_{ct} + \gamma L_l + \delta GDP_{ct} + \sigma_c + \tau_t + \epsilon_{lict}, \tag{3}$$

where $Downpayment_{lict}$ indicates the down payment (as a share of the house value at purchase) by each income group and $MaPP_{ct}$ stands for our measure of levies/taxes on financial institutions.

The risk-taking channel would imply a negative coefficient β on the macroprudential policy instruments for the sample of low-income households. In other words, when levies/taxes increase, low-income households take out loans with lower down payments. On the contrary, a positive coefficient for the sample of medium-/high-income households would suggest that medium-/high-income households take out loans with higher down payments when levies/taxes increase, which would provide evidence against the risk-taking channel and in favor of the borrowing cost channel described above.[20]

Results. Table 9 reports the results from regression (3) for the coefficient on the macroprudential measure for the two income groups, and Table 15 in the appendix reports the full set of results. The coefficient on levies/taxes is positive and significant for medium-/high-income households, whereas it is negative but not significant for low-income households. This result suggests that medium-/high-income households tend to increase down payments during a policy tightening, whereas for low-income households there is no

[19]For simplicity of notation, we omit a superscript indicating the income group.

[20]Note that in this exercise, we are interested in understanding if low-income households in *absolute terms* supply smaller down payments during a tightening episode, rather than if they do so in relative terms compared to medium-/high-income households. Hence, we opt for a regression specification of the form in (3), where our main explanatory variable of interest is the macroprudential measure, rather than (1), where the main explanatory variable would be macroprudential measure interacted with household income.

Table 9: Testing the Intensive Margin of Credit Re-allocation

	(1) Downpayment	(2) Downpayment
Levy/Tax	1.667*	-0.862
	(0.944)	(1.464)
Country FE	Yes	Yes
Time FE	Yes	Yes
Observations	3655	771
Subset	income > 40th percentile	income ≤ 40th percentile

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

statistically significant change in their down payment during a tightening episode. This evidence goes against the risk-taking channel as a driver for the differential effects and in favor of the cost of borrowing channel we find in Section **??**.

Test 2: Extensive margin of credit reallocation. We now turn to testing the extensive margin of credit reallocation. This is complementary to the first test. Even though we do not find evidence of banks issuing on average larger loans to lower-income households, it is still possible that banks increase their risk exposure by issuing a higher number of riskier loans to low-income households (i.e., loans to low-income households with high-LTVs). In this exercise, we test whether banks are more likely to extend loans to low-income households with high-LTV. We re-estimate equation (3) with two modifications. First, the dependent variable is a dummy variable, $LowIncomeHighLTV_{lict}$, taking value of one if the loan belongs to a household within the 0-40th percentile and with an LTV of above 50, and zero otherwise; second, we run the regression on the entire sample without splitting it to different income groups.

Table 10: Testing the Extensive Margin of Credit Re-allocation

	(1) Low-income High-LTV
Levy/Tax	-0.0130
	(0.0134)
Country FE	Yes
Time FE	Yes
Observations	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results. Table 10 reports the main result of the regression analysis, and Table 16 in the appendix reports the full set of results. The coefficient on levies/taxes is negative and not significant, suggesting that, following a tightening in levies/taxes, the likelihood of

banks lending to low-income households with high-LTV does not increases significantly. This result corroborates our previous findings on the intensive margin, providing further evidence against the risk-taking shifting channel.

Taken together, our data and the analysis that we conduct on the intensive and the extensive margin of loan extension do not yield evidence in favor of the risk-taking channel. That is, when levies/taxes on financial institutions tighten, there is not sufficient evidence that banks engage in risk-taking behavior in order to compensate for the loss in profits due to the higher regulatory costs. On the contrary, our analysis provider further consistent evidence with the cost of borrowing channel.

3.2.3 Flight-to-quality channel

Our earlier results suggest that when the minimum capital requirement is tightened, lower-income households experience a larger reduction in mortgage loans than higher-income households. We hypothesize that this differential result is due to banks reducing risky loan exposure in response to a higher capital requirement. Because lower-income households have higher loan risk profile on average (measured by higher LTV, as shown in Table 3), a reduction in the segment of risky loans will affect lower income households more. To test this hypothesis, we run regression (1) on subsamples of loans of LTV ratios above and below 50 percent.[21][22] If the "flight-to-quality channel operates, we would expect the effect to be more pronounced in the sample of risky loans with high LTV ratios.

Results. Table 11 reports the results. We find that, for the subsample of loans with LTV ratios between 50-100, our coefficient of interest increases and becomes statistically more significant. On the contrary, when considering only loans with an LTV ratio smaller than 50, the coefficient on the interaction term remains positive, but it is smaller and statistically insignificant. In other words, we find no evidence that in the low-risk segment (i.e., loans low LTV ratios), low-income households are affected by a tightening in minimum capital requirement more than high-income households. But in the high-risk segment (i.e., loans with high LTV ratios), low-income households experience a signifi-

[21] In the standardized approach (SA) of the Basel framework for calculating risk-weighted assets, only loans with an LTV of 50 or higher receive a positive risk weight.

[22] We also exclude the dummy variable denoting loans with an LTV larger than 80 from this specification.

cantly larger reduction in mortgage loans than high-income households. These results are consistent with the interpretation that lenders respond to high capital requirement by contracting risky loans, typically issued to low-income households (as shown in Table 3). Table 14 in the appendix provides the full set of results of the regressions when splitting the sample by LTV ratios.

Table 11: Loan Amounts: Splitting the Sample

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)
Min. Cap. X HH Income	0.00112**	0.00137***	0.000670
	(0.000488)	(0.000475)	(0.000540)
Sample Split	LTV $\leq$ 100	LTV $\in$ [50,100]	LTV $<$ 50]
Country X Time FE	Yes	Yes	Yes
Obs	4582	3543	1028

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.3 Differential effects on house prices

In this section we assess whether a tightening in the macroprudential measures we consider has a differential effect on house prices. At the aggregate, earlier studies have found either a weak negative impact of a tightening in macroprudential policy on house price growth (Alam et al., 2019); or a more pronounced significant negative effect when only housing-related macroprudential measures are considered (Akinci and Olmstead-Rumsey, 2018).[23] Acharya et al. (2022) have found that LTV and DTI limits are effective in cooling down the housing market and in making it more homogeneous in terms of geographical areas and across property types. Tzur-Ilan (2020) and Igan and Kang (2011) show borrowers move away from hot housing markers, slowing down house prices in Israel and South Korea. However, these studies either focus on the aggregate effects or examine the effects of borrower-based macroprudential measures such as LTV, DTI, DSTI ratios on house prices across the distribution of households. Here, we examine if a tightening in levies/taxes on financial institutions and minimum capital requirements affects the value of a house that households of different income groups purchase.

We first run a regression akin to (1), with the log value of the house at the time of

[23]In their analysis, the housing-related macroprudential index sums the cumulative variables for the LTV, DSTI, and other housing measures as reported in section 2.2 in the paper.

the purchase as the dependent variable. If the coefficient on the interaction term between macroprudential policy and household income is significant, it would suggest that lender-based macroprudential tools could yield effects on the price of the property households end up buying. However, our micro-level analysis does not provide evidence of such effect. This outcome is not too surprising because, first, the effect of the policy at the aggregate level may not be powerful enough to generate impact on house prices at the micro level by restricting borrowing. Second, the literature generally finds more muted effects of macroprudential policies that do not directly target the housing market than those that do.[24]

We also examine if there is evidence of differential effects of the macroprudential instruments we consider on house prices at the aggregate level. To this end, we aggregate our household-level data by income group j (1=0-40th, 2=41-60th, 3=61-80th, 4=81-100th percentile),[25] and run the following set of regressions at the aggregate level for each of the four household income groups j

$$HousePrice_{ct}^{j} = \beta^{j} MaPP_{ct} + \gamma GDP_{ct} + \sigma_c + \tau_t + \epsilon_{ct}, \quad \forall j \tag{4}$$

$HousePrice_{ct}^{j}$ denotes the average house price at the time of purchase for each income group j. For example, $HousePrice_{ct}^{1}$ denotes the average house price at the time of purchase for households in the income group 0-40th percentile. $MaPP_{ct}$ denotes the average levy/tax or minimum capital requirements for country c at time t. GDP_{ct} denotes real GDP growth. Finally, σ_c and τ_t are country and time fixed effects, respectively, and ϵ_{ct} is the error term, clustered at country level.

The left panel in Figure 1 plots the coefficients β for each income group j equal from 1 to 4 from the levies/taxes regression. The right panel plots the same coefficient from the capital requirements regression. A tightening in levies/taxes is associated with households that are in the bottom income bracket buying less expensive houses. The result is significant at 10 percent level. On the contrary, households that are in the top 20th percentile appear to buy more expensive houses following a tightening in the same policy measure, but the results are not statistically significant. One interpretation of

[24] **?**, using meta-analysis, more generally, find weaker and more imprecise effects of macroprudential regulation on house prices.

[25] We combine the two bottom quintiles in order to have a similar number of observations across the income groups.

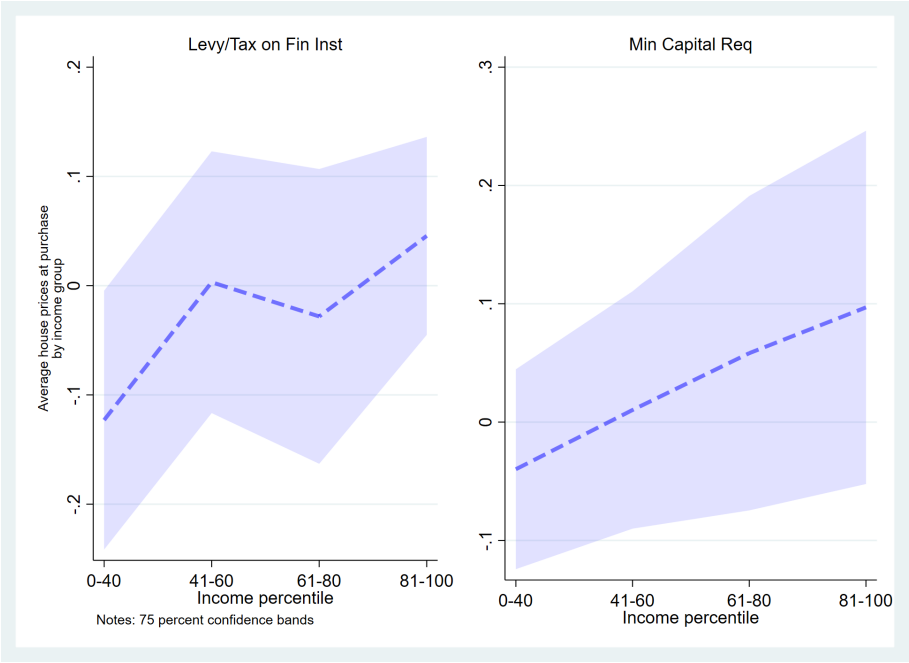

Figure 1: The left hand-side panel plots the coefficients β on levies/taxes in regression (4) for each income group. The right hand-side panel, similarly, plots the coefficient β on minimum capital requirements.

these results is that when levies/taxes tighten, lower-income households hedge against the higher borrowing costs induced by the tighter regulation by buying less expensive houses.

Turning to minimum capital requirements, the signs of the coefficient suggest that following a policy tightening, lower-income households tend to buy less expensive houses; on the other hand, higher-income households, (i.e., those in the income group 60th percentile and above) tend to buy more expensive houses when the regulation tightens. These results are not significant at conventional statistical levels. But the signs on the coefficients are consistent with the flight-to-quality channel: as lenders shift lending towards higher-income households, higher demand for housing may boost house purchase prices for higher-income households.

Overall, the analysis on the differential effects of macroprudential policy on house prices, while weaker than our earlier results on loans and down payments, suggest that low-income households hedge against higher borrowing costs induced by higher levies/taxes by buying less expensive houses on average compared to higher-income households. In terms of the differential effects of minimum capital requirements on house prices, the results are weak while consistent with the flight-to-quality channel.

4 Robustness tests

Controlling for interactions of macroprudential policy with other household-level characteristics. We show that households may be differentially affected by macroprudential policy depending on their income. One concern is that the result could be driven by other household characteristics that are correlated with income. To mitigate this concern, we rerun regression (1) by adding the interaction of macroprudential policy and household characteristic one at a time. Specifically, we run 5 versions of regression (1) by adding an interaction of an additional household characteristic (age, net wealth, gender, employment status, education level) with our macroprudential policy instrument. Table 17 in the appendix reports the results for the levies/taxes regression. Similarly, Table 18 reports the results for minimum capital requirements regression. In both cases, our baseline results continue to hold. The coefficients of the interaction of macroprudential policy and income have the same sign and remain to be statistically significant. Therefore, our baseline result on the differential effects depending on household income are robust to other household characteristics. One reason why household income is important for the differential effect could be that income is one of the key information a lender examines when extending mortgages.

Controlling for potential differential effects arising from monetary policy. Another potential concern is that the differential effects on new loans may be driven by the interaction of other contemporaneous policies with income. The literature has shown that monetary policy could have heterogeneous effect across the income distribution of households (see for example Bonifacio et al., 2021). To mitigate the concern that monetary policy may drive our results, we rerun our baseline regressions (1) for loan amount while controlling for the interaction term between a monetary policy shock and household income. As a measure of the monetary policy shock, we use the OIS (Overnight Index Swap) yield with 3-month maturity (monetary event window), constructed by Altavilla et al. (2019).[26] Appendix Table 19 reports the results. The coefficients on the interaction term between macroprudential policy and household income remain statistically significant with the same signs as before. The interaction of household income with monetary

[26]The data on monetary policy shocks can be obtained here.

policy indicates that the effects of a monetary policy tightening are less effective for high-income households as the coefficient on the interaction term is positive, but they are not significant. Therefore our baseline results are robust and not driven by monetary policy.

Controlling for interactions of household income with other macroprudential policy instruments. Although our analysis focuses on levies/taxes on financial institutions and minimum capital requirements, one concern that may arise is that other macroprudential policies may be driving the differential effects as set of macroprudential policies could be tighten simultaneously. To ensure that our results are robust, we run our baseline specification (1) by adding, one at the time, the interaction of household income and the macroprudential policies listed in Table 4 as a control. The run a similar regression that controls for the interaction term of household income and the aggregate macroprudential policy index, (i.e., one comprising all macroprudential policies). Table 20 and Table 21 in Appendix report the results for tax/levy on financial institutions and minimum capital requirements, respectively. Across all regressions, the coefficient on the interaction term between income and levies/taxes on financial institutions as well asminimum capital requirements remain statistically significant with the same signs as before. Other macroprudential policies may additionally yield differential effect as their interaction with household income is significant in some cases, but importantly our results on the levy/tax on financial institutions and minimum capital requirements are unaffected.

5 Conclusion

Using a comprehensive dataset linking macroprudential policy instruments and household financial and socio-demograpic information, we find evidence of differential effects of lender-based macroprudential policy instruments. Higher-income households on average experience a larger reduction in mortgage loan size than lower-income households when regulation on levy/tax on financial institutions tightens. Our evidence suggests that this is likely due to higher-income households being better able to hedge high borrowing cost induced by the regulation tightening. In contrast, lower-income households on average experience a larger reduction in mortgage loan size than higher-income households when regulation minimum capital requirement tightens. We provide suggestive evidence con-

sistent with flight-to-quality on mortgage lending when the minimum capital requirement tightens.

These results have important policy implications. By providing one of the first analysis on the differential effects of macroprudential policy on households, our work sheds light on the policy debate on the overall effectiveness of macroprudential regulation as well as its potential uneven impact. The equity implication of macroprudential regulation is an important and fruitful venue for further research.

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A Regression Tables

This section of the appendix lists all regression tables referenced in the main text of the paper.

Table 12: Loans Regression

	(1) New Loan (ln)	(2) New Loan (ln)
Levy/Tax X HH Income	-0.00181**	
	(0.000719)	
Min. Cap. X HH Income		0.00112**
		(0.000488)
Age	0.0213	0.0255
	(0.0435)	(0.0429)
Age X Age	-0.0118	-0.0126
	(0.0126)	(0.0127)
HH Income	0.00677***	0.00612***
	(0.000744)	(0.000731)
HH Net Wealth	0.00417***	0.00410***
	(0.000637)	(0.000622)
HH working members	-0.0106	-0.0110
	(0.0390)	(0.0391)
gender	-0.0440**	-0.0435*
	(0.0223)	(0.0233)
At least College	0.153***	0.155***
	(0.0171)	(0.0165)
Unemployed	0.0383	0.0396
	(0.0583)	(0.0625)
Retired	-0.0595	-0.0454
	(0.0956)	(0.0974)
Other	-0.0545	-0.0649
	(0.151)	(0.143)
Loan Maturity	0.0266***	0.0266***
	(0.00222)	(0.00221)
mortgage rate type	-0.0533	-0.0562
	(0.0431)	(0.0437)
New Loan (Not Refinanced)	0.115***	0.114***
	(0.0221)	(0.0221)
LTV > 80	0.334***	0.335***
	(0.0322)	(0.0313)
Constant	9.763***	9.740***
	(0.282)	(0.288)
Country X Time FE	Yes	Yes
Obs	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Loan Rate & Downpayment Regression

	(1) Current rate	(2) Downpayment
Levy/Tax	0.140**	
	(0.0569)	
Levy/Tax X HH Income		0.0541***
		(0.0204)
Real GDP Growth	-0.00810	
	(0.0381)	
Age	0.00541	0.124
	(0.0946)	(1.141)
Age X Age	0.0230	-0.103
	(0.0251)	(0.301)
HH Income	-0.00606***	-0.0209
	(0.00178)	(0.0180)
HH Net Wealth	-0.00397**	0.163***
	(0.00176)	(0.0213)
HH working members	0.0660	-0.741
	(0.0740)	(0.793)
gender	0.0167	0.555
	(0.0754)	(0.891)
At least College	-0.0618	0.375
	(0.0587)	(0.583)
Unemployed	-0.128	0.415
	(0.155)	(2.285)
Retired	-0.0503	4.031**
	(0.212)	(1.798)
Other	0.221	3.207
	(0.176)	(2.140)
Loan Maturity	0.00559	-0.288***
	(0.00428)	(0.0652)
mortgage rate type	0.642***	2.294
	(0.121)	(1.628)
New Loan (Not Refinanced)	-0.161***	-2.624***
	(0.0599)	(0.770)
LTV > 80	0.0220	-34.67***
	(0.0678)	(0.682)
Constant	3.233***	55.08***
	(0.628)	(8.485)
Country FE	Yes	No
Time FE	Yes	No
Country X Time FE	No	Yes
Obs	4402	4426

Standard errors in parentheses
* Downpayment is measured as a percentage of property value
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Loan Amounts: Splitting the Sample

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)
Min. Cap. X HH Income	0.00112**	0.00137***	0.000670
	(0.000488)	(0.000475)	(0.000540)
Age	0.0255	0.0343	-0.0309
	(0.0429)	(0.0325)	(0.0900)
Age X Age	-0.0126	-0.0115	-0.0121
	(0.0127)	(0.0104)	(0.0150)
HH Income	0.00612***	0.00636***	0.00624***
	(0.000731)	(0.000728)	(0.00206)
HH Net Wealth	0.00410***	0.00449***	0.00677***
	(0.000622)	(0.000681)	(0.00104)
HH working members	-0.0110	-0.00964	-0.0567
	(0.0391)	(0.0287)	(0.150)
gender	-0.0435*	0.00657	-0.187**
	(0.0233)	(0.0252)	(0.0842)
At least College	0.155***	0.185***	0.0325**
	(0.0165)	(0.0369)	(0.0160)
Unemployed	0.0396	0.0864	-0.193*
	(0.0625)	(0.0769)	(0.114)
Retired	-0.0454	0.0193	-0.145
	(0.0974)	(0.0848)	(0.180)
Other	-0.0649	0.0900	-0.204
	(0.143)	(0.113)	(0.270)
Loan Maturity	0.0266***	0.0242***	0.0329***
	(0.00221)	(0.00185)	(0.00124)
mortgage rate type	-0.0562	-0.0700*	0.0726
	(0.0437)	(0.0395)	(0.105)
New Loan (Not Refinanced)	0.114***	0.0901***	0.118***
	(0.0221)	(0.0257)	(0.00670)
LTV > 80	0.335***		
	(0.0313)		
Constant	9.740***	10.41***	9.018***
	(0.288)	(0.277)	(0.109)
Sample Split	LTV $\leq$ 100	LTV $\in$ [50,100]	LTV < 50]
Country X Time FE	Yes	Yes	Yes
Obs	4582	3543	1028

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Testing the Intensive Margin of Credit Re-allocation

	(1) Downpayment	(2) Downpayment
Levy/Tax	1.667*	-0.862
	(0.944)	(1.464)
Real GDP Growth	0.190	-0.454
	(0.554)	(0.638)
Age	0.837	-2.208
	(1.364)	(1.910)
Age × Age	-0.244	0.245
	(0.364)	(0.456)
HH Income	-0.0211	-0.0200
	(0.0353)	(0.0557)
HH Net Wealth	0.159***	0.189***
	(0.0204)	(0.0485)
Working HH members	-0.955	-0.198
	(1.110)	(1.561)
Gender	-0.117	2.858**
	(0.973)	(1.356)
At Least Some College	0.318	0.654
	(1.009)	(1.433)
Unemployed	0.287	-0.590
	(2.480)	(2.864)
Retired	1.866	10.02**
	(3.332)	(4.893)
Other	6.999	0.311
	(4.902)	(3.784)
length of loan at time of borrowing/refinancing	-0.330***	-0.172
	(0.0882)	(0.105)
Adjustable Rate on loan	2.775*	-2.067
	(1.625)	(2.490)
Refinancing loan	-2.843***	-0.949
	(0.974)	(1.782)
Dummy LTV>80	-34.50***	-35.01***
	(0.805)	(1.319)
Constant	49.44***	57.69***
	(7.468)	(11.08)
Country FE	Yes	Yes
Time FE	Yes	Yes
Observations	3655	771
Subset	income > 40th percentile	income ≤ 40th percentile

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Testing the Extensive Margin of Credit Re-allocation

	(1) Low-income High-LTV
Levy/Tax	-0.0130
	(0.0134)
Real GDP Growth	0.000762
	(0.00726)
Age	0.00351
	(0.0206)
Age × Age	0.0000792
	(0.00495)
HH Income	-0.0108***
	(0.000488)
HH Net Wealth	0.000381
	(0.000342)
Working HH members	-0.0748***
	(0.0200)
Gender	-0.00391
	(0.0162)
At Least Some College	0.0249*
	(0.0140)
Unemployed	0.00876
	(0.0693)
Retired	-0.221***
	(0.0611)
Other	-0.00834
	(0.0616)
Length of loan at time of borrowing/refinancing	-0.0000803
	(0.000913)
Adjustable Rate on loan	0.00765
	(0.0241)
Refinancing loan	-0.0200
	(0.0161)
Dummy LTV>80	0.0572***
	(0.0146)
Constant	1.046***
	(0.135)
Country FE	Yes
Time FE	Yes
Observations	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Robustness Checks I: MaPP Levy/Tax

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)	(4) New Loan (ln)	(5) New Loan (ln)
Levy/Tax X HH Income	-0.00178**	-0.00198**	-0.00183**	-0.00180**	-0.00163**
	(0.000748)	(0.000797)	(0.000717)	(0.000730)	(0.000734)
Levy/Tax X Age	-0.00292				
	(0.0490)				
Levy/Tax X Age X Age	0.00145				
	(0.0119)				
Levy/Tax X HH Net Wealth		0.000397			
		(0.00103)			
Levy/Tax X gender			-0.00917		
			(0.0333)		
Unemployed X Levy/Tax				0.0171	
				(0.0617)	
Retired X Levy/Tax				0.0474	
				(0.0878)	
Other X Levy/Tax				-0.448**	
				(0.186)	
At least College X Levy/Tax					-0.0443
					(0.0362)
Age	0.0219	0.0217	0.0210	0.0205	0.0214
	(0.0431)	(0.0432)	(0.0431)	(0.0435)	(0.0434)
Age X Age	-0.0120	-0.0120	-0.0117	-0.0116	-0.0117
	(0.0126)	(0.0127)	(0.0125)	(0.0128)	(0.0127)
HH Income	0.00678***	0.00679***	0.00678***	0.00683***	0.00671***
	(0.000755)	(0.000746)	(0.000736)	(0.000735)	(0.000721)
HH Net Wealth	0.00416***	0.00412***	0.00416***	0.00419***	0.00420***
	(0.000667)	(0.000685)	(0.000642)	(0.000633)	(0.000644)
HH working members	-0.0106	-0.0112	-0.0110	-0.0113	-0.0102
	(0.0388)	(0.0392)	(0.0387)	(0.0392)	(0.0388)
gender	-0.0440*	-0.0437*	-0.0435*	-0.0434*	-0.0452**
	(0.0225)	(0.0225)	(0.0227)	(0.0224)	(0.0221)
At least College	0.152***	0.152***	0.152***	0.152***	0.156***
	(0.0166)	(0.0170)	(0.0173)	(0.0174)	(0.0168)
Unemployed	0.0386	0.0385	0.0387	0.0354	0.0337
	(0.0591)	(0.0586)	(0.0581)	(0.0614)	(0.0578)
Retired	-0.0601	-0.0590	-0.0597	-0.0710	-0.0581
	(0.0998)	(0.0963)	(0.0957)	(0.104)	(0.0961)
Other	-0.0541	-0.0552	-0.0541	-0.0387	-0.0528
	(0.151)	(0.150)	(0.150)	(0.152)	(0.152)
Loan Maturity	0.0266***	0.0266***	0.0266***	0.0267***	0.0266***
	(0.00222)	(0.00226)	(0.00221)	(0.00223)	(0.00221)
mortgage rate type	-0.0532	-0.0532	-0.0532	-0.0533	-0.0538
	(0.0427)	(0.0430)	(0.0430)	(0.0430)	(0.0429)
New Loan (Not Refinanced)	0.115***	0.115***	0.115***	0.117***	0.113***
	(0.0224)	(0.0223)	(0.0222)	(0.0218)	(0.0220)
LTV > 80	0.334***	0.334***	0.334***	0.334***	0.335***
	(0.0317)	(0.0322)	(0.0322)	(0.0318)	(0.0324)
Constant	9.762***	9.764***	9.763***	9.754***	9.767***
	(0.282)	(0.281)	(0.283)	(0.282)	(0.279)
Country X Time FE	Yes	Yes	Yes	Yes	Yes
Obs	4582	4582	4582	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Robustness Check II: MaPP Min. Cap.

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)	(4) New Loan (ln)	(5) New Loan (ln)
Min. Cap. X HH Income	0.00125***	0.00118**	0.00103**	0.00125**	0.00113**
	(0.000464)	(0.000529)	(0.000488)	(0.000515)	(0.000554)
Min. Cap. X Age	-0.0754***				
	(0.0288)				
Min. Cap. X Age X Age	0.0106				
	(0.00785)				
Min. Cap. X HH Net Wealth		-0.000132			
		(0.000545)			
Min. Cap. X gender			-0.0344		
			(0.0359)		
Unemployed X Min. Cap.				0.130**	
				(0.0613)	
Retired X Min. Cap.				-0.00877	
				(0.0714)	
Other X Min. Cap.				0.141	
				(0.353)	
At least College X Min. Cap.					-0.00177
					(0.0313)
Age	0.0688	0.0256	0.0254	0.0264	0.0255
	(0.0473)	(0.0425)	(0.0430)	(0.0431)	(0.0429)
Age X Age	-0.0191	-0.0127	-0.0125	-0.0128	-0.0127
	(0.0139)	(0.0125)	(0.0127)	(0.0127)	(0.0127)
HH Income	0.00603***	0.00610***	0.00613***	0.00606***	0.00612***
	(0.000737)	(0.000708)	(0.000716)	(0.000721)	(0.000740)
HH Net Wealth	0.00407***	0.00416***	0.00410***	0.00411***	0.00410***
	(0.000624)	(0.000732)	(0.000634)	(0.000623)	(0.000616)
HH working members	-0.0119	-0.0111	-0.0102	-0.0123	-0.0110
	(0.0388)	(0.0393)	(0.0389)	(0.0391)	(0.0393)
gender	-0.0428*	-0.0434*	-0.0263	-0.0437*	-0.0434*
	(0.0228)	(0.0234)	(0.0280)	(0.0229)	(0.0233)
At least College	0.153***	0.155***	0.156***	0.155***	0.156***
	(0.0167)	(0.0165)	(0.0163)	(0.0167)	(0.0241)
Unemployed	0.0355	0.0399	0.0400	-0.0424	0.0396
	(0.0625)	(0.0629)	(0.0614)	(0.0649)	(0.0620)
Retired	-0.0461	-0.0451	-0.0448	-0.0431	-0.0453
	(0.0970)	(0.0970)	(0.0956)	(0.121)	(0.0976)
Other	-0.0765	-0.0655	-0.0668	-0.110	-0.0648
	(0.144)	(0.144)	(0.144)	(0.175)	(0.142)
Loan Maturity	0.0265***	0.0266***	0.0265***	0.0265***	0.0266***
	(0.00220)	(0.00224)	(0.00218)	(0.00217)	(0.00221)
mortgage rate type	-0.0585	-0.0560	-0.0574	-0.0585	-0.0562
	(0.0427)	(0.0443)	(0.0434)	(0.0432)	(0.0440)
New Loan (Not Refinanced)	0.112***	0.114***	0.114***	0.113***	0.114***
	(0.0210)	(0.0220)	(0.0222)	(0.0214)	(0.0219)
LTV > 80	0.336***	0.335***	0.336***	0.336***	0.335***
	(0.0307)	(0.0314)	(0.0308)	(0.0319)	(0.0314)
Constant	9.770***	9.741***	9.747***	9.742***	9.739***
	(0.290)	(0.287)	(0.287)	(0.288)	(0.288)
Country X Time FE	Yes	Yes	Yes	Yes	Yes
Obs	4582	4582	4582	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: Robustness Check III: Differential Effects of MaPP vs. Monetary Policy

	(1) New Loan (ln)	(2) New Loan (ln)
Levy/Tax X HH Income	-0.00137*	
	(0.000784)	
Min. Cap. X HH Income		0.00132*
		(0.000679)
Monetary policy Shock X HH Income	0.0000943	0.000143
	(0.000105)	(0.0000942)
Age	0.0152	0.0194
	(0.0435)	(0.0434)
Age X Age	-0.0100	-0.0109
	(0.0120)	(0.0121)
HH Income	0.00687***	0.00618***
	(0.000754)	(0.000822)
HH Net Wealth	0.00399***	0.00393***
	(0.000726)	(0.000723)
HH working members	-0.0115	-0.0125
	(0.0397)	(0.0399)
gender	-0.0459*	-0.0444
	(0.0277)	(0.0279)
At least College	0.143***	0.144***
	(0.0223)	(0.0219)
Unemployed	0.0105	0.0118
	(0.0616)	(0.0645)
Retired	-0.0747	-0.0630
	(0.117)	(0.116)
Other	-0.0591	-0.0661
	(0.203)	(0.199)
Loan Maturity	0.0261***	0.0261***
	(0.00225)	(0.00226)
mortgage rate type	-0.0568	-0.0603
	(0.0520)	(0.0523)
New Loan (Not Refinanced)	0.115***	0.115***
	(0.0302)	(0.0301)
LTV > 80	0.333***	0.334***
	(0.0322)	(0.0313)
Constant	9.830***	9.821***
	(0.346)	(0.355)
Country X Time FE	Yes	Yes
Obs	4435	4435

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 20: Robustness Check IV: Differential Effects of Other MaPP (Levy/Tax)

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)	(4) New Loan (ln)	(5) New Loan (ln)	(6) New Loan (ln)	(7) New Loan (ln)	(8) New Loan (ln)	(9) New Loan (ln)
Levy/Tax X HH Income	-0.00161**	-0.00181**	-0.00181**	-0.00167**	-0.00185***	-0.00181**	-0.00181**	-0.00181**	-0.00161**
	(0.000757)	(0.000723)	(0.000719)	(0.000709)	(0.000711)	(0.000719)	(0.000721)	(0.000719)	(0.000727)
All Mapp X HH Income	-0.000298								
	(0.000284)								
Liqu. Requirements X HH Income		-0.00464***							
		(0.00121)							
Risk Weights X HH Income			-0.000495						
			(0.000885)						
Cap. Buff. X HH Income				-0.00248***					
				(0.000690)					
Lending Stds. Rest. X HH Income					-0.00177**				
					(0.000877)				
Cred. Growth & Vol. X HH Income						0.00117			
						(0.00453)			
expo. & concentration X HH Income							-0.0000281		
							(0.00146)		
Loan-Loss X HH Income								0.00253	
								(0.00331)	
Min. Cap. X HH Income									0.000942*
									(0.000508)
Country X Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	4582	4582	4582	4582	4582	4582	4582	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 21: Robustness Check V: Differential Effects of Other MaPP (Minimum Capital Requirements)

	(1) New Loan (ln)	(2) New Loan (ln)	(3) New Loan (ln)	(4) New Loan (ln)	(5) New Loan (ln)	(6) New Loan (ln)	(7) New Loan (ln)	(8) New Loan (ln)	(9) New Loan (ln)
Min. Cap. X HH Income	0.00263***	0.00107**	0.000942*	0.00112**	0.00127***	0.00129***	0.00112**	0.00112**	0.00116**
	(0.000613)	(0.000493)	(0.000508)	(0.000483)	(0.000476)	(0.000467)	(0.000488)	(0.000491)	(0.000492)
All Mapp X HH Income	-0.00136***								
	(0.000333)								
Liqu. Requirements X HH Income		-0.00440***							
		(0.00121)							
Levy/Tax X HH Income			-0.00161**						
			(0.000727)						
Risk Weights X HH Income				-0.000497					
				(0.000918)					
Cap. Buff. X HH Income					-0.00285***				
					(0.000645)				
Lending Stds. Rest. X HH Income						-0.00193**			
						(0.000892)			
Cred. Growth & Vol. X HH Income							0.000617		
							(0.00459)		
expo. & concentration X HH Income								-0.000114	
								(0.00148)	
Loan-Loss X HH Income									0.00351
									(0.00345)
Country X Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	4582	4582	4582	4582	4582	4582	4582	4582	4582

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Data cleaning

In this section we outline the detailed steps involved in cleaning and combining the datasets used in our analysis.

B.1 Setting up of the HFCS dataset

1. Download files from the ECB Astra website and run the preprocessing code provided in the HFCS user guide. For each wave of the HFCS, this merges all imputations together into a "wide format and makes sure that all id and weight variables are properly included. Additionally, this code also reduces the memory requirements of the dataset by changing some of the variable datatypes. This corresponds to the .do files called "loading_HFCS_wave_... in the HFCS setup folder

2. Combine all the waves of the HFCS dataset into one mortgage-level dataset. This corresponds to the .do file called final_setup_allobs_workingversion. The steps to this are:

   a. Keep only the variables that we are interested in.

   b. Separate the variables into loan-level and household-level variables, taking advantage of the fact that each mortgage from a single household will retain the same set of household variables.

   c. For each household, keep only the first mortgage that uses the primary residence as collateral as well as the first mortgage on up to 2 additional (non-primary) properties.

   d. Define the dummy variable took_loan=1 if the loan observation is not missing the size of the mortgage loan or the year of origination. Define took_loan=0 otherwise.

   e. Define the categorical variable loan_for, which denotes the type of collateral used for the mortgage (primary, 1st additional property, 2nd additional property). This

variable is used to construct other variables conditional on the property type (primary residence, 1st additional, 2nd additional property).

f. Consolidate the variable names across waves and loan-types (since the variable names may differ by survey wave or mortgage collateral).

g. Drop duplicate observations.

h. Keep observations if and only if the mortgage was taken within 3 years of the year in which household variables were measured.

3. Save output data as allwaves_last_3_yrs_allobs_workingversion.dta

B.2 MaPP dataset

1. Download the MaPPed excel sheet from here.

2. We use the implementation dates for each MaPP policy as many of the announcement dates are missing.

3. Count the number of tightening and loosenings for each MaPP category and sum these by country and year to obtain the net_tightening variables for each category of MaPP.

4. Save output data as MAPP_panel_policycounts.dta.

B.3 Merging HFCS and MaPP databases

1. Join the cleaned HFCS and MaPP datasets on the country year level.

2. Add the macrovariables (GDP growth, CPI, and unemployment rate) from WEO.

3. Add in the real House price growth using data from the BIS.

4. Rebase CPI to 2015 (arbitrary base year).

5. Save the output as final_data_last_3_yrs_allobs_workingversion.dta.

B.4 Setting up baseline regressions

1. Deflate all the nominal (euro-denominated) variables.
2. Take the natural log of the initial mortgage amount.
3. Drop observations with implausible values for age and education (non-integer or negative values).
4. Split age, education, employment into categories as follows:
   a. Age is split into decades (20, 30, 40, ,80, 90),
   b. Education is split into no college and at least some college or more education,
   c. Employment status is split into (1) employed/self-employed (2) unemployed (3) retired (4) other,
   d. Economically active members in the household is split into (1) no active members (2) one active member (3) 2 or more active members,
5. Construct LTV, LTI, and DSTI variable.
6. Winsorize variables as follows (simply dropping observations outside the bounds):
   (a) Net wealth at 97.5%,
   (b) Interest rate and length of loan at 1% and 99%,
   (c) Loan amount, property value, income, net financial position, net housing wealth, net liquid assets, LTV, LTI, and DSTI at 2.5% and 97.5%.
7. Standardize income, wealth and financial variables.
8. Remove observations with LTV greater than 100 or DSTI greater than 80.
9. Save output dataset as reg_data_3_yrs_workingversion.dta.