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Bank lending rates and the riskiness of euro area household loans

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Abstract

I assess the impact of the recent hike in bank lending rates on euro area retail borrowers using a novel microsimulation framework that updates household-level data of a recent representative survey with up-to-date macro-financial information. The key novelty is that existing mortgages are gradually repaid, and new ones are extended, a feature necessary for medium-term simulations in a period of sizable credit growth. Since lending rates have increased, debt servicing has become more demanding, and the simulated share of distressed loans has increased. Effects are stronger for adjustable-rate mortgages, and especially for the most recent among them, but are present in all portfolios.

JEL codes: C1, G2, G51, E52**.**

Keywords: monetary policy, financial stability, household finance, microsimulations.

Non-technical summary

Central banks in most major jurisdictions around the world increased policy rates and phased out asset purchases and other unconventional policy measures, in reaction to increased and persistent inflationary pressures. As a result, lending rates spiked for all types of borrowers, as monetary authorities activated the interest rate channel of monetary policy. Despite the retreat of inflation to lower levels in 2024, its outlook remains uncertain.

The level and speed of monetary tightening were deemed necessary to fight inflation but have triggered memories of the Global Financial Crisis, when monetary tightening triggered a severe recession which, in the case of US, was closely linked to the household sector. Although mitigating policies have since been put in place in developed economies, the assessment of household loan riskiness is a necessary item in policymakers' toolkits, especially for the euro area, whose heterogeneous mortgage markets affect the way monetary policy is transmitted to its economies.

This paper combines the only publicly available, standardised data source for euro area household balance sheets with a novel microsimulation methodology to derive estimates of the riskiness of euro area household loans. The data were mainly collected in 2020-2021 and cover extensive information on household demographics, income, assets, and liabilities. The microsimulation framework updates the survey information using quarterly country-level macroeconomic and financial developments between the time of data collection and 2023 Q2, thus covering 4 quarters of tightening of financing conditions. Its key novelty is that features dynamic household behaviour with respect to mortgage-financed house purchases, as existing mortgages are gradually repaid, and new mortgages are issued. It further incorporates a range of key, occasionally binding constraints that households face (budget constraint, macroprudential borrower-based measures, expenses related to taxation and social contributions).

My simulations suggest that the increase of bank lending rates has affected adversely the debt servicing capabilities of euro area household borrowers, although simulated debt burden has slightly decreased as a share of household income. Effects on debt servicing are stronger for adjustable-rate mortgages, followed by consumer credit. As a result, debt servicing distributions of adjustable-rate mortgages now look riskier than those of fixed rate mortgages, although their risk levels were similar before

the beginning of the recent tightening. Moreover, and due to the assumption that mortgage contracts have an amortisation schedule according to the French loan convention, increases in interest rates affect more recent adjustable-rate mortgages more than older ones, as for this type of loans the share of the monthly payments that cover interest expenses is higher at the early years.

Increase in debt service obligations translates into an elevated share of simulated loans held by financially distressed borrowers. Again, adjustable-rate mortgages are more likely to be in distress. Finally, and looking at the collateral that households hold in the form of real assets, more than 90% of the euro area loans have been extended to households whose real estate assets are worth more than their debt, which is a source of robustness from a financial stability perspective. The results of this paper provide a useful benchmark for academics, policy makers and banking supervisors that are interested in a potential build-up of non-performing loans in the current conjuncture.

1. Introduction

In the aftermath of the global pandemic, central banks in most major jurisdictions around the world increased policy rates and phased out asset purchases and other unconventional policy measures in reaction to increased and persistent inflationary pressures. As a result, lending rates spiked for all types of borrowers, as monetary authorities activated the interest rate channel of monetary policy. Despite the retreat of inflation to lower levels in 2024, its outlook remains uncertain.

The level and speed of monetary tightening were deemed necessary to fight inflation but have triggered memories of the Global Financial Crisis, when monetary tightening of a comparable size triggered a severe recession which, in the case of US, was closely linked to the household sector (Mian and Sufi, 2011; Mian et al., 2013). Although borrower-based macroprudential policies have since been put in place in developed economies (Cerutti et al., 2017), households remain an important sector where credit risk could materialise, making the assessment of household loan riskiness is a necessary item in policymakers' toolkits. Such considerations are particularly relevant in the euro area, whose heterogeneous mortgage markets affect the way monetary policy is transmitted to its economies (Campbell, 2013).

This paper assesses the impact of the recent increase in bank borrowing costs to the riskiness of euro area household loans using a novel microsimulation framework. The starting point of the analysis is the most recent wave of the Household Finance and Consumption Survey, a representative survey of euro area households collected by the Eurosystem. The data were mainly collected in 2020-2021 and cover extensive information on household demographics, income, assets, and liabilities. The microsimulation framework developed in this paper updates the survey information using quarterly country-level macroeconomic and financial developments between the time of data collection and 2023 Q2, thus covering 4 quarters of tightening of financing conditions.

The key methodological novelty of this paper is that it features dynamic household behaviour with respect to mortgage-financed house purchases, as existing mortgages are gradually repaid, and new mortgages are issued. Propensities to get a new mortgage and conditional new mortgage amounts are assigned using reduced-form econometric models, while new contracts are equipped with amortisation schedules, loan-to-value ratios, and interest rate status (fixed or adjustable). Due to dynamic mortgage issuance,

the framework has the flexibility to track the build-up of household debt during periods of expansion (and deleveraging during economic downturns), a feature that makes it particularly suitable for the question this paper asks, i.e., the impact of monetary policy tightening after considerable credit growth in the period since the latest data collection.

The levels of financial assets, real assets, and consumer liabilities are updated using a static balance sheet assumption, whereby valuations and amounts are fluctuating in line with aggregate movements (i.e., households make no transactions). The simulated dynamics of employment and income of various sources match country-level unemployment rates and salary growth. Playing with the strengths of microsimulation approaches, I further incorporate a range of key, occasionally binding constraints that households face (budget constraint, macroprudential borrower-based measures, expenses related to taxation and social contributions).

I use the simulations to generate statistics that capture the riskiness of euro area household loans. In particular, I calculate median debt service-to-income ratio (DSTI) of the loans, the share of loans with DSTI greater than 40%, median debt-to-income ratio (DTI), the share of loans with DTI higher than 5, median debt-to-real estate assets (DTA), the share of loans with DTA greater than 1, and the share of loans that are held by financially distressed borrowers, i.e., to borrowers whose financial assets and quarterly gross income are not enough to cover their quarterly expenses in the simulations. Importantly, and in contrast to most of the related literature, I calculate these statistics over the distribution of loans, and not that of households.

My simulations suggest that the increase of bank lending rates has affected adversely the debt servicing capabilities of euro area household borrowers, although simulated debt burden has slightly decreased as a share of household income. Effects on debt servicing are stronger for adjustable-rate mortgages (ARMs), followed by consumer credit. As a result, debt servicing distributions of adjustable-rate mortgages now look riskier than those of fixed rate mortgages (FRMs), although their risk levels were similar before the beginning of the recent tightening. This result is the flip side of the results of Di Maggio et al. (2017), who report that the drop of bank rates during the great Recession benefited greatly households with adjustable-rate mortgages. Moreover, and due to the assumption that mortgage contracts have an amortisation schedule according to the *French loan* convention, increases in interest rates affect more

recent ARMs more than older ones, as for this type of loans the share of the monthly payments that cover interest expenses is higher at the early years.

Increase in debt service obligations translates into an elevated share of simulated loans held by financially distressed borrowers. Again, ARMs are more likely to be in distress. Finally, and looking at the collateral that households hold in the form of real assets, more than 90% of the euro area loans have been extended to households whose real estate assets are worth more than their debt, which is a source of robustness from a financial stability perspective.

This paper adds to the literature by developing a dynamic microsimulation framework for household financial decisions that takes into consideration all the major aspects of the household balance sheet. It builds on Ampudia et al. (2016a), who develop a microsimulation framework that assesses the effect of the Great Recession to euro area households using the first data collection of HFCS in 2010. Their framework assumes that debt burdens remain constant over time which was a plausible assumption for examined period but is less suitable for the evaluation of recent developments. Ampudia et al. (2016b) analyse the financial fragility of euro area households using the same dataset and take a stress testing approach which assumes macroeconomic shocks at the time of data collection and estimates their contemporaneous impact on households, which omits vulnerabilities that accumulate over time, or materialise after the data collection[2]. Gross and Población (2017) and Giannoulakis et al. (2023) use a static microsimulation framework in combination with a macro model to assess the effectiveness of borrower-based macroprudential policies. Michelangeli and Pietrunti (2014) develop a model that assesses the financial vulnerability of Italian households with a model that features dynamic mortgage generation and takes income dynamics into consideration but does not simulate changes in financial assets. Attiná et al. (2020) extend Michelangeli and Pietrunti (2014) to account for high consumer credit growth and mortgage renegotiations.[3]

A related but distinct strand of the literature develops life-cycle models of household portfolio choice. In these models, household behaviour is approximated by a problem of optimal choice of assets and liabilities with the goal of maximizing lifetime utility under income and asset returns uncertainty. Applications of this

[2] HFCS is only collected every approximately 3 years in most countries.
[3] Gross et al. (2022) for an extended literature review of household finance microsimulation papers.

approach include stock market participation (Gomes and Michaelides, 2005), saving in old age (De Nardi et al., 2010), and mortgage default (Campbell and Cocco, 2015).[4] Despite their theoretical appeal and their success in explaining many aspects of household behaviour, these models become intractable when they need to take into account the many state variables that households have when making their decisions (age, income, income uncertainty, markets uncertainty) and the many assets and liabilities they can choose from (stocks, bonds deposits, housing, mortgages, credit cards, consumer loans etc.). In contrast, this paper assumes inertia as an approximation of household behaviour in all financial decisions, except for decisions on mortgages. Empirical findings on household inertia in the areas of stockholding (Bilias et al., 2010) and in management of 401(k) retirement accounts (Shea, 2001) provide some support to this static balance sheet approach.

2. Data

The main data source of this paper is Eurosystem's Household Finance and Consumption Survey (HFCS), whose latest wave was collected in 2020-2021 (in most countries after the beginning of the COVID-19 pandemic) and surveyed approximately 80,000 households from 22 European Union countries.[5] HFCS is the only publicly available source for micro-level data on the assets and liabilities of euro area households. Furthermore, it provides detailed information on household demographics, employment status and income sources.

From HFCS we collect household-, mortgage contract- and person-level data of interest. The key unit of observation of the survey is the household, for which we extract information on its composition (single or couple, number of any dependent children), financial assets (deposits, bonds, stocks, voluntary pensions/whole life insurance, mutual funds, business assets, money owed to households), real estate assets (main residence, other real estate holdings), non-labour-related income (rents, dividends, coupons, social security, transfers, other), consumer debt (credit cards, credit lines/overdrafts, other non-mortgage debt), non-durable consumption (amounts spent on consumer goods and services) and any rent payments.

[4] See Gomes et al. (2021) for a comprehensive review of that literature.
[5] See European Central Bank (2023a, 2023b) for detailed descriptions of the survey methodology and high-level results. I focus on euro area countries and, for various issues related to data availability, I conduct the analysis for 15 of them, namely: Austria, Belgium, Cyprus, Germany, Estonia, Spain, France, Croatia, Luxemburg, Latvia, Malta, the Netherlands, Portugal, Slovenia, and Slovakia.

Critically for this project, mortgage data are collected at the contract level, so in case of households with multiple mortgages, each mortgage can be simulated individually. HFCS links real assets to mortgages and contains information on mortgage terms at origination (fixed or adjustable-rate mortgage, original amount, maturity, initiation year) and the current loan state (current amount outstanding, monthly payments, current interest rate).

Finally, for the adults of the household I also use data collected at the person level, such as demographics (gender, age, education) and labour-related information (employment status, salaries, pensions, unemployment benefits). These data allow simulating changes in employment status at the relevant level of granularity.

I further make use of HFCS's household weights and of the imputations it provides for key missing values. The survey's weights that are necessary to construct reasonable distributional statistics, as oversampling techniques are applied to cover richer households adequately. Furthermore, missing values are imputed using multiple imputations methods, whereby 5 different imputed values are estimated for each missing value to capture the uncertainty associated with imputation methodologies.

Apart from the household data described above, I compile a macro dataset that contains country-level time series on inflation (Harmonised Index of Consumer Prices, or HICP), nominal consumption, aggregate employment, salary developments, stock market performance, deposit rates, consumer loans stocks and rates, adjustable- and fixed-rate mortgages (ARMs and FRMs) stocks and rates, and residential real estate prices. I further use data on the evolution of 3-month Euribor, a commonly used benchmark for resetting the interest rates of ARMs. These aggregate data are used to inform the evolution of household balance sheets from the time of collection to 2023Q2, using the framework described in the next session.

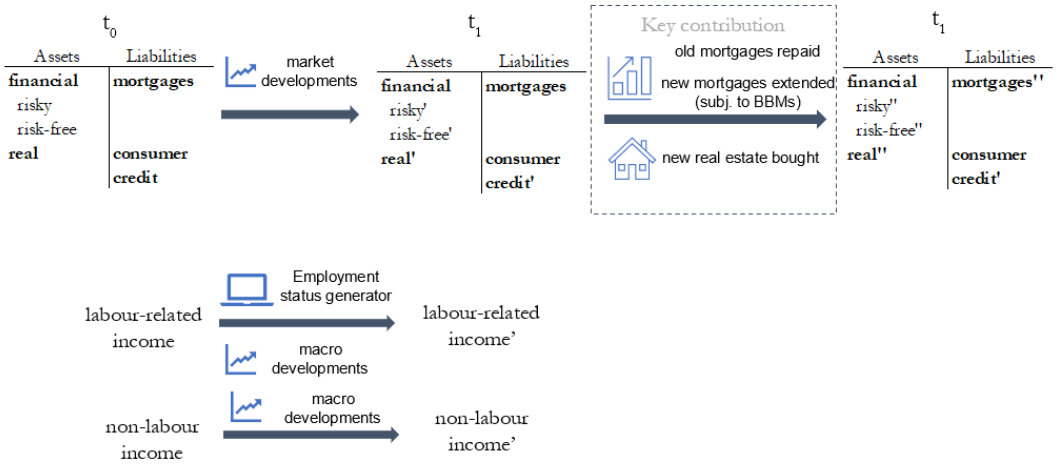
3. Simulation framework

3.1. Overview

The framework of this paper is multiperiod and generates simulations of HFCS data on a quarterly basis, using the year of the data collection as a starting point. In every quarter, the age of the household financial respondent (who is a proxy for the age of the household) increases by 3 months, while other demographic variables (education, gender, and household composition) remain constant. This implies that

the I abstract away from changes due to new household formation, divorces, births, and deaths. Those events, although obviously important for those that are subject to them, are relatively infrequent for the time window of the simulations (2-3 years) so the bias introduced by abstracting from them is rather contained.[6]

Figure 1: Overview of the simulation framework steps for one period and their impact on household balance sheets and income sources.



The key idea underpinning the simulation framework of this paper is that households are inert with respect to all aspects of their financial assets and liabilities, with the crucial exception of mortgages, where they make an active decision in every quarter as to whether they should get a new mortgage or not. As this decision depends on household's financial situation and its income, the framework in every quarter proceeds in three steps (Figure 1). First, assets and non-mortgage liabilities are updated with a static balance sheet approach (see section 3.2). Second, income and consumption are updated with a methodology that follows country-level employment, salary, and nominal consumption developments (see section 3.3). Third, existing mortgages are repaid (see section 3.4). Forth, and conditional on the new, simulated data on assets, consumer credit, employment status, income, and existing mortgages, some households get new mortgages and buy real estate assets with them (see section 3.5). As a final step, I estimate the variables of interest, i.e., loans' debt-to-income ratio (DTI), debt service-to-income ratio (DSTI), loan-to-value ratio (LTV) and a measure of financial distress (see section 3.6).

[6] See Love (2010) for an account of the implications of changes in marital status and of having children for household saving and portfolio choices.

3.2. Simulations of static balance sheet items

In every period, the first step of the methodology is to update the values of each household's financial assets and consumer credit following a static balance sheet assumption (Ampudia et al., 2016a,b, Gross and Población, 2017). According to this, households make no transactions in these parts of their balance sheet and, as a result, the simulated amounts are simple projections of the original amounts, using the relevant macro-level developments. This step is illustrated at the upper left side of Figure 1, which shows the building blocks of the simulation framework.

To perform this part of the simulation, I aggregate the information provided by HFCS into two financial assets (risk-free and risky), a real asset and a consumer credit loan. The risky asset includes shares, business assets, and money owed to households, whereas the risk-free asset contains deposits, bonds, voluntary pension/whole life insurance, and other assets. Moreover, 50% of holdings in mutual funds, pension assets and managed accounts are included in the risky asset the remaining 50% to the risk-free asset, mirroring the fact that these assets are on average rather balanced. Real assets consist of the household's primary residence (when they own their home), other real estate and holdings in vehicles and valuables. In a similar fashion, consumer credit comprises of credit lines/overdrafts, credit cards, and other non-mortgage loans.

Risk-free financial assets are simulated using country-level data on deposit rates of banks, while risky assets and real estate holdings follow the country's stock market and residential real estate prices, respectively. The value of the real estate that households own is updated using the residential price index of the country, assuming that households are restricted from selling their property. Other real assets evolve according to the inflation (country-level Harmonised Index of Consumer Prices - HICP) and consumer credit evolves according to the aggregate change in consumer credit issued by the countries' banks (using Eurosystem's Balance Sheet Items statistics). Finally, I also update consumer credit loans service as follows:

$$LS_t = \frac{L_t}{L_{t-1}} LS_{t-1} + L_t \times \Delta \mathrm{LIR_t}$$

Where LS_t is the service, L_t is the amount of consumer credit outstanding, and $\Delta \mathrm{LIR_t}$ is the change in the country's consumer loan rates.

3.3. Income, taxes, and expenses

As a second step, I simulate household income for the period. I first update the employment status and labour-related income of household members with an approach that is broadly in line with Ampudia et al. (2016a). For retirees and people that are out of the labour market, their status is an absorbing state. Also, all people that belong to the labour force (employed and unemployed) retire at the age of 65.

Regarding the transition between the employed and the unemployed status I estimate micro-level unemployment rates that follow the dynamics of aggregate ones and a Heckman selection model of labour income for every country, controlling for gender, age bracket dummies and education, and using dummies on being a couple and having a child as exclusion restrictions. The output of the model, supplemented by a random component, provides a ranking of household members with respect to their probability of being employed. I use this ranking to increase the number of employed in economies where employment increases, and to turn the status of employed to unemployed in countries where employment conditions deteriorate.

After determining the employment status, I turn to the calculation of gross income amounts. Labour income of persons already employed in the previous quarter is adjusted mechanically according to the evolution of aggregate country-level developments of salary per capita. The newly employed get the salary that is implied by the Heckman model, also adjusted by the macro salary developments, as the amount estimates of the Heckman model refer to the time of data collection. For the newly unemployed and the newly retired, I estimate their income by applying the relevant OECD replacement rates to their past labour income, while existing unemployment benefits and pensions grow according to HICP. Finally, the household income sources that are not related to labour income, namely rents, financial income, social security, transfers and (residual) other income are also updated using the HICP.

Regarding expenses, I update rent payments using HICP and amounts spent on consumer goods and services using the aggregate evolution of country-level nominal consumption. As HFCS does not provide comparable information on taxes and social contributions, I follow Tzamourani (2021) and calculate the sum of taxes and social contributions for each household using the country-specific decile breakdowns provided by EUROMOD statistics (version 5.0+) on the distribution and decomposition of disposable income.

3.4. Repayment of existing mortgages

The key methodological contribution of this paper is that it features repayments of existing mortgages and extension of new ones in each period. For existing mortgages, I make use of the detailed information that HFCS provides on their setup, namely on whether they are ARMs or FRMs, their original and current amount outstanding, their monthly repayment, the interest rate currently paid, the loans' maturity and their year of initiation.

I further assume that mortgages are amortised using the schedule of "French loans", which are typical structures in the euro area (European Central Bank, 2009). The key characteristic of these loans is that repayments of the outstanding amount are slower during the first years of the loan, and they accelerate towards the end. As a result, borrowers pay more interest in the first years, which in the case of ARMs implies payments that are more sensitive to changes in the reference interest rate.

I follow Adalid and Falagiarda (2018) for the equations that govern the calculations of repayments and their breakdown between interest payments and capital repayments. In the case of FRMs, the evolution of the outstanding amount L_t is calculated based on the interest rate i and the mortgage debt servicing payment LS:

$$L_{t+1} = (1 + i)L_t - LS$$

Equivalently, mortgage debt servicing payment can be split into a capital repayment and interest payment for the period (R_{t+1} and IP_{t+1}, respectively):

$$LS = (L_t - L_{t+1}) + i\, L_t \equiv R_{t+1} + IP_{t+1}$$

For ARMs, calculations are complicated by the fact that debt servicing changes every period, due to changes in interest rates (i_t), while the repayment schedule is determined by the interest rate that was prevailing at the time that the mortgage was issued (i_0). Since this information is missing at the household level, I proxy this rate using information on current interest rate of the mortgage and the country-level evolution of ARM interest rates (i_t^c), keeping a constant spread between the two over time:

$$i_0 = i_0^c + (i_t - i_t^c)$$

Using i_0, i_t, and information on current debt servicing LS_t, I then retrieve current repayment:

$$R_t = \frac{LS_t - i_t L_t}{(1 + i_t)}$$

Mortgage debt servicing payment becomes:

$$LS_{t+1} \equiv R_{t+1} + IP_{t+1} = (1 + i_0)R_t + i_{t+1}L_t$$

The formula captures the changes in debt servicing due to changes in interest rates.

Table 1: Regressions used to assign new mortgages to households.

	Has a new mortgage	New mortgage amount (log)
Already has a mortgage	-0.305***	-0.667***
	(0.037)	(0.073)
net worth (IHS)le	0.063***	0.092***
	(0.011)	(0.031)
income (log)	0.175***	0.411***
	(0.024)	(0.055)
unemployed	-0.352***	0.231
	(0.099)	(0.182)
out of job market	-0.057	0.053
	(0.069)	(0.147)
retired	-0.376***	0.056
	(0.096)	(0.215)
education: lower secondary	-0.057	-0.122
	(0.089)	(0.254)
education: higher secondary	-0.097	0.100
	(0.078)	(0.217)
education: tertiary	0.022	0.191
	(0.077)	(0.221)
aged 36-45	-0.260***	-0.118*
	(0.046)	(0.070)
aged 46-55	-0.498***	-0.408***
	(0.047)	(0.078)
aged 56-65	-0.793***	-0.329***
	(0.056)	(0.101)
aged 66-75	-1.172***	-1.179***
	(0.091)	(0.197)
aged above 75	-1.602***	-0.521
	(0.133)	(0.451)
is a couple	0.059	0.061
	(0.036)	(0.067)
is female	0.010	-0.040
	(0.031)	(0.056)
has child	0.039	-0.058
	(0.036)	(0.066)
constant	-4.309***	6.195***
	(0.234)	(0.545)
Obs.	54571	941
R-squared	.z	0.416
Log-likelihood	-3998.822	-1133.443
country dummies	yes	yes

Standard errors are in parenthesis. *** *p<0.01*, ** *p<0.05*, * *p<0.1*

3.5. New mortgages issuance

Given the repayments of existing mortgages, I estimate the aggregate volume of new contracts that needs to be issued to match the evolution of the stock of mortgages that is reported at the country level. The framework then ranks households with respect to the propensity of getting a new mortgage and assigns to each of them the value of the loan and the value of the property they may buy. It also generates the type of mortgage (FRM or ARM) and the relevant interest rate and the amortization schedule. Finally, it caps individual borrowing so that households can afford down payments and that all new loans are in line with any macroprudential borrower-based measures that exist in the country. The remainder of the section provides the details of how these steps are designed.

The propensity of getting a new mortgage is estimated by a probit regression. The explained variable consists of all the new mortgages that households were granted on the year of the HFCS data collection, or the year before (approximately 940 households in the entire euro area dataset). Given the small sample size, I pool the data for all countries and run one probit regression for each data imputation, including country dummies. Explanatory variables include whether the household already has a mortgage, household level income and net worth, household composition variables and the age, occupational status, and education of the household financial respondent. For the amount that will be granted conditional on getting a mortgage, I run an OLS regression of logged amounts on the same explanatory variables.

Results of the regressions for one of the imputations are reported in Table 1. Households with higher income, with higher net worth, and of younger age are more likely to get a mortgage and receive higher amounts if they get it. Employment status matters for the propensity to get a mortgage but not for the amount granted. Also, already having a mortgage decreases the probability to get a new mortgage, as well as the conditional amount. Country dummies capture cross-country differences. Results for the other imputations are very similar.[7]

The fitted values of the regressions, together with a random component, are used to generate a list of candidate new borrowers that are ranked with respect to the probability of getting a mortgage, and to also calculate a tentative mortgage amount for them. I further assign LTV ratios randomly, drawing from a normal distribution

[7] Available upon request.

that has the country mean of LTVs on new mortgages and the variance of the pooled LTV data. I combine the simulated loan amounts and LTVs to infer the values of the real estate that is purchased with these loans. On other loan characteristics, I set the loan duration to be equal to the country average and I assign the fixed/adjustable rate mortgage status randomly, based on the country-level propensities at the time of the data collection.[8] With this information, and the equations of section 3.4, I calculate the monthly payment of the simulated new contract.

As a next step, I cap the tentative loan amounts and/or the downpayments that households need to pay to make sure that households (a) have enough financial assets for the downpayment (budget constraint) and (b) adhere to the limits implied by the macroprudential borrower-based measures that many euro area countries have implemented. The latter set limits to the riskiness of new borrowers by applying caps to indicators such as debt-to-income ratio (DTI), debt service-to-income ratio (DSTI) and loan-to-value ratio (LTV). The methodology of this paper caps new borrowing in ways that respect the main constraints that national competent authorities have established at the country level (see Appendix Table A.1 for the constraints used and European Systemic Risk Board, 2023, for all the measures in place). After applying these occasionally binding constraints, the framework uses the ranking to issue, for each country, mortgages to the households with the highest such probability up to the point that the necessary aggregate amount is generated.

The value of the real estate holdings of the households is then increased accordingly by the amount of the asset purchased. This feature of the framework abstracts away from other motivations for getting a mortgage (e.g., education purposes, vehicle purchases, or consolidation of consumption debts). Still, according to HFCS data, most households got a mortgage to buy or refurbish property, activities that both increase the value of the real estate that they hold.

3.6. Measurement of household debt riskiness

Given the simulation outcomes, each household is linked to four risk indicators:

[8] European Central Bank (2009) and Campbell (2013) report on the heterogeneity of FRM shares in the mortgage markets of euro area countries. Ehrmann and Ziegelmeyer (2017) find that relatively more ARMs are taken out when economic growth is strong, the interest rate spread is high, or unemployment shows low volatility. Albertazzi et al. (2019) provide evidence that FRM shares are higher in countries where historical inflation volatility is lower and the correlation between unemployment and the short-term interest rate is higher. Lower household financial literacy and the use of mortgages to back covered bonds and mortgage-backed securities are also contributing factors.

a. *DTI* measures the level of overall household debt as a share of its income (net of taxes and social contributions). This captures the size of the debt outstanding that the borrower needs to repay.
b. *DSTI* measures the overall borrower debt payments as a share of net income and allows monitoring the impact of debt obligations on household liquidity.
c. *Financial distress* is an indicator that captures cases where the household's financial assets and quarterly income are not sufficient to cover the quarterly payments for taxes, social contributions, consumption of non-durable goods and services and debt servicing. This measure is more comprehensive than debt servicing as it is affected also by the dynamics of nominal consumption (which include inflation) and by the financial resources that households have accumulated in previous periods.
d. *Debt-to-Assets ratio* (*DTA*), which is the ratio of total household debt over the total value of the household's real estate assets. This is an indicator of the level of collateral that can be retrieved for the loans, given that the legal framework of most euro area countries implies that households are liable for their debt regardless of the value of the asset bought with the mortgage (i.e., strategic defaults are not an option).

Table 2: Borrowing rates in the euro area

	FRM mortgage rate	ARM mortgage rates	consumer credit rates	3-month Euribor	Deposit Facility Rate (ECB)
2021 Q4	1.30	1.34	5.11	-0.58	-0.5
2022 Q1	1.47	1.40	5.37	-0.50	-0.5
2022 Q2	1.87	1.68	5.61	-0.24	-0.5
2022 Q3	2.25	2.27	6.49	1.01	0.75
2022 Q4	2.61	3.09	6.51	2.06	2.00
2023 Q1	3.14	3.92	7.63	2.91	3.00
2023 Q2	3.41	4.42	7.03	3.54	3.50
Change between 2022 Q2 and 2023 Q2 (p.p., aggregate and country range)	1.54 [0.20, 2.27]	2.74 [0.33, 3.47]	1.42 [-1.1, 5.34]	3.78 -	4.00 -

Notes: ARM/FRM mortgage rates and consumer credit rates are the average rates of new business in the euro area.

For these measures, we construct distributions that are weighted by loan amounts. Effectively, this is done by multiplying survey population weights with the amount of the outstanding loans that the households hold. This is a departure from the literature, which analyses distributions that weighted only by survey weights and estimates the share of the population that is affected by financial developments. The focus of this paper is instead the riskiness of the stock of household loans in an economy, for which weighting by the loan size in addition to the survey weights is necessary. In terms of statistics, for DTI, DSTI, and DTA, I measure the median of their distribution in the stock of loans and the share of the loan stock for which the indicators are above a certain conventional threshold level (above 5 for DTI, 40% for DSTI and 1 for DTA). I further estimate the share of the loan stock that is owed by households that is in simulated financial distress.

4. Results

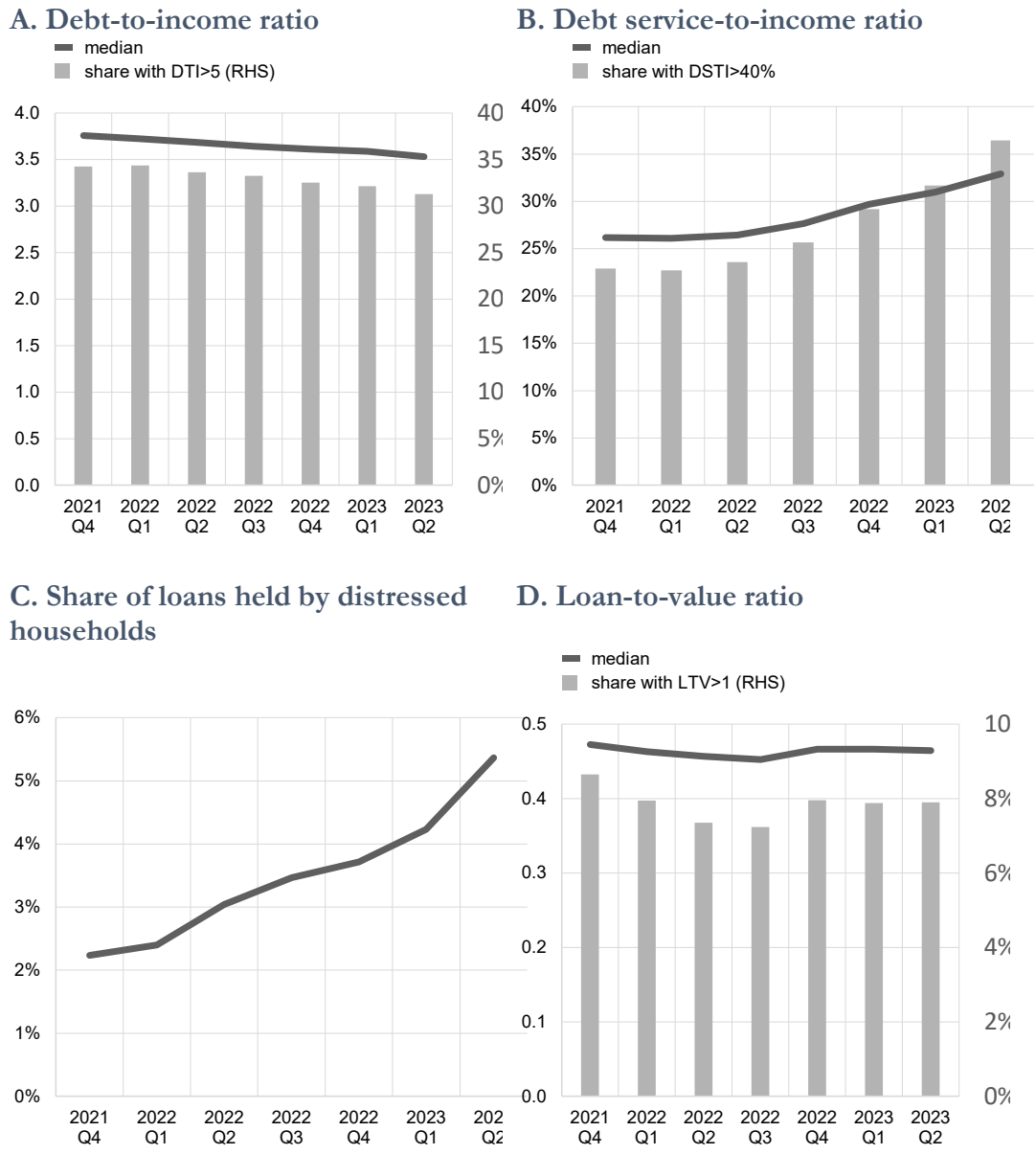
4.1. Macro-financial developments and baseline results

On 27 July 2022, the European Central Bank initiated its monetary policy tightening, which was immediately reflected in the cost of borrowing of euro area households (Table 2). At the euro area level, borrowing rates for new loans increased from 1.42 percentage points for the (most expensive) consumer credit rated to 2.74 percentage points for the (cheaper) ARM rates. Moreover, 3-month Euribor increased by 3.78 percentage points, feeding into the debt servicing costs of existing ARM loans, and contributing to their riskiness in an adverse way.

The simulations suggest that the increase of bank lending rates has put strain on debt servicing of euro area household loans, although the simulated debt burden as a share of income has slightly decreased (Figure 2, panels A and B).[9] Median euro area loan DSTI has increased by 6 percentage points between 2022 Q2 and 2023 Q2, while the share of loans extended to borrowers with DSTI greater than 40% has increased from 26% to 33% in the simulations. On the other hand, the debt burden of household loans, measured by the median DTI, has decreased from 3.8 to 3.5. Also, the share of loans given to households that have debt more than five times the amount of their annual net income also decreasing for 35% to 32%.

[9] HFCS data have been collected at different points in time for each country. As a result, and to include as many countries as possible in the analysis, I present the results of the simulations from 2021 Q4 onwards.

Figure 2: Simulations of riskiness indicators of euro area household loans



Notes: Euro area results refer to the joint distribution of loans from 15 euro area countries. Distributional statistics are weighted using survey weights multiplied by loan weights.

Increase in debt service obligations has translated into an elevated simulated share of loans held by financially distressed borrowers (Figure 2, panel C). As described in the previous section, financial distress is defined as the state where borrowers' financial assets and quarterly gross income are not enough to cover their quarterly expenses. In 2022 Q2, 3.2% of simulated loans were marked as distressed, but this has increased to 5.4% by 2023 Q2.

Developments in real estate asset prices counteract the increases in aggregate debt amounts, with debt as a share of total real estate assets (DTA) remaining relatively stable over the period (Figure 2, panel D). Though this is to be expected for the new loans by construction, the fact that it holds for the stock of loans implies that households tend to have enough collateral for their debt, which is a sign of robustness, even if strategic defaults are not an option for retail borrowers in the euro area.

4.2. Debt type and debt riskiness

As discussed, household debt contracts differ with respect to their sensitivity to interest rate risk. FRMs are issued at market-prevailing interest rates but keep these rates constant over time, while the interest rates of ARMs and consumer credit are fluctuating over time. This implies that an increase in interest rates affects the loan servicing of new FRMs and of all ARMs (new and old) and of all consumer debt. As a result, the riskiness of FRMs is expected to increase more slowly than that that of the other two loan types. First, new FRMs will have higher rates than their older counterparts. Also, although the loan servicing amounts remain constant for old FRMs, the overall debt servicing amounts of the households that hold them may increase, if these households also hold ARMs or consumer debt. Moreover, they may be affected by any adverse changes in income, unemployment, or consumption.

Table 3: DSTI: breakdown by the type of loans

	medians			share of loans with DSTI greater than 40%		
	ARM	**FRM**	**consumer credit**	**ARM**	**FRM**	**consumer credit**
2021 Q4	24%	27%	25%	24%	21%	28%
2022 Q1	24%	27%	26%	23%	21%	28%
2022 Q2	24%	27%	26%	25%	21%	29%
2022 Q3	27%	27%	28%	29%	22%	31%
2022 Q4	32%	27%	29%	37%	22%	35%
2023 Q1	35%	27%	31%	42%	22%	37%
2023 Q2	37%	28%	33%	46%	26%	40%
Change between 2022 Q2 and 2023 Q2	13%	2%	7%	21%	5%	11%

Breaking down the stock of euro area household loans by contract type reveals that ARMs, whose debt servicing indicators were in line with those of FRMs and

consumer credit at the beginning of 2022, have become much harder to service, followed by consumer debt. (Table 3). This result is true for both median DSTIs and the share of loans with DSTI greater than 40%. On the contrary, median DSTI of FRMs has increased only slightly according to the simulations. As new FRMs are issued at more expensive rates, we observe that the share of FRMs with DSTI greater than 40% has somewhat picked up in the simulations. As with the aggregate results, the changes observed are not explained by changes in the DTIs of these subsamples, pointing to the prevailing role of lending rate changes (Table 4).

Table 4: DTI: breakdown by the type of loans

	medians			share of loans with DTI greater than 5		
	ARM	**FRM**	**consumer credit**	**ARM**	**FRM**	**consumer credit**
2021 Q4	3.95	3.83	2.09	36%	35%	24%
2022 Q1	3.89	3.80	2.11	35%	35%	24%
2022 Q2	3.81	3.78	2.12	34%	35%	24%
2022 Q3	3.77	3.74	2.14	34%	34%	24%
2022 Q4	3.73	3.68	2.14	33%	34%	24%
2023 Q1	3.71	3.65	2.13	32%	33%	24%
2023 Q2	3.66	3.62	2.12	31%	33%	24%
Change between 2022 Q2 and 2023 Q2	-0.15	-0.16	0.00	-3%	-2%	0%

The results above carry over to the simulations of distressed loans in the euro area. Table 5 shows that for ARMs there is a stronger increase in the share of distressed loans, followed by consumer credit. FRMs are also not immune to this development, as changes in consumption affect households across the board.

4.3. Loan age and debt riskiness of adjustable-rate mortgages

The assumption that mortgages are amortised using the French loan convention has the implication that increases in interest rates affect more recent ARM holders more than older ones, as for French loans, the share of the monthly payments that cover interest expenses is higher at the early years (Adalid and Falagiarda, 2020). To investigate this, I make a breakdown of ARMs in four cohorts, namely those that were issued before 2007, from 2007 to 2011, from 2012 to 2016 and from 2017 to 2021.

Table 5: Share of distressed loans: breakdown by the type of loans

	ARM	FRM	consumer credit
2021 Q4	3.3%	1.6%	3.8%
2022 Q1	4.4%	2.6%	3.8%
2022 Q2	4.4%	3.1%	4.2%
2022 Q3	4.9%	3.2%	4.3%
2022 Q4	6.0%	3.2%	4.6%
2023 Q1	7.0%	3.4%	6.0%
2023 Q2	7.7%	3.6%	6.5%
Change between 2022 Q2 and 2023 Q2	3.3%	0.5%	2.3%

Debt servicing costs have increased more strongly for recent ARMs (Table 6). Median DSTI of the most recent cohort (issued between 2017 and 2021) has increased by 17 percentage points, against 11-12 percentage points for older cohorts. This pattern is more visible for the share of loans with DSTI above 40%, where there is a reverse relationship between the age of the loan cohort and the increase of the share.

These changes add to the existing differences in riskiness among the cohorts, as the older loans appear to be easier to service. This is related to the overall positive income growth that has decreased DSTI over a longer period. Moreover, loan renegotiations, which were frequently agreed in the years after the European sovereign debt crisis, may have further contributed to this pattern.[10] As in previous sections, the results are not driven by changes in DTI for the sub-portfolios examined (see Appendix Table A.2).

The increase of the simulated share of financially distressed borrowers after the bank lending rate hikes is higher for households that got their mortgage more recently (Table 7). As a result, and despite the fact that ARMs issued between 2012 and 2016 are more likely to be distressed in early 2022 according to the simulations, the most recent ARM cohort is the more likely to be distressed after four quarters of monetary tightening.

[10] Attiná et al. (2020) document the importance of renegotiations for the Italian mortgage market between 2013 and 2017.

Table 6: DSTI of ARMs: breakdown by time of issuance

Panel A: medians

	Before 2007	Between 2007-2011	Between 2012-2016	Between 2017-2021
2021 Q4	19%	21%	25%	28%
2022 Q1	18%	20%	24%	28%
2022 Q2	19%	21%	25%	28%
2022 Q3	21%	24%	28%	32%
2022 Q4	25%	27%	32%	38%
2023 Q1	28%	30%	35%	41%
2023 Q2	30%	32%	37%	45%
Change between 2022 Q2 and 2023 Q2	11%	11%	12%	17%

Panel B: share of ARMs with DSTI above 40%

	Before 2007	Between 2007-2011	Between 2012-2016	Between 2017-2021
2021 Q4	17%	19%	22%	28%
2022 Q1	16%	19%	23%	28%
2022 Q2	16%	20%	23%	31%
2022 Q3	19%	23%	26%	37%
2022 Q4	23%	28%	33%	47%
2023 Q1	28%	33%	39%	52%
2023 Q2	31%	37%	44%	57%
Change between 2022 Q2 and 2023 Q2	14%	17%	21%	26%

5. Concluding remarks

This paper combines the only publicly available, standardised data source for euro area household balance sheets with a novel microsimulation methodology to derive estimates of the riskiness of euro area household loans. It identifies pockets of vulnerability among ARMs, especially the most recent ones, and in consumer credit. The paper provides results that highlight the impact of bank rates and, effectively, monetary policy tightening, on euro area household loans. From a methodological perspective, the highlights the importance of micro-simulation methods for the analysis of developments where heterogeneity of borrower characteristics is pervasive, multiple occasionally binding constraints are important, and medium-term results are of policy relevance.

Table 7: Share of distressed ARMs: breakdown by time of issuance

	Before 2007	Between 2007-2011	Between 2012-2016	Between 2017-2021
2021 Q4	3.0%	3.8%	4.9%	3.1%
2022 Q1	5.3%	3.0%	5.9%	4.8%
2022 Q2	5.3%	2.8%	6.1%	4.8%
2022 Q3	5.8%	3.1%	6.5%	5.4%
2022 Q4	6.3%	4.1%	7.0%	7.2%
2023 Q1	6.9%	4.7%	7.9%	8.8%
2023 Q2	7.4%	5.7%	8.3%	9.8%
Change between 2022 Q2 and 2023 Q2 (p.p.)	2.1%	2.8%	2.2%	5.0%

The results of this paper provide a useful benchmark for academics, policy makers and banking supervisors that are interested in a potential build-up of non-performing loans in the current conjuncture. It can be extended to add more realistic country-specific institutional details and can be applied for stress testing purposes. More behavioural aspects can also be considered, such as heterogeneous household reactions in their propensity to consume, real assets liquidations to service debt and renegotiations. In principle, the framework can also be extended to assess the impact of the introduction of macroprudential borrower-based measures. Any work on that front, however, would need to carefully model the impact of such measures on credit flows and the related repercussions for all the macroeconomic and financial variables that are used as input for the model.

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Appendix

Table A.1: Borrower-based macroprudential measures

	LTV limit	DSTI limit	DTI limit
Austria	0.90	0.4	-
Belgium	0.90	0.5	9
Cyprus	0.80	0.8	-
Germany	-	-	-
Estonia	0.850	0.5	-
Spain	-	-	-
France	-	0.35	-
Croatia	-	-	-
Luxemburg	1	-	-
Latvia	0.90	0.4	6
Malta	0.90	0.4	-
Netherlands	1.00	0.3	-
Portugal	0.90	0.5	-
Slovenia	0.80	0.5	-
Slovakia	0.80	0.6	8

Notes: See European Systemic Risk Board (2023) for the detailed list of measures.

Table A.2: DTI of ARMs: breakdown by time of issuance

Panel A: medians

	Before 2007	Between 2007-2011	Between 2012-2016	Between 2017-2021
2021 Q4	3.04	3.28	3.39	4.74
2022 Q1	3.00	3.22	3.33	4.66
2022 Q2	2.95	3.15	3.32	4.58
2022 Q3	2.88	3.08	3.31	4.56
2022 Q4	2.85	3.06	3.28	4.53
2023 Q1	2.89	3.04	3.29	4.49
2023 Q2	2.84	2.98	3.24	4.46
Change between 2022 Q2 and 2023 Q2	-0.10	-0.17	-0.08	-0.13

Panel B: share of ARMs with DTI above 5

	Before 2007	Between 2007-2011	Between 2012-2016	Between 2017-2021
2021 Q4	23%	25%	26%	47%
2022 Q1	22%	24%	26%	46%
2022 Q2	21%	23%	26%	45%
2022 Q3	21%	22%	27%	45%
2022 Q4	21%	21%	26%	44%
2023 Q1	20%	21%	25%	43%
2023 Q2	19%	21%	24%	42%
Change between 2022 Q2 and 2023 Q2	-2%	-2%	-2%	-3%

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