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# When Monetary and Macroprudential Policies Tighten Together: Evidence from the Czech Mortgage Market

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# When Monetary and Macroprudential Policies Tighten Together: Evidence from the Czech Mortgage Market

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**Abstract**

This paper examines how mortgage lending adjusts when higher interest rates coincide with tighter borrower-based regulatory constraints. Using loan-level data from the Czech Republic for 2020–2023, we exploit a unique policy sequence that combines rapid monetary tightening with the subsequent re-tightening of LTV, DTI, and DSTI limits in order to trace changes in borrower and loan characteristics among new originations. During the initial phase of tightening, higher interest rates curtailed mortgage lending, yet some adjustment was still possible: new loans started to feature higher downpayments and longer maturities, which partly absorbed the rise in financing costs. As tightening persisted and borrower-based limits were reinstated, these adjustment margins narrowed. Liquidity buffers were depleted, and new lending increasingly reflected financially stronger borrowers with lower leverage and lower default risk. The evidence further shows that while monetary policy primarily reduced lending volumes, it was the re-application of borrower-based limits that improved the risk composition of new loans.

**JEL Codes:** E58, G21, G28, G51.

**Keywords:** Borrower-based limits, household finance, loan-level data, macroprudential policy, monetary policy.

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## 1. Introduction

In the years following the Global Financial Crisis (GFC), aggressive monetary easing led to an extended period of historically low interest rates, during which macroprudential policy tools were widely implemented to temper household leverage and support financial stability (Cerutti et al., 2017; Alam et al., 2019). However, the post-Covid surge in interest rates, driven by renewed inflationary pressures and evolving economic conditions, has pushed macroprudential policy into an operational realm that remains largely uncharted. This development is especially salient for borrower-based measures such as loan-to-value (LTV), debt-to-income (DTI), and debt-service-to-income (DSTI) limits, originally calibrated in an era of cheap credit. Mortgage markets, which typically account for the largest share of household borrowing, are now exposed to higher financing costs that could alter loan affordability, default risk, and overall credit demand in ways diverging from the post-GFC norm. Existing research on these borrower-based measures (BBMs henceforth) has predominantly focused on conditions under low interest rates (Acharya et al., 2022; Hodula et al., 2023; Van Bekkum et al., 2024; Hodula et al., 2025), leaving open critical questions about how they will function when borrowing costs climb significantly.

This paper investigates how the profile of mortgage borrowers changes in response to monetary policy tightening and the reintroduction of borrower-based regulatory limits (LTV, DTI, and DSTI), using rich loan-level data from the Czech Republic. Our analysis examines how tightening affects loan size, borrower liquidity and affordability, risk composition, and collateral values in newly originated mortgages. By leveraging the natural sequence of monetary tightening followed by macroprudential tightening between 2020 and 2023, we provide new evidence on how these tools interact in practice.

Methodologically, we employ a two-step identification strategy that combines propensity score matching with a difference-in-differences framework. In the first step, we match loans originated before and after tightening on observable borrower and contract characteristics to ensure comparability between constrained and unconstrained groups. In the second step, we exploit the sequencing of monetary and macroprudential policy actions to measure relative changes in mortgage outcomes across regimes. Monetary policy exposure is captured by the residual spread between contractual mortgage rates and lagged maturity-matched swap rates, while borrower-based constraints are identified by flagging loans whose LTV, DTI, or DSTI ratios approach or exceed regulatory thresholds.

Our results indicate that the composition of borrowers receiving mortgages changed significantly during the tightening cycle, particularly once both monetary and macroprudential tightening were in place. During the initial phase of monetary policy tightening, when BBMs remained relaxed, we observe that borrowers sought to offset rising interest rates by increasing downpayments, taking on longer maturities, and purchasing higher-value properties. Once BBMs were reinstated and tightened, however, borrower profiles shifted sharply: new loans increasingly went to individuals with stronger income positions, lower leverage, and shorter loan horizons. This pattern reflects a reallocation of new lending toward borrowers with stronger repayment capacity.

We further document that income-based regulatory limits, especially DSTI, appear to interact strongly with monetary policy tightening. As rates rise, DSTI thresholds become more salient, restricting borrowing capacity and leading to a reallocation of credit away from more vulnerable households. The share of high-risk borrowers in the originated pool declines as tightening intensifies, and the average probability of default among new loans falls–especially in the second phase of the tightening cycle. These changes are consistent with heightened screening and self-selection dynamics under dual policy constraints.

Patterns in collateral values reinforce this interpretation. Borrowers pledging a single property tend to purchase cheaper homes over time, while those using multiple collateral assets are better able to maintain financing volumes despite worsening affordability. This suggests that additional collateral acts as a buffer against regulatory and rate-driven constraints.

This study makes three key contributions to the literature on housing finance and macroeconomic policy. First, we provide empirical evidence on how monetary and macroprudential tightening jointly shape the composition of mortgage lending, using a unique episode of sequential policy changes and detailed loan-level data. Second, we document substantial heterogeneity in these responses across borrower income levels, risk profiles, and collateral strategies, underscoring the importance of distributional effects in credit reallocation. Third, our findings highlight the role of DSTI limits as a binding constraint under rising interest rates, particularly for vulnerable borrower segments, and suggest that these limits materially influence the observed structure of credit during tightening cycles.

Our findings have important implications for policy design. The combination of rising interest rates and borrower-based macroprudential measures can lead to sharper shifts in mortgage access, especially among lower-income and higher-risk borrowers. While each tool targets a distinct risk channel, their interaction may unintentionally reinforce selectivity and reduce credit availability for vulnerable groups. These results highlight the need for flexible, cycle-aware regulatory frameworks that account for borrower heterogeneity and the dynamic effects of concurrent policy instruments.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and outlines our contribution. Section 3 provides institutional background on the Czech mortgage market and describes the dataset. Section 4 details the modeling framework and empirical strategy. Section 5 presents the main results and their interpretation. Finally, Section 6 concludes with policy implications and directions for future research.

## 2. Related Literature

The mortgage market plays a critical role in financial stability and the transmission of economic policies, making it a focal point for both monetary and macroprudential regulators. Research has shown that fluctuations in credit availability and house prices can amplify economic cycles, with mortgage debt serving as both a driver of consumption and a source of financial fragility (Mian and Sufi, 2011; Jordà et al., 2015; Mian et al., 2017).

Monetary policy shapes mortgage lending through both price and credit channels, influencing who borrows, on what terms, and under what constraints. While lower policy rates reduce borrowing costs and stimulate demand (Gertler and Karadi, 2015), financial frictions play a key role in how credit is allocated. Tighter monetary policy can reduce loan origination by weakening bank balance sheets (the bank lending channel) or eroding borrower collateral and liquidity under the the balance sheet channel (Kashyap and Stein, 2000; Peek and Rosengren, 1995). Loan-level evidence confirms that tighter monetary policy not only reduces lending by financially constrained banks, but also shifts the composition of borrowers and alters lender risk preferences and screening behavior (Jiménez et al., 2012; Di Maggio et al., 2017; Dell'Ariccia et al., 2017). Our analysis builds on this micro-level literature, focusing on how sustained interest rate increases reshape mortgage origination patterns, especially once BBMs are reinstated.

Borrower-based macroprudential policies, such as LTV, DTI, and DSTI caps, have become central to financial stability frameworks, particularly in housing finance. These tools aim to curb excessive household leverage and reduce default risks by limiting credit exposures relative to collateral and income. Cross-country studies confirm their effectiveness in slowing credit growth and dampening housing market cycles (Kuttner and Shim, 2016; Cerutti et al., 2017; Akinci and Olmstead-Rumsey, 2018). Recent studies show that BBMs affect not only aggregate credit growth but also the composition of borrowers and loan terms. Income-based measures like DTI and DSTI often prove more binding than collateral-based LTV caps, especially in periods of rising interest rates (ESRB, 2018; Hodula et al., 2023). Micro-level studies show that BBMs affect borrower behavior through downpayment adjustments, property choices, and loan maturities, with effects varying across income groups, age cohorts, and regions (Araujo et al., 2024, Grodecka, 2020, Hodula et al., 2023, Hodula et al., 2025). We examine how borrower profiles change when BBMs are reinstated during a period of monetary tightening, using loan-level data from the Czech mortgage market.

## 3. Background and Stylized Facts

In this section, we first provide the relevant institutional background of the Czech mortgage market (Section 3.1), followed by a description of the data (Section 3.2) and a set of stylized facts that motivate our analysis (Section 3.3).

### 3.1 The Czech Mortgage Market

Housing is a key pillar of the Czech Republic's economy, representing a significant part of household wealth and the largest segment of the banking sector's loan portfolio. Unlike many other markets, the Czech housing market did not undergo a major correction after the 2008 Global Financial Crisis. Instead, it experienced rapid growth in mortgage lending and property prices between 2015 and 2017, driven by an easing of monetary policy rates (Figure 1). In response to these developments, the Czech National Bank (CNB) introduced a LTV limit in 2015, which was subsequently tightened and supplemented with DTI and DSTI limits in 2018.[1] The CNB progressively tightened its BBMs until 2020, aiming to mitigate systemic risks and prevent overheating in the mortgage market. These measures effectively reduced the size of new loans, particularly among younger and high-income borrowers, while encouraging risk-sensitive pricing among banks (Hodula et al., 2023). The combination of LTV, DTI, and DSTI limits proved more effective in managing risks than using LTV limits alone.

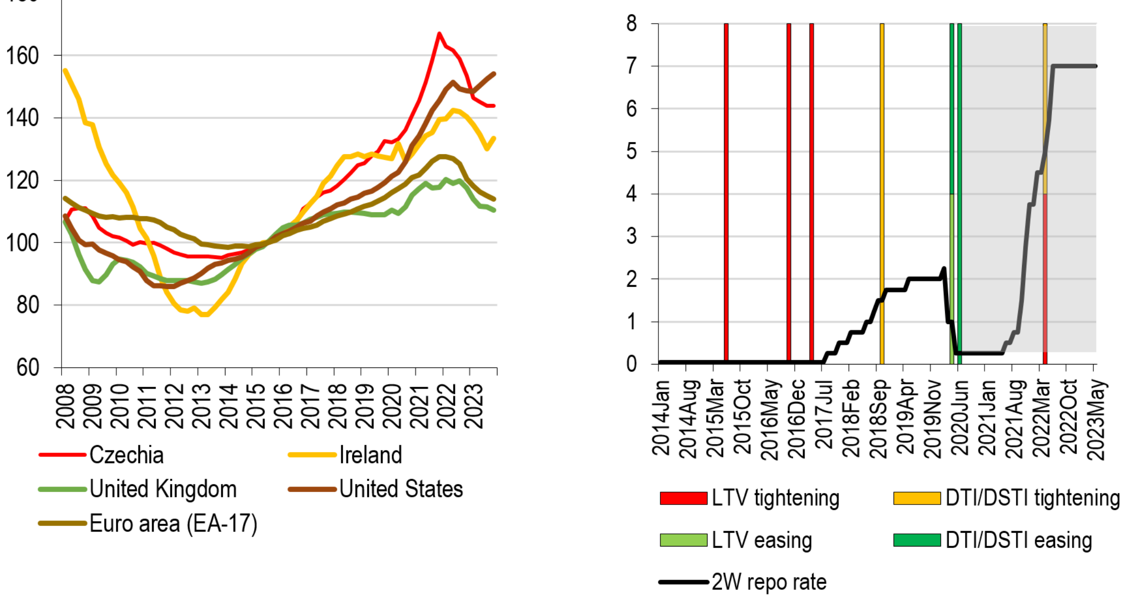
In response to the COVID-19 pandemic, the CNB relaxed these limits in the first half of 2020 to support economic activity, raising the LTV cap from 80% to 90% and abolishing DTI and DSTI limits temporarily. This regulatory easing led to increased mortgage lending, allowing borrowers to access larger loans and purchase more expensive properties, though it also resulted in decreased collateral requirements and increased household leverage, particularly among high-income

[1] Because the Czech legal system did not allow the use of statutory limits at the time of the regulation's implementation, the CNB opted to issue a recommendation that was de-jure non-binding. However, the CNB enforced the fulfillment of the recommended borrower-based limits through clear communication to the banks that any non-compliance would lead to an additional capital requirement under Pillar 2 of Basel III. Compliance was monitored through a mortgage loan survey, and banks were fully compliant as a result.

borrowers (Hodula et al., 2025). Furthermore, the monetary policy rate was cut from 2.25% to 0.25% during the first half of 2020.

***Figure 1: Development Concerning the Mortgage Loan Market***

*(A) House Prices: International Comparison* *(B) Monetary and Regulatory Actions over 2014–2023*



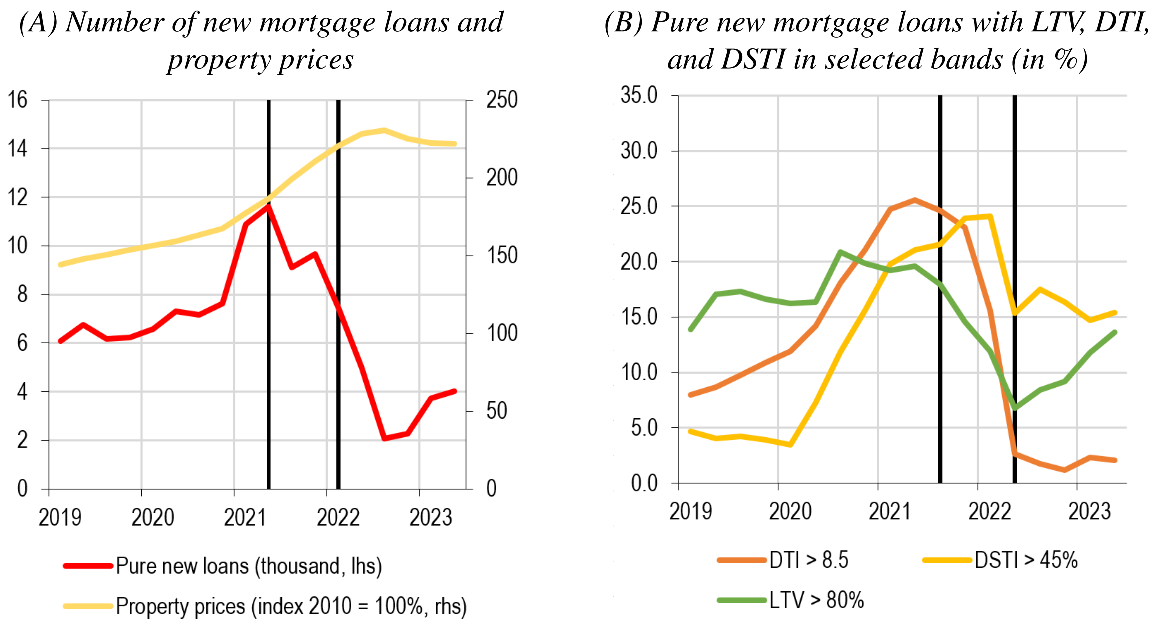

***Note:*** The left-hand figure shows real house prices (2010 = 100) obtained from the OECD database, as expressed by the ratio of nominal prices to the consumer expenditure deflator in each country, both seasonally adjusted. In the right-hand graph, the solid black line denotes the 2-week (2W) repo rate while the columns mark the dates of borrower-based measures tightening/easing. The shaded area marks our analyzed sample period.

After the pandemic, persistent inflationary pressures that emerged across Europe led to a gradual tightening of monetary policy, marked by an increase in the 2-week repo rate from 0.25% to 7%. The period of rapid rate increases coincided with differing regulatory stances, including both loose and tightened BBMs, making it possible to compare their respective impacts on credit dynamics. The shaded area in panel B of Figure 1 highlights this period of interest, highlighting the sequence of monetary tightening followed by the reinstatement of BBMs. Figure A1 zooms in on the period of interesting spanning 2020–2023 as it lists all policy actions throughout the period.

The relaxed BBMs, combined with rising interest rates, led to notable changes in the Czech mortgage market's credit standards. Figure 2 shows a decline in the proportion of loans with LTV ratios above 80%, while lower LTV loans became more common, consistent with higher borrowing costs. Conversely, the share of loans exceeding income-based limits, especially the DSTI ratio, increased significantly. In early 2022, around 26% of new loans had a DSTI above 45%, surpassing previous exemptions.

On April 1, 2022, the CNB tightened BBMS, lowering the LTV cap and reinstating DTI and DSTI limits. Figure 2 provides context: Panel A shows a sharp fall in mortgage originations following the start of the rate hikes in mid-2021 and the early-2022 BBMs reinstatement, while property prices level off. Panel B shows how the composition of new mortgages adjusted to the BBMs tightening: the shares of LTV (>80%), DTI (>8.5), and DSTI (>45%) loans peak in mid-2021 and decline once the limits take effect.

***Figure 2: New Mortgage Loans and Property Prices over the 2019–2023 Period***




***Note:*** The vertical lines denote the begging of the hiking cycle of the CNB in 2021 and the re-introduction of borrower-based limits in 2022.

## 3.2 Data

Our analysis uses loan-level data on mortgage originations in the Czech Republic from June 2020 to May 2023. The primary data source is the semi-annual regulatory survey conducted by the CNB, which collects comprehensive loan-level information on all newly issued residential mortgage loans. These surveys have been conducted regularly since 2015, covering all banks actively engaged in the Czech mortgage market.

The survey data include a wide range of variables, such as loan size, interest rate, collateral value, and LTV, DTI, and DSTI ratios. Borrower-specific details, like age, income, and number of loan applicants, are also available. For multiple applicants on a single loan, borrower information is aggregated, except for age, which pertains to the primary borrower.

To ensure the accuracy of our analysis, we applied a rigorous data cleaning process. We excluded mortgages with implausible values, such as borrower age under 18 or over 70, loan maturities outside the 5-40 year range, and interest rate fixations exceeding 20 years. We also winsorized extreme values (identified at the 1st and 99th percentiles) and discarded records with missing key information, such as postcodes.

In our analysis, we focus exclusively on new mortgage loans and exclude refinanced loans. For refinances, the dataset does not allow us to observe the timing of the original loan origination, which makes it impossible to consistently assign these contracts to the relevant monetary and macroprudential policy regimes. Moreover, borrower-based macroprudential measures generally do not apply to refinanced loans when the principal amount is unchanged, meaning that refinances are not subject to the same policy constraints as new originations. In addition, refinancings within the same bank (refixes) are not recorded in the survey, resulting in only partial coverage of refinancing activity. Restricting the sample to new mortgage loans therefore ensures a consistent, policy-relevant flow of originations and allows for cleaner inference on how monetary and macroprudential policies are reflected in the composition of newly granted credit.

### 3.3 Sample Period

Table 1 summarizes our 2020–2023 window, whose sequencing of policy actions underpins the analysis. Our Control Period spans from June 1, 2020, to June 1, 2021, characterized by a loose monetary policy (2-week repo rate stood at 0.25%) and BBMs that included a 90% LTV limit with a 5% volume exception, no DTI limit, and a DSTI cap that was removed on July 8, 2020. During this period, mortgage borrowing conditions were relatively unrestricted. The Post 1 Period, from August 1, 2021, to March 31, 2022, witnessed the start of monetary policy tightening, with the 2-week repo rate increasing from 0.25% to 5%, while BBMs remained loose. Despite the significant tightening of monetary conditions, BBMs did not tighten until the announcement on November 26, 2021, with the new limits set to take effect on April 1, 2022. Finally, the Post 2 Period, from May 1, 2022, to May 1, 2023, reflects a period following the reinstatement of borrower-based limits under already tight monetary conditions. The 2-week repo rate ranged from 5% to 7%, and strict BBMs were enforced: an LTV cap reduced to 80% (with an exception for up to 90% for certain borrowers), a DSTI limit of 45% (with an allowance up to 50%), and a DTI cap of 8.5 (9.5 for clients under 36).

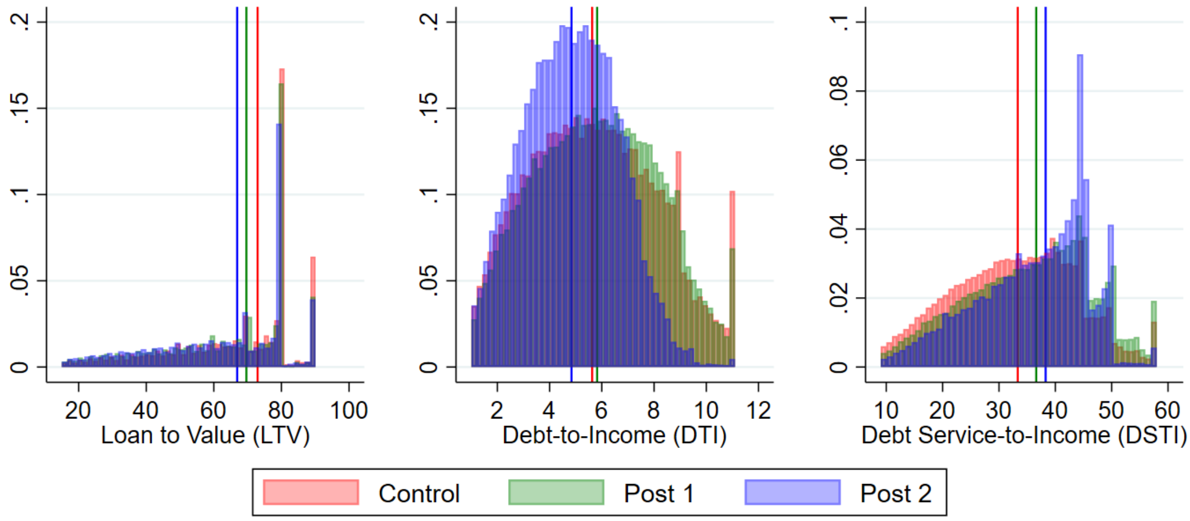
***Table 1: Control and Treatment Periods***

| Period | 2W repo | BBMs | Date | State |
|---|---|---|---|---|
| Control | 0.25% | LTV 90% (5% volume excp.)* | 1.6.2020–1.6.2021 | Loose MP & BBMs |
| Post 1 | 0.25–5% | LTV 90% (5% volume excp.)** | 1.8.2021–31.3.2022 | MP tightening & BBMs loose |
| Post 2 | 5–7% | LTV 80% (90%); DSTI 45% (50%); DTI 8.5 (9.5)*** | 1.5.2022–1.5.2023 | MP & BBMs tightening |

***Note:*** * DSTI limit removed completely by 8.7.2020; before 50% with 5% volume exception. At the same date, LTV limit on buy-to-rent eased to 90%. No DTI limit during this period.
** During this period, specifically on 26.11.2021, tightening of BBMs was announced. The announced limits were effective from 1.4.2022.
*** Numbers in brackets refer to limits for clients below 36 years.

Figure 3 illustrates how the distribution of underwriting ratios among newly originated mortgages evolved across the three policy phases. The LTV distribution shifts steadily toward lower values, reflecting both higher funding costs and the stricter cap introduced with BBMs tightening. The DTI distribution initially shifts upward in Post1, when only monetary tightening is in force, consistent with households stretching their incomes to access loans despite rising rates. In Post2, however, the distribution shifts back down as the DTI cap becomes binding. The DSTI distribution rises sharply with higher interest rates, and following the April 2022 BBMs reintroduction a clear bunching emerges at the 45% threshold, showing how the new cap constrained origination.

***Figure 3: Changing Distribution of LTV, DTI, and DSTI During the Sample Periods***




***Note:*** The histograms illustrate the distribution of mortgage loans based on Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt-Service-to-Income (DSTI) limits across three periods. The vertical lines denote median values for each period, highlighting shifts in borrowing patterns as macroprudential and monetary policy conditions evolved.

Table A1 shows means across mortgage and client characteristics across the different periods. Notably, the Loan-to-Value (LTV) ratio decreases from 65.46% in the Control Period to 61.32% in Post 2, indicating a shift towards more conservative lending standards. Simultaneously, the Debt Service-to-Income (DSTI) ratio rises from 32.56% to 36.19%, showing that borrowers faced higher repayment burdens as bank interest rates increased sharply from 2.09% to 5.55%.

These shifts are accompanied by an increase in the average log of downpayments and monthly payments, suggesting that borrowers had to commit more upfront capital and shoulder higher servicing costs. Furthermore, the reduction in loan fixation periods from 6.33 to 5.45 years implies a growing preference for shorter-term interest rate fixations in a rising rate environment. These differences provide a compelling backdrop for our analysis, as they illustrate how tightening conditions may have altered borrower behavior and risk profiles in the Czech mortgage market.

## 4. Methodology

In this section, we set out the empirical strategy used to assess how monetary policy tightening and borrower-based macroprudential measures shaped the composition of new mortgage lending. Our central research question is how this dual tightening affected the characteristics and composition of newly originated mortgage loans.

Several features of our dataset and policy environment shape the methodology. First, the mortgage survey provides rich information on borrower and loan characteristics at origination, but we observe each loan only once, precluding panel methods and requiring careful controls for unobserved heterogeneity. Second, because the data cover only successfully originated loans, not denied or withdrawn applications, we capture policy effects through shifts in the composition of accepted borrowers rather than through overall approval rates. Third, both monetary policy and

BBMs changes are economy-wide shocks, leaving no clean "untreated" control group. We exploit cross-sectional variation in exposure across borrowers and banks and variation over time around policy changes, while accounting for anticipation around announcements.

### 4.1 Identification of Treated Borrowers

Because both monetary and borrower-based policies apply to the entire market, we exploit cross-sectional differences in exposure to identify the borrowers most affected by each policy. We classify loans that faced systematically higher borrowing costs relative to market benchmarks as *monetary-policy constrained*. For borrower-based measures, we simply flag loans that exceed the CNB's regulatory thresholds on LTV, DTI, or DSTI ratios, making use of the Czech "soft limit" framework that allows banks to allocate a fraction of lending above the caps.

**Monetary Policy Constrained Borrowers.** To measure exposure to monetary tightening at the loan level, we compare each mortgage's contractual interest rate with a maturity-matched market benchmark. Specifically, for loan $i$ originated in month $t$ with fixation maturity $m$, we compute the spread:

$$s_{it} = r_{it} - \mathrm{IRS}_{m,t-4}, \tag{1}$$

where $r_{it}$ is the interest rate charged on the loan and $\mathrm{IRS}_{m,t-4}$ is the $m$-year interest rate swap observed four months earlier. Aligning maturities ensures that differences in contractual fixation structures do not mechanically drive spreads, while the four-month lag captures the empirically observed delay between CNB policy rate changes and banks' mortgage pricing (see Table A2 and Figure A3).[2] The resulting spread $s_{it}$ reflects the residual cost of borrowing after accounting for maturity premia and the typical pass-through lag.

We classify a loan as *monetary-policy constrained* if its spread lies above the median value in the post-treatment periods. This thresholding delivers a transparent, relative measure of which borrowers faced systematically higher borrowing costs once monetary policy tightened. To ensure robustness, we later verify that our results are stable to alternative thresholds (60th–90th percentiles) and to defining treatment using within-bank residual spreads.

We then match each constrained borrower to a pre-tightening loan with similar observable characteristics: loan size, LTV, DTI, DSTI, borrower income and age, maturity, fixation, bank, and region. This one-to-one propensity-score matching (caliper 0.01) ensures that for every borrower identified as constrained ex-post, we have a counterpart in the pre-treatment period with closely comparable observable characteristics.

As a result, when we later compare outcomes across periods, we are not simply contrasting "high-spread vs. low-spread" borrowers, but rather asking: how did otherwise similar loans evolve once monetary policy tightened? Conditional on the matching covariates, variation in $s_{it}$ primarily reflects differences in pricing relative to the swap benchmark. We interpret it as exposure to monetary tightening through bank pass-through

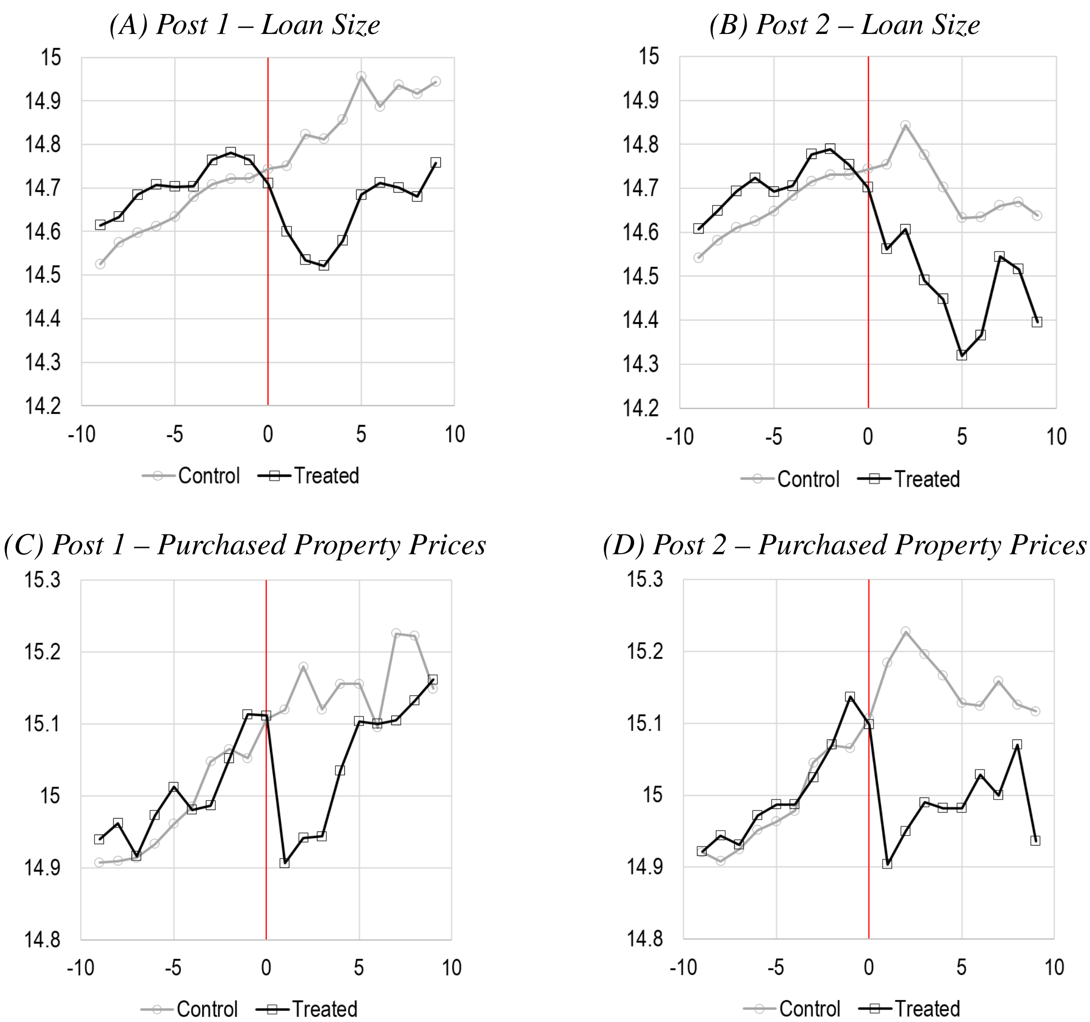
Diagnostics reported in Appendix B confirm that the matching delivers balanced samples. This matching design is central to our identification strategy, because it provides the counterfactual

[2] The four month lag of policy pass-through echoes to international findings of Hristov et al. (2020) and Czech-specific results of Gregor et al. (2022).

missing in an economy-wide shock: the same type of borrower, observed before and after policy takes hold.

Figure A4 shows the distribution of MP constrained borrowers over time, together with the evolution of the average mortgage rate. The share of constrained borrowers increases during periods of significant policy tightening, consistent with higher borrowing costs. The decline observed in the second post-treatment period likely reflects a combination of affordability constraints and the reintroduction of tighter borrower-based macroprudential regulations, which reduced the pool of eligible borrowers.

***Figure 4: Dual Policy Tightening and Average Loan Size: Nonparametric Evidence***




***Note:*** Each panel shows average outcomes for MP-constrained and unconstrained borrowers during the pre-treatment periods. Panels A and B report average loan size, while Panels C and D report the average property price of the purchased house (not aggregate house prices). Constrained borrowers are defined as those with an above-median spread over IRS (see Section 4.1). Vertical lines mark the beginning of the tightening periods.

Figure 4 plots the average loan size and the average purchased property price for constrained and unconstrained borrowers during the pre-treatment periods. Panels A and B focus on loan size, while Panels C and D focus on property prices. In all cases, trajectories are broadly parallel before the tightening episodes, suggesting that constrained and unconstrained borrowers were evolving similarly prior to intervention. This pattern supports the validity of our empirical approach and reduces concerns that subsequent differences are driven by pre-existing divergent trends.

**BBM-Constrained Borrowers.** To identify exposure to borrower-based regulations, we fix the regulatory thresholds introduced in Post 2 and apply them consistently across all periods. A loan is classified as BBM-constrained if its loan-to-value (LTV), debt-to-income (DTI), or debt-service-to-income (DSTI) ratio exceeds these caps: LTV $> 80\%$; DTI $> 8.5$ (9.5 for borrowers under 36); DSTI $> 45\%$ (50% for borrowers under 36). By revealed preference, borrowers taking loans above these cutoffs are identified as constrained (Van Bekkum et al., 2024; Hodula et al., 2025).

An important feature of the Czech framework is the combination of "soft" and "hard" caps: banks may allocate a fixed share of their portfolio to mortgages exceeding the caps. This means that even in Post 2, some loans are observed above the thresholds, allowing us to directly study their outcomes relative to unconstrained borrowers. This feature is essential for our design, since it provides within-period variation in regulatory exposure.

In the next step, we integrate the two dimensions of exposure. We first examine outcomes for monetary-policy constrained borrowers alone. We then interact the monetary policy and BBMs classifications to ask whether dual exposure generates different effects than monetary policy tightening in isolation. This sequential approach allows us to distinguish the incremental role of BBMs rules in shaping mortgage market outcomes.

## 4.2 Model Specification

We estimate the following specification:

$$Y_{i,t} = \beta_1 \left(Post_t \times MP_i^C\right) + \gamma' X_{i,t} + \alpha_{b\times t} + \alpha_{l\times t} + \varepsilon_{i,t} \tag{2}$$

Here, $Y_{i,t}$ represents the outcome variable for borrower $i$ at time $t$, such as the logarithm of the mortgage loan amount. $Post_t$ is a dummy variable indicating the post-treatment period (either Post 1 or Post 2), and $MP_i^C$ is a dummy variable indicating whether borrower $i$ is constrained by monetary policy. The interaction term $Post_t \times MP_i^C$ captures the differential effect of the policy tightening on constrained borrowers. The vector $X_{i,t}$ includes borrower characteristics such as age deciles, income deciles, employment status, number of loan applicants, loan maturity, and fixation period. We incorporate bank-by-month fixed effects $\alpha_{b\times t}$ to absorb any unobserved heterogeneity across banks, including both time-invariant characteristics (such as business models and risk tolerance) and time-varying factors (such as changes in funding costs or lending strategies). Additionally, district-by-month fixed effects $\alpha_{l\times t}$ control for local economic conditions and housing market dynamics that evolve over time.[3]

To further analyze the impact of BBMs constraints, we extend the model by including additional interaction terms:

$$Y_{i,t} = \beta_1 \left(Post_t \times MP_i^C\right) + \beta_2 \left(Post_t \times MP_i^C \times BBM_i^C\right) + \gamma' X_{i,t} + \alpha_{b\times t} + \alpha_{l\times t} + \varepsilon_{i,t} \tag{3}$$

[3] Standalone terms for $Post_t$ and $MP_i^C$ are absorbed by the fixed effects.

In this extended specification, $BBM_i^C$ is a dummy variable indicating whether borrower $i$ is constrained by BBMs. The triple interaction term $Post_t \times MP_i^C \times BBM_i^C$ allows us to examine the combined effect of monetary policy tightening and BBMs on constrained borrowers.[4]

We estimate separate regressions for each BBMs (LTV, DTI, and DSTI) to explore their individual impacts. We repeat the estimation across outcomes capturing loan size, pricing, borrower risk, liquidity, and collateral. Additionally, we conduct heterogeneity analyses by splitting the sample based on borrower income levels, risk profiles, and bank characteristics to understand how the effects of policy tightening vary across different segments of the market.

To interpret the coefficients, the parameter $\beta_1$ on the interaction term $\text{Post}_t \times MP_i^C$ represents the difference-in-differences estimate of the effect of monetary policy tightening on MP-constrained borrowers, relative to unconstrained borrowers in the same period. In the extended specification with BBMs, the coefficient $\beta_2$ on the triple interaction term $\text{Post}_t \times MP_i^C \times BBM_i^C$ captures the additional effect for borrowers who are constrained by both monetary policy and BBMs, relative to those constrained by neither or only one of the policies. This term allows us to assess whether the combined constraints have an incremental impact beyond their individual effects.

**Robustness Checks.** To ensure the robustness of our findings, we perform several additional analyses. First, we test different thresholds for classifying borrowers as MP constrained, such as the top 40% or 60% of the interest rate differential distribution, to examine whether our results are sensitive to the chosen cutoff points. Second, we conduct placebo tests by assigning pseudo-treatment periods where no policy changes occurred. This helps verify that our results are not driven by underlying trends or unrelated factors. Third, we employ alternative matching techniques, including nearest-neighbor matching and kernel matching, to assess whether our results hold across different matching algorithms and are not an artifact of the specific method used. Lastly, we analyze subsamples based on borrower characteristics, such as distinguishing between first-time buyers and repeat buyers, as well as varying loan purposes, to explore whether the effects differ across different groups. By conducting these robustness checks, we aim to strengthen the validity of our conclusions and demonstrate that our findings are consistent across various specifications and samples.

# 5. Results

This section presents the empirical results on how monetary and borrower-based macroprudential tightening affected the composition of newly originated mortgage loans. To structure the discussion, we group the outcomes into four *observable adjustment margins* commonly examined in the literature: (i) loan size, (ii) loan conditions and borrower liquidity, (iii) borrower risk composition, and (iv) collateral values and property characteristics.

## 5.1 Loan Size and Origination Patterns

Table 2 reports estimates for the logarithm of new mortgage amounts during Post 1 and Post 2. The specification focuses on the interaction between monetary policy tightening and borrower

[4] For parsimony, standalone terms ($\text{Post}_t$, $\text{MPC}_i$, $\text{BBM}_i$) and lower-order interactions (e.g., $\text{Post}_t \times \text{BBM}_i$, $\text{MPC}_i \times \text{BBM}_i$) are included in the estimation but omitted from the display; $X_{it}$ contains borrower/loan controls (income, age, LTV, DTI, DSTI, maturity, fixation, applicants); $\mu_{b\times t}$ and $\lambda_{\ell\times t}$ are bank×month and location×month fixed effects. Coefficients of interest are $\beta_1$ (monetary policy tightening) and $\beta_2$ (increment under joint monetary and borrower-based measures tightening).

heterogeneity, proxied by BBMs thresholds. In our setup, MP-constrained borrowers are identified by their higher sensitivity to rate increases (see Section 4.1), while BBM-constrained borrowers are defined ex ante based on regulatory ratios (LTV, DTI, DSTI). This design allows us to address two questions: (i) whether monetary tightening alone disproportionately affects borrowers that would later fall under regulatory scrutiny (Post 1, before BBMs were binding), and (ii) whether the joint imposition of BBMs and higher rates amplifies these credit supply effects once both tools operate simultaneously (Post 2).

The negative and significant interaction $Post_t \times MP_i^C$ indicates that monetary policy tightening reduces loan amounts for borrowers more exposed to interest-rate increases. Quantitatively, after the policy rate hikes in Post 1, loan amounts fell by about 0.9% more for MP-constrained households relative to unconstrained ones, holding other factors constant. When we interact this with ex ante BBMs thresholds, the heterogeneity becomes sharper: borrowers with high DTI or DSTI ratios reduced their loan amounts by an additional 3.8% and 5.4%, respectively. In contrast, the triple interaction with LTV is insignificant, suggesting that income-based limits matter more for interest rate sensitivity than collateral constraints. Because BBMs were not yet binding in Post 1, this pattern indicates that borrowers who later fall above BBMs thresholds are more sensitive to monetary tightening. This pattern supports our interpretation of the BBMs thresholds as a useful way to identify ex ante heterogeneity in monetary policy transmission.

In the Post 2 period, when both monetary tightening and BBMs limits were simultaneously in force, the contraction in credit supply becomes more pronounced. Both the double interaction $Post_t \times MP_i^C$ and the triple interactions $Post_t \times MP_i^C \times BBM_i^C$ remain negative and statistically significant. Borrowers who are jointly exposed to higher rates and binding regulatory caps experience the largest decline in loan amounts. For borrowers constrained by DTI (DSTI), the cumulative reduction in loan size reaches roughly 10.6% (7.3%) relative to comparable unconstrained borrowers. This pattern indicates that once BBMs caps become binding, banks further restrict credit supply to households already sensitive to interest-rate shocks, further shifting new originations toward smaller loan amounts.

To test whether these effects depend on the chosen treatment threshold, we re-estimate the model using progressively tighter definitions of MP-constrained borrowers. Figure C1 confirms that the negative impact on loan size intensifies monotonically as the cutoff rises—from the top 40% to the top 10% of the spread distribution. Borrowers facing the highest effective borrowing costs thus experience the most pronounced credit contraction, reinforcing that our baseline results reflect genuine exposure to monetary tightening rather than arbitrary group assignment.

***Table 2: Regression Results for Log-Amount of New Mortgage***

Panel A: Post 1 Period

| | (1) MP constrained only | (2) LTV constrained | (3) DTI constrained | (4) DSTI constrained |
|---|---|---|---|---|
| $MP_i^C$ | 0.000 | 0.001 | -0.002 | -0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $Post_t \times MP_i^C$ | -0.009*** | -0.007* | -0.005 | -0.004 |
| | (0.003) | (0.004) | (0.004) | (0.004) |
| $BBM_i^C$ | | 0.118*** | -0.004 | -0.008* |
| | | (0.003) | (0.004) | (0.004) |
| $Post_t \times BBM_i^C$ | | -0.035*** | 0.039*** | 0.064*** |
| | | (0.004) | (0.006) | (0.006) |
| $MP_i^C \times BBM_i^C$ | | -0.002 | 0.022*** | 0.033*** |
| | | (0.005) | (0.007) | (0.008) |
| $Post_t \times MP_i^C \times BBM_i^C$ | | 0.001 | -0.038*** | -0.054*** |
| | | (0.007) | (0.010) | (0.010) |
| Location-month FEs | Y | Y | Y | Y |
| Bank-month FEs | Y | Y | Y | Y |
| Borrower-level controls | Y | Y | Y | Y |
| $N$ | 128,992 | 128,992 | 128,992 | 128,992 |
| adj. $R^2$ | 0.893 | 0.896 | 0.893 | 0.894 |

Panel B: Post 2 Period

| | (1) MP constrained only | (2) LTV constrained | (3) DTI constrained | (4) DSTI constrained |
|---|---|---|---|---|
| $MP_i^C$ | -0.009*** | -0.008*** | -0.011*** | -0.013*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $Post_t \times MP_i^C$ | -0.048*** | -0.045*** | -0.045*** | -0.043*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $BBM_i^C$ | | 0.126*** | -0.000 | -0.006 |
| | | (0.003) | (0.003) | (0.004) |
| $Post_t \times BBM_i^C$ | | -0.039*** | 0.093** | 0.092*** |
| | | (0.008) | (0.042) | (0.015) |
| $MP_i^C \times BBM_i^C$ | | -0.006 | 0.028*** | 0.037*** |
| | | (0.006) | (0.008) | (0.009) |
| $Post_t \times MP_i^C \times BBM_i^C$ | | -0.026** | -0.106** | -0.073*** |
| | | (0.011) | (0.051) | (0.020) |
| Location-month FEs | Y | Y | Y | Y |
| Bank-month FEs | Y | Y | Y | Y |
| Borrower-level controls | Y | Y | Y | Y |
| $N$ | 101,890 | 101,890 | 101,890 | 101,890 |
| adj. $R^2$ | 0.887 | 0.890 | 0.887 | 0.887 |

***Note:*** The table shows regression results of equation (2) and (3). $MP_i^C$ and $BBM_i^C$ represent monetary policy and borrower-based measures constrained borrowers as identified in Section 4.1. Borrower-level controls include: borrower age deciles, income deciles, employment status, number of loan applicants, loan maturity, and fixation period. Standard errors, reported in parentheses, are clustered at the mortgage level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

**Heterogeneity Across Borrowers and Banks.** To examine whether credit supply effects differ systematically across borrowers and lenders, we analyze heterogeneity along two dimensions: (i) borrower income and risk profile, and (ii) bank size and capitalization. This section complements the baseline estimates by identifying which segments of the market are most sensitive to policy tightening.

*Borrower Characteristics:* We begin by splitting the sample by borrower income and ex-ante risk, proxied by the probability of default (PD). The results, summarized in Figure C2, show that lower-income and higher-risk households experience the largest contraction in loan amounts during both tightening phases. In Post 1, when only monetary policy operated, these groups reduced borrowing moderately—consistent with banks tightening standards and borrowers self-selecting into smaller loans as rates rose. In Post 2, when BBMs limits became binding, the contraction intensified sharply. The double and triple interaction terms for low-income and high-risk borrowers are both larger in magnitude, confirming that the joint tightening of monetary policy and BBMs disproportionately affects financially weaker households.

*Bank Characteristics*: We next examine how the lending response varies by bank characteristics. Following the literature on the bank-lending channel (Jiménez et al., 2012; Gropp et al., 2019), we categorize banks by market share and capital headroom. Figure C3 plots the estimated coefficients for borrowers served by smaller and less-capitalized institutions. The results reveal that these banks transmit tightening more strongly: borrowers from smaller or less-capitalized banks experience deeper reductions in loan amounts compared with those borrowing from large or well-capitalized peers.

## 5.2 Loan Conditions and Borrower Liquidity

We next examine how monetary policy tightening and borrower-based measures (BBMs) affected borrowers' liquidity positions and their ability to adjust loan terms. Table 3 reports estimates for key affordability margins—downpayment, debt service, maturity, fixation, and LTV ratios—through the coefficient on $Post_t \times MP_i^C$.

During the initial tightening phase in Post 1, the distribution of originated loans shifted toward higher downpayments and longer maturities, particularly among loans classified as MP-constrained (Table 3, Panel A). Such changes are consistent with a tightening environment in which credit was increasingly allocated to borrowers with greater liquidity buffers or to contracts structured to preserve affordability at higher rates.

When interest rates remained elevated and BBMs were reinstated, the composition of originations changed further. The coefficient on downpayment becomes negative in the Post 2 period (Table 3, Panel B), indicating that new loans involved lower equity shares relative to property value. This pattern suggests diminishing liquidity reserves among the borrowing population observed in the data. Maturities continued to lengthen slightly, but the average debt-service ratio increased, reflecting more limited scope for affordability adjustment. The decline in LTV ratios during this period primarily reflects smaller approved loan amounts rather than higher downpayments. Fixation periods shortened across all groups, consistent with greater repricing flexibility under heightened interest-rate uncertainty.

***Table 3: Regression Results for Liquidity Constraints Channel***

Panel A: Post 1 Period

| Dependent variable: | (1)<br>Downpayment | (2)<br>Debt service | (3)<br>Maturity | (4)<br>Fixation | (5)<br>LTV |
|---|---|---|---|---|---|
| $MP_i^C$ | -0.021 | -0.012*** | -0.009*** | 0.000 | -0.177* |
| | (0.016) | (0.004) | (0.002) | (0.001) | (0.092) |
| $Post_t \times MP_i^C$ | 0.063** | -0.047*** | 0.035*** | -0.014*** | 0.008 |
| | (0.028) | (0.007) | (0.004) | (0.001) | (0.159) |
| Location-month FEs | Yes | Yes | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes | Yes | Yes |
| $N$ | 31,435 | 128,992 | 128,992 | 128,992 | 128,989 |
| adj. $R^2$ | 0.317 | 0.507 | 0.303 | 0.328 | 0.760 |

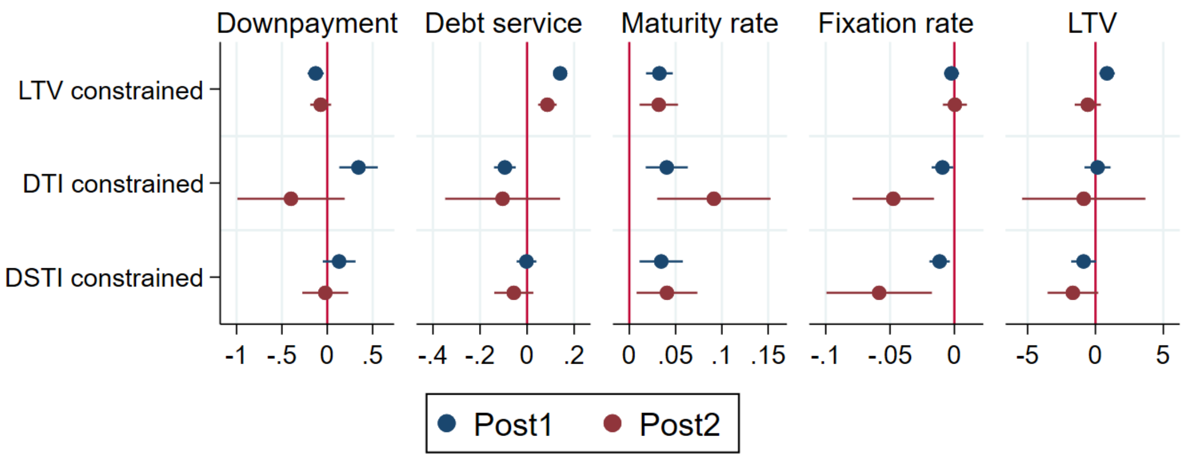
Panel B: Post 2 Period

| Dependent variable: | (1)<br>Downpayment | (2)<br>Debt service | (3)<br>Maturity | (4)<br>Fixation | (5)<br>LTV |
|---|---|---|---|---|---|
| $MP_i^C$ | 0.037* | -0.024*** | -0.027*** | -0.013*** | -0.503*** |
| | (0.020) | (0.005) | (0.003) | (0.001) | (0.116) |
| $Post_t \times MP_i^C$ | -0.085** | -0.013 | 0.011** | -0.023*** | -0.585** |
| | (0.034) | (0.011) | (0.005) | (0.002) | (0.228) |
| Location-month FEs | Yes | Yes | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes | Yes | Yes |
| $N$ | 25,930 | 101,890 | 101,890 | 122,750 | 101,888 |
| adj. $R^2$ | 0.349 | 0.499 | 0.313 | 0.378 | 0.756 |

***Note:*** The table shows regression results of equation (2). $MP_i^C$ represent monetary policy constrained borrowers as identified in Section 4.1. Borrower-level controls include: borrower age deciles, income deciles, employment status, number of loan applicants, loan maturity, and fixation period. Standard errors, reported in parentheses, are clustered at the mortgage level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

The triple-interaction results ($Post_t \times MP_i^C \times BBM_i^C$) reported in Figure 5 show that income-based caps amplified the compositional shifts. Among loans subject to DTI and DSTI thresholds, higher downpayments were more prevalent during Post 1 but declined markedly during Post 2. As interest rates rose, BBMs on income ratios restricted borrowing capacity, shifting new originations toward smaller loans and longer maturities. Unsurprisingly, the strongest compression in maturity and fixation terms occurs for DSTI-constrained loans.

***Figure 5: Regression Results for Liquidity Constraints Channel: The Effect on BBM-Constrained Borrowers***




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3). Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

**Heterogeneity Across Borrowers and Banks.** To assess whether liquidity-related adjustments vary systematically across borrower and lender types, we analyze heterogeneity along two dimensions: (i) borrower income and risk profile, and (ii) bank market share and capitalization.

*Borrower Characteristics:* Figure C4 presents results by *income* and *ex-ante risk* categories. In both dimensions, tightening conditions are reflected in sharper compositional shifts within newly originated loans. The share of loans with higher downpayments and longer maturities increases modestly in Post 1 but declines in Post 2, while average debt-service ratios rise. For lower-income and higher-risk groups, fixation horizons shorten the most, indicating that originations in these categories were more sensitive to prevailing interest-rate conditions. These shifts in observed loan characteristics confirm that liquidity and affordability constraints became a key margin of adjustment in the later phase of the tightening cycle.

*Bank Characteristics:* Figure C5 shows that compositional changes also differ across banks. In Post 1, loans originated by low-share institutions feature higher downpayments and lower LTV ratios, pointing to a more liquidity-conservative composition of lending at smaller institutions during the early stage of monetary tightening. By Post 2, this pattern stabilizes for low-share banks, while high-share banks display stronger declines in LTVs and further maturity extensions, reflecting a broader tightening in loan composition once BBMs limits re-applied. Broadly similar—though less systematic—differences appear when banks are grouped by regulatory capital headroom: loans from low-capital institutions exhibit slightly larger reductions in LTVs and higher debt-service ratios in Post 2.

## 5.3 Risk Composition of New Lending

We examine how the composition of newly originated loans evolved in terms of borrower risk indicators, that is the probability of default (PD) and income-based ratios (DTI, DSTI), across the two tightening phases. Table 4 reports the double-interaction estimates for monetary-policy exposure, while Figure 7 complements these with the triple interactions that incorporate BBMs constraints.

During the initial phase of monetary tightening in Post 1, the risk profile of newly originated mortgages shifted toward higher values. Average borrower PD increased, and both DTI and DSTI ratios rose among new loans as interest rates moved up. These changes occurred before income-based limits were reinstated and reflect adjustments along pricing and affordability margins rather than the direct effect of regulatory caps. As a result, new originations in Post 1 became more concentrated among borrowers with higher repayment burdens and greater exposure to interest rate increases.

When BBMs limits were reinstated in Post 2, the pattern reversed: the PD of newly originated loans declined even as DTI and DSTI ratios remained elevated. The estimated reduction in PD (about three percentage points) reflected a re-sorting of the originated pool toward lower-risk borrowers, consistent with income-based caps shifting new originations away from the highest-risk loans. This decline reflects a compositional shift in new originations rather than a change in underlying default risk in the population.

***Table 4: Regression Results for Risk and Default Channel***

Panel A: Post 1 Period

| Dependent variable: | (1) PD | (2) DTI | (3) DSTI |
|---|---|---|---|
| $MP_i^C$ | -0.015*** | -0.218*** | -0.247*** |
| | (0.006) | (0.015) | (0.090) |
| $Post_t \times MP_i^C$ | 0.035*** | 0.102*** | 1.300*** |
| | (0.009) | (0.027) | (0.139) |
| Location-month FEs | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes |
| $N$ | 127,384 | 128,992 | 128,994 |
| adj. $R^2$ | 0.415 | 0.413 | 0.079 |

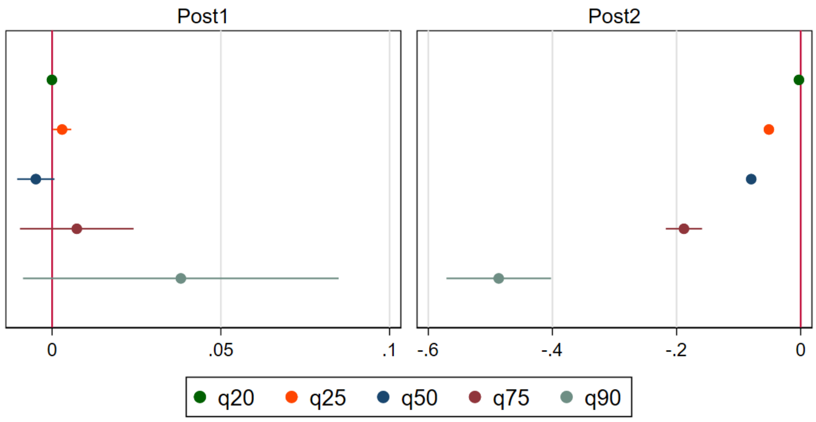
Panel B: Post 2 Period

| Dependent variable: | (1) PD | (2) DTI | (3) DSTI |
|---|---|---|---|
| $MP_i^C$ | -0.013** | -0.202*** | -0.382*** |
| | (0.007) | (0.019) | (0.101) |
| $Post_t \times MP_i^C$ | -0.029** | 0.245*** | 1.722*** |
| | (0.012) | (0.035) | (0.182) |
| Location-month FEs | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes |
| $N$ | 100,650 | 101,890 | 110,194 |
| adj. $R^2$ | 0.444 | 0.412 | 0.079 |

***Note:*** The table shows regression results of equation (2). $MP_i^C$ represent monetary policy constrained borrowers as identified in Section 4.1. Borrower-level controls include: borrower age deciles, income deciles, employment status, number of loan applicants, loan maturity, and fixation period. Standard errors, reported in parentheses, are clustered at the mortgage level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

Figure 6 shows that the increase in PD during Post 1 was concentrated in the upper deciles of the risk distribution, meaning that new originations were skewed toward riskier borrowers as rates first rose. By Post 2, these upper-decile effects turned negative, and high-risk loans nearly disappeared from new originations once BBMs limits became binding.

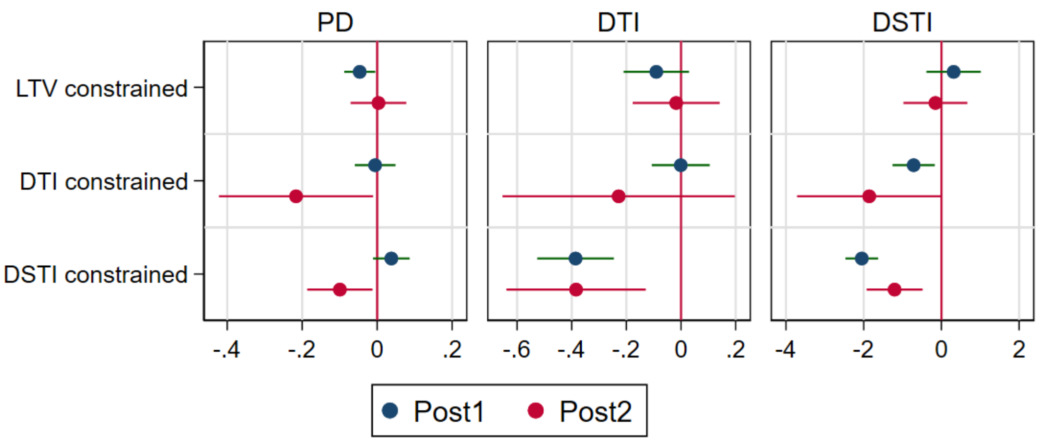
***Figure 6: Regression Results for Risk and Default Channel: Effect on PD Quantile***




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C$ from equation (2) for different quantiles of the client PD. Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

Figure 7 shows that income-based limits, particularly DSTI, are associated with a compression of the upper tail of the DTI and DSTI distributions once the caps are reinstated. This effect is strongest in Post 2, when higher interest rates coincide with binding income-based limits and high-ratio loans largely disappear from new originations. The decline in average PD observed in Post 2 is therefore consistent with a compositional shift driven by the reintroduction of BBMs limits, as newly originated loans become less concentrated among the highest-risk borrowers.

***Figure 7: Regression Results for Risk and Default Channel: The Effect on BBM-Constrained Borrowers***




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3). Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

**Heterogeneity Across Borrowers.** Figure C6 presents how the composition of newly originated loans varied across borrower groups defined by *income* (Panel A) and by whether they held a single or multiple mortgages (Panel B).

*Borrower Income Level:* Among MP-constrained loans, those issued to lower-income borrowers displayed larger increases in DSTI ratios in both tightening phases compared with loans to higher-income borrowers. This pattern shows that new originations among lower-income households became concentrated at higher debt-service levels as policy rates rose, implying tighter affordability conditions within this segment. The effect was stronger in Post 2, when BBMs limits further restricted access to high-DSTI loans. At the same time, the average PD among originated loans declined more for the low-income group in Post 2, reflecting a compositional shift toward lower-risk borrowers once the regulatory caps became binding.

*Single vs. Multiple Mortgages:* Differences also emerged between loans secured by a single property and those backed by multiple collateral assets. In Post 1, loans to single-mortgage borrowers exhibited larger increases in PD, suggesting that new originations in this group were relatively riskier early in the tightening cycle. By Post 2, PDs in this segment fell more sharply, consistent with the exclusion of higher-risk loans from new originations after the reinstatement of BBMs limits. Loans to borrowers with multiple mortgages showed smaller changes in PD, DTI, and DSTI, indicating that the composition of lending to this group remained relatively stable and featured borrowers with stronger repayment capacity or additional collateral.

### 5.4 Collateral Values and Property Characteristics

Table 5 shows how collateral valuations and the purchase prices of financed properties evolved across the two tightening phases. In Post 1, changes in collateral values are limited, while purchase prices decline modestly for MP-constrained loans. These patterns indicate that early monetary tightening was associated with only limited shifts in the value of properties financed in new originations.

By Post 2 (Panel B), both collateral valuations and property purchase prices declined more noticeably. For loans backed by a single property, collateral valuations fell by roughly 5 p.p., and the purchase prices of financed properties declined by about 7 p.p. For loans secured by multiple collaterals, the decline in the purchase price of the newly financed property was considerably larger—nearly 20 p.p.—while the change in total collateral valuation remained small and statistically insignificant. This difference arises because the collateral measure reflects the total appraised value of all pledged assets rather than the value of the purchased property alone. Thus, when borrowers pledge additional properties, the overall collateral valuation is buffered even if the financed property itself is substantially cheaper.

Figure C7 displays the triple-interaction estimates for the combination of monetary-policy and BBMs constraints. The coefficients are small and mostly insignificant across all specifications, indicating that once both policies tightened, the additional interaction term between monetary exposure and BBMs status did not capture any further systematic variation in collateral valuations or purchase prices. T his suggests that the adjustment in property values was a broad feature of the overall tightening environment rather than an incremental effect of specific regulatory thresholds.

***Table 5: Regression Results for Housing Market and Collateral Channel***

Panel A: Post 1 Period

| Variable | Collateral Value | | | House Price | | |
|---|---|---|---|---|---|---|
| | All | Single Coll. | Multiple Coll. | All | Single Coll. | Multiple Coll. |
| $MP_i^C$ | 0.011*** | 0.010*** | 0.006 | 0.004 | 0.005 | -0.011 |
| | (0.003) | (0.004) | (0.007) | (0.005) | (0.006) | (0.013) |
| $Post_t \times MP_i^C$ | -0.019*** | -0.022*** | -0.025* | -0.056*** | -0.066*** | -0.010 |
| | (0.006) | (0.006) | (0.015) | (0.010) | (0.010) | (0.026) |
| Location-month FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes | Yes | Yes | Yes |
| $N$ | 128,988 | 110,943 | 17,933 | 39,768 | 32,304 | 7,220 |
| adj. $R^2$ | 0.602 | 0.580 | 0.650 | 0.686 | 0.695 | 0.675 |

Panel B: Post 2 Period

| Variable | Collateral Value | | | House Price | | |
|---|---|---|---|---|---|---|
| | All | Single Coll. | Multiple Coll. | All | Single Coll. | Multiple Coll. |
| $MP_i^C$ | 0.010** | 0.007* | 0.003 | 0.005 | 0.005 | -0.002 |
| | (0.004) | (0.004) | (0.009) | (0.007) | (0.008) | (0.017) |
| $Post_t \times MP_i^C$ | -0.051*** | -0.049*** | -0.043 | -0.072*** | -0.057*** | -0.193*** |
| | (0.009) | (0.010) | (0.026) | (0.014) | (0.015) | (0.046) |
| Location-month FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank-month FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Borrower-level controls | Yes | Yes | Yes | Yes | Yes | Yes |
| $N$ | 101,887 | 87,898 | 13,795 | 32,498 | 26,488 | 5,687 |
| adj. $R^2$ | 0.588 | 0.570 | 0.641 | 0.676 | 0.684 | 0.674 |

***Note:*** The table shows regression results of equation (2). $MP_i^C$ represent monetary policy constrained borrowers as identified in Section 4.1. Borrower-level controls include: borrower age deciles, income deciles, employment status, number of loan applicants, loan maturity, and fixation period. Standard errors, reported in parentheses, are clustered at the mortgage level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

**Heterogeneity Across Borrowers.** Figure C8 explores how the effects on collateral valuations and property purchase prices differed across borrower income and risk groups.

*Borrower income.* Panel A shows that in Post 1, both collateral values and purchase prices were broadly stable across income groups. In Post 2, a clear divergence emerged: loans to high-income borrowers were associated with a decline in collateral valuations, while the purchase prices of financed properties remained largely unchanged. In contrast, loans to low-income borrowers displayed the opposite pattern—collateral valuations were broadly stable, but the purchase prices of financed properties declined significantly. These differences suggest that, under dual tightening, lending to higher-income borrowers became secured by lower-valued collateral on average, whereas lending to lower-income borrowers became concentrated in cheaper financed properties.

*Borrower risk.* Panel B indicates that collateral valuations and property purchase prices declined for both high- and low-risk borrowers in Post 2, with differences across risk groups being small and statistically insignificant. The broad similarity of coefficients implies that once both monetary and borrower-based measures were active, the composition of new lending shifted toward lower-valued properties across the entire risk distribution rather than being concentrated in a particular risk segment.

## 6. Conclusions

This paper studies a sequence of rapid monetary tightening followed by the reinstatement of borrower-based macroprudential limits, using loan-level data from the Czech mortgage market. We document how this policy sequence is reflected in the composition of newly originated mortgages, including borrower leverage, affordability, and risk.

Monetary and borrower-based macroprudential policies are found to operate through distinct mechanisms. Monetary tightening reduces borrowing capacity, leading to smaller loans, longer maturities, and lower-valued collateral within new originations. The reactivation of BBMs limits reinforced these trends, narrowing the risk profile of new lending and contributing to a shift toward financially stronger borrowers. While the average riskiness of new loans declined, lower-income and higher-risk households became increasingly underrepresented in new originations. At the same time, borrower liquidity evolved unevenly: downpayments initially increased as households with available buffers absorbed part of the rate shock, but later declined as these buffers were depleted, consistent with tighter liquidity among newly originated borrowers.

These findings underscore the need for flexible calibration of BBMs in response to changing macro-financial conditions. When monetary policy is already restrictive, additional tightening through BBMs may provide limited stability gains while amplifying affordability pressures for more vulnerable households. This raises a broader policy question: should borrower-based measures function primarily as structural safeguards, or should they adjust countercyclically alongside monetary conditions? A structural approach enhances predictability, but our evidence suggests that BBMs can become overly constraining in high-rate environments. Allowing for gradual, state-contingent adjustments could help maintain access to sustainable credit during downturns without weakening prudential objectives.

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# Appendix A: Additional Information

***Figure A1: Timeline of the Policy Actions over the 2020-2023 Period***

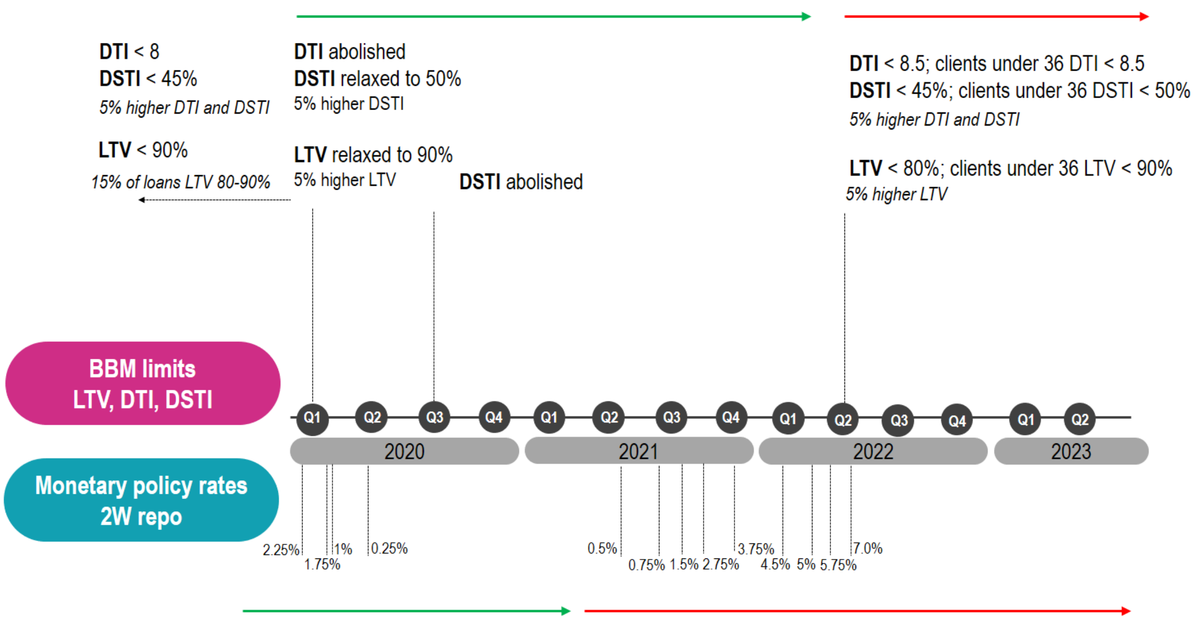
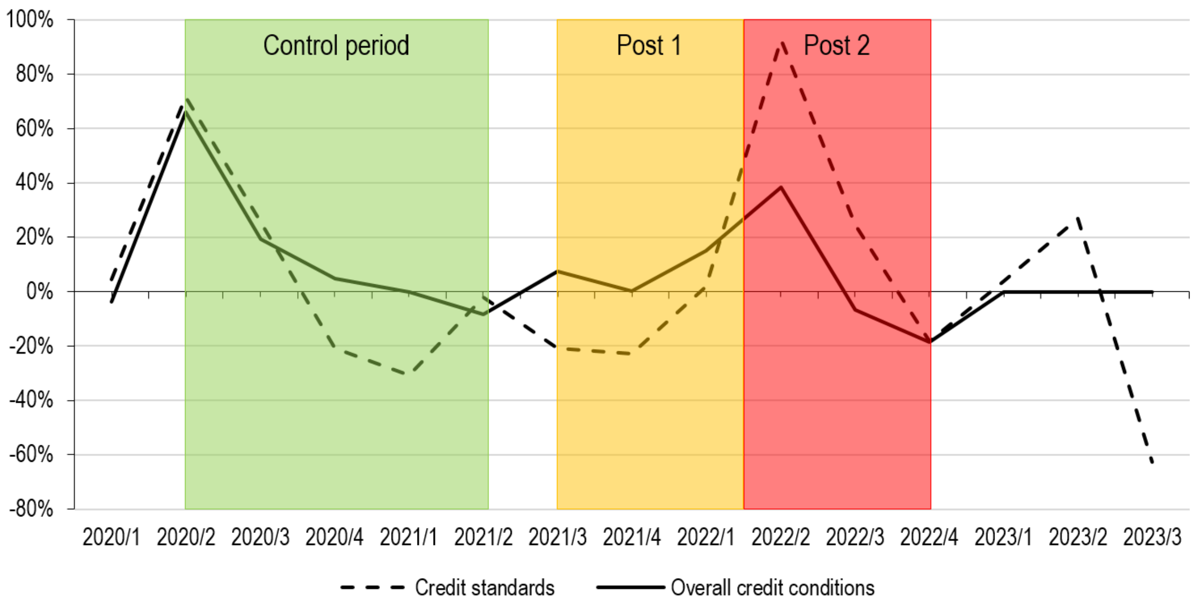



***Figure A2: Insights from the Bank Lending Survey – Loans for House Purchase***




***Note:*** Credit standards = Question 8: Over the past three months, how have your bank's credit standards as applied to the approval of loans or credit lines to households changed? Overall credit conditions = Over the past three months, how have your bank's credit terms and conditions for approving loans for house purchase changed?

***Table A1: Summary Statistics by Period***

| Variable | Units | Control | Post 1 | Post 2 |
|---|---|---|---|---|
| Log(Amount) | | 14.65 | 14.77 | 14.66 |
| Log(Collateral) | | 15.20 | 15.40 | 15.39 |
| Log(Downpayment) | | 13.46 | 13.74 | 13.85 |
| Log(Price) | | 14.97 | 15.12 | 15.56 |
| Log(Income) | | 13.30 | 13.42 | 13.56 |
| Log(Debt) | | 13.68 | 13.78 | 13.85 |
| Log(Consumer Debt) | | 12.20 | 12.67 | 12.51 |
| Log(Credit Card Debt) | | 10.26 | 10.25 | 10.24 |
| LTV | % | 65.46 | 62.56 | 61.32 |
| DSTI | % | 32.56 | 35.23 | 36.19 |
| DTI | | 5.67 | 5.80 | 4.81 |
| PD (Client) | % | 0.54 | 0.30 | 0.50 |
| Maturity Rate | years | 26.17 | 26.50 | 26.23 |
| Fixation Rate | years | 6.33 | 6.29 | 5.45 |
| Log(Payment) | | 9.20 | 9.42 | 9.57 |
| Age | years | 36.82 | 37.16 | 37.36 |
| Interest Rate | % | 2.09 | 3.01 | 5.55 |

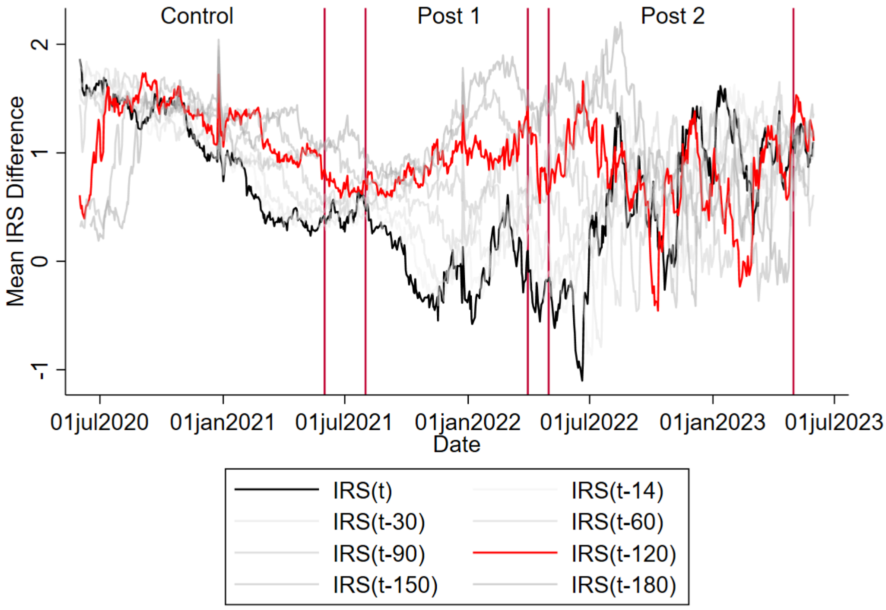
***Note:*** This table presents summary statistics for key mortgage and borrower characteristics across three periods: Control, Post 1, and Post 2. LTV represents the loan-to-value ratio, while DTI and DSTI capture debt-to-income and debt-service-to-income constraints, respectively. PD (Client) indicates the estimated probability of default by banks.

***Table A2: Correlation Between the Mortgage Lending Rate and the IRS at Different Lags (Daily Frequency)***

| IRS lag (days) | IRS (t) Cont. | IRS (t-14) 2 weeks | IRS (t-30) 1 month | IRS (t-60) 2 months | IRS (t-90) 3 months | **IRS (t-120) 4 months** | IRS (t-150) 5 months | IRS (t-180) 6 months |
|---|---|---|---|---|---|---|---|---|
| post 1 | 0.7499 | 0.7497 | 0.7585 | 0.7966 | 0.7939 | **0.8013** | 0.7523 | 0.7084 |
| post 2 | -0.026 | 0.0832 | 0.223 | 0.493 | 0.6302 | **0.6404** | 0.6306 | 0.6517 |

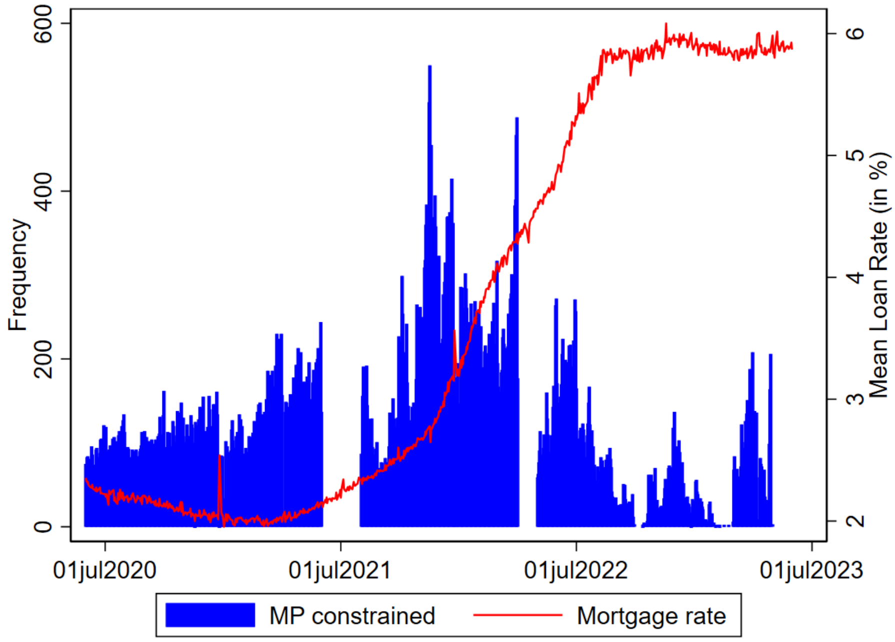
***Note:*** $t$ denotes days.

***Figure A3: Difference Between Observed Lending Rate and Lagged IRS Rates***



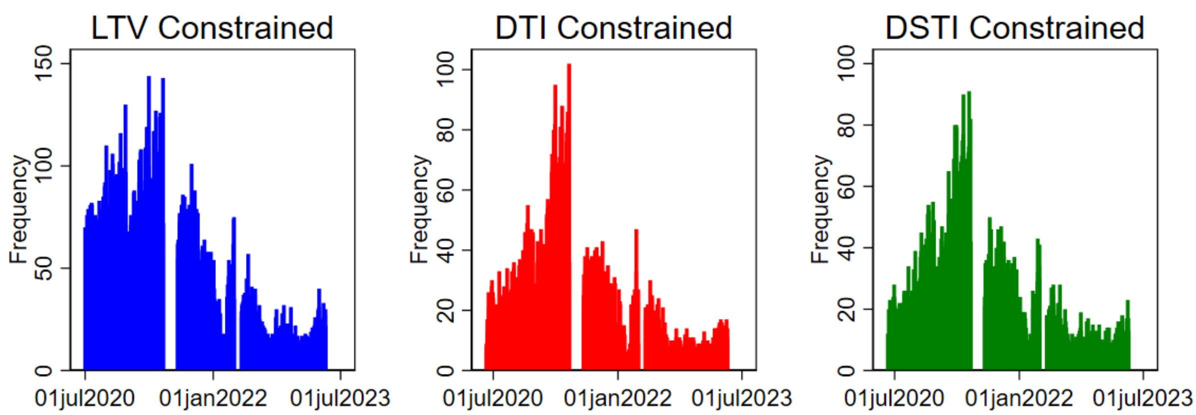

***Note:*** This figure illustrates the difference between observed lending rates on mortgage loans and lagged IRS (interest rate swap) rates over time. The various lines correspond to different IRS lag periods, capturing potential delays in the transmission of monetary policy rate changes to lending rates. Vertical lines mark the different policy periods (Control, Post 1, and Post 2), highlighting shifts in the interest rate differential as macroprudential and monetary policy conditions evolved. The IRS at different maturities (e.g., IRS t-30, IRS t-90, etc.) represents interest rate swaps with lagged maturities of 30, 90, 120, and 180 days, respectively.

***Figure A4: Distribution of MP Constrained Borrowers over Time***




***Note:*** This figure plots the number of borrowers identified as MP-constrained over time (left-hand axis) and the evolution of the mean mortgage loan rate (right-hand axis). The gaps between periods are deliberate, ensuring a clear separation of individual policy interventions without the risk of frontloading effects or policy implementation lag.

***Figure A5: Distribution of BBM Constrained Borrowers over Time***




***Note:*** This figure plots the number of borrowers identified as BBM-constrained over time. The gaps between periods are deliberate, ensuring a clear separation of individual policy interventions without the risk of frontloading effects or policy implementation lag.

## Appendix B: Details on the Matching Procedure

The matching procedure is meant to ensure that the treatment and control groups are comparable based on observed characteristics. We perform the matching separately for the control period and each of the two post-treatment periods (Post 1 and Post 2). This approach results in two matched datasets: one for the control and Post 1 periods, and another for the control and Post 2 periods. By matching loans in the control period with those in each post-treatment period separately, we maintain the integrity of the comparison and avoid contamination between the post-treatment periods.

We utilize a logistic regression model to calculate propensity scores, incorporating borrower characteristics such as age, income, employment status, loan maturity, fixation period, and other relevant variables. We implement a caliper of 0.01, meaning that treated and control units are only matched if their propensity scores are within 0.01 units of each other. This caliper helps ensure that only sufficiently similar units are matched, improving the quality of the matches. Furthermore, we match without replacement, ensuring that each control unit is used only once in the matching process. This prevents certain control units from being overrepresented in the matched sample.

To assess the quality of the matching, we conduct two tests, as illustrated in Figure B1 and Figure B2. Figure B1 tests the overlap assumption by verifying whether a sufficient number of treated mortgages received a match in the control period. The graph visually confirms the overlap assumption, indicating that the matched samples are comparable. Figure B2 examines whether the matching process effectively reduced sampling bias by comparing the distribution of covariates between the treatment and control groups. The observed bias reduction is well within acceptable thresholds (below 5%), suggesting that the matching procedure successfully balanced the groups.

***Figure B1: Testing the Overlap Assumption***

*(A) Post 1* *(B) Post 2*

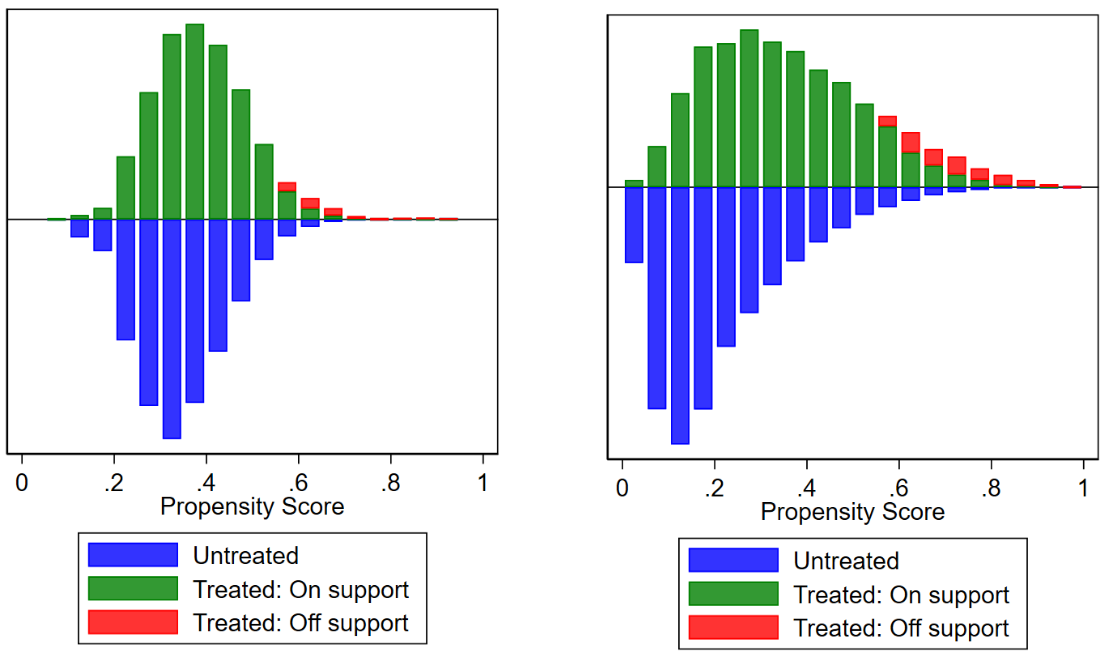


***Figure B2: Testing the Sampling Bias Reduction***

*(A) Post 1* *(B) Post 2*

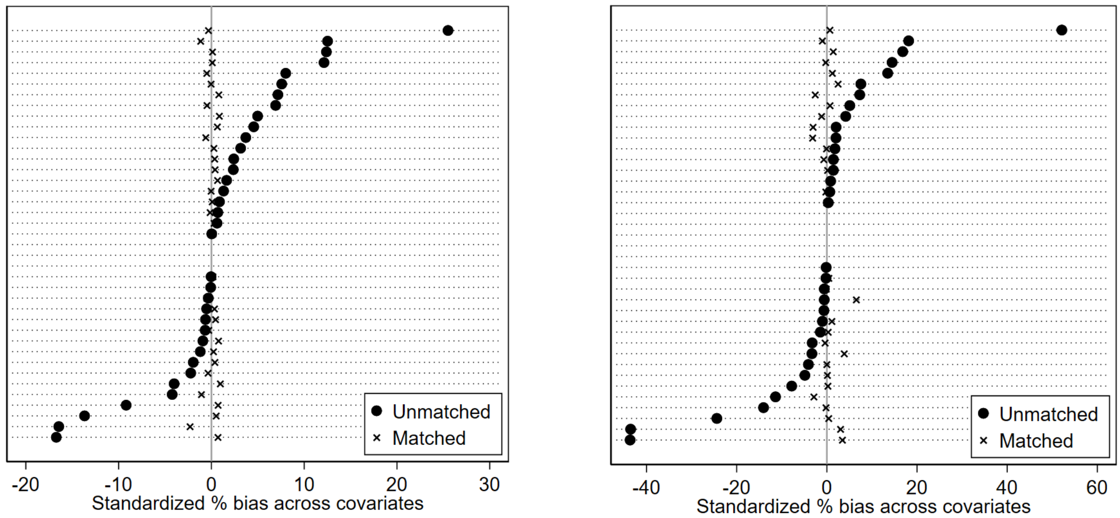



Table B1 presents the balance diagnostics for propensity score matching in Post 1 and Post 2, highlighting significant improvements in covariate balance after matching. In both periods, the Pseudo R-squared decreases substantially after matching, with Post 1 dropping from 0.036 to 0.000 and Post 2 from 0.13 to 0.002. The Mean Bias and Median Bias are also significantly reduced, with Post 1 achieving near-perfect balance (Mean Bias = 0.5, Median Bias = 0.4) and Post 2 showing excellent improvement (Mean Bias = 1.3, Median Bias = 0.7). The standardized difference of means and variance ratio further confirm successful matching, with standardized difference values falling below the 25% threshold and variance ratio values remaining within the acceptable range of [0.5, 2]. These results indicate that the matching procedure effectively minimizes sampling bias, providing a well-balanced dataset for causal analysis in both post-treatment periods.

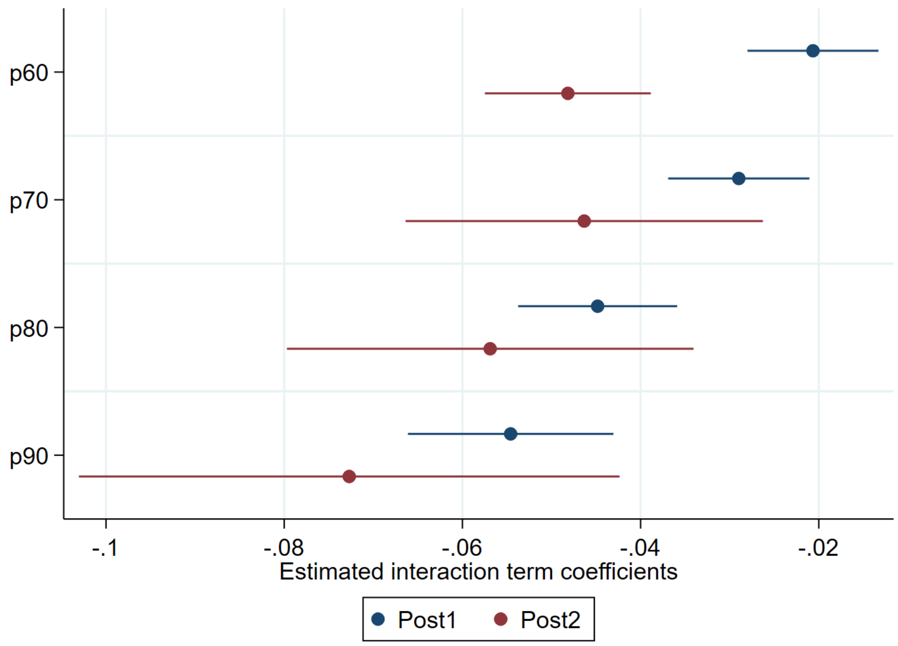
***Table B1: Statistical Validation of the Matching Procedure***

| | Sample | Ps R2 | LR chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|---|
| Post 1 | Unmatched | 0.036 | 6128.84*** | 5.3 | 2.8 | 45.6* | 1.11 | 80 |
| | Matched | 0 | 44.12 | 0.5 | 0.4 | 4.4 | 1 | 60 |
| Post 2 | Unmatched | 0.13 | 16080.79*** | 9.3 | 3.7 | 92.5* | 0.94 | 60 |
| | Matched | 0.002 | 148.49*** | 1.3 | 0.7 | 10.7 | 0.69 | 80 |

***Note:*** Ps R2: Pseudo R-squared. LR chi2: Likelihood Ratio (LR) Chi-square. MeanBias/MedBias: Mean and Median Bias. B: Standardized Difference of Means. R: Variance Ratio. %Var: Variance Explained by the Propensity Score.

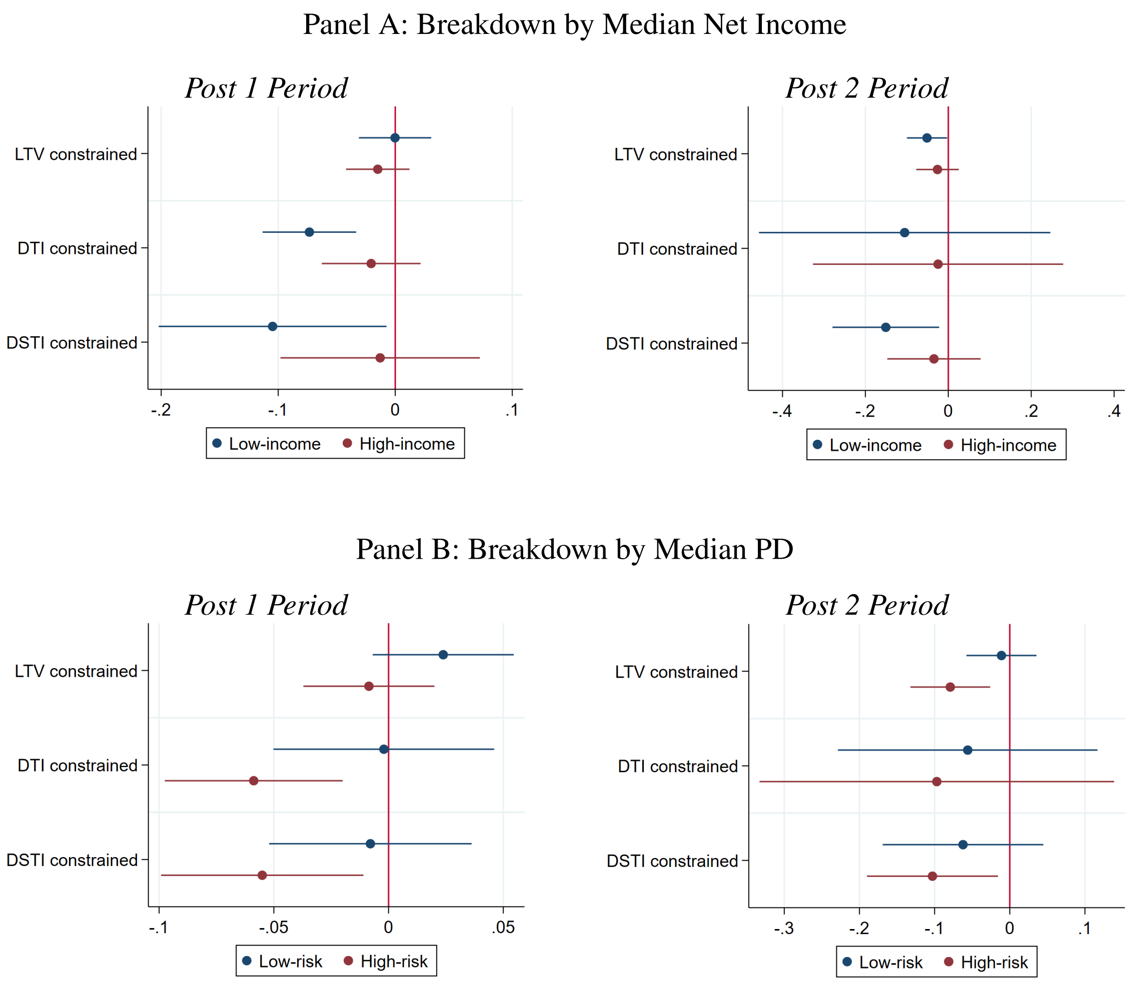
# Appendix C: Additional Regression Results

***Figure C1: Sensitivity Check:*** $Post_t \times MP_i^C$ ***Parameter Estimates for Different*** $MP_i^C$ ***Thresholds***




***Note:*** The graph shows coefficient estimates of $Post_t \times MP_i^C$ from equation (2) for differently specified monetary policy (MP) constrained borrowers $(MP_i^C)$. In the baseline, $(MP_i^C = 1)$ indicates borrowers whose interest rate differential between the observed lending rate and the lagged Interest Rate Swap exceeds the median value in the post-treatment period. As a sensitivity check, we incrementally apply tighter thresholds: the 60th, 70th, 80th, and 90th percentiles. Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

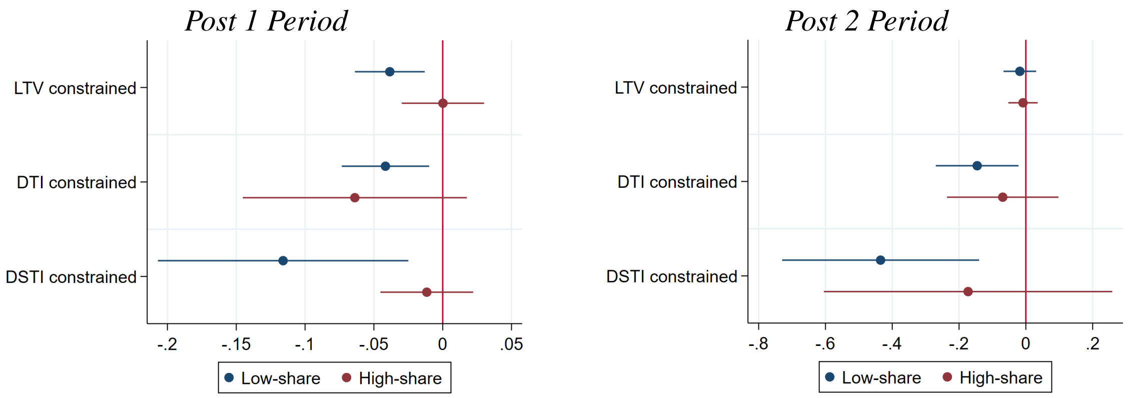
***Figure C2: Regression Results for Log-Amount of New Mortgage: Borrowers' Heterogeneity***



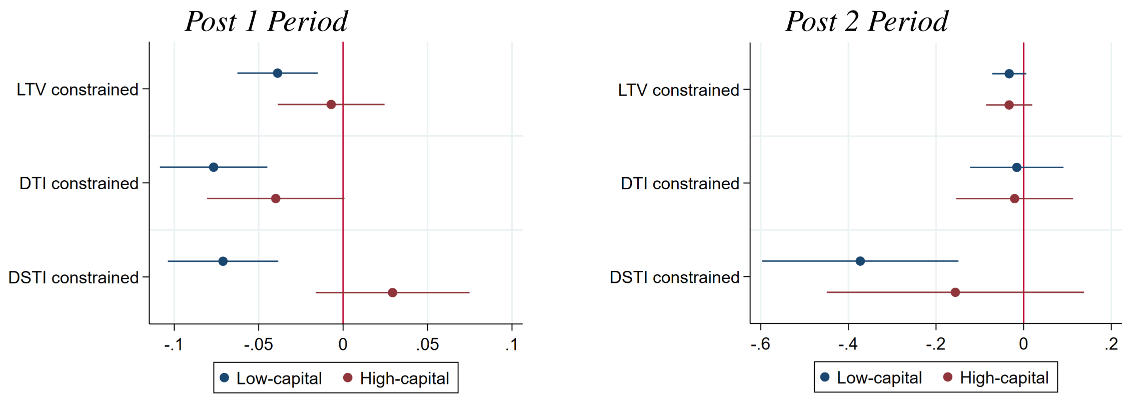

***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3) for the low/high income and low/high risk borrower sub-samples. Low- and high-income borrowers are categorized as those in the first and third quartiles of the annual net borrower income distribution, respectively. Similarly, low- and high-risk borrowers are categorized as those in the first and last quartiles of the clients' probability of default distribution. Standard errors are clustered at the mortgage level, and the error bands represent 95% confidence intervals.

***Figure C3: Regression Results for Log-Amount of New Mortgage: Banks' Heterogeneity***

Panel A: Breakdown by Median Market Share

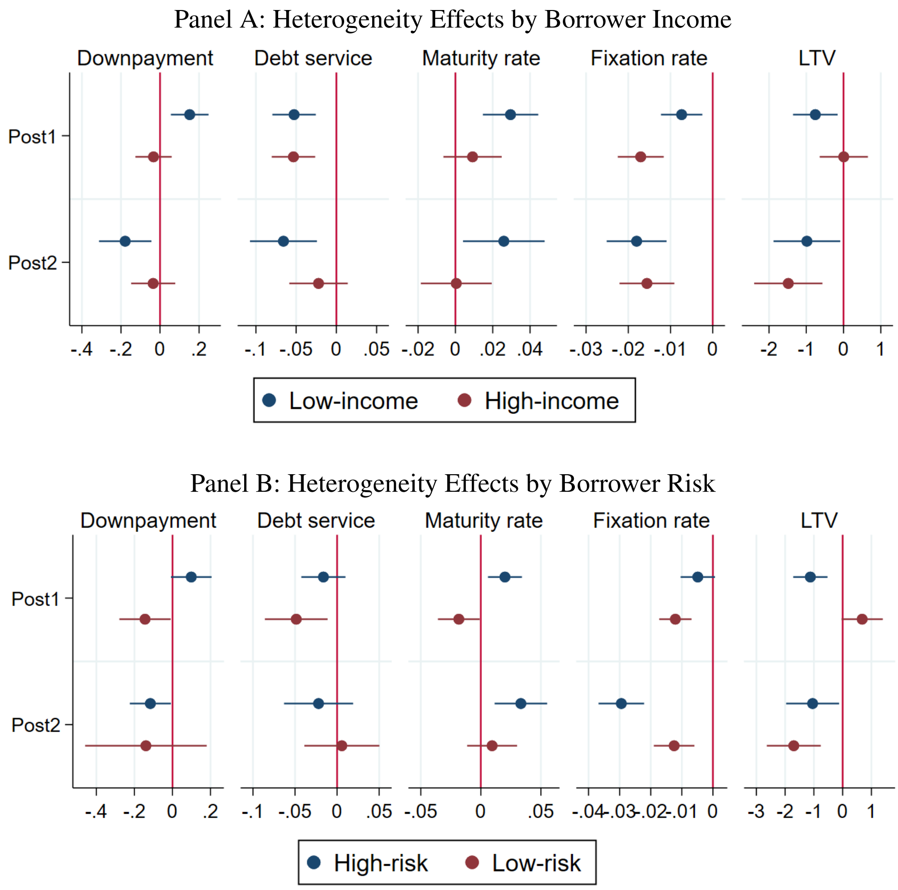



Panel B: Breakdown by Median Capital Headroom




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3) for the low/high market share and low/high capital headroom bank sub-samples. Bank market share is defined as the ratio of a bank's total mortgage portfolio value to the total mortgage market value. Bank capital headroom is measured as the ratio of a bank's total regulatory capital to its minimum required regulatory capital. The classification of banks is based on end-2019 data (first and last quartiles of the banks' market share and capital headroom respectively) and remains unchanged throughout the sample period. Notably, there are no significant shifts in banks' market shares or capital levels during the period. Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

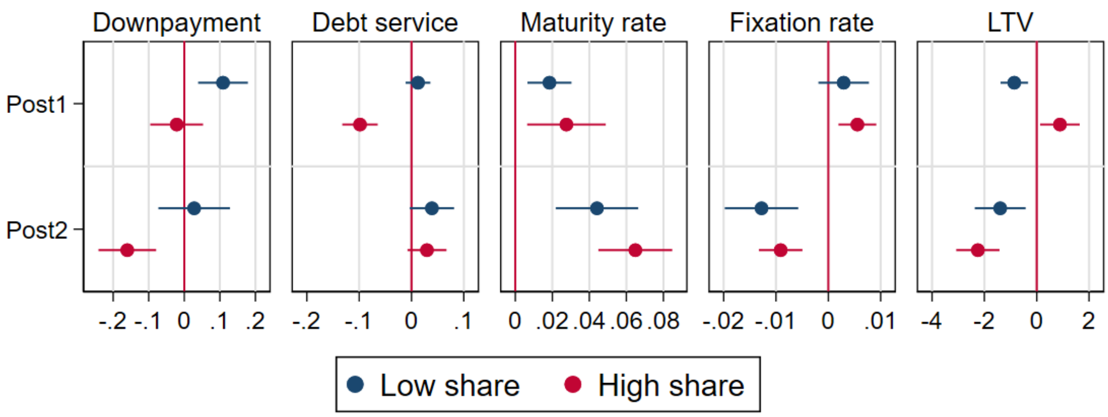
***Figure C4: Regression Results for Liquidity Constraints Channel: Borrowers' Heterogeneity***



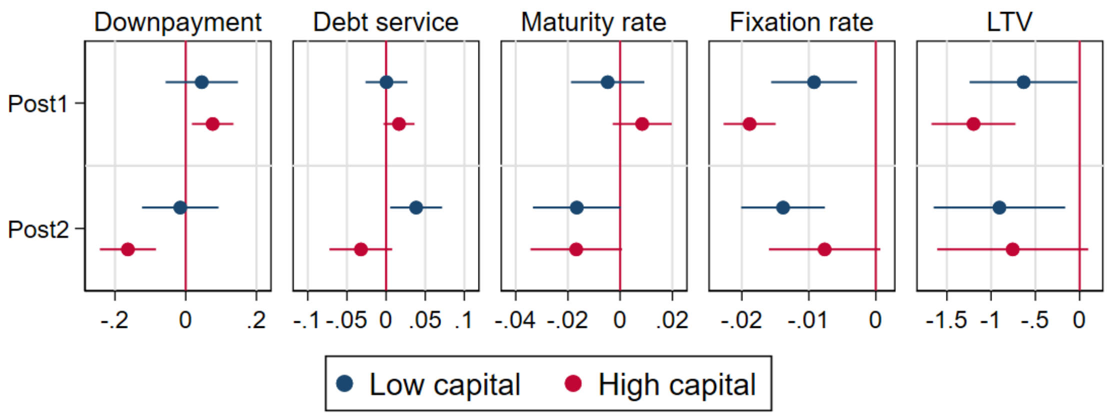

***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C$ from equation (2) for the low/high borrower income and low/high borrower risk sub-samples. Low- and high-income borrowers are categorized as those in the first and third quartiles of the annual net borrower income distribution, respectively. Similarly, low- and high-risk borrowers are categorized as those in the first and last quartiles of the clients' probability of default distribution. Standard errors are clustered at the mortgage level, and the error bands represent 95% confidence intervals.

***Figure C5: Regression Results for Liquidity Constraints Channel: Banks' Heterogeneity***

Panel A: Breakdown by Median Market Share

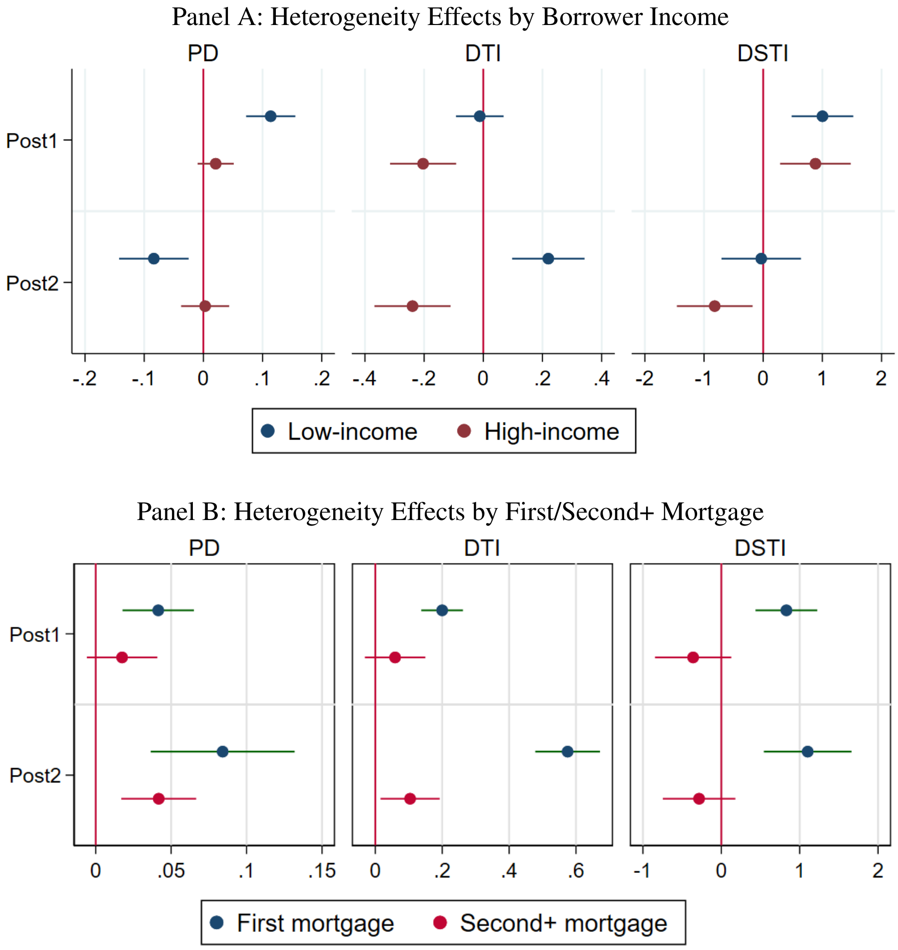



Panel B: Breakdown by Median Capital Headroom



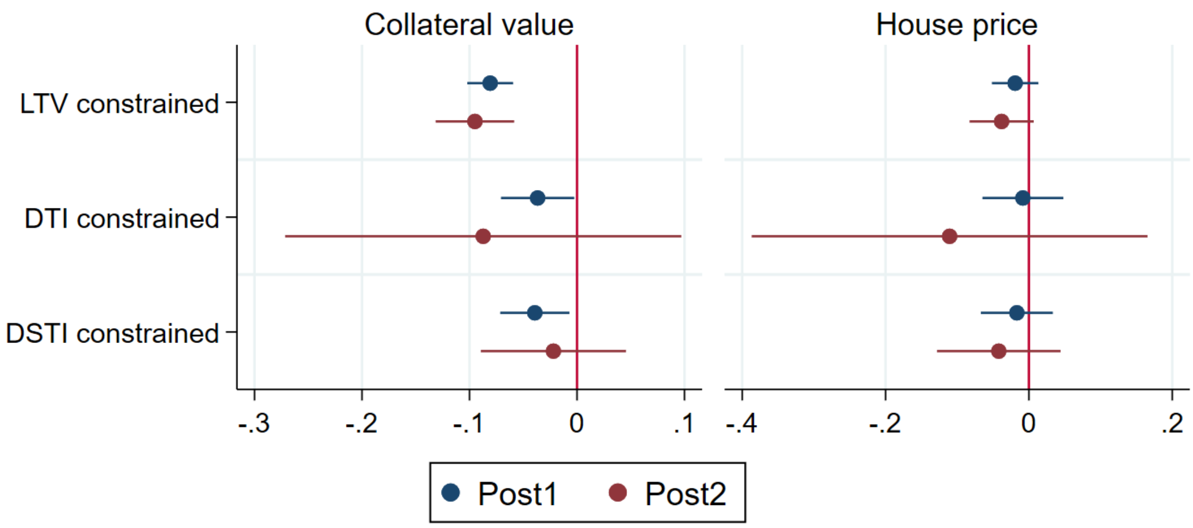

***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3) for the low/high market share and low/high capital headroom bank sub-samples. Bank market share is defined as the ratio of a bank's total mortgage portfolio value to the total mortgage market value. Bank capital headroom is measured as the ratio of a bank's total regulatory capital to its minimum required regulatory capital. The classification of banks is based on end-2019 data (first and last quartiles of the banks' market share and capital headroom respectively) and remains unchanged throughout the sample period. Notably, there are no significant shifts in banks' market shares or capital levels during the period. Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

***Figure C6: Regression Results for Risk and Default Channel: Borrowers' Heterogeneity***



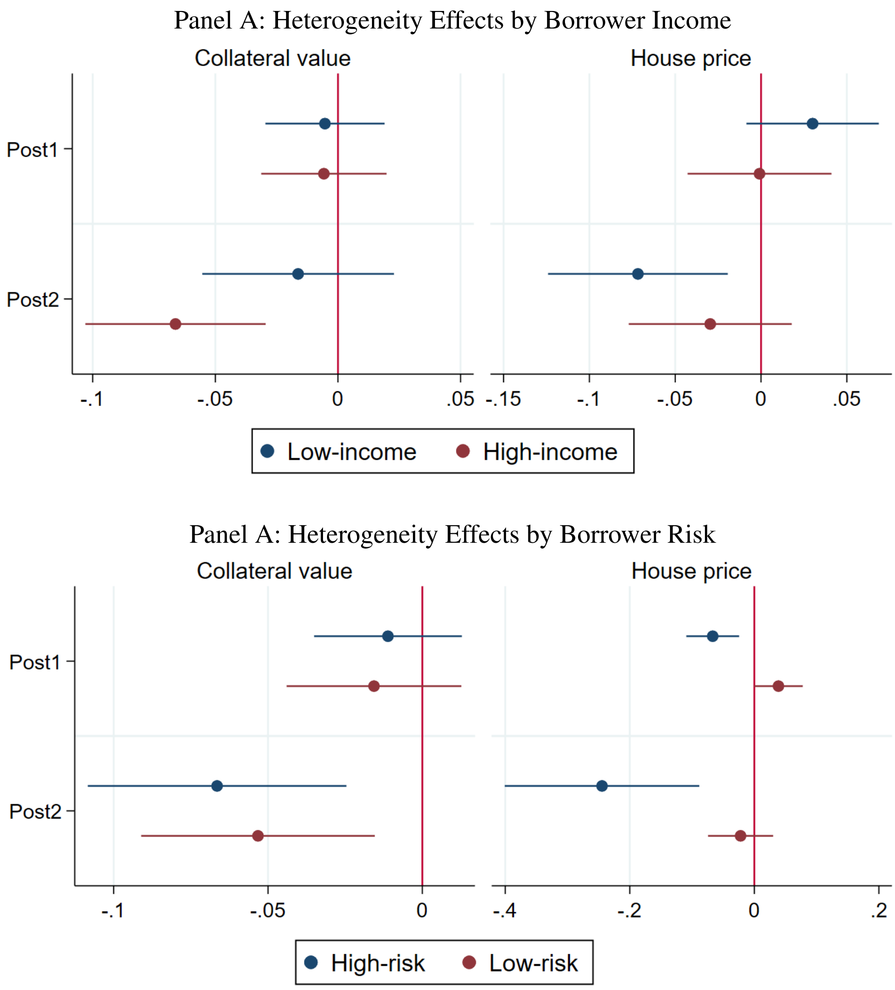

***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C$ from equation (2) for the low/high borrower income and low/high borrower risk sub-samples. Low- and high-income borrowers are categorized as those in the first and third quartiles of the annual net borrower income distribution, respectively. Similarly, low- and high-risk borrowers are categorized as those in the first and last quartiles of the clients' probability of default distribution. Standard errors are clustered at the mortgage level, and the error bands represent 95% confidence intervals.

***Figure C7: Regression Results for Collateral Valuations and Property Purchase Prices: The Effect on BBM-Constrained Loans***




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C \times BBM_i^C$ from equation (3). Standard errors are clustered at the mortgage level. Error bands represent the 95% confidence interval.

***Figure C8: Regression Results for Collateral Valuations and Property Purchase Prices: Borrowers' Heterogeneity***




***Note:*** The graphs show coefficient estimates of $Post_t \times MP_i^C$ from equation (2) for the low/high borrower income and low/high borrower risk sub-samples. Low- and high-income borrowers are categorized as those in the first and third quartiles of the annual net borrower income distribution, respectively. Similarly, low- and high-risk borrowers are categorized as those in the first and last quartiles of the clients' probability of default distribution. Standard errors are clustered at the mortgage level, and the error bands represent 95

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