Working Paper Series —— 1/2025

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Czech National Bank —— Working Paper Series —— 1/2025

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Payment Holidays, Credit Risk, and Borrower-Based Limits: Insights from the Czech Mortgage Market

Martin Hodula and Lukáš Pfeifer *

Abstract

The Czech Republic provides a unique setting to examine the effects of loan moratoria during the COVID-19 pandemic, as it combined broad-access legislative moratoria with stricter, eligibility-based bank moratoria. Using detailed loan-level data from the Czech mortgage market, we find that legislative moratoria were predominantly precautionary, addressing a wide range of borrowers, whereas bank moratoria were primarily utilized by higher-risk borrowers facing solvency challenges. Post-moratoria, we observe limited materialization of credit risk, which was nearly twice as high for bank moratoria compared to legislative moratoria. Stricter borrower-based regulations (LTV, DTI, and DSTI limits) implemented prior to the pandemic were associated with lower moratoria uptake and reduced post-moratoria arrears. These findings underscore the effectiveness of combining universal legislative moratoria with targeted bank measures to balance immediate economic relief and long-term financial stability.

JEL Codes: E44, G21, G28, G51.
Keywords: Borrower-based measures, COVID-19 economic policy, credit risk mitigation, loan moratoria, mortgage arrears.

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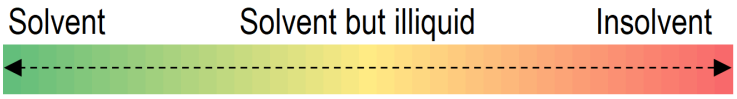
The authors note that this paper represents their own views and not necessarily those of the Czech National Bank. We would like to thank Simona Malovaná, Jin Cao (discussant), Safwan Naser (discussant), Petros Katsoulis (discussant), Ayaz Zeynalov (discussant), Libor Holub, and Jan Janků, for their extensive comments on an earlier version of the paper. We also extend our gratitude to David Pacoň for his assistance with the data. The paper has benefited greatly from feedback received during presentations at the Czech National Bank, the 8th Annual Workshop of ESCB Research Cluster 3, the 13th Bienial Conference of the Czech Economic Society, the VSB-Technical University of Ostrava, and the 21st European System of Central Banks Emerging Markets Workshop. All errors and omissions remain the fault of the authors.

1. Introduction

The COVID-19 pandemic profoundly disrupted the global economic landscape, affecting households and businesses with a degree of uncertainty not seen in recent history. The resulting economic contraction was exacerbated by restrictions such as lockdowns, which disrupted supply chains and curtailed consumer spending (Baker et al., 2020; Bonadio et al., 2021). In response, governments worldwide launched support programs, including loan payment deferrals. These moratoria aimed to alleviate the cash-flow pressures of distressed corporate and individual borrowers affected by the pandemic.

Moratoriums, or "payment holidays" aim to prevent defaults by borrowers facing temporary cash flow issues. Their design is critical for balancing the short-term needs of borrowers with long-term financial stability considerations. After the introduction of moratoria, the Bank for International Settlements (BIS) argued that the financial stability implications of payment deferral programs would depend on the extent to which borrowers are able and willing to repay their debt obligations once the payment holidays expire (Coelho and Zamil, 2020). Therefore, the design of payment holidays is crucial, particularly in setting eligibility criteria and deciding on termination timing and method, which can be challenging during periods of extreme uncertainty. At the start of the pandemic, many countries adopted lenient frameworks, allowing borrowers to qualify by simply declaring pandemic-related impacts. As a result, the tool could have been used by borrowers with diverse risk profiles (Figure 1). Distinguishing between temporarily illiquid and chronically insolvent borrowers is crucial but challenging for policymakers. Consequently, a few countries, including the Czech Republic, introduced a bank moratorium after the legislative one ended, allowing payment holidays to continue through individual bank negotiations.

Figure 1: Spectrum of Affected Borrowers



Note: This figure illustrates the spectrum of affected borrowers during the loan moratoria, ranging from Solvent (green), through Solvent but Illiquid (yellow), to Insolvent (red). Borrowers classified as solvent were able to meet their financial obligations without distress. Those categorized as solvent but illiquid experienced temporary liquidity issues yet remained solvent. Borrowers marked as insolvent faced significant financial difficulties, were unable to service their debts, and were at a high risk of default.
Source: Coelho and Zamil (2020).

Taking advantage of the unique policy setup and confidential mortgage-level data in the Czech Republic, we offer a detailed analysis of the differences between the application of legislative and bank moratoria, which varied in terms of access—legislative moratoria were freely available, whereas bank moratoria required meeting specific eligibility criteria. Using a probit model, we first ask whether the risk profiles of borrowers who opted for legislative and/or bank moratoria differ. Since only pre-pandemic loans were eligible to be included in the moratoria programs, our sample comprises all mortgages granted between July 2015 and December 2019. In general, we confirm prior intuition that moratoria were used by borrowers with riskier characteristics. This aligns with evidence from the UK and the US showing that households most likely to have applied for the moratorium tended to face tighter credit constraints during the pandemic (Albuquerque and Varadi, 2022) and/or were more likely to have higher pre-COVID delinquency rates (Cherry et al., 2021).

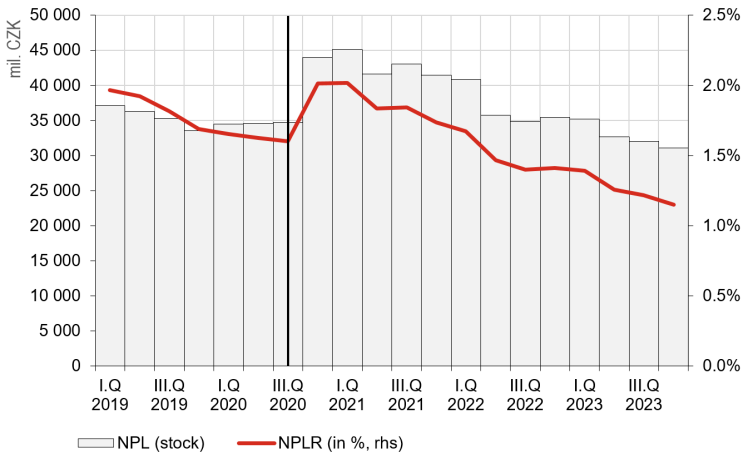
We identify notable differences between legislative and bank moratoria borrowers. Legislative moratoria were used by borrowers with varying risk profiles. The use of legislative moratoria, akin

to liquidity relief mechanisms discussed by Kaplan and Violante (2014), highlights their precautionary nature during periods of heightened uncertainty. Similarly, Gorton and Ordonez (2014) argue that liquidity shortages can propagate systemic risks, underscoring the importance of such interventions in crisis settings. Bank moratoria, on the other hand, were accessed by considerably riskier borrowers. Bank moratoria, by targeting riskier borrowers with eligibility criteria, thus reflect solvency-focused interventions. This is consistent with the findings of Di Maggio and Kermani (2017), who argue that credit expansions and their subsequent contractions disproportionately impact riskier borrowers, echoing the observed targeting of riskier borrowers under bank moratoria. This also aligns with the idea that capitalized banks manage risk exposure by deferring the recognition of credit risk (Drechsler et al., 2018).

Second, we examine the link between mortgage moratoria and arrears, providing insights into how moratoria uptake affects subsequent financial outcomes. This layer of analysis is crucial, as one of the key questions faced by policymakers when using payment deferral programs is when and how to terminate them. For this investigation, our sample of mortgages is expanded with information on whether a mortgage experienced payment difficulties after the moratoria programs were terminated. Using a two-stage estimation procedure to mitigate endogeneity, we identify only a weak materialization of credit risk following the termination of legislative moratoria, which corroborates the idea that the main motives for their uptake were precautionary entry due to significant uncertainty or liquidity problems. In terms of bank moratoria, the probability of experiencing payment difficulties following the program termination was more pronounced but economically weak, without financial stability implications. This confirms that solvency problems were among the main determinants for enrollment in bank moratoria.

Our main findings suggest that the ending of the legislative moratorium can be effectively combined with a transitional period of non-legislative payment holidays. If the base probability of mortgage arrears is estimated to be 1.5% in our sample, the moratoria mortgages increase this probability to 5.3%. However, the moratoria group represents only about 12% of the total mortgage portfolio. As a result, the overall arrear probability for the entire portfolio increased modestly from 1.5% to about 2% after the moratoria programs were terminated (Figure 2).

Figure 2: Mortgage Non-Performing Loans Ratio (NPLR)



Source: CNB.

Our analysis also provides insights into the role of mortgage market regulation in mitigating credit risk. Over the studied period, the Czech mortgage market experienced shifts in its regulatory

framework.[1] Using various estimation techniques, our results suggest that tighter regulations at the time of loan origination are linked to a reduced likelihood of loans entering moratoria. Additionally, for loans that did enter moratoria, stricter regulatory conditions are associated with a lower probability of those loans falling into arrears after the moratoria ended.[2] However, it is important to note that, due to data limitations, we cannot confidently establish a causal relationship.

Our paper is closely related to the literature studying the effects of mortgage market modifications. A substantial body of influential research has examined the effectiveness of various debt forbearance measures, including refinancing, restructuring, and modifications to loan terms such as interest rates, principal, and maturity. In this context, payment holidays have been shown to be more effective in reducing defaults than other forms of mortgage modifications that do not reduce short-term payments (Agarwal et al., 2017; Ganong and Noel, 2020). However, there is a lack of evidence on the effects of terminating payment deferral programs. We aim to fill this gap by providing evidence on the effects of terminating loan moratoria during the COVID-19 pandemic.

Among papers studying the effects of pandemic moratoria, the closest to ours is Albuquerque and Varadi (2022), who examine how payment holidays in the UK helped smooth household consumption during the pandemic. They first analyze the characteristics of mortgagors who participated in the moratoria program, finding similarities to our findings. However, we contribute additional insights by exploring the experience of combining legislative and bank-initiated moratoria (which was not implemented in the UK), highlighting that the characteristics differed substantially between the two programs. More importantly, we examine the link between mortgage moratoria and arrears after the termination of these programs.

Our findings are particularly relevant to the 2020 European Banking Authority (EBA) Statement, which allowed loans under moratoria to remain classified as standard exposures (i.e., not automatically moved to stage 2), with reclassification decisions left to the discretion of individual banks (EBA, 2020). The EBA highlighted that moratoria were designed to provide temporary relief without implying a significant increase in credit risk, as long as the underlying borrower viability remained intact. Consistent with this, our results show that legislative moratoria were used primarily as a precautionary measure during heightened uncertainty, and we observed no significant increase in credit risk once these moratoria ended. This outcome was likely reinforced by subsequent bank-initiated moratoria and generally accommodative economic policies, which further supported financial stability.

The evaluation of moratorium utilization during the pandemic holds significant economic and political implications, particularly concerning the formulation of specific eligibility criteria for this measure and its potential future applications.[3] The moratorium on loan repayments can be regarded as a non-traditional instrument within economic policy for financial stability, deployable during profound economic crises predominantly triggered by exogenous shocks associated with

[1] From 2015 until the start of the COVID-19 pandemic, the market was governed by a loan-to-value limit introduced in 2016 and gradually tightened, as well as income-based limits (debt-to-income and debt-service-to-income) implemented in 2018.

[2] Micro-level empirical studies on the effectiveness of macroprudential borrower-based measures in limiting systemic risk are scarce. This stems from data limitations at the loan level, where in most cases the loan is observed only during origination and cannot be easily matched with information on loan arrears. Most up-to-date evidence is thus based on bank-level data (Cerutti et al., 2017; Morgan et al., 2019).

[3] For instance, in July 2022, the Polish government re-used mortgage loan moratoria to alleviate the negative impact of the energy crisis on Polish households.

significant uncertainty about future economic developments. The experience with moratoria during a pandemic, therefore, presents a challenge for understanding the nuances of moratorium implementation, its effectiveness, and its broader consequences on economic systems. This analysis aims to contribute to the broader discourse on the role of government and central bank interventions in the mortgage loan market, offering insights that could help shape the design of loan moratoria policies in the future. Our findings contribute to the ongoing debate on the design of crisis interventions. Farhi and Tirole (2012) emphasize the moral hazard and systemic risks posed by broad-based liquidity measures, highlighting the importance of complementary targeted interventions like bank moratoria. By addressing distinct borrower segments, the Czech approach illustrates how combining broad liquidity relief with solvency-focused interventions can mitigate credit risk while maintaining financial stability.

The rest of this paper is structured as follows. Section 2 provides institutional details of the Czech mortgage market and the moratoria program. Section 3 presents the data employed in the paper and describes the data curation process. Section 4 presents results regarding the determinants of borrower choice to enter loan moratoria. Section 5 and Section 6 shows estimates of whether loans under moratoria were more likely to become delinquent compared to non-moratoria loans and explores the role of borrower-based regulation in this relationship. Section 7 concludes.

2. Institutional Structure of the Czech Mortgage Market

In this section, we provide institutional details. Section 2.1 provides a brief overview of the Czech mortgage market. Section 2.2 introduces mortgage moratoria, including details on the timing, eligibility criteria, and an international comparison. Section 2.3 discusses the delinquency and foreclosure process.

2.1 Overview of the Mortgage Market

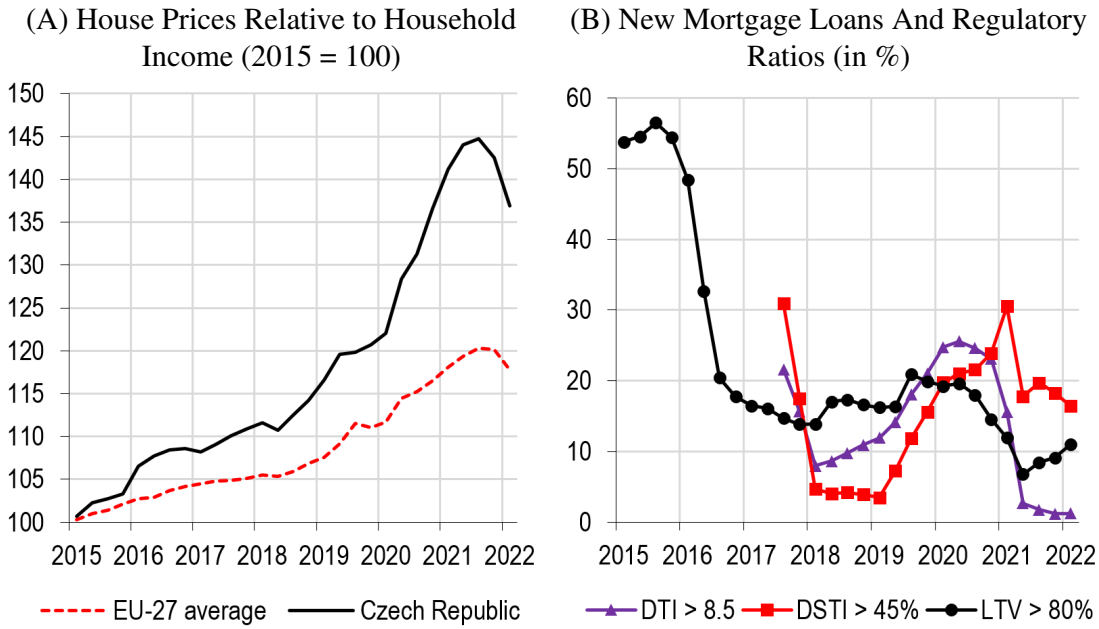
Housing in the Czech Republic is a key sector of the real economy and constitutes a major part of household wealth and bank lending. The Czech housing loan market is dominated by banks, which hold over 95% of the market share, with building societies accounting for the remaining 5%. Banks benefit from ample liquidity, funding mortgages primarily through customer deposits and the issuance of covered bonds. Interest rates on mortgages are fixed, as floating-rate options are virtually unavailable. The fixed-rate period typically ranges from three to ten years during the reporting period. However, borrowers can prepay or refinance their mortgage loans outside the fixed-rate period. In such cases, banks may charge only administrative costs for early repayment, not lost profit, as was previously the practice. The possibility of early mortgage repayment applies to all loans granted after 1 December 2016 or to loans granted earlier but with a fixed-rate period that expired after that date.

Mortgage interest rates are generally determined by adding a borrower-specific risk premium to a base rate. This base rate is influenced by factors such as the Czech National Bank's benchmark interest rates and yields on government bonds of corresponding maturities. As a result, rates vary among borrowers based on factors such as creditworthiness and financial circumstances.

Given its systemic importance, the sector is at the center of macroprudential policy. Past financial crises and experiences in many countries have demonstrated that unsustainable developments in real estate markets can have severe repercussions on the stability of the financial system and the economy as a whole (Mian and Sufi, 2015; Garriga and Hedlund, 2020). In September 2019, the European

Systemic Risk Board issued warnings and recommendations for 11 EU/EEA countries, including the Czech Republic, regarding risks associated with the real estate market. The key vulnerabilities identified were house price overvaluation, high and accelerating house price growth, high mortgage credit growth, and the loosening of lending standards. In the Czech Republic, house price growth has outpaced the increase in disposable income, and housing affordability, as measured by the price-to-income ratio, has decreased significantly compared to the EU average (Figure 3, panel A). While cyclical factors play an important role in fueling these vulnerabilities, many structural factors also contribute, particularly the long-term mismatch between housing supply and demand.

Figure 3: Development in the Czech Mortgage Market (2015–2022)



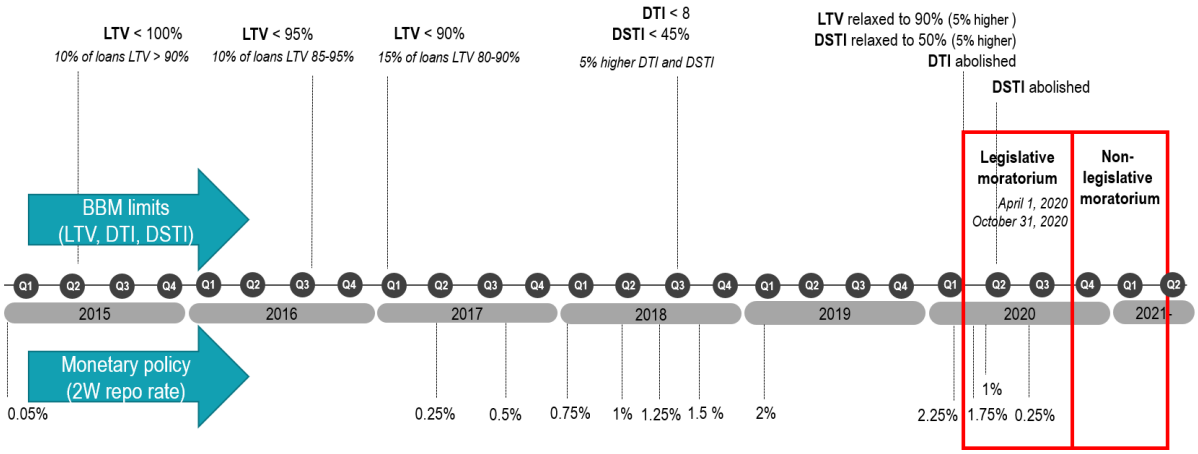
Note: The left-hand graph presents data for the Czech Republic and the average of the 27 EU countries, illustrating house prices relative to household income. The right-hand graph shows the distribution of mortgages across different regulatory thresholds as a percentage of total mortgages.
Source: The left-hand graph data were taken from the OECD database, while the right-hand graph data are from the Czech National Bank database.

In response to the increasing vulnerability of newly originated mortgage loans, the Czech National Bank (CNB) introduced borrower-based measures (BBMs) in 2015. Hodula et al. (2023b) provides an overview of the tightening rounds of these borrower-based limits alongside an analysis of their impact on the mortgage loan market. These measures have been gradually tightened since their introduction. Before the pandemic began in 2020, lenders had to ensure that the LTV ratio for retail loans secured by residential property did not exceed 80%. Additionally, borrowers' debt could not exceed nine times their net annual income (DTI), and borrowers could spend no more than 45% of their net monthly income on debt service (DSTI). These limits could be exceeded only for up to 10% of loans for LTV and 5% of loans for DTI and DSTI, resulting in a portfolio of newly originated mortgage loans with less vulnerable characteristics (Figure 3, panel B).

In response to the pandemic, on 1 April 2020, the CNB eased the LTV and DSTI limits and abolished the DTI limit. On 18 July 2020, the CNB also abolished the DSTI limit. Only the recommended LTV limit of 90% remained in place, with a 5% exemption for mortgage loans with an LTV above 90%. Additionally, the monetary policy rate was reduced from 2.25% to 0.25% during the first half of 2020. The release of BBM limits and the easing of monetary policy contributed to the mortgage

market continuing to follow a strong upward trend despite the pandemic. The full timeline of policy actions covering the sample period is shown in Figure 4.

Figure 4: Czech Mortgage Market: Timeline of Policy Actions



Note: The timeline shows key changes in regulatory policy measures and corresponding monetary policy actions. Abbreviations: LTV = Loan-to-Value ratio, DTI = Debt-to-Income ratio, DSTI = Debt-Service-to-Income ratio, BBM = Borrower-Based Measures (regulatory limits aimed at borrowers).
Source: Own compilation.

2.2 Mortgage Moratoria During the COVID-19 Pandemic

Motivating the need to support the mortgage market during the pandemic, historical evidence has shown that sectors most burdened by mortgage debt often experience the most severe downturns. For instance, during the financial crisis, areas in the US, such as the construction sector and regions known as the "sand states," were disproportionately affected due to their high levels of mortgage debt (Mian and Sufi, 2009). Furthermore, research indicates that financial crises paired with housing market collapses tend to result in more profound economic impacts and slower recoveries (Reinhart and Rogoff, 2009). Given this background, protecting the mortgage market during the COVID-19 pandemic was crucial, as vulnerabilities in this sector could lead to broader economic instability and delay recovery efforts. Thus, the implementation of mortgage moratoria was not only a relief measure but also a strategic intervention to prevent a cascade of financial failures that could exacerbate the pandemic's economic fallout.

At the start of the pandemic, there was significant uncertainty about future economic developments and their impact on clients' ability to repay their debts. In response to the economic freeze, European Union Member States provided immediate support to mitigate the sudden impact on economic activity. A range of support measures was introduced, with loan moratoria being the most commonly used measure among pandemic-impacted borrowers in the EU.

Loan moratoria were introduced as early as March 2020. Under the Czech loan moratorium, several credit institutions allowed clients who experienced a temporary loss of income due to the coronavirus or related preventive measures (e.g., lockdowns) to postpone repayments. In April 2020, the Parliament of the Czech Republic approved a legal credit moratorium (Act No. 177/2020 Coll., on certain measures in the area of loan repayment in connection with the COVID-19 pandemic). Clients of credit institutions could apply for the legal moratorium until 30 September

2020, with deferment of installments allowed until 31 October 2020. The maximum period for postponing loan repayment was set at six months.

The deferral option applied to both business and consumer loans, including mortgages originated and utilized before 26 March 2020. If a client opted for installment deferral, the loan repayment period was extended accordingly for the duration of the suspension. Upon resumption of repayment, the client settled the deferred installments along with accrued interest. The interest rates were maintained at the contractual level during the deferment period. This utilization of the moratorium underscores the proactive measures taken to mitigate the financial strains induced by the pandemic.

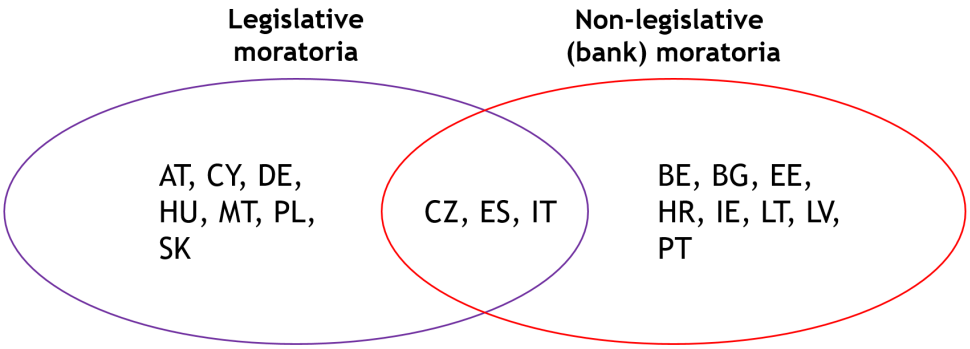
The end of the legal moratorium led to a return to market principles. However, considerable uncertainty about future economic developments persisted due to the ongoing pandemic. Therefore, a non-legislative (banking) moratorium was implemented. The subsequent bank moratorium was a more targeted measure, approved by banks based on an assessment of individual clients. The controlled easing of these measures aimed to balance continued support for vulnerable borrowers with ensuring the resilience of the financial sector.

The utilization of debt repayment moratoria was widespread across European Union member states, encompassing both legislative and non-legislative measures (Figure 5). Most moratoria expired within 3–6 months. Eligibility criteria for accessing these moratoria were generally lenient. Most often, the only conditions for entering a moratorium were the existence of performing credit and an indication of the negative impact of the pandemic on the client. In some countries, documentation of a specific amount of income loss, a negative impact on employment, or health complications was required. In certain cases, the granting of a moratorium was linked to specific client characteristics (e.g., liquidity position, maximum property price, primary residence status). A detailed overview of moratoria implementation in EU countries is shown in Table A1. The international overview emphasizes the rather unique setup in the Czech Republic, specifically a combination of both legislative and non-legislative (bank) moratoria and virtually unrestricted conditions for applying to the moratoria program.

In the Czech Republic, repayment installments were deferred after the debtor's notification of intent to invoke a legal moratorium to the creditor, citing the adverse economic repercussions of the coronavirus pandemic as the rationale for this course of action. The debtor was not required to substantiate these reasons, leaving the decision entirely to the debtor. This ultimately broadened the spectrum of affected borrowers to include not only those with a high-risk profile but also solvent borrowers.

Several policy measures implemented during the COVID-19 pandemic likely complemented moratoria in mitigating financial strain and reducing mortgage defaults. Social care contributions, direct income compensation, and deferred tax payments provided liquidity to households, while reductions in pension contributions and increased benefits, such as sickness and child support, helped stabilize budgets. These measures supported household finances during the pandemic, likely reducing default risks and reinforcing financial stability (see Table A2).

Figure 5: Loan Moratoria: International Comparison



Note: The figure highlights the variation in moratorium types across different EU countries during the pandemic, distinguishing between countries that implemented legislative moratoria and those relying on non-legislative measures. AT = Austria, CY = Cyprus, DE = Germany, HU = Hungary, MT = Malta, PL = Poland, SK = Slovakia (countries that implemented legislative moratoria); CZ = Czech Republic, ES = Spain, IT = Italy (countries that used both legislative and non-legislative (bank) moratoria); BE = Belgium, BG = Bulgaria, EE = Estonia, HR = Croatia, IE = Ireland, LT = Lithuania, LV = Latvia, PT = Portugal (countries with non-legislative (bank) moratoria only).
Source: Own compilation.

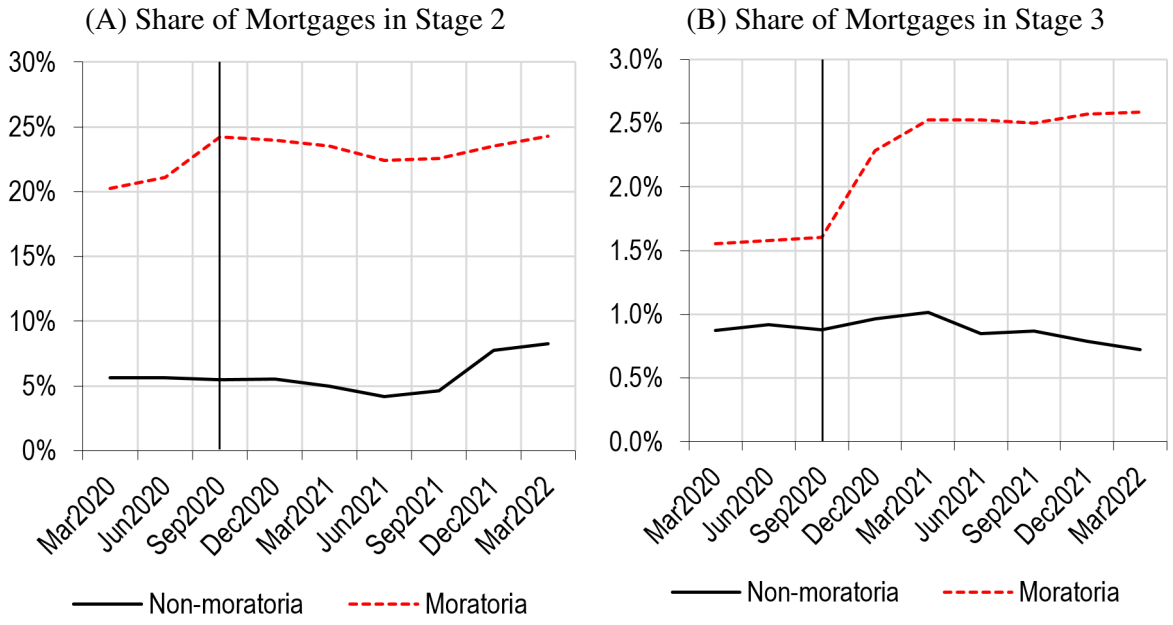
2.3 Mortgage Delinquencies

IFRS 9 accounting standards recognize three stages of credit risk: stage 1 represents the lowest risk, and stage 3 the highest. The reclassification between stages 1 and 2 should occur in the event of a significant increase in credit risk. However, the criteria for defining a significant increase in credit risk are not clearly established. The European Banking Authority (EBA) guidelines set the starting point at 30 days past due. Additionally, banks use a combination of qualitative and quantitative criteria illustrating the evolution of credit risk and expected macroeconomic developments for the transition between stages. Similar indicators are used to move loans from stage 2 to stage 3, where the application of the criteria is clearly defined through the default criterion—i.e., if the exposure is 90 days past due (see EBA, 2017). Therefore, stage 2 exposures and non-performing loans (NPLs) are key monitoring metrics for assessing potential risks.

Given the novelty of loan moratoria as a policy tool, little is known about its financial stability implications. Consequently, regulations concerning credit risk were relaxed in response to the utilization of loan repayment moratoria. The European Banking Authority (EBA) issued a statement indicating that loans under moratorium did not have to be automatically classified as exposures with increased credit risk (Stage 2). The decision to reclassify was entirely at the discretion of the bank.

The volume of mortgage loans with an approved moratorium amounted to CZK 181 billion, roughly 12% of the then mortgage loan portfolio of the domestic banking sector. At the EU level, 7% of residential mortgage loans were granted moratoria on loan repayments (EBA, 2020). Czech banks migrated loans in moratoria to stage 2 to a relatively large extent (Figure 6, panel A). While the share of stage 2 mortgage loans in the total portfolio ranged between 4% and 7% until 2022, the share of mortgage loans for which the moratorium was used for a certain period ranged between 21% and 24%.

Figure 6: Comparison of Mortgage Risk Classification: Impact of Moratoria on Stage 2 and Stage 3 Loans (as a Percent of Total)



Note: The left-hand graph shows the share of mortgages classified as Stage 2 (significant credit risk increase), while the right-hand graph shows mortgages in Stage 3 (default or credit-impaired). Both graphs compare loans under moratoria (dashed red line) and non-moratoria (solid black line).
Source: CNB.

As the pandemic situation improved, many governments and other authorities began phasing out mortgage payment moratoria. Upon the expiration of the legal moratorium, there was indeed a partial materialization of risks. The proportion of non-performing loans (NPLs) to total loans, essentially aligning with the share of exposures with impairment (Stage 3), almost doubled after the legal moratoria ended (Figure 6, panel B). The share of non-performing loans in the group of mortgage loans for which the moratorium was used reached around 2.5%, while for the total mortgage loan portfolio, it remained below 1%. This phenomenon highlighted the transitional impact of the pandemic on credit risk dynamics, where latent risks evolved into tangible challenges for financial institutions. The subsequent analysis and management of these challenges became imperative for maintaining the resilience and stability of the banking sector.

3. Data

In this section, we provide details on the data used in the paper. Section 3.1 summarizes our data pre-processing before entering the empirical analyses. Section 3.2 presents summary statistics of the dataset.

3.1 Data Curation

Our main data source for the analysis is the supervisory survey data on all newly granted residential mortgage loans in the Czech Republic, available from 2015. This confidential dataset includes anonymized origination-level data on all provided retail loans secured by residential property. We study loans granted from July 2015 through December 2019, as the payment deferral was applicable only to pre-pandemic loans. However, the dataset excludes customers who utilized the moratorium

but received a mortgage loan from the bank before July 2015. The data form a cross-sectional dataset, covering information from over half a million mortgages. The origination details in the dataset are similar to those found in other loan-level data. In particular, there is information on original loan terms as well as mortgage, property, and borrower characteristics (e.g., loan size, collateral value, income, property location, and interest rate).[4]

In the initial phase, it was imperative to preprocess data from individual survey rounds to facilitate seamless integration. This process required accommodating variations in the number of variables across different rounds, as well as accounting for changes in variable names over time or methodological alterations (such as shifts between percentage and integer representations).[5] During the second phase, considerations were extended to encompass individual idiosyncrasies inherent in the data collection process, such as the use of decimal points versus commas, diverse coding practices among banks, and other nuanced discrepancies. A higher number of incorrect or incomplete data entries is particularly associated with the first years of the supervisory survey dataset.

Subsequently, data pertaining to moratoria and mortgage arrears were integrated into the main survey dataset. Since detailed data on moratoria loans and arrears are stored in separate confidential datasets, we used a combination of six common variables present in all datasets to match individual mortgages. The selected variables used to identify mortgages were bank code, loan origination date, loan size, collateral size, applicant's net income, and interest rate. The selection of these variables for one-to-one matching was driven by their relative uniqueness and the need to ensure an adequate number of records across all datasets.[6] This combination enabled the pairing of over 70% of the data on moratoria.[7]

Regarding the identification of mortgage arrears, the process was slightly more complex. First, the database records information on each mortgage whenever the borrower is behind on payments. This can happen multiple times and may not necessarily lead to a significant increase in credit risk. Fortunately, the database also includes information on when the borrower missed a payment and the amount categorized as past due. This enables us to focus on the mortgages relevant to our analysis. Specifically, we assign a flag indicating that a mortgage is in arrears if the borrower missed at least one full monthly payment and this occurred within two years after the moratoria programs ended.[8] Using this matching procedure, we successfully paired over 75% of mortgages (approximately 16,000) with our main dataset.

[4] Borrower characteristics are consolidated values in cases where the mortgage loan is extended to multiple applicants. For instance, net income is compiled as the overall net income declared by all borrowers in the mortgage loan agreement. The sole exception is the reported age, which is provided solely for the primary borrower.

[5] The survey data encompass a total of 25 variables that exhibit temporal fluctuations. Over time, new variables mandated for reporting by financial institutions have been incorporated into the survey. Consequently, more recent survey rounds include novel variables that are absent in their older counterparts, rendering a direct temporal comparison of these data unfeasible.

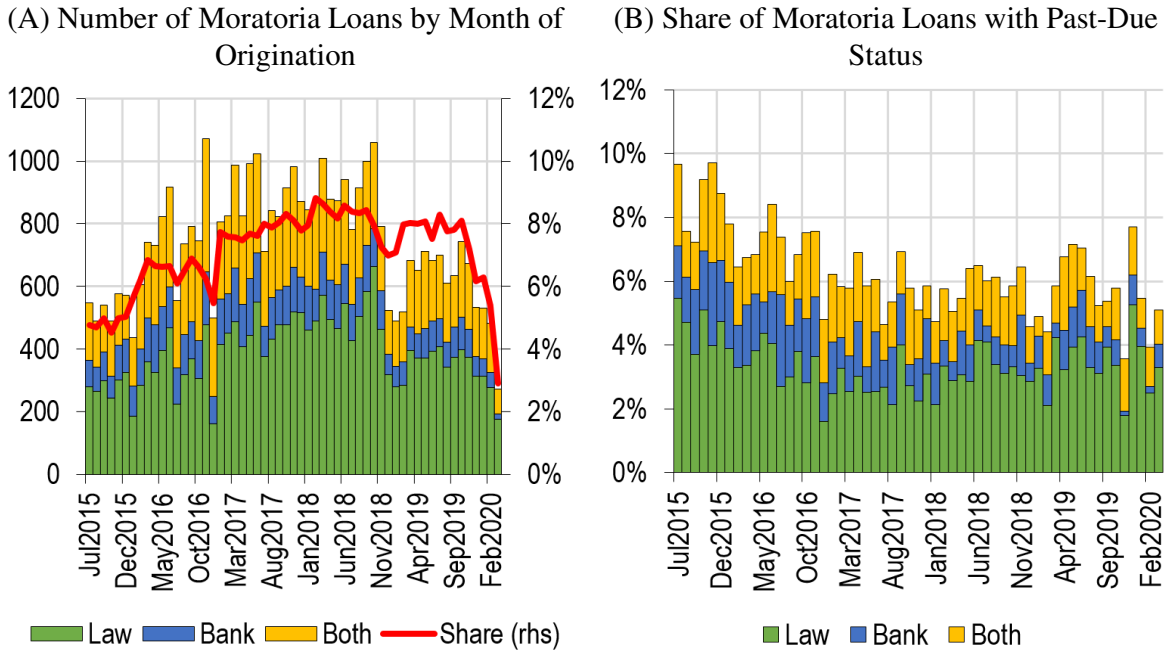
[6] The inclusion of additional variables did not increase the number of matched records. Conversely, reducing the number of common variables resulted in a loss of necessary uniqueness for the newly created variable crucial for proper data pairing. In an extremely limited number of cases, duplicate values of the newly created variable were identified. These duplicates were attributed to errors in data entry during the survey or the inadvertent inclusion of the same loan twice. Such duplicates were excluded from the sample.

[7] The original moratoria dataset comprises over 46,000 new mortgages, and we were able to pair over 33,000 of them.

[8] In cases with multiple entries for the same mortgage, we retain the entry with the highest past-due amount.

Figure 7 illustrates the number of mortgages that fell under moratoria and the percentage of those that went into arrears after the moratoria ended. Given the cross-sectional nature of the dataset, mortgages are categorized by their month of origination. The number of mortgages appears relatively stable over time, with a notable break in the third quarter of 2018, coinciding with the introduction of income-based regulatory limits (DTI and DSTI).

Figure 7: Loans Under Moratoria and Past-Due Status



Source: CNB.

In our forthcoming analyses, we specifically focus on newly issued mortgages, deliberately excluding refinanced loans, given the cross-sectional nature of our mortgage survey data. This dataset captures information solely at the point of loan origination and does not account for any changes that occur if a mortgage is subsequently refinanced. This static snapshot implies that any refinancing activity, which would alter the terms and conditions of a mortgage, is not reflected in our dataset.

Refinancing is a conventional financial strategy influenced by shifts in economic conditions, particularly fluctuations in interest rates. In contrast, payment holidays are non-standard measures employed to bridge temporary liquidity and solvency challenges resulting from significant exogenous shocks characterized by an exceptional degree of uncertainty. Therefore, including refinanced mortgages could significantly distort our analytical results. This is because we investigate which characteristics of the loan or client at origination influenced the use of the moratorium or repayment problems. Furthermore, refinanced loans typically undergo adjustments in interest rates, principal amounts, or repayment terms, making their nature unsuitable for our purposes. These significant changes, which are pivotal for a nuanced understanding of mortgage dynamics, are missing in a cross-sectional dataset that does not update post-origination changes. Analyzing these loans as if they represented their original issuance conditions could lead to erroneous interpretations of current mortgage behaviors and market trends.

Moreover, refinancing decisions are often influenced by shifts in economic conditions, including interest rate developments and the financial status of borrowers. Fortunately, our database includes an indicator variable that identifies whether a loan has been refinanced. This feature allows us to systematically exclude these loans from our analyses. Note that this exclusion primarily affected non-moratoria loans, with approximately 130,000 refinanced mortgages excluded (about 21% of the total dataset). From the moratoria loans, only about 7,000 mortgages were excluded (about 17%), and less than 500 were excluded from the moratoria with past-due dataset (about 15%). By focusing on the original terms of newly issued mortgages and considering the context of stable or increasing interest rates, we ensure a cleaner and more accurate representation of the market at the specific cross-sectional point in time.

After merging all datasets, we thoroughly examined the data to identify and exclude potential logical errors in reports. Entries containing errors, such as mortgages with a borrower age of less than 18 or more than 70 years, a loan maturity of less than 5 years or more than 40 years, an interest rate fixation period of more than 20 years, or a number of loan applicants exceeding 4, were excluded from the analysis. Additionally, we applied winsorization to handle extreme values for loan amount, collateral value, and borrower-based measures (LTV, DTI, and DSTI), identified using the 1st and 99th percentiles.

3.2 Bird's-Eye View of the Data

Table 1 presents the descriptive statistics for observable characteristics of loans in the moratoria and non-moratoria groups from July 2015 to December 2019. Clear differences emerge between these two groups, highlighting the elevated risk profiles associated with loans under moratoria. First, loans under any type of moratorium have significantly higher mortgage and collateral values compared to those without moratoria. Specifically, the average mortgage size for loans with moratoria is roughly 20% higher than for non-moratoria loans, and even higher for loans under bank moratoria. Similarly, the average collateral value for moratoria loans is 15% to 18% greater, reflecting substantial financial exposure. These differences suggest that borrowers with larger loan obligations and correspondingly higher collateral values may have opted for moratoria as a precautionary measure to manage financial stress during uncertain times.

Loans with moratoria also have longer maturities, which may indicate an approach to spreading payment burdens over an extended period. Despite these risk management strategies, the data reveal significant credit risk: the arrears rate for loans with moratoria is more than three times higher than that for non-moratoria loans (6.19% compared to 1.75%). This elevated arrears rate underscores the financial vulnerability of borrowers who sought moratoria.

Higher Loan-to-Value (LTV) and Debt-to-Income (DTI) ratios for loans with moratoria further emphasize this riskiness. These metrics indicate that moratoria loans involved higher borrowing relative to property values and income, suggesting greater financial strain. Although these ratios remain below the Czech National Bank's long-term risk thresholds (LTV of 80%, DSTI of 45%, and DTI of 9), the increased proportion of loans approaching these thresholds among moratoria borrowers highlights their vulnerability to financial pressures.

When comparing legislative and bank moratoria, the statistics reveal some apparent similarities. Both groups have comparable average mortgage sizes, loan rates, and borrower incomes, suggesting a seemingly uniform financial profile among those who opted for payment deferrals. For instance, the average mortgage size for legislative moratoria loans is only marginally lower than that for bank moratoria loans, and borrower income levels appear quite similar. However,

these surface-level similarities may mask deeper differences due to potential correlations among risk factors. Specifically, while legislative moratoria were accessible to a broader spectrum of borrowers, the eligibility criteria for bank moratoria likely attracted those facing more acute financial vulnerabilities. The precautionary behavior associated with legislative moratoria could mean that some borrowers had higher LTV or DTI ratios but were otherwise financially stable. This nuanced distinction indicates that, even if some metrics appear alike, underlying risk dynamics could differ significantly, influenced by interactions between income levels, debt obligations, and other financial stress indicators.

Table 1: Summary Statistics

Variable	Units	Non-moratoria	Moratoria	Legislative	Bank
Mortgage size	CZK	1,940,049	2,336,154	2,307,317	2,366,267
Collateral value	CZK	3,176,499	3,650,875	3,556,405	3,749,959
Property price	CZK	3,005,487	3,248,731	3,217,558	3,313,583
Monthly payment	CZK	9 389	10 438	10 871	10 046
Loan maturity	years	24.67	26.82	26.41	27.18
Loan fixation	years	5.84	5.87	6.23	5.51
Arrears	%	1.75	6.19	6.01	6.38
Loan rate	%	2.33	2.43	2.44	2.41
LTV	%	64.91	68.66	69.26	68.03
DTI	base units	5.13	5.90	5.95	5.83
DSTI	%	32.21	37.13	37.31	36.91
LTI	%	4.15	4.53	4.70	4.32
LSTI	%	23.69	25.02	27.54	22.48
Borrower income	CZK	548,832	578,600	566,499	591,118
Borrower debt (total)	CZK	721,303	1,080,340	978,473	1,195,530
of which: other mortgages	CZK	675,460	986,971	949,418	1,009,105
of which: consumer loans	CZK	106,876	189,606	203,709	181,116
of which: credit cards	CZK	22,819	24,866	26,578	23,796
PD	%	1.03	1.20	1.60	0.77
Borrower age	years	36.78	35.70	35.79	35.61
No. of co-applicants	base units	1.44	1.48	1.46	1.49
No. of dependents	base units	1.02	0.97	1.05	0.89
Intermediated loan	%	25.99	30.38	31.66	29.04
Employee (1=yes, 0=no)	%	81.67	79.25	78.45	80.07
Second+ mortgage	%	68.48	78.64	80.50	76.54
Number of mortgages		441,517	33,064	16,890	16,174

Source: CNB.

Table 2 highlights notable differences in risk characteristics between loans in arrears and those not in arrears, with particular emphasis on loans in arrears that were under moratoria. Mortgage size is marginally higher for loans in arrears overall (1.3%) but substantially higher for loans in arrears with moratoria (19.4%), suggesting that larger financial obligations may contribute to payment difficulties, particularly among moratoria borrowers. Collateral values show contrasting trends: they are lower for loans in arrears without moratoria, while those in arrears with moratoria have higher collateral values, indicating that even borrowers with significant assets faced financial challenges. Borrower incomes are generally lower for loans in arrears, but loans in arrears with moratoria exhibit relatively higher incomes, reflecting a potential selection bias of higher-income borrowers into moratoria programs. Despite this, total debt levels are significantly higher for moratoria loans in arrears, underscoring a mismatch between income and debt-servicing capacity.

Risk metrics such as Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt-Service-to-Income (DSTI) ratios are consistently higher for loans in arrears, especially for those with moratoria. For example, LTV reaches 71.46% and DTI 5.83 for loans in arrears with moratoria, compared to 64.82% and 5.13 for loans not in arrears. Additionally, borrowers with moratoria in arrears show a greater proportion exceeding regulatory thresholds for LTV and DSTI, highlighting their elevated financial vulnerability. These findings suggest that while moratoria may have temporarily alleviated financial pressures, they were more commonly utilized by borrowers with higher leverage and debt burdens, leaving them at greater risk of payment difficulties once the moratoria ended.

Table 2: Credit Risk Characteristics for Mortgages in Arrears

Variable	Units	Mortgage in Arrear		
		No	Yes	Yes (moratoria)
Mortgage size	CZK	1,940,006	1,942,493	2,316,486
Collateral value	CZK	3,179,275	3,023,218	3,492,585
Monthly payment	CZK	9,399	8,875	10,310
Loan rate	%	2.33	2.51	2.55
Borrower income	CZK	549,558	508,222	543,519
Borrower debt (total)	CZK	721,398	715,753	932,350
PD	%	1.02	1.83	1.75
Borrower age	years	36.80	35.48	35.02
Second+ mortgage	%	0.68	0.74	0.79
LTV	%	64.82	69.60	71.46
DTI	base units	5.13	5.49	5.83
DSTI	%	0.32	0.35	0.38
Number of mortgages		441,584	16,415	2,626
Mortgage share:				
LTV>80	%	26.41	32.41	35.32
DTI>8	%	12.30	14.67	17.43
DSTI>40	%	27.47	35.42	46.42

Source: CNB.

4. Determinants of Moratoria Choice and Past-Due Status

4.1 A Probit Model

In the first part of the paper, we examine the characteristics that influenced borrowers' decisions to enter loan moratoria. Given the broad accessibility of legislative moratoria and the more selective nature of bank moratoria, understanding these factors is essential for designing future repayment deferral programs and calibrating their parameters to balance short-term relief with long-term financial stability. From a financial stability perspective, identifying the key determinants of moratoria uptake enables an evaluation of the relative risk profiles of moratoria borrowers and their potential implications for the overall mortgage portfolio.

To achieve our objective, we estimate a series of probit models with different specifications of the dependent variable. The primary dependent variable is a binary indicator denoting whether a mortgage participated in the moratoria program (M_i). Additionally, we estimate separate models where the dependent variable is a dummy for participation in legislative moratoria (M_i^{leg}) or bank

moratoria (M_i^{bank}), allowing us to examine the differences in characteristics driving uptake for each type of moratorium. The general specification of our probit regression is as follows:

$$Prob\left(\frac{M_i = 1|X'i}{Mi = 0|X'i}\right) = \alpha b + \alpha_s + \alpha_t + \Phi(X'i\beta) + \varepsilon i \tag{1}$$

where Φ is the cumulative normal distribution function, $X'i$ represents a vector of observable borrower, mortgage, and spatial characteristics as listed in Table 1. The fixed effects αb, α_s, and α_t represent bank-, postal-code-, and month-level effects, respectively, and are included to mitigate omitted variable bias by capturing unobservable heterogeneity across these dimensions.

The inclusion of fixed effects is crucial for improving the accuracy of our estimates. Bank-fixed effects (α_b) control for differences in lending practices, risk appetites, and moratoria application criteria across banks. For instance, some banks may have implemented stricter eligibility rules for moratoria borrowers, while others may have been more lenient, affecting the likelihood of participation independently of borrower-specific characteristics. Postal-code-fixed effects (α_s) account for regional variations in economic conditions, housing markets, and the spread of pandemic-related financial stress. For example, borrowers in regions with higher unemployment or lower housing demand may have been more likely to opt for moratoria due to greater economic uncertainty. Month-fixed effects (α_t) capture time-specific factors such as changes in government policy, shifts in pandemic severity, or broader economic fluctuations that could influence moratoria uptake.

This rich set of fixed effects aims to control for unobserved heterogeneity that might otherwise bias our results. For instance, without bank-fixed effects, our estimates might incorrectly attribute differences in moratoria participation to borrower characteristics when, in reality, they reflect variations in bank policies. Similarly, excluding postal-code-fixed effects could lead to spurious correlations if certain borrower profiles are concentrated in regions with distinct economic dynamics.[9]

To ensure robust inference, we cluster standard errors using a triple grouping of bank ID, month, and postal code. This approach accounts for potential correlations in unobserved factors that influence moratoria participation. Clustering by this triple grouping is necessary because failing to account for such correlations could lead to underestimated standard errors and overstated statistical significance. By clustering on this grouping, we provide a more conservative and reliable estimation of standard errors, ensuring valid hypothesis testing even in the presence of complex error structures.

The vector β contains the parameters to be estimated. Leveraging the richness of our loan-level dataset, we assume that the maximum likelihood (ML) estimates of β are consistent, asymptotically efficient, and normally distributed under correct model specification. Estimating models with separate dependent variables for overall moratoria, legislative moratoria, and bank moratoria enables us to rigorously identify the distinct characteristics associated with participation in each program, providing insights into the risk profiles of borrowers under different moratorium types.

[9] We also experimented with various combinations of fixed effects. While these tests increased computational demands, they did not significantly alter the estimated parameters or model fit, reinforcing the robustness of our specification.

4.2 Who Are the Recipients of Mortgage Moratoria?

Table 3 provides the first evidence on the mortgage-level characteristics most closely associated with borrower's decision to opt for loan moratoria. We report marginal effects calculated after probit regressions where the dependent variable takes the value of one if the loan was in the moratoria program.[10]

Identified determinants collectively suggest a trend where borrowers with potentially higher credit risks are more likely to opt for moratoria. Specifically, longer loan maturities, higher interest rates, larger loan sizes, higher borrower debt, and lower borrower incomes are associated with an increased likelihood of choosing moratoria.

For instance, loan maturity, interest rates, and loan size collectively form a triad that significantly influences the decision to opt for moratoria. Longer loan terms and higher interest rates both reflect an increased financial burden over time, with marginal effects indicating that as these factors intensify, so does the likelihood of borrowers seeking moratoria. Specifically, interest rate effects of up to 3.56 percentage points (column 5) highlight how even small increases in rates can significantly affect borrowers with tight financial margins.[11] The strong association between higher interest rates and the likelihood of entering moratoria highlights the role of interest rates as an effective risk indicator. Borrowers with higher rates were more likely to seek payment deferrals, reflecting their heightened vulnerability to financial stress. This suggests that banks set the risk premium on mortgage loans appropriately during the period under review, effectively capturing borrower risk profiles and aligning pricing with underlying credit risk.

Debt-related variables further underscore the financial stressors driving moratoria uptake. Borrowers with higher Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt-Service-to-Income (DSTI) ratios were significantly more likely to participate. A 1-decile increase in LTV is associated with a 0.37 percentage point rise in the likelihood of moratoria participation, while a similar increase in DTI adds 0.96 percentage points. These findings highlight the role of leverage and debt burdens in influencing borrowers' decisions, reflecting their heightened financial vulnerability. Additionally, total borrower debt, as well as specific debt types like consumer loans and credit card debt, showed strong positive effects on moratoria participation. For example, a 1-decile increase in consumer loan debt increases the likelihood of participation by 1.98 percentage points, suggesting that borrowers with diverse debt obligations relied on moratoria to manage cash flow challenges.

Lower borrower incomes also played a significant role, with marginal effects reaching -0.88 percentage points. This finding illustrates the vulnerability of lower-income households, who were more likely to use moratoria as a financial safety net. Employment status was another key determinant, with employed borrowers being 2 percentage points less likely to participate.

These results highlight the critical role of moratoria in supporting borrowers facing liquidity pressures, particularly those with high leverage, substantial debt burdens, and limited financial flexibility.

[10] In a probit model, the marginal effect of an independent variable quantifies the change in the probability of the dependent variable switching from 0 to 1, given a small (unit) change in the independent variable.

[11] To clarify, if the probability of choosing moratoria was 10% at an interest rate of 1%, then at an interest rate of 2%, all else being equal, the probability would increase to approximately 13.56%. This interpretation assumes that the effect of interest rates on the likelihood of entering moratoria is linear and that other variables in the model are held constant.

Table 3: What Characteristics Explain Loans Falling Under Moratoria?

Marginal effect (pct.)	(1)	(2)	(3)	(4)	(5)
Loan maturity	0.0026***	0.0027***	0.0018***	0.0030***	0.0029***
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0007)
Loan fixation	-0.0000	-0.0001	-0.0006	-0.0008	-0.0003
	(0.0000)	(0.0001)	(0.0007)	(0.0007)	(0.0005)
Loan interest rate	0.0229***	0.0280***	0.0279***	0.0259***	0.0356***
	(0.0009)	(0.0019)	(0.0031)	(0.0031)	(0.0052)
Loan size$^{\Delta}$	0.0054***	0.0081***			0.0005
	(0.0007)	(0.0014)			(0.0039)
Collateral value$^{\Delta}$	0.0011***	0.0002			-0.0015
	(0.0003)	(0.0005)			(0.0014)
Monthly payment$^{\Delta}$	0.0001	-0.0005			0.0098***
	(0.0007)	(0.0013)			(0.0037)
Borrower income$^{\Delta}$	-0.0005**	-0.0077***			-0.0088***
	(0.0002)	(0.0005)			(0.0014)
Borrower age$^{\Delta}$	0.0006***	0.0002	0.0011*	0.0000	0.0014
	(0.0002)	(0.0004)	(0.0007)	(0.0007)	(0.0011)
Employee (yes)	-0.0197***	-0.0175***	-0.0223***	-0.0204***	-0.0061
	(0.0015)	(0.0026)	(0.0043)	(0.0043)	(0.0069)
Client PD	0.0074***	0.0091***	0.0077***	0.0072***	0.0084***
	(0.0003)	(0.0007)	(0.0011)	(0.0011)	(0.0024)
No. of co-applicants	0.0008	0.0026	-0.0019	-0.0020	-0.0026
	(0.0011)	(0.0019)	(0.0031)	(0.0031)	(0.0051)
Intermediated loan (yes)	-0.0002	-0.0011	-0.0072*	-0.0056	0.0022
	(0.0016)	(0.0021)	(0.0038)	(0.0038)	(0.0056)
Loan for rent (yes)	0.0152***	0.0026	0.0015	0.0010	0.0297
	(0.0052)	(0.0055)	(0.0083)	(0.0082)	(0.0194)
Borrower debt (total)$^{\Delta}$		0.0123***			
		(0.0004)			
LTV$^{\Delta}$			0.0037***	0.0035***	
			(0.0006)	(0.0006)	
DTI$^{\Delta}$			0.0096***		
			(0.0006)		
DSTI$^{\Delta}$				0.0109***	
				(0.0006)	
Second+ mortgage (yes)			0.0347***	0.0213***	0.0166**
			(0.0033)	(0.0034)	(0.0074)
Borrower debt (other)$^{\Delta}$					0.0181***
					(0.0031)
Consumer loans debt $^{\Delta}$					0.0198***
					(0.0027)
Credit card debt$^{\Delta}$					0.0048***
					(0.0018)
Bank FE	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
Observations	329,438	114,154	92,400	92,448	34,045
M=1	25,021	10,060	7,668	7,672	2,869
M=0	304,417	104,094	84,730	84,776	31,176
ROC	0.65	0.66	0.65	0.67	0.67
Correctly classified (%)	92.4	91.1	91.7	91.7	91.5

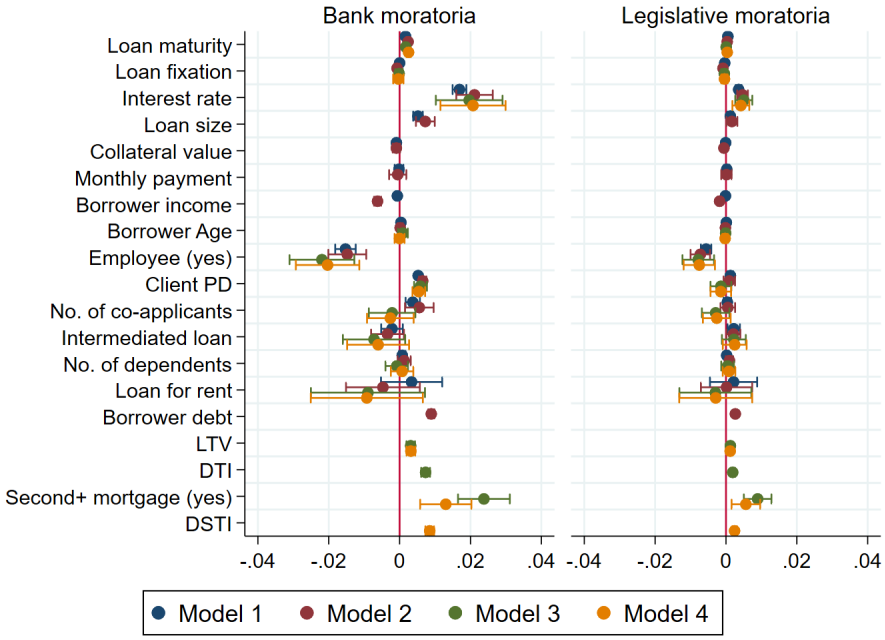
Note: The table shows marginal effects estimated after the probit regressions. Δ indicates that the variable is in deciles; otherwise, the variables are kept in base units. Standard errors (in parentheses) are clustered using a triple grouping of bank ID, month, and postal code. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3 Determinants of Legislative/Bank Moratoria Participation

Figure 8 illustrates the estimated marginal effects of borrower and loan characteristics on the likelihood of participating in legislative and bank moratoria, using model specifications 1–4 from Table 3. The results highlight significant differences in borrower profiles and access criteria between the two types of moratoria.

Bank moratoria show strong associations with indicators of financial vulnerability. Borrowers with higher Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt-Service-to-Income (DSTI) ratios were significantly more likely to opt for bank moratoria, reflecting their heightened financial constraints. Additionally, larger loan sizes, higher interest rates, and greater levels of total debt—including consumer loans—also increased the likelihood of participation. These results emphasize that bank moratoria were primarily accessed by riskier borrowers with heavier debt burdens and repayment obligations. The targeted nature of bank moratoria is evident from these patterns, which align with stricter eligibility criteria requiring borrowers to demonstrate financial distress.

Figure 8: Bank and Legislative Moratoria Participation Determinants



Note: The figure shows estimated marginal effects of borrower and loan characteristics on the likelihood of opting for legislative and bank moratoria, based on four different model specifications. Tabulated estimates are provided in Appendix Table B1. Positive values indicate characteristics that increase the probability of participation, while negative values indicate a reduction. Error bars represent 95% confidence intervals.

In contrast, legislative moratoria show smaller but still significant effects for similar variables, such as LTV, DTI, DSTI, and loan size. This indicates broader participation across a more diverse borrower base. Lower borrower incomes and employment instability were also key drivers of participation, reflecting the inclusive design of legislative moratoria, which required no proof of financial distress. Legislative moratoria were thus used as a precautionary tool by borrowers facing temporary liquidity constraints, consistent with their broader access criteria.

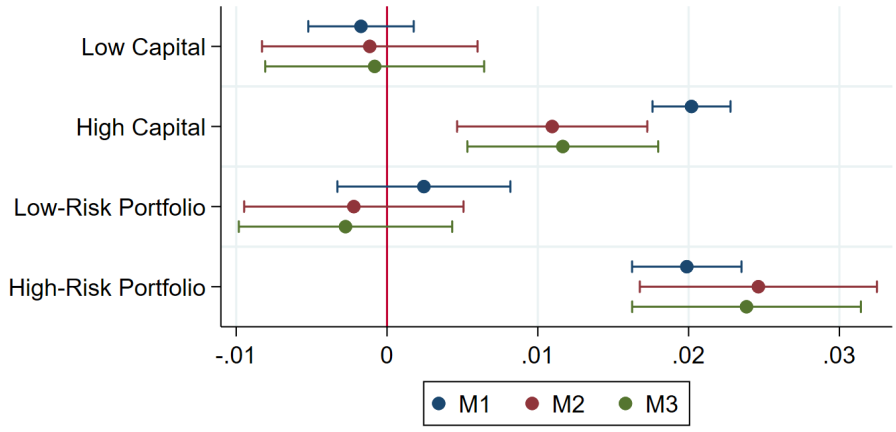
The results underline the contrasting roles of the two moratoria types. While legislative moratoria served as a broad safety net for borrowers during the pandemic, bank moratoria were more focused on addressing severe financial vulnerabilities. The stronger effects for high-risk indicators in bank moratoria highlight their targeted nature, while legislative moratoria provided relief for a wider spectrum of borrowers, including those with less pronounced financial risks. These findings emphasize the importance of carefully designing moratoria to balance inclusivity and financial stability.

4.4 Insights on Bank Moratoria

Given that the eligibility criteria for bank payment holidays were determined at each bank's discretion, some institutions may have opted for more lenient entry requirements to attract a larger number of borrowers, effectively delaying the materialization of credit risk. Figure 9 shows that banks with higher capitalization and riskier portfolios (as measured by the average portfolio probability of default) were more likely to adopt such lenient criteria. This behavior is expected for banks with riskier portfolios, as they may have used the banking moratorium to defer the recognition of credit risk. However, the correlation with higher capitalization is less intuitive.

It is worth noting that during the period under review, all banks in the Czech banking sector were well-capitalized. Additionally, the materialization of credit risk was muted due to generous economic policy support (see Table A2), which helped shield banks' capital positions. Finally, this result may also reflect the structure of the domestic banking sector, where smaller banks—typically associated with riskier portfolios—tend to maintain larger capital surpluses.

Figure 9: Bank Moratoria and Bank Heterogeneity



Note: The graph shows estimated marginal effects for the low/high capital and risk dummies, based on three model specifications corresponding to columns 1, 2, and 5 in Table 3. Marginal effects for other variables were estimated but are not displayed. The capital dummy equals one if a bank's capital headroom is in the first quartile of its distribution as of 2019. Similarly, the risk dummy equals one if a bank's average probability of default is in the third quartile of its distribution as of 2019. Error bars indicate 95% confidence intervals.

4.5 Regulatory Ratios and Mortgage Moratoria Choice

Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt-Service-to-Income (DSTI) ratios are fundamental tools in macroprudential policy, actively employed by the Czech National Bank (CNB) to ensure financial stability. These regulatory limits curb excessive borrowing, mitigate systemic risks, and protect borrowers and lenders during economic uncertainty. Given their critical role in managing credit risks, understanding their interaction with borrowers' decisions to enter moratoria is vital, especially during crises like the COVID-19 pandemic.

Table 4 highlights differences in borrower profiles for legislative and bank moratoria, particularly their relationship with regulatory ratios. Borrowers opting for bank moratoria displayed higher levels of risk, reflected in the top LTV, DTI, and DSTI values, suggesting stricter eligibility criteria targeting those in acute financial distress. In contrast, legislative moratoria were used more broadly, with participation spanning lower and intermediate regulatory brackets, reflecting less restrictive eligibility frameworks designed for widespread relief. The distinction underscores the importance of regulatory thresholds in shaping borrower behavior and managing credit risks during crises.

Table 4: Regulatory Ratios and Mortgage Moratoria Choice

Marginal effects (pct.)	Legislative	Bank	Legislative	Bank	Legislative	Bank
LTV [60–70]	0.0018	-0.0022*				
	(0.0012)	(0.0013)				
LTV [70–80]	0.0082***	0.0022				
	(0.0008)	(0.0019)				
LTV [80–90]	0.010***	0.0032*				
	(0.0010)	(0.0015)				
LTV [90+]	0.0145***	0.0100***				
	(0.0012)	(0.0011)				
DTI [6–7]			-0.0061***	-0.0037		
			(0.0020)	(0.0023)		
DTI [7–8]			0.0029	0.0037		
			(0.0022)	(0.0025)		
DTI [8–9]			0.0071***	0.0097***		
			(0.0023)	(0.0028)		
DTI [9+]			0.0107***	0.0140***		
			(0.0027)	(0.0033)		
DSTI [30–40]					0.0064	-0.0006
					(0.0061)	(0.0083)
DSTI [40–50]					0.0176***	0.0127
					(0.0062)	(0.0084)
DSTI [50+]					0.0229***	0.0223***
					(0.0067)	(0.0086)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	323,679	319,938	323,679	319,938	323,679	319,938
M=1	11,783	13,460	11,783	13,460	11,783	13,460
M=0	311,896	306,478	311,896	306,478	311,896	306,478
ROC	0.81	0.81	0.81	0.81	0.81	0.81
Correctly classified (%)	96.36	95.79	96.36	95.79	96.36	95.79

Note: The table shows marginal effects estimated after the probit regressions. The model specification matches columns 3 and 4 of Table 3. Baseline categories: LTV<60, DTI<6, and DSTI<30. Standard errors (in parentheses) are clustered using a triple grouping of bank ID, month, and postal code. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

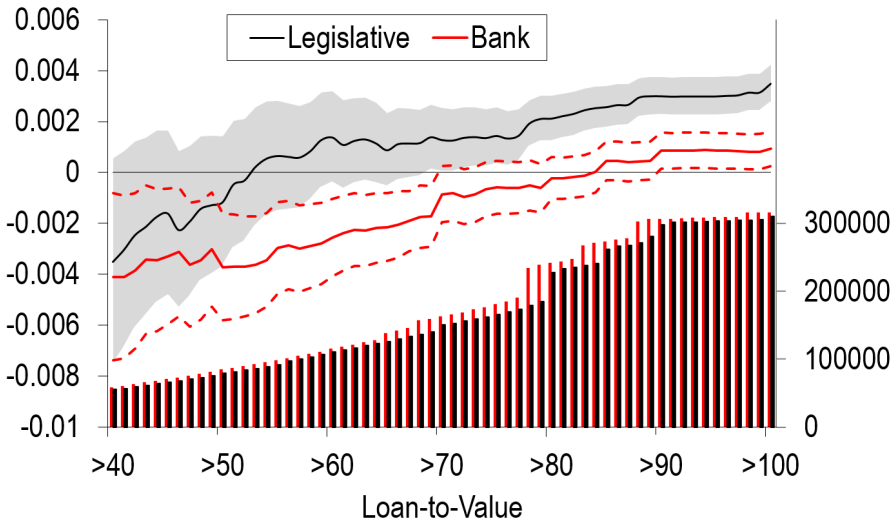
To further explore the relationship between borrower risk and moratoria choice, we conduct a series of probit models that incorporate an interaction between the Loan-to-Value (LTV) ratio and a

dummy variable. The dummy variable is set to one for loans with LTV ratios below or equal to an incremental threshold, starting from 30 and increasing by one unit in subsequent iterations. These models are designed to capture how incremental changes in LTV ratios influence the likelihood of choosing moratoria, with controls and fixed effects included as in Table 3, columns 3 and 4.

Figure 10 demonstrates the estimated marginal effects from these iterative models. The results reveal a clear positive relationship between higher LTV ratios and the likelihood of moratoria uptake. Legislative moratoria show a broader, more uniform distribution of marginal effects across lower and moderate LTV categories, suggesting they were accessed by a wider range of borrowers, regardless of their financial leverage. This is consistent with the lenient eligibility criteria for legislative moratoria, which allowed borrowers to self-declare pandemic-related financial distress without strict assessment.

In contrast, bank moratoria display a sharper increase in marginal effects at higher LTV levels, particularly beyond the regulatory threshold of 90%. The relationship between LTV and the likelihood of moratoria uptake becomes more pronounced in this segment, highlighting that bank moratoria were accessed predominantly by borrowers with higher financial leverage and potentially greater credit risk. This finding aligns with the more selective nature of bank moratoria, which required borrowers to meet specific eligibility criteria, leading to a concentration of riskier profiles within this group.

Figure 10: Moratoria Choice at Different LTV Values



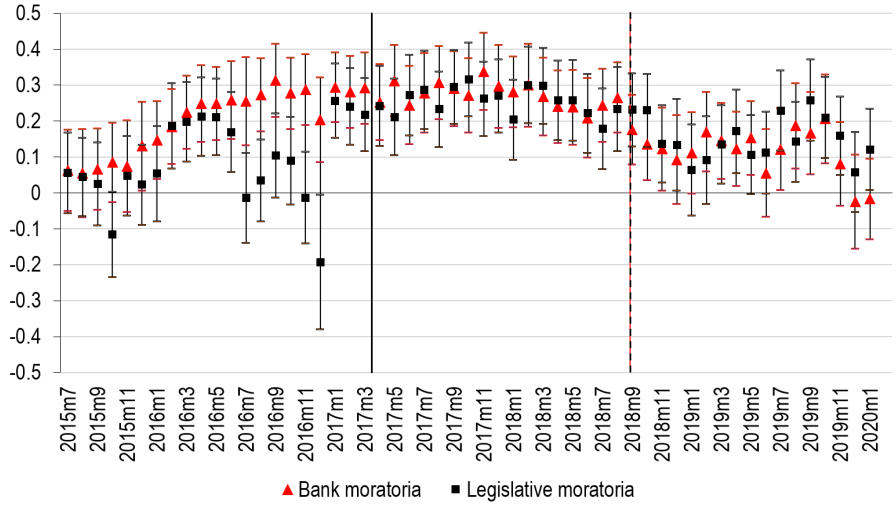
Note: The y-axis shows the change in the probability that a mortgage loan will become delinquent two years after the end of the moratorium due to a one-unit increase in the LTV value. The estimates represent marginal effects obtained from a series of probit models, using the specification in column 1 of Table 3. These models were gradually estimated on a sample of mortgages with LTV values ranging from 40 to 100 (x-axis). The number of observations included in each iteration is displayed as a bar chart. Error bars represent 95% confidence intervals.

Notably, these results are consistent with the findings from Table 4, further corroborating the idea that LTV ratios are a key determinant in borrower decisions during the pandemic. The iterative approach provides additional granularity, showing that the probability of moratoria uptake is not uniform across risk categories but intensifies with higher leverage. This insight emphasizes the importance of regulatory thresholds in understanding borrower behavior and assessing the financial vulnerabilities of loan portfolios.

4.6 Loan Moratoria Choice over Time

Figure 11 shows estimated parameters for individual month fixed effects, with vertical lines indicating the application date of borrower-based measure tightening. The solid line denotes a tightening of the LTV limit, while the red dotted line marks the introduction of income-based limits (DTI and DSTI). From the graph, it appears that the introduction of income-based limits significantly decreased the probability of entering moratoria for mortgages granted in the new (tighter) regulatory setup. This likely does not reflect seasonality in mortgage issuance, which is typically lower during winter months, as the decrease in estimated parameters persists.

Figure 11: Moratoria Choice at Individual Months



Note: The graph shows estimated parameters for individual month fixed effects based on the probit model specification in column 1 of Table 3, with 95% confidence bands. The baseline category is July 2015. The solid line indicates a tightening of the LTV limit, while the red dotted line marks the introduction of income-based limits (DTI and DSTI).

In the last exercise in this section of the paper, we segmented our sample into three periods based on the relative tightness of borrower-based macroprudential regulation (Table B2): LTV100 covers the period from July 2015 to September 2016, during which an LTV limit of 100 applied; LTV90 ranges from October 2016 to September 2018, when an LTV limit of 90 was in place; and LTV-DTI-DSTI spans from October 2018 to December 2019, when the LTV limit of 90 was accompanied by newly introduced DTI and DSTI limits.

The analysis highlights notable variations in the impact of borrower characteristics on moratoria participation across different regulatory regimes. The effect of loan size diminishes with increasing regulatory tightness, particularly during the LTV-DTI-DSTI period. This suggests that stricter regulations not only curbed the issuance of excessively large loans but also reduced their influence on moratoria decisions, encouraging more prudent borrowing behavior.

Borrower income, in contrast, shows limited significance across most periods, with a notable exception during the LTV-DTI-DSTI regime where it exhibits a small negative effect. This finding aligns with the idea that tighter regulatory measures may have better screened out higher-risk, lower-income borrowers, reducing the likelihood of these borrowers opting for moratoria.

Interest rates, however, remain a consistent and significant determinant of moratoria participation across all periods. The magnitude of their effect increases markedly during the LTV-DTI-DSTI regime, despite record-low average interest rates in the market. Borrowers with higher rates were still more likely to seek moratoria, reflecting banks' risk-sensitive pricing strategies under soft regulatory limits. These borrowers may have surpassed the hard LTV/DTI/DSTI caps but were allowed loans at higher interest rates, compensating for the added risk (Hodula et al., 2023b). This reinforces the role of pricing mechanisms in managing borrower risk within regulated frameworks while maintaining flexibility through soft limits.

5. Loan Moratoria and Credit Risk

The implementation of moratoria encompassed borrowers across a spectrum of financial stability, reflecting a diversity of risk profiles. This is particularly evident in the contrasting nature of legislative and bank moratoria. Legislative moratoria were broadly accessible, requiring only a declaration of pandemic-related hardship, while bank moratoria involved more stringent eligibility criteria, targeting borrowers with higher perceived financial vulnerabilities.

This dual framework creates a unique opportunity to examine risk dynamics after the moratoria programs were terminated. While some borrowers, particularly under the legislative moratorium, could have used the payment deferral as a precautionary measure during heightened uncertainty, others leveraged bank moratoria to manage more pressing financial challenges.

Analyzing mortgage performance after the moratoria's conclusion is essential to distinguishing between borrowers who faced temporary liquidity constraints and those with more persistent solvency issues. This differentiation is key to understanding how legislative moratoria served as a broad safety net and how bank moratoria captured borrowers at greater risk of credit distress, thereby shedding light on the varied credit risk implications of these programs.

5.1 Inverse Probability Weighting with Regression Adjustment

In the previous section, we examined the characteristics of loans under moratoria, suggesting increased credit risk among borrowers who chose to enter loan moratoria programs. This observation raises an identification challenge when studying mortgage performance after moratoria programs were terminated. Specifically, if borrowers with higher credit risk are more likely to participate in moratoria programs, there is endogeneity because the decision to enter a moratorium is not independent of default risk. Moreover, unobserved factors—such as a borrower's overall financial health, risk tolerance, or socio-economic circumstances not captured in our dataset—may influence both the likelihood of entering a moratorium and the likelihood of default. Therefore, we need to employ an identification strategy that addresses potential endogeneity arising from both observed and unobserved factors.

Identification. We use the inverse probability weighting with regression adjustment (IPWRA) estimator to analyze whether moratoria loans were more likely to default. This is a two-stage estimation process. In the first stage, we draw on the previously specified probit model in eq. 1 to determine the probability of the treatment status (i.e., loan falling under moratoria). In the next part, we refer to the probability of having a moratorium as the propensity score, and its estimate is

denoted by $\hat{p}_i$. In the second stage, we estimate regression weights given by the inverse of $\hat{p}_i$ while controlling for relevant observables stacked in vector Z:[12]

$$PastDue_i = f(Z_i, \beta) + \theta_i \tag{2}$$

Weighting by the inverse of the propensity score puts more weight on those observations that were difficult to predict and thereby re-randomizes the treatment. In our application, this implies putting more weight on moratoria decisions that were taken as a surprise based on observables, and putting less weight on those decisions that could be predicted. By utilizing inverse-probability weights, the IPWRA estimator accounts for selection bias in moratoria choice and estimates the average treatment effect (ATE) as follows:

$$ATE = E[PastDue_i(M_i = 1) - PastDue_i(M_i = 0)] \tag{3}$$

$PastDue_i$ denotes an indicator variable for whether mortgage i has received past-due status. In this setup, the time span exceeds our analysis, as we draw the information on the past-due status from a different database. Mortgage loans would be marked as past due if the borrower missed the loan payment within two years after the moratoria ended.[13]

To test the robustness of our estimations, we consider a propensity score matching (PSM) estimator. The PSM estimator matches treated and untreated units based on their propensity scores, which are the predicted probabilities of receiving treatment given the covariates. This method creates a control group that closely resembles the treatment group in terms of observed covariates, facilitating comparisons within the common support region where treated and untreated units have similar propensity scores. PSM is non-parametric, does not rely on outcome model assumptions, and ensures that comparisons are made only where there is overlap in propensity scores, enhancing the validity of the estimated treatment effects.

5.2 Average Treatment Effects

We begin by estimating the average treatment effect (ATE) of a loan having a moratorium on the probability of entering arrears. Table 5 presents the results for all moratoria loans and separately for mortgages with either legislative or bank moratoria. Overall, loans under moratoria are significantly more likely to experience arrears compared to non-moratoria loans, with an estimated ATE of 3.8 percentage points (pp). Given that the base rate of loans entering arrears is 1.5% (as shown by the mean for non-moratoria loans), this implies an increase in the probability of entering arrears to 5.3% for moratoria loans.

The results also reveal notable differences between legislative and bank moratoria. Legislative moratoria, which were broadly accessible and aimed at providing precautionary relief, show a

[12] We consider deciles of loan size, loan collateral value, borrower income, and employment status as controls. We further consider month and bank fixed effects.

[13] While the choice of a two-year countdown period after the moratoria ended is somewhat arbitrary, estimation results are not sensitive to a reduction of the considered period (results are available upon request).

smaller effect, with the probability of entering arrears increasing from 1.5% to 4.3%. In contrast, bank moratoria, which targeted riskier borrowers through stricter eligibility criteria, exhibit a substantially larger effect. For these loans, the probability of entering arrears rises from 1.5% to 6.5%.

Economically, the credit risk materialization after the moratoria ended was limited, with the overall arrears probability for the entire portfolio rising modestly from 1.5% to 1.96%. This small increase reflects the combined effects of legislative and bank moratoria, each accounting for 6% of the portfolio. Legislative moratoria contributed 0.17 percentage points to the increase in arrears probability, while bank moratoria, targeting riskier borrowers, had a larger impact, contributing 0.30 percentage points. These findings underscore the distinct roles of the two programs: legislative moratoria provided a broad safety net for precautionary or liquidity-constrained borrowers, while bank moratoria addressed borrowers with more acute financial vulnerabilities, yet without significantly destabilizing overall portfolio credit risk.

Table 5: Are Moratoria Loans More Likely To Fall into Arrears?

Past due (1/0)	All	Legislative	Bank
ATE (1 vs 0)	0.038***	0.028***	0.050***
	(0.001)	(0.002)	(0.002)
Mean (moratoria=0)	0.015***	0.015***	0.015***
	(0.001)	(0.001)	(0.001)
ATE (1 vs 0) PSM	0.038***	0.031***	0.081***
	(0.002)	(0.003)	(0.023)
Treated	25,021	13,147	13,929
Control	308,610	347,907	347,907

Note: The table reports the estimated average treatment effect (ATE) of moratoria on the probability of becoming past due, alongside the mean probability of becoming past due for the control group. PSM denotes propensity score matching estimation. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A key robustness check involves redefining mortgage arrears. In the baseline specification, a mortgage is considered in arrears if the borrower missed one month's payment. For this robustness test, we increase the threshold to two months of missed payments. The results, summarized in Table B3, show that while the estimated parameters are smaller, the overall patterns remain consistent.

Participation in legislative moratoria is associated with a modest increase in the probability of entering arrears, reflecting the broader and precautionary nature of these programs. In contrast, bank moratoria continue to show a larger increase in arrears probability, highlighting their focus on borrowers with higher financial vulnerabilities. These findings further support the conclusion that legislative and bank moratoria had distinct impacts on borrower behavior, with the latter associated with more concentrated credit risk materialization. The results are robust across both the IPWRA and PSM estimation methods, underscoring the validity of the analysis even under a stricter definition of arrears.

6. Moratoria Loans and Past Due: The Role of Macroprudential Borrower-Based Limits

Evaluating the effectiveness of borrower-based regulatory measures in the mortgage market is inherently challenging. Mortgage performance is influenced by a range of factors, including borrower behavior, economic conditions, and market dynamics, making it difficult to isolate the impact of specific regulations. Additionally, regulatory measures often evolve over time, and their effects may take years to materialize, further complicating direct evaluation.

However, the COVID-19 pandemic and the implementation of loan moratoria provide a unique natural experiment to assess regulatory effectiveness. By analyzing the interaction between borrower-based limits and the credit risk associated with moratoria loans, we can draw indirect implications about the role of regulation in mitigating financial vulnerabilities during periods of economic stress.

Table 6 examines the impact of loan moratoria on the likelihood of loans entering arrears across three distinct regulatory periods, characterized by progressively tighter borrower-based measures. These include Loan-to-Value (LTV), Debt-to-Income (DTI), and Debt Service-to-Income (DSTI) limits. The analysis aims to evaluate how these regulatory changes influenced the credit risk associated with loans under moratoria. Comparing estimates across different regulatory periods poses inherent challenges due to variations in borrower characteristics, economic conditions, and regulatory frameworks. However, the inclusion of extensive controls and fixed effects ensures that the estimated average treatment effects (ATEs) primarily reflect the impact of moratoria participation while mitigating the influence of confounding factors. This approach enables a clearer comparison of credit risk dynamics under differing regulatory environments.

The results reveal a clear trend: as borrower-based measures tightened, the credit risk associated with moratoria loans decreased. During the least restrictive period (LTV cap of 100%), loans under moratoria were 4.9 percentage points more likely to enter arrears compared to non-moratoria loans. With a base arrear rate of 1.6%, this corresponds to an increase in the likelihood of arrears to 6.5%. In the subsequent period (LTV cap of 90%), the ATE drops to 3.7 percentage points, reducing the arrear probability to 5.2%. The most stringent regulatory period, incorporating LTV, DTI, and DSTI caps, shows the lowest effect, with an ATE of 2.9 percentage points, resulting in an arrear probability of 4.2%. These findings align with the broader literature, which demonstrates that regulatory tightening typically shifts mortgage market characteristics towards lower-risk profiles (Akinci and Olmstead-Rumsey, 2018; Hodula et al., 2023b; Acharya et al., 2022). Differentiating between legislative and bank moratoria produces similar findings (Table B4).

From a financial stability perspective, the results underscore the critical role of regulatory frameworks in mitigating credit risk. The observed decline in credit risk associated with tighter regulation highlights the effectiveness of borrower-based measures in addressing financial vulnerabilities. Particularly, the combination of LTV, DTI, and DSTI limits proves instrumental in reducing the likelihood of arrears among moratoria loans, supporting the resilience of the mortgage market during periods of economic uncertainty.

Table 6: Different Regulatory Periods

Past due (1/0)	LTV 100% till Oct2016	LTV 90% Oct2016–Oct2018	LTV 90%, DTI 9, DSTI 45% since Oct2018
ATE (1 vs 0)	0.049***	0.037***	0.029***
	(0.003)	(0.002)	(0.003)
Mean (moratoria=0)	0.016***	0.015***	0.013***
	(0.001)	(0.001)	(0.001)
ATE (1 vs 0) PSM	0.042***	0.039***	0.029***
	(0.003)	(0.002)	(0.003)
Treated	6,747	13,866	6,419
Control	104,955	165,461	77,224

Note: The table reports the estimated average treatment effect of the moratoria indicator variable (the treatment) on the probability of becoming past due, alongside the mean probability of becoming past due for the control group. Mortgage groups are differentiated by the regulatory environment in place at the time the mortgage was granted. PSM denotes propensity score matching estimation. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7 evaluates the impact of loan moratoria on the likelihood of loans entering arrears, differentiating between borrowers constrained by regulatory limits (LTV, DTI, DSTI) and those unconstrained. Constrained borrowers are defined as those at or above the regulatory thresholds.[14] This segmentation provides a useful lens to identify how regulatory constraints interact with borrower risk and credit outcomes.

The results highlight significant differences between constrained and unconstrained borrowers under moratoria. For instance, LTV-constrained borrowers under moratoria face a 4.9 percentage point increase in arrears likelihood (stacked probability of 6.7%), compared to a 3.4 percentage point increase for unconstrained borrowers (4.8%). Similar patterns emerge for DTI- and DSTI-constrained borrowers, where the likelihood of arrears is consistently higher for those constrained by regulatory limits. Notably, the Z-tests confirm that these differences are statistically significant across all regulatory dimensions. Differentiating between legislative and bank moratoria produces similar findings (Table B5).

The findings underscore the elevated credit risk posed by constrained borrowers, even when benefiting from moratoria. This risk materialization aligns with prior evidence suggesting that banks adjust pricing for such borrowers, reflected in higher interest rates (Hodula et al., 2023b). While the segmentation by regulatory constraints provides valuable insights into borrower behavior and risk, it does not fully address the issue of causality. The observed differences could still stem from unobserved characteristics correlated with both the regulatory constraints and borrower risk, rather than the regulation itself. Nevertheless, the approach offers a meaningful way to analyze the effectiveness of borrower-based measures in targeting vulnerable segments and managing systemic risk.

[14] In the Czech context, borrowers can exceed regulatory caps under soft limits, allowing a portion of loans (5% of new loans) to bear a higher DTI and DSTI; in the case of LTV, the soft limit varied over time and ranged from 5 to 15%) to be issued above hard regulatory thresholds.

Table 7: Constrained vs. Unconstrained Borrowers

Past due (1/0)	LTV		DTI		DSTI	
	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained
ATE (1 vs 0)	0.034***	0.049***	0.029***	0.047***	0.028***	0.046***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Mean (moratoria=0)	0.014***	0.018***	0.013***	0.015***	0.013***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Z-test	4.17***		6.43***		6.43***	
ATE (1 vs 0) PSM	0.036***	0.044***	0.029***	0.039***	0.029***	0.040***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Treated	19,686	14,084	10,278	23,492	9,209	24,561
Control	479,048	364,578	364,142	313,842	227,307	335,452

Note: The table shows the estimated average treatment effect of the moratoria indicator variable (the treatment) on the probability of becoming past due, alongside the mean probability of becoming past due for the control set. Mortgages are selected into two groups based on their LTV, DTI, and DSTI values. LTV-constrained borrowers have an LTV greater than or equal to 80. DTI-constrained borrowers have a DTI greater than or equal to 9. DSTI-constrained borrowers have a DSTI greater than or equal to 45. A Z-test is used to determine whether the differences between coefficients in the groups are statistically significant. PSM denotes propensity score matching estimation. The statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7. Conclusion

In this paper, we analyzed the characteristics of clients who utilized the freely available legislative moratoria and the subsequent bank moratoria, which required specific eligibility criteria, in the Czech mortgage market during the pandemic. Additionally, we examined the evolution of credit risk following the expiration of these moratoria and assessed the role of preventive borrower-based measures (BBMs) implemented in the years leading up to the pandemic.

Our findings reveal that payment holidays were generally utilized by borrowers with riskier profiles. However, mortgagors participating in bank moratoria programs exhibited significantly higher risk levels based on borrower characteristics at the time of mortgage origination. This distinction is further supported by the evolution of credit risk following the end of the moratoria. Loans under moratoria were more susceptible to payment difficulties than non-moratoria loans. Specifically, while the baseline rate of non-moratoria loans becoming past due was 1.5%, legislative moratoria increased this probability to 4.3%, and bank moratoria elevated it to 6.5%. These results suggest that legislative moratoria were primarily driven by precautionary motives or liquidity constraints, whereas bank moratoria were more closely linked to solvency challenges.

The second part of our findings highlights the significant role of borrower-based measures in mitigating credit risk during the pandemic. Stricter regulations, implemented prior to the pandemic, were associated with reduced sensitivity to economic shocks and a lower likelihood of solvency issues. Mortgages adhering to the hard limits of BBM measures were significantly less likely to experience payment difficulties after the moratoria ended compared to those granted within the softer limit areas.

The implications of our findings offer several policy conclusions. First, this study contributes to understanding the behavior of mortgage portfolios under stress and the interaction between borrower characteristics, regulatory measures, and credit risk in the context of loan moratoria. These insights

can inform macro stress testing and assist in assessing the riskiness of mortgage portfolios for macroprudential policymaking.

Second, our results underscore the importance of eligibility criteria design in shaping the risk profile of borrowers using payment holidays and influencing subsequent credit risk materialization. The findings suggest that legislative moratoria, applied without eligibility criteria, were largely precautionary measures during heightened uncertainty. In contrast, bank moratoria served as a transitional measure, primarily benefiting borrowers with more persistent financial challenges.

Third, this paper adds to the literature on the effectiveness of borrower-based macroprudential measures (LTV, DTI, DSTI) in mitigating credit risk. These regulations were shown to play a critical role in maintaining financial stability during economic crises by reducing riskier lending practices. However, excessively stringent settings may stifle market mechanisms, making complementary measures such as capital buffers more appropriate. Introducing systemic risk buffers, particularly in mortgage markets with structural vulnerabilities, may enhance resilience to exogenous shocks like pandemics (Basten, 2020; Behncke, 2023; Hodula et al., 2023a).

Lastly, our analysis highlights the need for continuous monitoring and adaptation of regulatory frameworks to evolving economic conditions and borrower behaviors. A proactive approach to financial regulation can better manage mortgage-related risks and reinforce the stability of the financial sector.

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Appendix A: Moratoria and Other Covid-19 Policies

Table A1: Moratoria Overview in European Union Countries

Country	Objective	Eligibility criteria	Maximum duration of measure for the beneficiary	Claims coverage	Type of moratoria
AT	Temporal illiquidity of households and micro enterprises	Performing loans	> 9 months <= 12 months	Principal and interest	Legislative
BE	Postpone debt service payments on outstanding loans	Performing, reduction in income, liquid resources of less than €25,000	> 6 months <= 9 months	Principal and interest	Non-Legislative
BG	Relief mechanism for clients affected by the pandemic	Performing loans	<= 9 months	Principal and interest	Non-Legislative
CY	Bolster clients affected by the pandemic	Performing loans	N/A	Principal and interest	Legislative
CY	Bolster clients affected by the pandemic	Performing loans	N/A	Principal and interest	Legislative
CZ	Address potential liquidity problems	Negatively affected by the current situation	> 3 months <= 6 months	Principal and interest	Legislative
CZ	Address potential liquidity problems	Negatively affected by the current situation	<= 6 months	Principal and interest	Non-Legislative
DE	Reducing the burden on consumers	Income losses as a result of the pandemic	<= 3 months	Principal and interest	Legislative
EE	Assurance that the conditions for deferral period are similar across banks	Performing loans (no significant overdues)	> 9 months <= 12 months	Principal	Non-Legislative
ES	Empowering measure triggered by pandemic	Economically vulnerable	<= 3 months	Principal and interest	Legislative
ES	Empowering measure triggered by pandemic	Economically affected by pandemic	> 6 months <= 12 months	Principal and interest	Non-Legislative
HR	Relief for clients who are facing problems due to pandemic	Expected decline in liquidity	> 9 months <= 12 months	Principal and interest	Non-Legislative
HU	Support bridging the temporary payment difficulties	Economically affected by pandemic	> 9 months <= 12 months	Principal and interest	Legislative
HU	Support bridging the temporary payment difficulties	Economically affected by pandemic	> 3 months <= 6 months	Principal and interest	Legislative
HU	Support bridging the temporary payment difficulties	Economically affected by pandemic	<= 3 months	Principal and interest	Legislative
HU	Support bridging the temporary payment difficulties	Economically affected by pandemic	> 6 months <= 9 months	Principal and interest	Legislative
IE	Help clients affected by the pandemic	Expected decline in liquidity	> 3 months <= 6 months	Principal and interest	Non-Legislative
IT	Alleviate liquidity constraints on households hit by the pandemic	Loss of job, other income losses; serious handicap	> 9 months <= 12 months	Principal and interest	Non-Legislative
IT	Alleviate liquidity constraints on households hit by pandemic	Primary residency up to 400,000 euros, loss of paid employment or death/permanent disability or reduction in earnings of at least 33%	> 1 year <= 3 years	Principal and interest	Legislative
LT	Improving the financial situation of clients	Performing loans (no loans past due more than 30 days)	> 9 months <= 12 months	Principal	Non-Legislative
LV	Support bank clients and solve short-term difficulties	Affected by pandemic	N/A	Principal	Non-Legislative
MT	Bolster clients affected by the pandemic	Materially affected by pandemic	> 3 months <= 6 months	Principal and interest	Legislative
MT	Bolster clients affected by the pandemic	Materially affected by pandemic	> 6 months <= 9 months	Principal and interest	Legislative
PL	Support consumer-borrowers, who might encounter financial problems due to pandemic	Loss of job or other main source of income	<= 3 months	Principal and interest	Legislative
PT	Avoid loan delinquency due to pandemic	Unfavorable situation due to the pandemic	> 9 months <= 12 months	Principal and interest	Non-Legislative
SK	Bolster clients affected by the pandemic	Performing loans (no loans past due more than 30 days)	> 6 months <= 9 months	Principal and interest	Legislative

Table A2: Covid-19 Policy Measures with a Direct Effect on Employees and Self-Employed

Adoption date	Description of measure
12.03.2020	Social care contributions for employees and self-employed individuals who take care of children under 13 years of age due to the closure of educational facilities
26.03.2020	Relief of pension contributions for self-employed individuals for 6 months (March-August 2020)
31.03.2020	Income compensation (one-off grants totaling 25 thousand CZK) for self-employed individuals and partners of small companies
25.03.2020	Deferral of payment of income taxes
19.06.2020	Loss carryback: possibility to utilize a tax loss as a deductible item for two preceding tax years
02.09.2020	One-off increase in pension
14.10.2020	Social care contributions for employees and self-employed individuals who take care of children under 10 years of age or dependent persons due to the closure of educational facilities, forced quarantine of a child, or someone in the family
31.12.2020	Tax package II, including the abolition of the super-gross wage (tax reduction effect) and an increase in the basic tax credit per taxpayer, in particular
01.03.2021	Increase in sickness benefits during quarantine
01.04.2021	Increase in child benefits due to COVID-19
13.07.2021	Increase in the child tax credit due to COVID-19

Source: ESRB, Covid-19 Policy Measures by Country.

Appendix B: Additional Results

Table B1: Bank and Legislative Moratoria Participation Determinants: Full Probit Results

Marginal effect (pct.)	Bank moratoria				Legislative moratoria			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Loan maturity	0.0017***	0.0024***	0.0017***	0.0025***	0.0005***	0.0003**	0.0001	0.0004**
	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Loan fixation	0.0000	-0.0007*	-0.0001	-0.0004	-0.0003**	-0.0008***	-0.0005	-0.0004
	(0.0000)	(0.0004)	(0.0006)	(0.0007)	(0.0001)	(0.0003)	(0.0004)	(0.0004)
Interest rate	0.0169***	0.0211***	0.0196***	0.0207***	0.0036***	0.0047***	0.0050***	0.0042***
	(0.0010)	(0.0026)	(0.0048)	(0.0047)	(0.0004)	(0.0008)	(0.0012)	(0.0012)
Loan size	0.0052***	0.0073***			0.0012***	0.0017**		
	(0.0007)	(0.0014)			(0.0004)	(0.0008)		
Collateral value	-0.0009***	-0.0009*			-0.0001	-0.0006**		
	(0.0003)	(0.0005)			(0.0002)	(0.0003)		
Monthly payment	-0.0002	-0.0005			0.0002	0.0001		
	(0.0006)	(0.0012)			(0.0004)	(0.0007)		
Borrower income	-0.0006***	-0.0062***			-0.0001	-0.0018***		
	(0.0002)	(0.0005)			(0.0001)	(0.0003)		
Borrower age	0.0004*	0.0002	0.0009	-0.0000	0.0001	-0.0002	-0.0001	-0.0002
	(0.0002)	(0.0004)	(0.0007)	(0.0007)	(0.0001)	(0.0002)	(0.0004)	(0.0004)
Employee (yes)	-0.0153***	-0.0148***	-0.0219***	-0.0203***	-0.0056***	-0.0073***	-0.0078***	-0.0075***
	(0.0015)	(0.0027)	(0.0047)	(0.0046)	(0.0008)	(0.0014)	(0.0023)	(0.0023)
Client PD	0.0052***	0.0065***	0.0059***	0.0054***	0.0013***	0.0009	-0.0014	-0.0015
	(0.0003)	(0.0005)	(0.0009)	(0.0009)	(0.0004)	(0.0008)	(0.0015)	(0.0015)
No. of co-applicants	0.0037***	0.0056***	-0.0021	-0.0026	0.0004	0.0005	-0.0029	-0.0026
	(0.0010)	(0.0021)	(0.0034)	(0.0034)	(0.0005)	(0.0011)	(0.0020)	(0.0020)
Intermed. loan (yes)	-0.0022	-0.0034	-0.0072	-0.0061	0.0022**	0.0021**	0.0022	0.0025
	(0.0016)	(0.0024)	(0.0045)	(0.0045)	(0.0009)	(0.0010)	(0.0017)	(0.0017)
No. of dependents	0.0007	0.0013	-0.0008	0.0007	0.0002	0.0010*	0.0004	0.0009
	(0.0005)	(0.0009)	(0.0016)	(0.0016)	(0.0003)	(0.0005)	(0.0009)	(0.0009)
Loan for rent (yes)	0.0034	-0.0047	-0.0089	-0.0093	0.0021	0.0002	-0.0030	-0.0029
	(0.0044)	(0.0053)	(0.0082)	(0.0081)	(0.0034)	(0.0037)	(0.0052)	(0.0053)
Borrower debt (total)		0.0089***				0.0026***		
		(0.0004)				(0.0002)		
LTV			0.0031***	0.0032***			0.0012***	0.0012***
			(0.0006)	(0.0006)			(0.0003)	(0.0003)
DTI			0.0073***				0.0019***	
			(0.0006)				(0.0003)	
DSTI				0.0085***				0.0024***
				(0.0006)				(0.0004)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	228,392	74,657	24,044	24,044	306,155	106,043	33,753	33,753
M=1	11,647	4,859	1,602	1,602	13,055	5,029	1,526	1,526
M=0	216,745	69,798	22,442	22,442	293,100	101,014	32,227	32,227
ROC	0.74	0.73	0.74	0.75	0.81	0.82	0.83	0.84
Correctly classified (%)	94.90	93.49	93.33	93.34	95.74	95.26	95.48	95.48

Note: The table shows marginal effects estimated after the probit regressions. Δ indicates that the variable is in deciles, otherwise the variables are kept in base units. Standard errors (in parantheses) are clustered at individual loan level. The statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B2: What Characteristics Explain Loan Falling Under Moratoria? The Role of Regulation

Marginal effect (pct.)	Bank moratoria			Legislative moratoria		
	LTV100	LTV90	+DTI,DSTI	LTV100	LTV90	+DTI,DSTI
	(1)	(2)	(3)	(4)	(5)	(6)
Loan maturity	0.0012***	0.0018***	0.0027***	0.0005***	0.0007***	0.0003***
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Loan fixation	0.0000	-0.0006*	-0.0013***	-0.0000***	-0.0006***	-0.0006**
	(0.0000)	(0.0003)	(0.0005)	(0.0000)	(0.0002)	(0.0003)
Interest rate	0.0100***	0.0181***	0.0341***	0.0048***	0.0027***	0.0063***
	(0.0011)	(0.0017)	(0.0031)	(0.0008)	(0.0006)	(0.0008)
Loan size$^{\Delta}$	0.0052***	0.0055***	0.0037***	0.0022***	0.0015***	0.0005
	(0.0005)	(0.0005)	(0.0007)	(0.0003)	(0.0003)	(0.0003)
Collateral value$^{\Delta}$	-0.0014***	-0.0008*	-0.0002	-0.0004*	0.0004	-0.0001
	(0.0005)	(0.0005)	(0.0006)	(0.0002)	(0.0003)	(0.0003)
Borrower income$^{\Delta}$	-0.0003	-0.0006	-0.0013**	0.0001	-0.0003	-0.0007**
	(0.0003)	(0.0003)	(0.0006)	(0.0002)	(0.0002)	(0.0003)
Borrower age$^{\Delta}$	0.0012***	-0.0004	0.0010**	0.0001	0.0002	-0.0001
	(0.0003)	(0.0003)	(0.0005)	(0.0002)	(0.0002)	(0.0002)
Employee (1=yes)	-0.0099***	-0.0184***	-0.0150***	-0.0026**	-0.0082***	-0.0062***
	(0.0019)	(0.0024)	(0.0033)	(0.0011)	(0.0013)	(0.0016)
Probability of Default	0.0039***	0.0058***	0.0054***	0.0008	0.0028***	-0.0004
	(0.0004)	(0.0004)	(0.0007)	(0.0006)	(0.0006)	(0.0011)
Number of co-applicants	0.0026*	0.0047***	0.0009	-0.0000	0.0019**	-0.0005
	(0.0015)	(0.0016)	(0.0025)	(0.0009)	(0.0009)	(0.0012)
Intermediated loan (1=yes)	0.0111**	-0.0022	-0.0060**	0.0064***	0.0027*	0.0009
	(0.0044)	(0.0026)	(0.0028)	(0.0022)	(0.0016)	(0.0011)
Number of dependents	-0.0012*	0.0025***	0.0011	-0.0007	0.0003	0.0006
	(0.0007)	(0.0008)	(0.0011)	(0.0006)	(0.0005)	(0.0006)
Loan for rent (1=yes)		0.0105	-0.0033		0.0115*	-0.0051
		(0.0074)	(0.0070)		(0.0061)	(0.0041)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,710	143,853	69,205	71,572	105,181	50,656
M=1	3,563	6,733	2,744	2,557	5,894	3,182
M=0	88,147	137,120	66,461	69,015	99,287	47,474
ROC	0.81	0.81	0.83	0.78	0.74	0.70
Correctly classified (%)	96.11	95.32	96.03	96.43	94.40	93.72

Note: The table shows marginal effects estimated after probit regressions. Standard errors (in parentheses) are clustered at the individual loan level. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B3: Robustness Check: Credit Risk Materialization After Moratoria End

Defaulted (1/0)	All	Legislative	Bank
ATE (1 vs 0)	0.016***	0.015***	0.047**
	(0.001)	(0.002)	(0.012)
Mean (moratoria=0)	0.007***	0.007***	0.007***
	(0.001)	(0.001)	(0.001)
ATE (1 vs 0) PSM	0.016***	0.016***	0.048**
	(0.002)	(0.002)	(0.017)
(0.019)			
Treated	25,021	13,147	13,375
Control	308,610	347,907	320,250

Note: The table reports the estimated average treatment effect (ATE) of moratoria on the probability of becoming past due, alongside the mean probability of becoming past due for the control group. PSM denotes propensity score matching estimation. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B4: Different Regulatory Periods: Legislative vs. Bank Moratoria

Past due (1/0)	Legislative moratoria			Bank moratoria		
	LTV 100%	LTV 90%	+DTI,DSTI	LTV 100%	LTV 90%	+DTI,DSTI
ATE (1 vs 0)	0.049***	0.029***	0.023***	0.048***	0.052***	0.035***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Mean (moratoria=0)	0.015***	0.015***	0.015***	0.016***	0.017***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ATE (1 vs 0) PSM	0.042***	0.039***	0.058***	0.068***	0.035***	0.029***
	(0.003)	(0.002)	(0.003)	(0.008)	(0.015)	(0.002)
Treated	2,924	6,634	3,562	3,823	7,232	2,857
Control	104,955	165,461	77,224	104,955	165,461	77,224

Note: The table reports the estimated average treatment effect of the moratoria indicator variable (the treatment) on the probability of becoming past due, alongside the mean probability of becoming past due for the control group. Mortgage groups are differentiated by the regulatory environment in place at the time the mortgage was granted. PSM denotes propensity score matching estimation. Statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B5: Constrained vs. Unconstrained Borrowers: Legislative vs. Bank Moratoria

Past due (1/0)	LTV		DTI		DSTI	
	Unconst.	Constr.	Unconst.	Constr.	Unconst.	Constr.
Legislative moratoria						
ATE (1 vs 0)	0.031***	0.034***	0.023***	0.037***	0.021***	0.037***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
Mean (moratoria=0)	0.014***	0.018***	0.013***	0.015***	0.013***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Z-test	0.83		5.00***		3.77***	
Treated	9,130	5,820	3,856	9,042	3,799	9,450
Control	255,704	130,040	88,218	255,429	88,417	260,792
Bank moratoria						
ATE (1 vs 0)	0.050***	0.055***	0.043***	0.052***	0.043***	0.051***
	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)
Mean (moratoria=0)	0.015***	0.019***	0.015***	0.017***	0.013***	0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Z-test	1.18		2.01**		2.86***	
Treated	9,049	6,602	7,162	10,437	3,236	10,767
Control	265,649	135,926	88,218	265,272	92,216	270,242

Note: The table shows the estimated average treatment effect of the moratoria indicator variable (the treatment) on the probability of becoming past due, alongside the mean probability of becoming past due for the control set. Mortgages are selected into two groups based on their LTV, DTI, and DSTI values. LTV-constrained borrowers have an LTV greater than or equal to 80. DTI-constrained borrowers have a DTI greater than or equal to 9. DSTI-constrained borrowers have a DSTI greater than or equal to 45. A Z-test is used to determine whether the differences between coefficients in the groups are statistically significant. PSM denotes propensity score matching estimation. The statistical significance is denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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ISSN 1803-7070