Recourse and (strategic) mortgage defaults: Evidence from changes in housing market laws

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Abstract

We study the impact of a legislative change in Romania that retroactively modified mortgage recourse policies, providing a natural experiment to analyze borrower behavior under envolving legal frameworks. Using a granular dataset of mortgage loans originated between 2003 and 2016, combined with individual income tax records, we exploit an exogenous policy shift that transitioned mortgages from a creditor-friendly to a debtor-friendly regime. Our findings provide robust evidence that eliminating penalties for default significantly increased the probability of default among existing borrowers, particularly among high-income individuals and borrowers who are less liquidity-constrained – groups traditionally considered less prone to default. These findings underscore the unintended consequences of retroactive legislative changes, including deteriorated payment discipline and increased strategic default behavior.

Keywords: Mortgage market; Recourse; Mortgage default; Moral hazard; Negative equity.

JEL classification: G21, G28, K11, R20, R30.

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1. Introduction

Mortgage delinquencies and foreclosures have severe implications for both affected households and financial stability.[1] Defaults impair the solvency of lending institutions, reducing their capacity to extend credit. Following the Global Financial Crisis (GFC), housing markets - and mortgage debt in particular – were identified as key channels for spillover effects on the real economy (Mian and Sufi, 2014a). While mortgage defaults surged on both sides of the Atlantic during this period, default rates in Europe were substantially lower than in the U.S. A key factor underlying this divergence lies in the contrasting recourse laws between the two regions. In all European countries, mortgages are recourse loans, allowing lenders to pursue borrowers' personal (unsecured) assets and future income if the foreclosure sale does not fully cover the outstanding debt. By contrast, many U.S. states operate under non-recourse regimes, where lenders' claims are limited to the secured asset, leaving borrowers shielded from further liability when foreclosure proceeds fall short of the debt owned.[2] Arguably, the borrowers' limited liability in non-recourse jurisdictions may contribute to a higher likelihood of mortgage default. This paper provides new empirical evidence on the impact of a legislative change in Romania's recourse policy on mortgage defaults.

Understanding the relationship between recourse procedures, an important form of credit forbearance, and borrower default is critical for policymakers and financial institutions. The widespread adoption of credit forbearance policies during the 2020 pandemic crisis, coupled with the associated challenges in estimating potential credit losses, underscores the current relevance of this issue. Uncertainty about borrowers' repayment behavior - caused by payment moratoria – may incentivize lenders to tighten credit conditions when defaults rise, amplifying spillover effects on the real economy. The existing literature offers valuable insights into how recourse procedures influence borrowers' default behavior. Yet, most studies adopt a cross-sectional perspective, comparing the default process across jurisdictions with recourse versus non-recourse regimes. Relatively little is known about the dynamic effects of changes in recourse legislation within a single jurisdiction or the extent to which such changes influence the probability of mortgage default. Estimating the moral hazard effects of recourse policies is

[1] The negative effects spread across different dimensions. Mortgage defaults generate relocation costs for borrowers (Foote and Willen, 2018), reputation costs (e.g., lower credit scores; see Demyanyk et al., 2011), social stigma (Elul et al., 2010; Bhutta et al., 2017), and amplify downward trends in house prices (Gerardi et al., 2008; Campbell et al., 2011; Guren and McQuade, 2020) reducing lenders profitability and capitalization.

[2] Thirteen U.S. states do not allow for recourse in mortgage loan contracts (Páscoa and Seghir, 2020). Ghent and Kudlyak (2011) and Mitman (2016), among others, discuss the cross-state differences in recourse procedures in the U.S. Feldstein (2008) argues that U.S. mortgages are effectively non-recourse since lenders must seek judicial permission to foreclose a defaulted household even in states that have adopted a recourse legislation.

particularly challenging, as natural experiments involving time-varying recourse procedures within individual jurisdictions are exceedingly rare.[3]

Our paper addresses this gap by providing empirical evidence on the dynamics of mortgage arrears in response to legislative changes.[4] We focus on Romania, where a unique legal event – the transition of existing mortgages from recourse to non-recourse loans – offers a natural experiment to study incentives for mortgage default in a dynamic context. Prior to the enactment of the law, significant uncertainty surrounded its scope and beneficiary profiles, as the legislative draft underwent multiple amendments and its final provisions and introduction date remained largely unanticipated. The introduction of the *Datio in Solutum* law (Giving in Payment law) and its retroactive applicability provisions allowed all borrowers to fully discharge their mortgage liabilities by transferring the mortgage ownership to the lender (i.e., "walk away") without being subject to deficiency judgments. The *Datio in Solutum* law in Romania was introduced in response to financial and economic challenges following the GFC. After joining the European Union in 2007, Romania experienced a surge in housing prices and credit availability, with a significant share of mortgage loans denominated in foreign currencies. The crisis led to an economic downturn, a collapse in the property market, and rising interest rates, which put borrowers under significant strain. The situation worsened in 2015 when the Swiss franc appreciated sharply after the Swiss Central Bank removed its currency peg to the euro, further increasing repayment burdens and causing a spike in non-performing loans (NPLs) among household foreign currency borrowers. Although Romania's economy gradually recovered, slow wage growth and persistent unemployment left many borrowers financially vulnerable, increasing the risk of defaults.

The introduction of non-recourse legislation carries two potential implications. First, there is an ex-ante effect: banks, facing increased expected losses in the event of default, may adopt more conservative lending practices and tighten credit standards. In this context, the non-recourse regime can be viewed as beneficial, as it reallocates risk to economic agents better equipped to manage it. Second, there is an ex-post effect: non-recourse provisions may encourage moral hazard by reducing borrowers' skin in the game (i.e., the potential loss in case of default). Our analysis focuses on the latter effect, leveraging a unique and granular dataset of mortgage loans from the National Bank of Romania's credit registry. This dataset includes

[3] An exception is Li and Oswald (2017), who show that changes in recourse laws are associated with a decline in mortgage approval rates and loan size at origination.

[4] Throughout the paper, we use "arrears", "delinquencies", and "defaults" interchangeably, referring to past due payment obligations.

over 339 thousand unique mortgages originated between 2003 and 2016.[5] We further enrich this information with individual-level data from the Ministry of Finance, enabling us to construct affordability indicators that capture borrowers' indebtedness.

First, we identify borrowers who defaulted on their mortgage obligations both before and after the introduction of the *Datio in Solutum* law, as well as those who requested to give in payment. This allows us to examine how the law's enactment influenced borrowers' mortgage repayment behavior. For our analysis, we define a mortgage as delinquent if it is over 90 days past due. Second, we relax the assumption that the probability of mortgage default responds uniformly to the introduction of the *Datio in Solutum* law. Instead, we investigate the potential asymmetric effects of several borrower and loan characteristics under the new non-recourse regime.

Our main results can be summarized as follows. First, we complement the existing literature by showing that low income, high indebtedness, large loan amounts at origination, foreign-currency denomination, high-interest rates, and negative equity (i.e., when the outstanding mortgage exceeds the market value of the property) are all strongly positively associated with default. Second, we find robust evidence that switching from recourse to non-recourse results in a 60% increase in the one-year probability of default for borrowers eligible to invoke the *Datio in Solutum* law, while having no significant effect on those who are ineligible. Among borrowers who requested *Datio in Solutum,* the average probability of default rises by 5.1 percentage points, representing a 30-fold increase. Third, our results suggest that the relationship between borrower and loan characteristics and mortgage default is non-monotonic. The strongest effects on non-repayment after the introduction of the *Datio in Solutum* law are observed among borrowers with lower financial constraints (i.e., those with lower debt-service-to-income ratios or higher incomes), those with negative equity, and those with larger loan amounts at origination. These findings are consistent with the theory of strategic default: less-leveraged borrowers - either due to higher income or lower debt - are less likely to default. Conversely, borrowers with negative equity and larger loans stand to benefit more from the difference between their outstanding mortgage debt and the current value of the collateral in a non-recourse environment.

Our paper contributes to two main strands in the literature. First, it adds to the growing literature on the determinants of mortgage default, particularly studies examining the impact of recourse procedures on borrowers' probability of default. The theoretical literature highlights

[5] The loan-level data from the credit registry contains information about loan size at origination, the currency of denomination, residual maturity, current interest rate, current loan-to-value ratio, the name of the originating bank, the year of origination, and a selective number of borrowers' socio-economic characteristics.

three primary explanations for mortgage default: ability-to-pay (or cash flow) default, strategic default, and double-trigger default (Foote and Willen, 2018). The ability-to-pay theory suggests that borrowers default when they are unable to meet current payments due to negative life events that reduce cash flows or available income. The strategic default theory posits that borrowers voluntarily choose to default after a rational evaluation of the costs and benefits of continuing to service the mortgage, with declining house prices (and the resulting negative equity) as the sole driver of default. Finally, the double-trigger theory argues that defaults arise from the interaction of negative equity and adverse life events, both of which are necessary conditions for default. Empirical evidence underscores the strong relationship between mortgage delinquencies and these triggers.[6] However, disentangling the relative contributions of negative equity and negative life events has been challenging due to data limitations and measurement difficulties. Several papers show that borrowers with low or negative home equity are more likely to default (Guiso et al., 2013; Demiroglu et al., 2014). However, few papers argue that negative equity alone is a necessary but insufficient condition for default (Foote et al., 2008). Financially constrained borrowers with negative equity tend to default sooner than their unconstrained counterparts, as they value the immediate budget relief from default more highly than the longer-term costs (Campbell and Cocco, 2015). These papers show that in addition to negative equity, adverse macroeconomic (e.g., unemployment) or personal (e.g., reduction of income, job loss, illness, divorce) shocks that tighten liquidity constraints often explains borrowers' default behavior.[7] Recent work by Ganong and Noel (2023) advances this literature by addressing the challenge of separating the effects of negative life events from negative equity on mortgage default. Analyzing income trends leading up to default during the Great Recession, they find that most defaults are primarily driven by negative life events, with strategic defaults representing a small minority. We adopt a similar approach in our empirical methodology, controlling for changes in borrowers' income leading up to default to better understand the motivations behind negative equity defaults. Our findings confirm that negative equity is positively associated with default. Furthermore, we provide evidence that switching from recourse to non-recourse legislation significantly increases the probability of default for underwater borrowers without negative life event-default triggers, consistent with strategic default behavior.

[6] Default decisions may also depend on the borrower's house price expectations (Deng et al., 2000; Bhutta et al., 2010; Elul et al., 2010) and transaction costs (Bhutta et al., 2017). Guiso et al. (2013) show that borrowers' propensity to default is also determined by non-pecuniary factors, such as fairness, stigma, and morality.

[7] Studies supporting the double-trigger hypothesis include, among others, Bajari et al. (2008), Connor and Flavin (2015), Bhutta et al. (2010, 2017), Fuster and Willen (2017), Gerardi et al. (2018), Schelkle (2018), and Pavan and Barreda-Tarrazona (2020).

In addition to negative equity, a critical determinant of mortgage default is the prevailing recourse legislation.[8] Policymakers face a fundamental trade-off when designing recourse regimes. Under a creditor-friendly recourse framework, borrowers bear the full risk of default. During periods of macroeconomic uncertainty, the threat of financial distress may incentivize borrowers to increase savings, as default is not a viable option. While this behavior mitigates individual risk, it can suppress aggregate demand, thereby exerting a negative effect on the business cycle. Conversely, in a borrower-friendly recourse regime, lenders assume the default risk. The limited liability afforded to borrowers may encourage greater risk-taking in the housing market, with two key effects. First, heightened moral hazard exacerbates housing price cycles. Second, lenders respond to increased risk by adjusting their practices to mitigate potential losses, typically through higher financing costs (e.g., increased interest rates or larger down payments requirements). These elevated costs and stricter credit conditions can restrict housing consumption, with broader implications for the real economy.[9]

While recourse is often viewed as an efficient mechanism to deter (strategic) defaults (Ambrose et al., 1997), the empirical and theoretical evidence remains inconclusive. Several papers document that recourse mortgages are associated with a significantly lower likelihood of default (Demiroglu et al., 2014; Corbae and Quintin, 2015; Bhutta et al., 2017), with recourse reducing borrowers' sensitivity to negative equity (Ghent and Kudlyak, 2011). However, other papers suggest that the effect of recourse on default rates may be non-monotonic (Hatchondo et al., 2015) and, in some cases, may even encourage risk-taking in the housing market (Gete and Zecchetto, 2024). Stricter recourse policies can create conditions that lead to lax lending standards, increasing loan-to-value (LTV) ratios and, consequently, borrowers' indebtedness and probability of default. Moreover, creditor-friendly recourse regimes can lower financing costs for high-risk borrowers, potentially exacerbating the severity and persistence of economic recessions. Our paper contributes to this literature by providing novel evidence on the impact of changes in recourse legislation on mortgage default. Distinct from the existing papers, we focus on the dynamic effects of recourse policy, offering the first empirical analysis of the ex-post impact of a shift from a creditor-friendly to a debtor-friendly recourse framework, particularly in the context of retroactive applicability of the new legislation.

[8] Recourse legislation has important implications not only in terms of borrowers' protection (Harris and Meir, 2016), but also for house prices (Nam and Oh, 2021), housing consumption (Hatchondo et al., 2015), lending activity (Meador, 1982; Pence, 2006; Li and Oswald, 2017), and economic recovery (Gete and Zecchetto, 2024).
[9] Another concern is that these effects could be especially pronounced for low-income individuals, potentially making debt forgiveness programs regressive. For a discussion on the implications of U.S. student debt forgiveness, see Catherine and Yannelis (2023). Berger et al. (2023) analyze the distributional consequences of policies encouraging frequent mortgage refinancing.

Second, our paper relates to the literature on the impact of debt relief programs. While mortgages are recourse loans across all European countries, the GFC reignited debates surrounding the recourse versus non-recourse nature of mortgage loans, particularly in countries such as Ireland, Latvia, Romania, and Spain.[10] Among European countries, Spain was the first to draw significant attention to the potential benefits of non-recourse mortgages. Responding to substantial pressure from social movements, Spain implemented a limited version of *Datio in Solutum* ("*Dación en Pago*"), allowing borrowers to transfer property to creditors as a means of avoiding foreclosure. Similarly, Ireland introduced repossession legislation that restricted collateral enforcement on delinquent residential mortgages, signaling a shift toward greater borrower protections.

The event studied in this paper bears some resemblance to U.S. refinancing programs, such as the Home Affordable Refinancing Program (HARP) and the Home Affordable Modification Program (HAMP), which were introduced following the GFC to address widespread financial distress caused by the housing market collapse.[11] However, there is a critical distinction between the provisions of Romania's recourse legislation and those of the U.S. programs. The main difference lies in the party empowered to initiate modifications to the loan agreement. Under Romania's *Datio in Solutum* law, the decision to terminate the loan contract and discharge mortgage obligations by transferring property ownership rested entirely with the borrower. By contrast, U.S. programs were implemented at the discretion of financial intermediaries.[12] Eligibility requirements also diverged significantly. In the U.S., borrowers seeking to participate in these programs were required to meet strict eligibility criteria demonstrating financial hardship, such as specific loan-to-value ratios (for HARP) or debt-to-income ratios (for HAMP). In Romania, the *Datio in Solutum* law applied broadly to all existing and new borrowers with mortgages below 250,000 euro, with the exception of those benefiting from government-guaranteed lending programs. Importantly, no prerequisites were imposed regarding borrowers' indebtedness levels or payment history, effectively broadening the pool of eligible participants. This lack of restrictive eligibility criteria created incentives for moral hazard, as borrowers who were capable of fulfilling their mortgage obligations were presented with the option to walk away from their debt without financial repercussions.

[10] See Heys et al. (2012) and Moore et al. (2013) for an analysis of the legal regimes and the use of the legal instrument of *Datio in Solutum* in mortgage credit contracts across European jurisdictions.
[11] Other U.S. programs introduced to prevent foreclosures include FHASecure (September 2007), Hope Now Alliance (October 2007), Teaser Freezer (December 2007), Hope for Homeowners (2008), and California Foreclosure Prevention Laws (2008).
[12] For details on the application of U.S. programs, see Agarwal et al. (2017, 2023), Foote and Willen (2018), and Piskorski and Seru (2018).

Prior research on loan modifications and refinancing programs offers mixed findings. Some papers show that these policies can mitigate mortgage defaults and prevent excessive foreclosures (Agarwal et al., 2017; Gabriel et al., 2021). However, other research provides contrasting evidence. For instance, Collins and Urban (2018) find that foreclosure moratoriums fail to reduce default rates among borrowers benefiting from loan modification. Similarly, Mayer et al. (2014) report that mortgage modification programs can trigger substantial strategic responses from homeowners.

The closest papers to ours are those by Artavanis and Spyridopoulos (2023) and O'Malley (2021). Artavanis and Spyridopoulos (2023) examine the simultaneous introduction of a foreclosure moratorium and a personal bankruptcy law in Greece, finding that one-third of defaulters engaged in strategic default following these interventions. Likewise, O'Malley (2021) studies the introduction of repossession legislation in Ireland that prohibited collateral enforcement on delinquent residential mortgages originated before a specific date, documenting a significant rise in default rates among borrowers eligible for the legal relief. Our paper departs from this prior work by leveraging a natural experiment that allows us to study the behavior of borrowers with mortgages originated under a recourse regime, only to experience a subsequent change in the legislative framework that retroactively converted these mortgages to non-recourse. Unlike the aforementioned papers, which focus on temporary suspensions of collateral enforcement, our paper examines the effects of an intended permanent legislative shift.

The reminder of the paper proceeds as follows. Section 2 provides an overview of the institutional environment and the Romanian recourse law. Section 3 describes the dataset and presents key stylized facts. Section 4 outlines the empirical methodology. Section 5 presents the results, and Section 6 concludes. Descriptive statistics and figures are included in the Appendix.

2. Legal framework

Datio in Solutum law no. 77/2016, published on 28 April 2016 in Romania's Official Gazette, introduced "giving in payment" as a way for mortgage borrowers to fully settle debts by transferring property ownership without any deficiency judgments. Marketed as a social program for distressed borrowers unable to meet payment obligations[13], it applied to all existing

[13] See https://www.senat.ro/legis/PDF/2015/15L450EM.pdf.

(performing or non-performing) and new retail mortgage loans, except those exceeding 250,000 euro or issued under the *First Home* program.[14, 15]

The *Datio in Solutum* law in Romania was introduced in response to macroeconomic and financial challenges that arose from the lingering effects of the GFC. After Romania joined the European Union in 2007, housing prices surged due to increased demand, foreign investment, and easier access to credit. At that time, credit institutions operated under a self-regulation framework, setting their own credit standards rather than adhering to the central bank's restrictive limits. Many loans issued in 2007–2008 coincided with the housing market boom, just before the GFC's effects reached Romania.

The GFC triggered an economic downturn, reducing new mortgage issuance and causing property values to collapse, with housing prices falling by as much as 50% from their 2008 peak. Prices only began stabilizing after 2013. Meanwhile, interest rates, which had been stable, rose as banks tightened lending conditions to mitigate rising default risks. Variable-rate mortgage loans, which dominated the market (accounting for up to 90% of housing loans), became a significant source of risk.

Adding to these challenges, 92% of mortgage loans issued in 2007–2008 were denominated in foreign currencies, with 23% in Swiss francs. The risks asociated with Swiss franc loans were exacerbated in January 2015 when the Swiss National Bank unpegged the franc from the euro, causing the franc to appreciate sharply. This currency movement increased debt service costs for borrowers with Swiss franc-denominated loans. Furthermore, during the GFC, the Romanian leu depreciated sharply against major currencies, further exacerbating the strain on borrowers with foreign currency loans.[16] As a result, many households struggled with higher monthly payments, pushing non-performing loan (NPL) rates for foreign currency mortgages to 16.2% by April 2015.

Although Romania's GDP growth eventually recovered, wage growth remained slow, and the labor market showed only moderate improvement. Low wage increases and persistent unemployment limited borrowers' ability to manage higher loan servicing costs, leading to greater financial strain and elevated default risks.

[14] Corporate loans secured with real estate guarantees were not eligible. Likewise, mortgage loans for which the main collateral was not used as a dwelling, or those granted to borrowers that have been convicted for offenses connected with the loan, were not eligible either.

[15] The *First Home* program represents a governmental initiative introduced in 2009 to facilitate individuals' access to the purchase or construction of a dwelling by contracting state-guaranteed loans. The program brings several benefits for borrowers, such as preferential interest rates and lower down payments.

[16] Between June 2007 and December 2010, the Romanian leu depreciated by 37% against the euro, by 42% against the US dollar, and by 77% against the Swiss franc.

The introduction of the *Datio in Solutum* law in Romania created significant challenges for the country's banking sector, sparking intense debate among economists, policymakers, and the public. Proponents of the law argued that it would provide critical relief to financially constrained borrowers by enabling them to discharge their mortgage debt through property transfers to lenders. Additionally, it would enable more efficient risk-sharing between lenders and borrowers, potentially preventing future credit crises and enhancing financial stability.[17] Expectations for borrower uptake were high, with estimates suggesting up to 800,000 potential requests (Macovei, 2019).[18] To prepare for anticipated losses, banks increased their loan-loss provisions, leading to a deterioration in profitability and capitalization.[19] However, the actual uptake of the law proved to be far more limited, with only 6,287 borrowers – representing 2% of those eligible – submitting requests in 2016.

Initially, the law's implementation led to a sharp rise in mortgage non-performing loans (NPLs). Between May and June 2016, the NPL rate increased by 1.6 percentage points (Figure B.1), while the probability of default for eligible loans rose from 0.8% in January 2016 to 1.2% by October 2016.[20] Notably, mortgages under the *First Home* program, which were excluded from *Datio in Solutum*, experienced no significant change in NPL rates (Figure B.2).[21] Despite these early disruptions, the overall impact on eligible borrowers was limited, with most requests for debt discharge concentrated in 2016.

Critics of the law highlighted several shortcomings, particularly its retroactive application to existing loans. This backward-looking provision was argued to increase the cost of credit, reduce approval rates, and limit borrowers' access to finance.[22] Following the law's enactment, banks tightened credit standards by raising down payment requirements, leading to

[17] Risk-sharing between lenders and borrowers has been associated with a reduction in the incidence of foreclosures and the severity of future housing crises (Piskorski and Tchistyi, 2011; Campbell, 2013; Eberly and Krishnamurthy, 2014; Mian and Sufi, 2014b; Mian et al., 2015). Risk-sharing may also limit negative externalities (Guiso et al., 2013; Melzer, 2017). These effects are beneficial during periods of adverse economic conditions (Piskorski and Seru, 2018).

[18] The NBR statistics did not support the expected number of 800,000 beneficiaries. According to the NBR, approximately 300,000 borrowers had loans potentially eligible for *Datio in Solutum* at the end of 2016. Furthermore, the final version of the law was more restrictive regarding the eligibility criteria compared to the initial draft.

[19] Notification of Systemic Risk Buffer according to article 133 of Directive 2013/36/EU, National Bank of Romania, Financial Stability Department, available at https://www.esrb.europa.eu/pub/pdf/other/20161230_notification_ro_srb.en.pdf.

[20] The NPL rate is calculated based on the European Banking Authority's definition, which includes loans that are over 90 days past due and loans classified as unlikely to be repaid.

[21] The probability of default is estimated over a one-year horizon and represents the proportion of borrowers who transitioned from performing to having 90-day delays after four quarters.

[22] Increased protection for borrowers in default, such as eliminating deficiency judgments, can result in losses for lenders. These losses are indirectly passed on to new borrowers. To offset these risks, lenders may reduce approval rates, restrict lending volumes (Lin and Oswald, 2017), or increase credit costs over time (Agarwal et al., 2017). Shifting from recourse to non-recourse mortgages could also raise credit burdens, particularly for lower-income borrowers (Gete and Zechetto, 2018).

a reduction in the median LTV for new mortgages from 80% in March 2016 to 71% by September 2016 (Figure B.3).[23] Consequently, the flow of newly issued mortgages decreased by 8% in 2016 Q3 compared to 2015 Q3. Lending activity rebounded in subsequent quarters, supported by lower interest rates and revisions to the law.

Concerns about the potential for moral hazard also emerged. Critics argued that the law might incentivize strategic default by borrowers, undermining payment discipline. To address these issues, the National Bank of Romania advocated for clear eligibility criteria to distinguish between borrowers facing genuine financial difficulties and those acting opportunistically. The central bank identified the unpredictable legislative environment as one of the primary systemic risks to the financial sector in 2016 (NBR, 2016).

The constitutionality of the Datio in Solutum law was also contested. Lending institutions argued that the law violated principles such as the separation of powers, property rights, and legal certainty (Bulgaru and Lepădatu, 2016). In October 2016, the Constitutional Court ruled that debt discharge would apply only under conditions of proven unforeseeability, as determined by a court of law. This ruling, published in January 2017, clarified the legislative framework, reducing uncertainty for the banking sector. Following the decision, the mortgage NPL rate declined by 1.1 percentage points between January and February 2017 (Figure B.1).

Over time, the use of the *Datio in Solutum* mechanism diminished. Eight years after the law was enacted, only 11,030 debt discharge requests had been filled, with 57% submitted in 2016, 13% in 2017, and just 30% between 2018 and 2023. Most requests involved loans denominated in euro and Swiss francs (48% and 41%, respectively). Lending institutions approved only 14.6% of the requests, rejecting or contesting the majority, particularly those from performing borrowers. Of the borrowers who had been performing at the time of their requests, 57% became non-performing by May 2024.

The *Datio in Solutum* law had profound implications for Romania's financial sector. While it introduced mechanisms to support distressed borrowers, its unintended consequences—including credit tightening, increased NPLs, and legal uncertainty—highlight the complexities of balancing borrower protection with financial stability.

[23] Figure B.3 illustrates one dimension of how banks changed their lending behavior after the law's enactment. To estimate the impact of this legislation change, we focus our empirical analysis on loans granted before May 2016 to guarantee the alikeness of our set of loans.

3. Data

To study the relationship between changes in the recourse procedure and mortgage defaults, we exploit the loan-level data from the credit registry provided by the National Bank of Romania. The registry covers all mortgages above 4,500 euro on the banks' balance sheets at the time of the analysis (i.e., 99% of existing loans). The dataset consists of seven quarterly vintages from December 2014 to June 2016, providing an adequate time frame to study the potential effects triggered by the implementation of the *Datio in Solutum* law. We classify a borrower as defaulting when their loan becomes non-performing due to delays of more than 90 days within four quarters. In the case of debtors with multiple loans (i.e., with consumer loans in addition to mortgage loans), we monitor the payment behavior only for mortgage loans.[24] Debtors from a specific vintage who become non-performing during the analyzed period are excluded from future quarterly vintages.

The loan-level data contains information about loan size at origination, current loan-to-value ratio, the currency of denomination, residual maturity, current interest rate, as well as the name of the originating bank and the year of origination.[25] In the case of interest rate, loan-to-value ratio, and residual maturity we construct a weighted average by outstanding balance for borrowers with multiple loans, while currency of denomination, year of origination and bank of origination are taken from the loan with the largest balance outstanding.

The registry also collects a selective number of borrowers' socio-economic characteristics (e.g., age, county of residence). This detailed information about borrower and loan characteristics allows for a granular analysis of the recourse law's impact on borrowers' behavior. We control in our empirical analysis for originating bank's risk-taking profile and state of the economy at the date of loan origination by introducing bank, year, and vintage dummies.

We apply several restrictions on our dataset. First, when constructing our vintages, we exclude the non-eligible standard loans (those over 250,000 euro at origination) and the loans that "disappeared" from banks' balance sheets from December 2015 to June 2017, since we cannot determine their non-performance status (i.e., they are censored). Second, we do not include borrowers that are already in default (i.e., they encounter payment delays of over 90 days) as our main aim is to quantify the impact of the introduction of *Datio in Solutum* on

[24] Information regarding default is kept for 7 years in the credit registry.

[25] Residual maturity refers to the remaining period, in years, from the time of analysis until the loan's contractual maturity date. The interest rate is updated monthly, reflecting current credit conditions. Since approximately 90% of mortgage loans have variable rates, the current interest rate serves a more accurate indicator of affordability challenges than the rate at origination.

performing borrowers' behavior. Intuitively, the introduction of *Datio in Solutum* should not affect the incentives of borrowers with non-performing loans as they had already registered delays on their payment obligations before the law was enacted.

In our first empirical estimation we include *First Home* loans as a control group.[26] These specific loans benefit from government guarantees and are not eligible for *Datio in Solutum.* Put differently, the law's introduction should not impact the payment discipline of borrowers with *First Home* loans. Our initial dataset contains 1,9 million mortgage-data points and covers 339 thousand unique borrowers representing approximately 98% of the mortgage loans on banks' balance sheets at the time of the analysis. Appendix A.1 sets forth the definitions for the main variables used in the empirical analysis.

In the following empirical analyses, which examine the effect of the *Datio in Solutum* law on the probability of default and its associated non-linear effects, we focus exclusively on a dataset of standard mortgage loans. This dataset contains 932 thousand mortgage-data points over seven quarterly vintages (December 2014 – June 2016), representing 165 thousand unique debtors. We restrict our sample for two quarters before and five quarters after the introduction of the law to isolate the noise and potential effects of other events.

We complement the information from the credit registry with individual labor income data from the Ministry of Finance. This allows us to obtain information about borrowers' indebtedness, which we use for deriving affordability indicators (e.g., debt-service-to-income ratio). We employ the methodology from Nier et al. (2019) for calculating debt service by considering the borrowers' overall indebtedness (i.e., by including consumer loan payments).[27] We classify borrowers in four different income categories: those with unrecorded income, those earning between the minimum wage and the medium wage[28], those earning between the medium and double the medium wage, and those earning above double the medium wage. Borrowers that are not in the Ministry of Finance's database, as well as those with incomes below the minimum wage, are included in the category "unrecorded income" to distinguish them from borrowers with recorded information.[29] Borrowers with unrecorded income

[26] Our sample is split roughly equally between standard mortgage loans (49% of the total) and *First Home* loans (51%). The *First Home* program was initially denominated in euro. Starting from August 2013, banks granted these loans only in domestic currency. Thus, the share of foreign-currency denominated loans for *First Home* was close to 100% between 2009 to 2012, decreasing to 75% in 2013 and going to zero in 2014.

[27] Approximately 25% of borrowers in our sample have consumer loans in addition to their mortgages.

[28] For minimum and medium wages, we use the nationwide earnings data published by the Romanian National Institute of Statistics.

[29] The Ministry of Finance data contains information about borrowers' annual income for 2014 and 2015, and monthly income for 2016. When unavailable, the monthly income is calculated by dividing the annual income by 12. As a result of this approach, when a borrower is unemployed for some time during the year, their income is underestimated for the months they were employed.

represent 20% of our sample. Thus, excluding them might bias the estimation results. While we cannot rule out the fact that (some of) these borrowers might have additional sources of income either from unrecorded work or from other family members, we cannot compute their joint debt-service-to-income (DSTI) ratio of the household.

To assess whether borrowers who defaulted under the *Datio in Solutum* law experienced a cash flow or equity shock, we analyze the DSTI and LTV ratios at the quarter of default rather than including their four-quarter lagged values. Additionally, we consider changes in income over the past 12 months in our analysis. Borrowers are classified based on income changes as follows: those with a reduction of more than 25% are identified as having suffered a decrease in income; those with a change between -25% and +25% are identified as having a constant income; and those with an increase of more than 25% are identified as having an income increase.

Descriptive statistics

Table 1 presents the sample characteristics for the main variables used in our empirical analysis, highlighting the key differences between borrowers with standard vs. *First Home* loans. Borrowers with a standard mortgage loan tend to be older, with a mean age of 40 years compared to 34 years for *First Home* borrowers, and they have higher monthly incomes on average (800 vs. 641 euro). Standard mortgage loans have shorter maturities (18.5 vs. 24 years), larger amounts at origination (49,840 vs. 40,750 euro), and a higher degree of indebtedness[30] (mean DSTI of 84% compared to 75%). The mean LTV ratio is 84% for standard mortgage loans, while for *First Home* mortgage loans LTV cannot be computed due to governmental guarantees. [31] Additional descriptive statistics regarding the distribution of these variables can be found in Appendix A.2.

[30] The high average DSTI values can be attributed to several factors. First, nearly half of the mortgage loans were co-signed. Because our data from the Ministry of Finance is at the individual level rather than the household level, this may inflate the DSTI values. Second, many loans were issued during the 2007–2008 period when lending standards were particularly lax, contributing to the high levels of indebtedness.

[31] We convert local currency amounts to euro equivalents using the relevant EUR/RON exchange rate. The DSTI is calculated using the latest debt service and is divided by the average monthly income for the years 2014 and 2015, while 2016 data rely on monthly income figures. For the LTV ratio we use the latest value of the real estate collateral and divide it by the outstanding amount at the time of the construction of the vintage.

Table 1. Summary statistics for main variables of interest – Standard mortgage loans vs. *First Home* loans

Variable	Standard mortgage			*First Home* mortgage			Difference
	N	Mean	St. dev	N	Mean	St. dev	
Age[1)]	932,958	40	8	1,016,000	34	6	6***
Monthly income[2)]	744,439	799	810	862,535	641	535	158***
Debt-service-to-income ratio[3)]	744,439	84	91	862,535	75	82	9***
Loan-to-value ratio[3)]	821,159	84	45	-	-	-	
Interest rate[3)]	932,958	4.50	0.91	1,016,000	4.18	0.73	0.32***
Residual maturity[1)]	932,958	18.5	7.0	1,016,000	24.0	5.1	-5.50***
Loan size at origination[2)]	932,958	49,840	36,570	1,016,000	40,750	15,290	9,090***
Foreign - currency denomination [3)]	932,958	68	47	1,016,000	62	49	6***

Notes: This table shows the summary statistics of the data used in the empirical analysis. See the appendix for the definitions of variables. [1)] years, [2)] amount in euro, [3)] percent. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Loan-to-value data is unavailable for *First Home* loans because they are backed by a 50% government guarantee.

Table 2 - Panel A provides summary statistics for our main variables conditioned on whether or not borrowers hold 90 days past-due loans or requested *Datio in Solutum*. The mean monthly income for performing borrowers is around two times larger than for non-performing borrowers (791 vs. 473 euro). The average monthly income for borrowers requesting *Datio in Solutum* is similar in magnitude with that of borrowers who did not request *Datio in Solutum.* Performing borrowers are significantly less indebted (as indicated by the DSTI ratio) than non-performing borrowers (89% vs. 161%). Likewise, borrowers that did not request *Datio in Solutum* are significantly less indebted than borrowers that requested *Datio in Solutum* (89% vs. 133%).

Non-performing borrowers took out, on average, larger loans than performing borrowers (69,305 vs. 49,850 euro), with longer residual maturity (20 vs. 18.5 years), and with significantly higher LTV ratios (117% vs. 83%). We present in Appendix A.2 additional summary statistics for our sample along several dimensions: (i) by year of origination, (ii) by loan currency, (iii) by loan amount at origination, (iv) by LTV, (v) by income group, and (vi) by the level of DSTI.

A similar pattern emerges when we compare the mean values of loan characteristics conditional on the status of *Datio in Solutum* request. Borrowers requesting *Datio in Solutum* have, on average, loans that are twice as large as borrowers that did not request *Datio in Solutum* (94,200 vs. 49,770 euro), with longer residual maturity (23 vs. 18.5 years), and higher current LTV ratios (168% vs. 83%). Non-performing borrowers are slightly underwater. On average, the value of their property is lower than the outstanding mortgage by almost 1,000 euro. The situation is much worse for borrowers requesting *Datio in Solutum*: their outstanding mortgage is, on average, with 21,760 euro higher than the current value of their property.

Table 2 - Panel A. Mean values for main variables by performance status and *Datio in Solutum* request – standard mortgage loans

Variable	Performing borrowers	Non-performing borrowers	Difference	Did not request DiS	Requested DiS	Difference
Monthly income[1)]	791	473	318***	790	799	-9
Debt-service-to-income ratio[2)]	89	161	-72***	89	133	-44***
Loan-to-value ratio[2)]	83	117	-34***	83	168	-85***
Interest rate[2)]	4.6	4.8	-0.2***	4.6	4.5	0.1***
Residual maturity[3)]	18.5	19.9	-1.4***	18.5	22.9	-4.4***
Loan size at origination[1)]	49,854	69,305	-19,451***	49,771	94,206	-44,435***
Equity[1)]	13,587	-989	14,576***	13,657	-21,762	35,419***

Notes: This table shows the mean values for the main variables conditional on borrowers' performing status and *Datio in Solutum* request. [1)] amount in euro, [2)] percent, [3)] years. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2 - Panel B provides summary statistics for our main variables conditioned on whether borrowers were non-performing before and during the *Datio in Solutum* period. The data reveal that during the *Datio in Solutum* period, the mean monthly income for both performing and non-performing borrowers is significantly higher than before the *Datio in Solutum* period. Additionally, non-performing borrowers are significantly less indebted, as indicated by the DSTI ratio, during the *Datio in Solutum* period compared to before (153% vs. 179%). However, these borrowers recorded significantly higher LTV ratios (122% vs. 110%) during the *Datio in Solutum* period. The average 1-year income change varies significantly for non-performing borrowers during the *Datio in Solutum* period compared with the pre-*Datio in Solutum* period (29% vs. 0%), but it does not differ significantly between performing and non-performing borrowers. In terms of interest rate, residual maturity, and loan size at origination, non-performing borrowers are relatively similar before and during the *Datio in Solutum* period.

Table 2 - Panel B. Mean values for main variables by performance status and *Datio in Solutum* period – standard mortgage loans

Variable	*Datio in Solutum* **period = 0**			*Datio in Solutum* **period = 1**		
	Performing borrowers	**Non-performing borrowers**	**Difference**	**Performing borrowers**	**Non-performing borrowers**	**Difference**
Monthly income[1)]	748	391	357***	820	516	304***
Average 1 year income change[2)]	33.0	0.14	32.9	56.4	28.7	27.6
Debt-service-to-income ratio[2)]	97	179	-81***	84	153	-69.5***
Loan-to-value ratio[2)]	82	110	-27***	84	122	-37.8***
Interest rate[2)]	4.88	5.07	-0.19***	4.36	4.58	-0.22***
Residual maturity[3)]	18.6	19.8	-1.2***	18.5	20.0	-1.5***
Loan size at origination[1)]	50,268	68,150	-17,880***	49,617	71,581	-21,960***
Equity[1)]	11,087	-10,700	21,780***	6,954	-11,891	18,855***

Notes: This table shows the mean values for the main variables conditional on borrowers' performing status and *Datio in Solutum* request. [1)] amount in euro, [2)] percent, [3)] years. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4. Methodology

In this section, we outline the methodology used to assess the impact of *Datio in Solutum* on the probability of borrower default. The probability of default is estimated using a pooled logit model, where the dependent variable, $y_{i,t}$, is a dummy variable equal to 1 if the borrower's loan is more than 90 days past due. The set of explanatory variables includes borrower and loan characteristics lagged by four quarters (*t-4*).[32] The baseline specification adopts a standard difference-in-difference framework with quarterly vintages which includes both standard mortgage loans and *First Home* loans. The model is specified as follows:

$$y_{i,t} = \alpha + \beta_0 * Standard\ mortgage_i + \beta_1 * DiS\ period_t + \beta_2 * Standard\ mortgage_i * \\ * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \\ + \varepsilon_{i,t}, \quad (1)$$

where the indices *i* and *t* represent borrower and time, respectively. The variable *Standard mortgage* is a dummy equal to 1 for borrowers with a standard mortgage loan and 0 for those with a *First Home* loan. Similarly, *DiS period* is a dummy equal to 1 from 2016Q2 onwards and 0 before. The main coefficient of interest, β_2, captures the effect of the introduction of the *Datio in Solutum* law on the probability of default for standard mortgage loans relative to *First*

[32] All our results remain robust to the inclusion of contemporaneous variables (results not shown for brevity but available upon request).

Home loans, which were not eligible for the law and thus serve as the control group. A positive β_2 would indicate an increase in the default probability for borrowers eligible for debt release following the enactment of the law. The vector of borrower controls, $Z_{i,t-4}$, includes income category, DSTI, and age. The vector of loan characteristics, $L_{i,t-4}$, includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. To control for variations in risk management policies across banks and macroeconomic conditions at origination, we include bank and year-of-origination fixed effects. Additionally, county fixed effects are incorporated to control for regional differences in housing market conditions. The estimated probability of default for borrower *i* at vintage *t* is calculated as: $PD_{i,t} = \frac{e^{y_{i,t}}}{1+e^{y_{i,t}}}$.

We also estimate an alternative specification, replacing the *DiS period* dummy with quarterly vintages dummies. This approach allows for a more granular analysis, identifying the specific quarters during which the probability of default increased most significantly following the introduction of *Datio in Solutum.*

In all other model specifications, the sample is restricted to standard mortgage loans. In the second model, we focus on assessing the impact of requesting *Datio in Solutum* on the probability of default for eligible loans. The empirical specification is as follows:

$$y_{i,t} = \alpha + \beta_1 * DiS\ period_t + \beta_2 * DiS\ request_{i,t} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + \\ + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}, \quad (2)$$

where *DiS period* is a dummy variable equal to 1 from 2016Q2 onwards and 0 before, *DiS request* is a dummy equal to 1 for borrowers with a standard mortgage loan who requested *Datio in Solutum* and 0 for those who did not, and vectors $Z_{i,t-4}$ and $L_{i,t-4}$ represent borrower and loan characteristics, respectively. The coefficient β_1 captures changes in payment discipline for borrowers with standard mortgages following the introduction of *Datio in Solutum*. The main coefficient of interest, β_2, measures the impact of requesting *Datio in Solutum* on repayment behavior.

Subsequently, we refine our analysis to examine the potential non-linear relationships between borrower and loan characteristics and repayment behavior. This analysis employs the following specification:

$$y_{i,t} = \alpha + \beta_1 * DiS\ period_t + \sum_{j=1}^{k} \lambda^j Dummy^j_{i,t-4} + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + \\ + Origination\ FE + County\ FE + \varepsilon_{i,t}, \quad (3)$$

where a positive coefficient β_1 indicates that the probability of default for standard mortgages increased following the enactment of the law in 2016Q2. $Dummy^j_{i,t-4}$ is a dummy variable

equal to 1 if the variable of interest (e.g., income group, DSTI, currency, loan size at origination, or LTV) for borrower *i*, at time *t-4* falls into a specified category *j*, and 0 otherwise. Statistically significant coefficients, λ^j, identify whether specific borrower or loan characteristics exhibit non-linear effects on the probability of default. When a variable of interest is included as a dummy and interacted with the *DiS period* indicator, it is excluded as a standalone continuous control. Other controls, such as age (in $Z_{i,t-4}$) or interest rate and residual maturity (in $L_{i,t-4}$), are always retained as standalone controls.

For continuous variables such as DSTI, LTV, and *Amount at origination*, we create dummy variables to capture non-linear effects across categories. For income, we define four groups: unrecorded income, income below the medium wage, income between the medium wage and double the medium wage, and income above double the medium wage. By interacting the *Income group* dummy with the *DiS period* indicator, we test for a potential wealth effect, hypothesizing that higher-income borrowers face a lower opportunity cost of defaulting.

For DSTI, we define three groups: below 50%, between 50% and 100%, and above 100%. This categorization allows us to examine whether the *Datio in Solutum* law had a stronger impact on borrowers experiencing financial difficulties (proxied by high DSTI) or those strategically defaulting (e.g., borrowers with low DSTI who could afford to service their debt). For LTV, we define two groups: below 100% and above 100%. The latter group represents borrowers with negative equity, where the outstanding loan exceeds the value of the collateral property. This specification tests whether the possibility of non-recourse default increases the probability of default for such borrowers. Additionally, we include an *unrecorded* category for loans primarily backed by collateral other than real estate, for which constructing a meaningful LTV measure is infeasible. For *Amount at origination,* we classify loans into four categories: below 30,000 euro, between 30,000 and 60,000 euro, between 60,000 and 90,000 euro, and above 90,000 euro. This categorization allows us to investigate whether borrowers with larger loans exhibit higher risk, as they stand to gain more in absolute terms from default.

We extend model (3) by incorporating interaction terms between the *DiS period* dummy and borrower or loan characteristics. These interactions facilitate testing which characteristics are significantly associated with an increased probability of default following the enactment of the law:

$$y_{i,t} = \alpha + \beta * DiS\ period_t + \sum_{j=1}^{k} \lambda^j\ Dummy_{i,t-4}^{j} + \\ + \sum_{j=1}^{k} \theta^j\ Dummy_{i,t-4}^{j} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + \\ + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}. \quad (4)$$

Statistically significant θ^j coefficients are interpreted as evidence of an asymmetric effect of the *DiS period* across different borrower or loan characteristics.

To provide a more comprehensive breakdown of default drivers – identifying the prevalence of strategic default (due to negative equity), cash-flow default (due to liquidity constraints), and double-trigger default – we examine the periods before and during the *Datio in Solutum* regime. This is achieved by interacting changes in borrower income, borrower equity, and the *Datio in Solutum* period. The LTV dummy is divided into three categories, consistent with prior specifications. The first category includes borrowers with an LTV below 100% (i.e., borrowers with positive equity). The second category includes borrowers with an LTV above 100% (i.e., those with negative equity). The third category includes borrowers with non-real estate collateral, for whom LTV cannot be computed. For the income change dummy, borrowers are categorized based on income fluctuations over the previous 12 months. Those with an income decrease exceeding 25% are classified as experiencing a *negative income shock*, while those with an income increase of 25% or more are classified as experiencing an income increase. Borrowers with changes outside these thresholds are categorized as having constant income. This triple interaction between income changes, borrower equity, and the *Datio in Solutum* period enables us to identify which specific trigger – income changes, negative equity, or a combination of both (i.e., double trigger) - is significantly associated with an increased probability of default following the enactment of the law:

$$y_{i,t} = \alpha + \beta_0 * DiS\ period_t +$$
$$+ \sum_{j=1}^{3} {\beta_1}^j\ Income\ change\ dummy_{i,t}^j + \sum_{k=1}^{3} {\beta_2}^k\ LTV\ dummy_{i,t}^k +$$
$$+ \sum_{k=1}^{3}\sum_{j=1}^{3} \psi^{j,k}\ LTV\ dummy_{i,t}^k * Income\ change\ dummy_{i,t}^j +$$
$$+ \sum_{k=1}^{3} \delta^k\ LTV\ dummy_{i,t}^k * DiS\ period_t + \sum_{j=1}^{3} \vartheta^j Income\ change\ dummy_{i,t}^j * DiS\ period_t +$$
$$+ \sum_{k=1}^{3}\sum_{j=1}^{3} \eta^{j,k}\ LTV\ dummy_{i,t}^k * Income\ change\ dummy_{i,t}^j * DiS\ period_t +$$
$$+ \kappa_1 * DSTI_{i,t} + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}. \quad (5)$$

The main coefficient of interest, $\eta^{j,k}$, captures the interaction between income changes and borrower equity before and during the *Datio in Solutum* period. The vector of borrower characteristics, $Z_{i,t-4}$, includes income category and age, while the vector of loan

characteristics, $L_{i,t-4}$, includes loan size at origination, currency of denomination, residual maturity, and interest rate.

5. Results

This section presents the empirical results on the impact of the introduction of *Datio in Solutum* law on standard mortgage loans' probability of default. Table 3 reports the regression results from the difference-in-difference estimation based on Equation (1). The coefficient of the *Standard mortgage* loan dummy is positive and statistically significant, indicating that standard mortgage loans (i.e., our treatment group consisting of loans eligible for a *Datio in Solutum* request) exhibited a higher probability of default compared to *First Home* loans before the introduction of the law (0.19% vs. 0.03%).

The coefficient of the *DiS period* dummy in column (1) captures the effect of the *Datio in Solutum* introduction on *First Home* loans, the control group. As expected, the coefficient is statistically insignificant, suggesting that the payment discipline of borrowers with *First Home* loans remained unaffected by the introduction of the law, as these borrowers were not eligible to apply for *Datio in Solutum*. Finally, the coefficient of interaction term *Standard mortgage * DiS period*, which captures the impact of the *Datio in Solutum* on standard mortgage loans, is positive and statistically significant. This result indicates that the probability of default of standard mortgage loans increased substantially following the law's enactment. Specifically, the average estimated probability of default for standard mortgage loans rose by 60% after the law's introduction, from 0.19% to 0.30%.[33]

In column (2), we replace the *DiS period* dummy with quarterly vintage dummies to capture a more granular effect of the introduction of *Datio in Solutum*. This specification enables us to observe temporal variations in the probability of default. Consistent with the results from column (1), standalone coefficients for the quarterly dummies reflect changes in the probability of default for *First Home* borrowers by vintage relative to 2016Q1. All coefficients are statistically insignificant, reaffirming that the introduction of *Datio in Solutum* did not affect the payment discipline of borrowers with *First Home* loans. The primary coefficients of interest are the interaction terms between the *Standard mortgage* dummy and the quarterly dummies. The results indicate that the introduction of *Datio in Solutum* had an immediate and pronounced effect. The largest impacts are observed in 2016Q2 and 2016Q3,

[33] We obtain similar results (unreported, available on request) when we replicate the difference-in-difference specification using a matched sample to compare the repayment behavior for similar borrowers with different types of mortgages. We match borrowers on observable characteristics using a nearest-neighbor model based on age, income, indebtedness, loan amount and year of origination, maturity, currency, and county.

during which the average estimated probability of default for standard mortgage loans increased to 0.30% and 0.40%, respectively (see Figure C.1). These quarters also coincide with the highest number of *Datio in Solutum* applications (see Figure B.4). In contrast, the interaction coefficients for 2017Q1 and 2017Q2 are statistically insignificant. This period corresponds to a decline in *Datio in Solutum* requests, following the law's declaration of unconstitutionality in January 2017.

Table 3. Introduction of *Datio in Solutum* and probability of default

The table reports the results of logit regressions examining the impact of the introduction of *Datio in Solutum* on the probability of mortgage default. A difference-in-difference approach is employed using the following specification (Eq. 1): $y_{i,t} = \alpha + \beta_0 * Standard\ mortgage_i + \beta_1 * DiS\ period_t + \beta_2 * Standard\ mortgage_i * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$, where the indices *i* and *t* stand for borrower and time, respectively, $Standard\ mortgage_i$ is a dummy equal to 1 for borrowers with a standard mortgage loan and 0 for borrowers with a *First Home* loan, $DiS\ period_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before. The vector of borrower controls $Z_{i,t-4}$ includes income category, DSTI, and age. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. The regressors are 4-quarters lagged *(t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample for model (1) consists of quarterly vintages from 2015Q4 to 2017Q1. For model (2), *DiS period* is replaced with *Quarterly vintage* dummies to capture a more granular effect of the introduction of *Datio in Solutum*. The sample for model (2) is expanded to include data up to 2017Q2. Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**
Standard mortgage	0.5667***	0.6410***
	(0.1464)	(0.1893)
DiS period	0.1950	
	(0.1403)	
Standard mortgage * DiS period	0.2744*	
	(0.1489)	
2015Q4		-0.0483
		(0.2359)
2016Q2		0.1095
		(0.2256)
2016Q3		0.2892
		(0.2162)
2016Q4		-0.0710
		(0.2347)
2017Q1		0.2477
		(0.2172)
2017Q2		0.3264
		(0.2144)
Standard mortgage * 2015Q4		0.0541
		(0.2520)
Standard mortgage * 2016Q2		0.3407**
		(0.2397)
Standard mortgage * 2016Q3		0.4668**
		(0.2296)
Standard mortgage * 2016Q4		0.4873**
		(0.2485)
Standard mortgage * 2017Q1		-0.1708
		(0.2338)
Standard mortgage * 2017Q2		-0.0867
		(0.2301)
Observations	1,635,957	1,948,044
Bank FE	Yes	Yes
Origination FE	Yes	Yes
County FE	Yes	Yes
Borrower and loan characteristics	Yes	Yes
Pseudo R2	0.132	0.127
Likelihood	-15132	-17574

Table 4 reports the estimation results for the model specified in Equation (2), which examines the impact of requesting *Datio in Solutum* on the probability of default for eligible loans (i.e., standard mortgage loans). Column (2) includes controls for borrower characteristics, while column (3) adds controls for both borrower and loan characteristics. The coefficient of the *DiS period* dummy is positive across all specifications and becomes statistically significant in column (3) when all controls are included. This result indicates some deterioration in payment discipline among borrowers with standard mortgage loans following the introduction of *Datio in Solutum*. During the period when the law was active, the average estimated probability of default for these borrowers increased from 0.18% to 0.23%. The coefficient of the interaction between *DiS request* and *DiS period* dummies is positive and statistically significant in all specifications. This finding suggests that requesting *Datio in Solutum* led to a substantial decline in payment discipline. The average estimated probability of default for borrowers who requested *Datio in Solutum* during the period when the law was active rose by approximately five percentage points, increasing from 0.17% to 5.34%.

Table 5 reports the estimation results for the effect of the *Datio in Solutum* enactment on borrower's probability of default, based on the model specified in Equation (3). Column (1) examines the influence of borrower and loan characteristics on the probability of default without controlling for changes in recourse legislation. All coefficients in column (1) exhibit the expected signs and align with findings in the existing literature. Consistent with prior studies (see, e.g., Foote et al., 2008; Kelly and McCann, 2016; and Gerardi et al., 2018), we find that higher-income borrowers are less likely to default on their mortgages, while borrowers with unrecorded income (predominantly unemployed individuals) are the most likely to default (Figure C.2, left panel). Similarly, in line with previous research (e.g., Kelly and O'Toole, 2018; Kim et al., 2018; de Haan and Mastrogiacomo, 2020), our results indicate a strong positive association between borrowers' indebtedness, as proxied by DSTI, and the probability of default. Additionally, mortgage loans with higher amounts at origination (Figure C.5, left panel) and higher LTV ratios are significantly associated with an increase in the probability of default (Figure C.4, left panel).[34] Higher interest rates also exhibit a significant positive relationship with delinquency risk. Furthermore, borrowers with mortgage loans denominated in foreign currencies are more likely to default compared to those with loans denominated in domestic currency.

[34] The results are consistent with findings reported in Bajari et al. (2008), Demyanyk and Van Hemert (2009), Elul et al. (2010), Demiroglu et al. (2014), Gerardi et al. (2018), and Kim et al. (2018).

Table 4. *Datio in Solutum* request and probability of default for standard mortgage loans

The table reports the results of logit regressions examining the impact of requesting *Datio in Solutum* on the probability of default for standard mortgages. A difference-in-difference approach is employed using the following specification (Eq. 2): $y_{i,t} = \alpha + \beta_1 * DiS\ period_t + \beta_2 * DiS\ request_{i,t} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$, where the indices i and t stand for borrower and time, respectively, *DiS period*$_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before, *DiS request*$_i$ is a dummy equal to 1 for borrowers with a standard mortgage loan who requested *Datio in Solutum* and 0 for those who did not. The vector of borrower controls $Z_{i,t-4}$ includes income category, DSTI, and age. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. The regressors are 4-quarters lagged (*t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample includes only standard mortgages with balances below 250,000 euro, representing borrowers eligible to request *Datio in Solutum.* Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**	**(3)**
DiS period	0.032	0.036	0.237***
	(0.051)	(0.052)	(0.054)
DiS request * DiS period	4.209***	4.173***	3.278***
	(0.060)	(0.062)	(0.073)
Age		0.004	0.008**
		(0.003)	(0.003)
Income		-0.020***	-0.020***
		(0.001)	(0.001)
DSTI			0.163***
			(0.019)
Amount at origination			0.002***
			(0.000)
Currency = 2, EUR			0.516***
			(0.082)
Currency = 3, CHF			0.678***
			(0.110)
LTV			0.718***
			(0.061)
No LTV information = 1			0.927***
			(0.096)
Residual maturity (years)			0.016***
			(0.005)
Interest rate			0.222***
			(0.032)
Observations	932,958	932,958	932,356
Bank FE	No	No	Yes
Origination FE	No	No	Yes
County FE	No	Yes	Yes
Pseudo R2	0.0739	0.0921	0.132
Likelihood	-15153	-14854	-14201

Table 5. Non-linear impact of borrower and loan characteristics on probability of default for standard mortgage loans

The table reports the results of logit regressions examining the impact of the introduction of *Datio in Solutum* on the probability of default for standard mortgages. The analysis uses quarterly vintage data from 2015Q4 to 2017Q2 and estimates alternative specifications of the following regression model (Eq. 3): $y_{i,t} = \alpha + \beta_1 * DiS\ period_t + \sum_{j=1}^{k} \lambda^j\ Dummy_{i,t-4}^{j} + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$ where the indices i and t stand for borrower and time, respectively, *DiS period*$_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before, $Z_{i,t-4}$and $L_{i,t-4}$ are vectors of borrower and loan characteristics, respectively, varying by specification. All included controls are presented in the table. The regressors are 4-quarters lagged (*t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample includes only standard mortgages with balances below 250,000 euro, corresponding to borrowers eligible to request *Datio in Solutum.* Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DiS period		0.491***	0.593***	0.499***	0.492***	0.507***
		(0.053)	(0.063)	(0.053)	(0.053)	(0.056)
Income group = Unrecorded	0.561***	0.561***		0.570***	0.573***	0.602***
	(0.073)	(0.072)		(0.072)	(0.073)	(0.076)
Income group = Medium - double medium wage	-0.501***	-0.498***	-0.501***	-0.488***	-0.500***	-0.481***
	(0.067)	(0.067)	(0.068)	(0.067)	(0.067)	(0.071)
Income group = Above double medium wage	-0.963***	-0.957***	-0.935***	-0.953***	-0.952***	-0.905***
	(0.082)	(0.082)	(0.089)	(0.082)	(0.082)	(0.087)
DSTI	0.301***	0.314***		0.320***	0.324***	0.327***
	(0.027)	(0.027)		(0.027)	(0.027)	(0.029)
Age	0.007*	0.006*	0.006	0.005	0.007**	0.006
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
Amount at origination (k euro)	0.006***	0.006***	0.006***	0.007***		0.006***
	(0.001)	(0.001)	(0.001)	(0.001)		(0.001)
Currency = 2, EUR	0.481***	0.467***	0.503***	0.531***	0.466***	0.688***
	(0.082)	(0.082)	(0.098)	(0.082)	(0.082)	(0.088)
Currency = 3, CHF	0.946***	0.944***	0.879***	1.202***	0.943***	1.473***
	(0.106)	(0.107)	(0.128)	(0.104)	(0.107)	(0.111)
LTV	0.960***	0.956***	1.020***		0.958***	
	(0.059)	(0.059)	(0.071)		(0.060)	
No LTV information = 1	1.177***	1.155***	1.281***		1.174***	
	(0.095)	(0.095)	(0.115)		(0.095)	
Residual maturity (years)	0.019***	0.022***	0.019***	0.030***	0.022***	0.035***
	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)
Interest rate	0.271***	0.321***	0.344***	0.317***	0.327***	0.329***
	(0.029)	(0.029)	(0.034)	(0.029)	(0.029)	(0.032)
DSTI = 50%-100%			0.493***			
			(0.080)			
DSTI >100%			0.834***			
			(0.082)			
LTV >100%				0.650***		
				(0.058)		
LTV = Unrecorded				0.497***		
				(0.079)		
Amount at origination = 30k -60k euro					0.088	
					(0.065)	
Amount at origination = 60k -90k euro					0.460***	
					(0.076)	
Amount at origination >90k euro					0.715***	
					(0.084)	
Negative equity						0.062***
						(0.007)
Observations	932,356	932,356	743,900	932,356	932,356	820,772
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Origination FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.0845	0.0873	0.0994	0.0834	0.0870	0.0828
Likelihood	-14978	-14931	-10395	-14996	-14936	-13238

In column (2), we include the *DiS period* dummy as an explanatory variable. As expected, defaults are more likely during the period when *Datio in Solutum* law was active. The

coefficient of our main variable of interest is positive and statistically significant, indicating that the introduction of *Datio in Solutum* led to a 65% increase in the average probability of default compared to the period when the law was not in effect.[35] These findings complement the existing literature (see, e.g., Jones, 1993; Demiroglu et al., 2014; and Chan et al., 2016), by showing that a shift toward a more debtor-friendly recourse regime results in a higher probability of mortgage default.

In columns (3), (4), and (5), we examine alternative measures of DSTI, LTV, and the amount at origination, respectively, to explore the non-monotonic effects of these variables. The results in column (3) show that the marginal effect of DSTI is both non-linear and statistically significant.[36] Specifically, increasing in the DSTI ratio from below 50% to a range between 50% and 100% raises the probability of default by 62%, a finding consistent with Nier et al. (2019) (see Figure C.3, left panel). This result underscores that borrower's indebtedness adversely affects repayment probability, particularly when the DSTI ratio exceeds 50%.

Similarly, column (4) highlights the non-monotonic relationship between LTV ratio and default probability. The LTV measure captures the combined effects of changes in collateral value and loan amortization. The marginal effect of high LTV (i.e., higher than 100%) on the probability of default is 89% higher than that of low LTV (i.e., below 100%).[37] These findings align with prior studies (see, e.g., Foote et al., 2009; Ellul et al., 2010; Goodstein et al., 2017). Borrowers in the "*LTV Unrecorded*" category exhibit a similar probability of default to those with LTV above 100%, indicating that borrowers with other types of collateral face similar risks to those with negative equity (see Figure C.4, left panel).

The results in column (5) show that the effect of loan amount at origination is also non-monotonic but smaller in magnitude compared to DSTI and LTV. The marginal effects indicate that the highest probability of default occurs for loans with amounts at origination exceeding 90,000 euro (see Figure C.5, left panel). Finally, column (6) incorporates an alternative proxy for negative equity, defined as the difference between the collateral value and the outstanding loan principal. The coefficient for this proxy is positive and statistically significant, suggesting that larger negative equity is associated with a higher probability of default. This result is consistent with the findings of Elul et al. (2010).

[35] Controlling for all other characteristics, the introduction of *Datio in Solutum* increases the probability of default from 0.17% to 0.28% for an average borrower.
[36] For this specification we include in our sample only borrowers for whom we can calculate their indebtedness (i.e., borrowers with recorded income).
[37] Controlling for all other characteristics, an average borrower with a LTV ratio below 100% has a probability of default of 0.18% compared to 0.34% for one with a LTV above 100%.

Table 6 presents the estimation results for the interactions between the *DiS period* dummy and borrower characteristics, based on the model specified in Equation (4). Column (1) examines the interaction effects between the *DiS period* dummy and borrower income categories, using *Below medium wage* as the reference group. The results indicate that the introduction of *Datio in Solutum* increased the probability of default across all income levels (see Figure C.2, right panel). However, the effect is more pronounced for borrowers with the highest incomes, as indicated by the positive and statistically significant interaction coefficients between the *DiS period* dummy with *Medium - double medium wage* and *Above double medium* dummies. Figure C.2 illustrates the marginal effects of income on the probability of becoming delinquent, showing that borrowers with the highest incomes experienced a 250% increase in their average probability of default, compared to a 60% increase for borrowers earning below the medium wage. [38,39] These results suggest that higher-income borrowers, despite being less financially constrained, exhibited a substantial deterioration in payment discipline following the introduction of *Datio in Solutum*.

In column (2), we interact the *DiS period* dummy with indicators for DSTI. The interaction coefficients are statistically insignificant, suggesting a uniform deterioration in payment discipline across DSTI categories. However, the marginal effects, as illustrated in Figure C.3 (right panel), reveal a significant impact on borrowers with lower financial constraints (i.e., those with DSTI below 50%). For this group, the introduction of *Datio in Solutum* increased the probability of default by 110%, while for the most indebted borrowers (i.e., those with DSTI above 100%), the increase was 70% increase.[40] These findings are consistent with the concept of strategic default, wherein less liquidity-constrained borrowers – whether due to higher income or lower debt - are typically expected to default less. However, the introduction of a more debtor-friendly recourse regime appears to have incentivized higher levels of non-repayment among these borrowers.

[38] Controlling for all other characteristics, the average probability of default for a borrower with an income higher than double the medium wage increases from 0.04% to 0.14% after the introduction of the *Datio in Solutum* law.
[39] Controlling for all other characteristics, the average probability of default for a borrower with an income below the medium wage increases from 0.2% to 0.32% after the introduction of the *Datio in Solutum* law.
[40] Controlling for all other characteristics, the average probability of default for borrowers with a DSTI below 50% increases from 0.07% to 0.15%, while for borrowers with a DSTI above 100% it increases from 0.2% to 0.34%.

Table 6. Mortgage default probability. Borrower characteristics and *Datio in Solutum*

The table reports the results of logit regressions examining the potential asymmetric effects of specific borrower attributes on the probability of default for standard mortgage loans under *Datio in Solutum*. The analysis uses quarterly vintage data from 2015Q4 to 2017Q2 and estimates alternative versions of the following regression specification (Eq. 4): $y_{i,t} = \alpha + \beta * DiS\ period_t + \sum_{j=1}^{k} \lambda^j\ Dummy_{i,t-4}^{j} + + \sum_{j=1}^{k} \theta^j\ Dummy_{i,t-4}^{j} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$, where the indices *i* and *t* stand for borrower and time, respectively, $DiS\ period_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before, $Dummy_{i,t-4}^{j}$ is a dummy equal to 1 if the variable of interest (e.g., income group or DSTI) for borrower *i*, at time *t-4*, falls in a specified category *j*, and 0 otherwise. The vector of borrower controls $Z_{i,t-4}$ includes income category, DSTI, and age. If DSTI is included as a dummy variable, the continuous version of DSTI is excluded from the controls. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. The regressors are 4-quarters lagged (*t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample includes only standard mortgages with balances below 250,000 euro, representing borrowers eligible to request *Datio in Solutum.* Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**
DiS period	0.442***	0.731***
	(0.075)	(0.149)
Income group = Unrecorded	0.761***	
	(0.116)	
Income group = Medium - double medium wage	-0.834***	
	(0.146)	
Income group = Above double medium wage	-1.441***	
	(0.183)	
DiS Period * Income group = Unrecorded	-0.235**	
	(0.116)	
DiS Period * Income group = Medium - double medium wage	0.428***	
	(0.159)	
DiS Period * Income group = Above double medium wage	0.605***	
	(0.194)	
DSTI = 50%-100%		0.452**
		(0.182)
DSTI >100%		1.012***
		(0.159)
DiS Period * DSTI = 50%-100%		0.031
		(0.197)
DiS Period * DSTI >100%		-0.220
		(0.167)
Observations	932,356	744,034
Bank FE	Yes	Yes
Origination FE	Yes	Yes
County FE	Yes	Yes
Borrower and loan characteristics	Yes	Yes
Pseudo R2	0.0882	0.0997
Likelihood	-14917	-10392

Table 7 reports the results of the model specified in Equation (4), where the *DiS period* dummy interacts with loan characteristics. Column (1) shows that the probability of default for borrowers with mortgages denominated in Swiss francs increased by 95% following the implementation of *Datio in Solutum*, compared to 45% for loans denominated in euro and 41% for loans denominated in Romanian leu.[41] The interaction coefficient between the *DiS period* dummy and *Currency = CHF* is positive and statistically significant, indicating a significant

[41] Controlling for all other characteristics, the average probability of default for borrowers with loans denominated in Swiss francs increases from 0.24% to 0.47%, from 0.18% to 0.28% for those with loans denominated in euro, and from 0.12% to 0.17% for those with loans denominated in Romanian leu.

deterioration in payment discipline, particularly among borrowers with Swiss franc-denominated mortgages.

Column (2) examines the non-linear effect of *Datio in Solutum* on the probability of default, conditional on the value of the LTV ratio. Borrowers with LTV ratios exceeding 100% are more likely to default than those with LTV ratios below 100%. As depicted in Figure C.4 (right panel), the introduction of *Datio in Solutum* increases the probability of default by 36% for borrowers with LTV ratios below 100%, while for those with LTV ratios above 100%, the probability of default doubles, reflecting a 100% increase.[42] These findings align with the theoretical literature, which predicts that negative equity - proxied by an LTV ratio greater than 100% - is positively and statistically significantly associated with default.[43]

Column (3) demonstrates that the introduction of *Datio in Solutum* resulted in a statistically significant deterioration in payment discipline among borrowers with the highest loan amounts at origination. The interaction coefficients for the *DiS period* dummy with both the *Amount at origination between 60,000 and 90,000 euro* dummy and the *Amount at origination above 90,000 euro* dummy are positive and statistically significant. In terms of average default probability, these borrowers experienced the most pronounced increases: 105% for those with amounts at origination between 60,000 and 90,000 euro, and 80% for those with amounts exceeding 90,000 euro. These increases are significantly higher than the 25% rise observed for borrowers with amounts at origination below 30,000 euro (see Figure C.5, right panel).[44]

[42] Controlling for all other characteristics, the average probability of default for borrowers with a LTV ratio below and above 100% increases from 0.14% to 0.19% and from 0.20% to 0.40%, respectively.
[43] Ghent and Kudlyak (2011) and Demiroglu et al. (2014) report similar results for underwater homeowners in non-recourse states in the U.S.
[44] Controlling for all other characteristics, the average probability of default for borrowers with an amount at origination between 60,000 and 90,000 euro and above 90,000 euro increases from 0.17% to 0.35%, and from 0.25% to 0.45%, respectively. Likewise, the average probability of default for borrowers with an amount at origination below 30,000 euro increases from 0.16% to 0.20%.

Table 7. Mortgage default probability. Loan characteristics and *Datio in Solutum*

The table reports the results of logit regressions examining the potential asymmetric effects of specific loan attributes on the probability of default for standard mortgage loans under *Datio in Solutum*. The analysis uses quarterly vintage data from 2015Q4 to 2017Q2 and estimates alternative versions of the following regression specification (Eq. 4): $y_{i,t} = \alpha + \beta * DiS\ period_t + \sum_{j=1}^{k} \lambda^j\ Dummy_{i,t-4}^{j} + + \sum_{j=1}^{k} \theta^j\ Dummy_{i,t-4}^{j} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$, where the indices i and t stand for borrower and time, respectively, *DiS period*$_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before, $Dummy_{i,t-4}^{j}$ is a dummy equal to 1 if the variable of interest (e.g., currency, loan size at origination and LTV) for borrower *i*, at time *t-4* falls in a specified category *j*, and 0 otherwise. The vector of borrower controls $Z_{i,t-4}$ includes income category, DSTI, and age. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. If loan size at origination is included as a dummy variable, the continuous version is excluded from the controls. The regressors are 4-quarters lagged (*t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample includes only standard mortgages with balances below 250,000 euro, representing borrowers eligible to request *Datio in Solutum.* Standard errors are shown in brackets. ∗∗∗, ∗∗, and ∗ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**	**(3)**
DiS period	0.341**	0.311***	0.244**
	(0.142)	(0.079)	(0.108)
Currency = EUR	0.382***		
	(0.147)		
Currency = CHF	0.684***		
	(0.176)		
DiS Period *Currency = EUR	0.109		
	(0.153)		
DiS Period *Currency = CHF	0.334*		
	(0.177)		
LTV >100%		0.367***	
		(0.101)	
LTV = Unrecorded		0.445***	
		(0.168)	
DiS Period * LTV >100%		0.364***	
		(0.106)	
DiS Period * LTV = Unrecorded		0.080	
		(0.181)	
Amount at origination = 30k -60k euro			-0.052
			(0.121)
Amount at origination = 60k -90k euro			0.097
			(0.143)
Amount at origination > 90k euro			0.443***
			(0.142)
DiS Period * Amount at origination = 30k -60k euro			0.185
			(0.137)
DiS Period * Amount at origination = 60k -90k euro			0.466***
			(0.155)
DiS Period * Amount at origination > 90k euro			0.354**
			(0.149)
Observations	932,356	932,356	932,356
Bank FE	Yes	Yes	Yes
Origination FE	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Borrower and loan characteristics	Yes	Yes	Yes
Pseudo R2	0.0875	0.0837	0.0873
Likelihood	-14929	-14990	-14931

Table 8 presents the estimates from the model specified in Equation (5), which distinguishes among the triggers of mortgage defaults. Column (1) investigates the effects of income changes and negative equity on the probability of default for standard mortgages. The findings indicate that a decrease in income over the past 12 months doubles the probability of

default[45], whereas an increase in income does not have a statistically significant effect.[46] Additionally, borrowers with negative equity - measured by current LTV - or those with unrecorded LTV exhibit a higher probability of default compared to borrowers with positive equity.

Column (2) examines whether a negative equity shock affects the probability of default differently for borrowers who experienced an increase in income versus those who experienced a decrease over the past 12 months. The results confirm that both negative equity and income decreases independently raise the probability of default, consistent with the findings in column (1). However, the impact of a negative income shock does not vary significantly between borrowers with negative and positive equity, challenging the double-trigger theory of default, which posits that the combination of both triggers is necessary to cause defaults.[47] Furthermore, the probability of default significantly increases for borrowers experiencing a negative equity shock despite an increase in income, suggesting evidence of strategic borrower behavior.

In column (3), the interaction of income changes and borrower equity with the *DiS period* is analyzed to identify the triggers - negative equity, income changes, or their combination - associated with an increase in the probability of default following the enactment of the law. The results reveal that the interaction between negative equity and the *DiS period* significantly raises the probability of default. Conversely, the coefficients for income changes and the *DiS period* are statistically insignificant, indicating that the effect of income shocks remained constant across the two periods. The triple interaction of income changes, current LTV, and the *DiS period* is positive and significant across all categories. However, the coefficients are not significantly different, suggesting that the impact of income shocks on default probability did not differ after the implementation of *Datio in Solutum*.

[45] Controlling for all other characteristics, a borrower with an income decrease has a probability of default of 0.43% compared to 0.22% for one whose income remains constant.
[46] Controlling for all other characteristics, a borrower with an income increase has a probability of default of 0.21% compared to 0.22% for one whose income remains constant.
[47] Controlling for all other characteristics, for a borrower with positive equity, a negative income shock leads to a 187% increase in the probability of default compared to a borrower with positive equity and constant income (0.28% vs. 0.15%). For a borrower with negative equity, a negative income shock results in a 206% increase in the probability of default compared to a borrower with negative equity and constant income (0.68% vs. 0.33%).

Table 8. Triggers of mortgage defaults

The table reports the results of logit regressions examining the impact of the introduction of *Datio in Solutum* on the probability of default for standard mortgages. The analysis uses quarterly vintage data from 2015Q4 to 2017Q2 and estimates alternative versions of the following regression specification (Eq. 5): $y_{i,t} = \alpha + \beta_0 * DiS\ period_t + \sum_{j=1}^{3} \beta_1{}^{j}\ Income\ change\ dummy_{i,t}^{j} + \sum_{k=1}^{3} \beta_2{}^{k}\ LTV\ dummy_{i,t}^{k} + \sum_{k=1}^{3}\sum_{j=1}^{3} \psi^{j,k}\ LTV\ dummy_{i,t}^{k} * Income\ change\ dummy_{i,t}^{j} + \sum_{k=1}^{3} \delta^{k}\ LTV\ dummy_{i,t}^{k} * DiS\ period_t + \sum_{j=1}^{3} \vartheta^{j} Income\ change\ dummy_{i,t}^{j} * DiS\ period_t + \sum_{k=1}^{3}\sum_{j=1}^{3} \eta^{j,k}\ LTV\ dummy_{i,t}^{k} * Income\ change\ dummy_{i,t}^{j} * DiS\ period_t + \kappa_1 * DSTI_{i,t} + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$ where the indices i and t stand for borrower and time, respectively, $DiS\ period_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before. The vector of borrower controls $Z_{i,t-4}$ includes income category and age. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, residual maturity, and interest rate.. The *Income change* dummy reflects changes in income compared to 12-months lagged income. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. The sample includes only standard mortgages with balances below 250,000 euro, representing borrowers eligible to request *Datio in Solutum.* Standard errors are shown in brackets. ∗∗∗, ∗∗, and ∗ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**	**(3)**
DiS period	0.498***	0.498***	0.172*
	-0.053	-0.053	-0.098
Income change dummy = decrease	0.660***	0.602***	0.433**
	-0.057	-0.086	-0.169
Income change dummy = increase	-0.029	-0.180*	-0.223
	-0.057	-0.093	-0.189
Current DSTI	0.154***	0.153***	0.156***
	(0.023)	(0.024)	(0.024)
Current LTV >100%	0.835***	0.764***	0.346***
	-0.058	-0.069	-0.127
Current LTV = Unrecorded	0.497***	0.445***	0.066
	-0.077	-0.096	-0.204
Income change dummy = decrease * Current LTV >100		0.111	0.439*
		-0.109	-0.227
Income change dummy = decrease * Current LTV =		0.029	0.311
Unrecorded		-0.171	-0.373
Income change dummy = increase * Current LTV >100		0.242**	0.163
		-0.12	-0.266
Income change dummy = increase * Current LTV =		0.243	0.232
Unrecorded		-0.178	-0.425
Current LTV >100% * DiS Period=1			0.542***
			-0.139
Current LTV = Unrecorded * DiS Period=1			0.488**
			-0.225
Income change dummy = decrease* DiS Period=1			0.225
			-0.193
Income change dummy = increase * DiS Period=1			0.07
			-0.216
Income change dummy = decrease *Current LTV >100% *			0.777***
DiS Period=1			-0.252
Income change dummy = decrease *Current LTV =			0.658**
Unrecorded * DiS Period=1			-0.325
Income change dummy = increase *Current LTV >100% *			0.845***
DiS Period=1			-0.267
Income change dummy = increase *Current LTV =			0.783**
Unrecorded * DiS Period=1			-0.336
Observations	932,160	932,160	932,160
Banks FE	Yes	Yes	Yes
Origination FE	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Vintage FE	Yes	Yes	Yes
Borrower and loan characteristics	Yes	Yes	Yes
Pseudo R2	0.0878	0.088	0.0887
Likelihood	-14912	-14909	-14898

Our findings indicate that defaults were primarily driven by negative equity, suggesting strategic borrower behavior. This conclusion is further reinforced by the observation that the share of non-performing borrowers with negative equity or unrecorded LTV, combined with a positive or stable income shock, increased following the enactment of *Datio in Solutum*. Appendix A.3 presents the distribution of borrowers by income shock and current LTV during the four quarters before and after the introduction of *Datio in Solutum*. The share of borrowers experiencing a negative income shock remained constant at 24% across both periods. The most notable shift occurred among borrowers with no income shock, where the proportion with positive equity declined from 36% to 28%, while the proportion with negative equity rose from 40% to 48%. These changes suggest that, despite rising incomes, borrowers with negative equity were incentivized to default under the new recourse regime introduced by *Datio in Solutum*.

Robustness tests

We perform several robustness tests to assess the validity of our results under alternative modeling specifications. First, we re-estimate the model specified in Equation (2) using the linear probability ordinary least squares model (OLS). Table 9 reports the results. Consistent with Gerardi et al. (2018) and O'Malley (2021), we estimate two alternative OLS specifications. Column (1) includes bank, year of origination, and county fixed effects, while column (2) omits fixed effects. In both specifications, the coefficient for the *DiS period* dummy is positive and statistically significant, indicating an increase in the probability of default of 0.11 percentage points, consistent with the findings in Table 6.

Second, we apply a difference-in-difference approach in column (3) using our logit model from Equation (1), including borrowers with multiple loans in the sample. The coefficient of the interaction term between the *Standard mortgage* dummy and *DiS period* dummy is positive, statistically significant, and of similar magnitude to the baseline estimates reported in Table 3. This finding underscores the robustness of our baseline results. Meanwhile, the coefficient of the *Multiple loans* dummy is positive but statistically insignificant, suggesting that borrowers with multiple loans are not inherently riskier than those with a single mortgage.

Finally, we employ a nearest-neighbor matching methodology based on propensity scores, following the approach proposed by Rosenbaum and Rubin (1983). This method involves a logit regression to match borrowers with similar characteristics who differ only in their *Datio in Solutum* request status. By doing so, we address the potential concern that borrowers applying for *Datio in Solutum* may have had a higher ex-ante probability of default.

Table 9. Robustness to different estimation methods

The table presents robustness tests for the main results on the impact of the *Datio in Solutum* introduction on the probability of mortgage default. A difference-in-difference approach is employed using the following specification (based on Eq. 2): $y_{i,t} = \alpha + \beta_1 * DiS\ period_t + \beta_2 * DiS\ request_{i,t} * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$, where the indices i and t stand for borrower and time, respectively, *DiS period*$_t$ is a dummy equal to 1 from 2016Q2 onwards and 0 before, *DiS request*$_i$ is a dummy equal to 1 for borrowers with a standard mortgage loan who requested *Datio in Solutum* and 0 for those who did not. The vector of borrower controls $Z_{i,t-4}$ includes income category, DSTI, and age. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, LTV, residual maturity, and interest rate. Model 1 reports OLS estimation results with bank, year of origination, and county fixed effects. Model 2 shows OLS estimates without fixed effects. The regressors are 12-month lagged (*t-4)*. The dependent variable y_{it} is a dummy equal to 1 if the borrower's loan is more than 90 days past due. Expanding on the specification in Table 3, the sample in column(3) also includes borrowers with multiple loans. Model 3 implements a difference-in-difference approach using the following specification (Eq. 1): $y_{i,t} = \alpha + \beta_0 * Standard\ mortgage_i + \beta_1 * DiS\ period_t + \beta_2 * Standard\ mortgage_i * DiS\ period_t + \gamma' Z_{i,t-4} + \mu' L_{i,t-4} + \theta * Multiple\ loan\ dummy_i + Bank\ FE + Origination\ FE + County\ FE + +\varepsilon_{i,t}$, where $Standard\ mortgage$ is a dummy equal to 1 for borrowers with a standard mortgage loan and 0 for borrowers with a *First Home* loan, and $Multiple\ loan\ dummy$ is equal to 1 if the borrower has more than one mortgage loan. Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)**	**(2)**	**(3)**
	OLS	OLS	Logit
Standard mortgage			1.9301***
			(0.1502)
DiS period	0.00119***	0.00114***	0.2178
	(0.000)	(0.000)	(0.1404)
Standard mortgage * DiS period			0.2653*
			(0.1485)
Multiple loans			0.0447
			(0.1176)
Income group = Unrecorded	0.00119***	0.00124***	0.5320***
	(0.000)	(0.000)	(0.0642)
Income group = Medium - double medium wage	-0.00127***	-0.00123***	-0.6070***
	(0.000)	(0.000)	(0.0655)
Income group = Above double medium wage	-0.00222***	-0.00215***	-1.0233***
	(0.000)	(0.000)	(0.0777)
DSTI	0.00090***	0.00093***	0.2619***
	(0.000)	(0.000)	(0.0233)
Age	0.00001	0.00001	0.0065*
	(0.101)	(0.330)	(0.0034)
Amount at origination (k euro)	0.00003***	0.00003***	0.0063***
	(0.000)	(0.000)	(0.0006)
Currency = 2, EUR	0.00062***	0.00057***	0.3814***
	(0.000)	(0.000)	(0.0822)
Currency = 3, CHF	0.00370***	0.00301***	0.9379***
	(0.000)	(0.000)	(0.1090)
LTV	0.00307***	0.00271***	0.9453***
	(0.000)	(0.000)	(0.0611)
No LTV information	0.00284***	0.00232***	1.2248***
	(0.000)	(0.000)	(0.1000)
Residual maturity (years)	0.00002**	0.00001	0.0261***
	(0.039)	(0.422)	(0.0046)
Interest rate	0.00070***	0.00059***	0.2418***
	(0.000)	(0.000)	(0.0319)
Observations	932,958	932,958	1,663,854
Banks FE	Yes	No	Yes
Origination FE	Yes	No	Yes
County FE	Yes	No	Yes
R2	0.00378	0.00301	0.131
Likelihood	1.472e+06	1.472e+06	-15675

The nearest-neighbor matching strategy addresses concerns regarding the endogeneity of selection for borrowers who applied for *Datio in Solutum* through a two-step methodology. First, we estimate a logit model where the dependent variable is *DiS request*, and the independent variables include standard borrower and loan characteristics. Consistent with

Equation (5), we include interactions between income shocks and the borrower's current LTV to assess whether liquidity constraints or negative equity influenced *Datio in Solutum* requests, and whether the effect of income shocks varied with the level of LTV. This model, estimated over the period when *Datio in Solutum* was available, identifies the factors that increase the probability of requesting *Datio in Solutum* (Table 10, column 1). Using the model, we calculate the *Datio in Solutum* request probability for all borrowers, including those who did not request *Datio in Solutum*. Second, the strategy matches each borrower who requested *Datio in Solutum* with a borrower who did not but exhibits a similar profile (Table 10, column 2). This matching mitigates selection bias by ensuring comparability between the samples, allowing us to confirm that the observed effect of *Datio in Solutum* is not driven by borrowers' ex-ante characteristics.

We estimate the following logit model for the probability of requesting *Datio in Solutum:*

$$DiS\ Request_{i,t} = \alpha + \\ + \sum_{j=1}^{3} {\beta_1}^{j}\ Income\ change\ dummy_{i,t}^{j} + \sum_{k=1}^{3} {\beta_2}^{k}\ LTV\ dummy_{i,t}^{k} + \\ + \sum_{k=1}^{3}\sum_{j=1}^{3} \psi^{j,k}\ LTV\ dummy_{i,t}^{k} * Income\ change\ dummy_{i,t}^{j} + \\ + \kappa_1 * DSTI_{i,t} + \kappa_2 * Income\ category_{i,t-4} + \kappa_3 * Age_{i,t-4} + \mu' L_{i,t-4} + \\ + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}\ . \qquad (6)$$

We estimate the model using vintages over the 2016Q2 - 2017Q1 period (i.e., when *Datio in Solutum* law was in effect). Z and L are vectors of borrower and loan characteristics, respectively. Using the estimated propensity score, we construct a nearest-neighbor matched sample comprising equal shares of borrowers who requested *Datio in Solutum* and those who did not. The results in column (1) from Table 10 indicate that borrowers with a higher level of indebtedness, foreign-currency-denominated loans, larger loan amounts at origination, and negative equity are more likely to request *Datio in Solutum.* Additionally, borrowers with unrecorded incomes exhibit a higher probability of requesting *Datio in Solutum.* Regarding income shocks, we find no statistically significant effects, either individually or when interacted with the borrower's LTV ratio.

Table 10. Nearest-neighbor model

Model (1) reports the results of logit regressions examining the probability of requesting *Datio in Solutum*. We use the following specification: $DiS\ Request_{i,t} = \alpha + \sum_{j=1}^{3} \beta_1{}^{j}\ Income\ change\ dummy_{i,t}^{j} + \sum_{k=1}^{3} \beta_2{}^{k}\ LTV\ dummy_{i,t}^{k} + \sum_{k=1}^{3}\sum_{j=1}^{3} \psi^{j,k}\ LTV\ dummy_{i,t}^{k} * Income\ change\ dummy_{i,t}^{j} + \kappa_1 * DSTI_{i,t} + \kappa_2 * Income\ category + \kappa_3\ Age_{i,t-4} + \mu' L_{i,t-4} + Bank\ FE + Origination\ FE + County\ FE + \varepsilon_{i,t}$ where the indices *i* and *t* stand for borrower and time, respectively. The dependent variable is a dummy $DiS\ Request_{i,t}$ equal to 1 if the borrower's applied for *Datio in Solutum* in the respective quarter. The vector of loan characteristics $L_{i,t-4}$ includes loan size at origination, currency of denomination, residual maturity, and interest rate. The *Income change* dummy reflects changes in income compared to 12-months lagged income. The regressors are 12-month lagged (*t-4)*. Model (2) estimates the impact of requesting *Datio in Solutum* on the probability of default for standard mortgage loans using a nearest-neighbor matched sample. The following specification is used: $y_{i,t} = \alpha + \beta_1 * DiS\ request_{i,t} + \sum_{j=1}^{3} \beta_1{}^{j}\ Income\ change\ dummy_{i,t}^{j} + \sum_{k=1}^{3} \beta_2{}^{k}\ LTV\ dummy_{i,t}^{k} + \sum_{k=1}^{3}\sum_{j=1}^{3} \psi^{j,k}\ LTV\ dummy_{i,t}^{k} * Income\ change\ dummy_{i,t}^{j} + \kappa_1 * DSTI_{i,t} + \kappa_2 * Income\ category + \kappa_3\ Age_{i,t-4} + \mu' L_{i,t-1} + Origination\ FE + Vintage\ FE + \varepsilon_{i,t}$. The dependent variable is a dummy y_{it} equal to 1 if the borrower's loan is more than 90 days past due. *DiS request* is a dummy equal to 1 for borrowers with a standard mortgage loan who requested *Datio in Solutum* and 0 for those who did not. Standard errors are shown in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	**(1)** ***Datio in Solutum*** **request**	**(2)** **Probability of default - matched sample estimation**
DiS request		3.1321***
		(0.2000)
Income change dummy = decrease	0.1447	0.1802
	(0.2228)	(0.7835)
Income change dummy = increase	-0.0069	0.1187
	(0.1316)	(0.5825)
Current LTV >100%	1.9143***	0.8223
	(0.1247)	(0.5501)
Current LTV = Unrecorded	1.5476***	0.8869
	(0.1665)	(0.6288)
Income change dummy = decrease * Current LTV >100	0.2545	0.1367
	(0.2421)	(0.8851)
Income change dummy = decrease * Current LTV = Unrecorded	0.1053	-0.1524
	(0.1894)	(0.5566)
Income change dummy = increase * Current LTV >100	-0.1353	0.0394
	(0.1400)	(0.6042)
Income change dummy = increase * Current LTV = Unrecorded	-0.2518	0.0643
	(0.1927)	(0.7080)
Current DSTI	0.0629***	0.0063
	(0.0207)	(0.0709)
Income group = Unrecorded	0.2331***	-0.2183
	(0.0556)	(0.1974)
Income group = Medium - double medium wage	-0.0212	-0.5208***
	(0.0532)	(0.1874)
Income group = Above double medium wage	-0.0224	-0.9204***
	(0.0552)	(0.1909)
Amount at origination (k euro)	0.0118***	-0.0005
	(0.0004)	(0.0015)
Currency = 2, EUR	0.6365***	-0.5197
	(0.1025)	(0.3719)
Currency = 3, CHF	1.9031***	-0.4007
	(0.1104)	(0.3904)
Residual maturity (years)	0.0377***	-0.0126
	(0.0043)	(0.0172)
Interest rate	0.0080	0.4043***
	(0.0396)	(0.1285)
Age	-0.0221***	-0.0104

	(0.0037)	(0.0125)
Observations	702,986	6,696
Vintage FE	Yes	Yes
Origination FE	Yes	Yes

These findings are consistent with the results in Table 8, which highlight negative equity as the primary driver of default following the implementation of the *Datio in Solutum* law. In the matched-logit regression (Table 10, column 2), the coefficient on the *DiS request* dummy is positive and statistically significant, suggesting an average default probability of 12.3% for borrowers who requested *Datio in Solutum* - 2.5 times higher than our estimates in Table 5. Furthermore, the estimated effect of requesting *Datio in Solutum* aligns with the results obtained using the OLS methodology. These findings confirm that the selection effect does not compromise the robustness of our results.

6. Conclusions

We empirically investigate whether and how changes in recourse legislation affect mortgage repayment behavior. Using a granular dataset of mortgage loans originating between 2003 and 2016, combined with individual income tax records, we analyze the impact of a new recourse law that retroactively reclassified standard mortgage loans from recourse to non-recourse on borrowers' default probability.

We find strong evidence that *Datio in Solutum* law significantly impacted payment discipline. Following the legislative change, the average probability of default among borrowers with standard mortgage loans rose by 60%. In contrast, the probability of default for *First Home* loans - which were ineligible to give-in payment - remained unchanged. The increase in defaults was particularly pronounced among borrowers who applied to give in payment. These results remain robust even after controlling for the higher ex-ante risk profiles of borrowers who requested *Datio in Solutum.*

Our findings reveal that better-off, less liquidity-constrained borrowers and those with negative equity experienced the largest increase in the probability of default under the new non-recourse regime. These results underscore that defaults in this context were primarily motivated by negative equity, as borrowers strategically exploited the shift in recourse rules. In contrast, defaults driven by cash-flow or liquidity constraints remained largely unaffected, highlighting a misalignment between the policy's intent and its outcomes. The *Datio in Solutum* law,

designed to provide relief for financially distressed borrowers, unintentionally created incentives for strategic defaults due to its overly permissive eligibility criteria.

This evidence informs the ongoing policy debate about balancing borrower protection with maintaining the integrity of credit markets. While legislative shifts from creditor-friendly to debtor-friendly policies aim to mitigate hardship, they also risk fostering moral hazard if not carefully designed. In the case of the *Datio in Solutum* law, a more targeted approach would have been preferable—one that focused on assisting genuinely distressed borrowers struggling with repayment due to cash-flow issues while minimizing opportunities for strategic default by wealthier or less liquidity-constrained individuals.

A more effective implementation could have included stricter eligibility criteria, such as requiring proof of persistent income shortfalls or other verifiable indicators of financial distress. Additionally, measures like individualized loan restructuring could better address borrowers' specific challenges without imposing blanket legislative changes that could destabilize the lending system. Broad-based recourse policy shifts, if enacted without careful evaluation, may undermine creditor confidence, increase loan losses, and compromise the solvency of financial institutions, ultimately reducing their ability to extend credit to the broader economy. Policymakers should therefore prioritize tailored interventions that enhance borrower protection for those truly in need while preserving the stability of the financial system and discouraging opportunistic behaviors.

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Appendix A.1. Variables definitions and data sources

Variable	Abbreviation	Definition	Source
Datio in Solutum	DiS	Equals 1 if a borrower requests *Datio in Solutum*, 0 otherwise.	Central Credit Registry
Borrower characteristics			
Income	Income	Borrower's current income. We classify borrowers in 4 categories: unrecorded income, below medium wage, average-double average wage, above double-average wage.	Ministry of Public Finance
Current debt-service-to-income ratio	DSTI	Borrower's overall indebtedness (that includes consumer loan obligations) relative to current income. We classify borrowers in 3 categories according to the individual DSTI ratio: below 50%, 50%-100%, and above 100%. Winsorized at 300%.	Central Credit Registry and Ministry of Public Finance.
County of residence	County	County where the loan was issued.	Central Credit Registry
Loan characteristics			
Bank	Bank FE	Originating bank. We take the bank of origination for the largest loan by outstanding balances in case of multiple loans.	Central Credit Registry
Loan size at origination	Amount at origination	Loan amount at origination. We construct 4 loan categories: below 30k, 30k-60k, 60k-90k, above 90k. We normalize the amount by the euro exchange rate at origination.	Central Credit Registry
Currency of denomination	Currency	Loan currency. We classify loans in 3 categories: domestic currency leu (RON), euro (EUR), and Swiss francs (CHF). We take the currency of denomination for the largest loan by outstanding balances in case of multiple loans.	Central Credit Registry
Current loan-to-value ratio	LTV	Outstanding loan amount divided by the current value (updated every 2 years) of the property. We classify loans in 3 categories: below 100%, above 100%, and no information. Winsorized at 200%.	Central Credit Registry
Residual maturity	Maturity	The number of years until maturity. We use a weighted average by outstanding balances in case of multiple loans.	Central Credit Registry
Current interest rate	Interest rate	Current interest rate. Information is available at the bank and loan level (differentiated by loan category, maturity, and currency). We use a weighted average by outstanding balances in case of multiple loans.	Monetary Balance Sheet, Central Credit Registry
Equity	Equity	The difference between the outstanding loan amount and the current value of the property (in euro).	Central Credit Registry

Appendix A.2. Additional descriptive statistics

	Standard mortgage				First Home mortgage			
Variable	**p10**	**p25**	**p75**	**p90**	**p10**	**p25**	**p75**	**p90**
Age[1)]	31	35	45	51	28	30	37	42
Monthly income[2)]	166.7	289.8	980.7	1,810	173.8	297.6	813.8	1,278
Debt-service-to-income ratio[3)]	15	25	103	300	18	27	82	289
Loan-to-value ratio[3)]	32	50	110	149	-	-	-	-
Interest rate[3)]	3.410	3.900	5.040	5.470	3.260	3.580	4.710	5.160
Residual maturity[1)]	8.667	13.30	23.42	27.75	15.92	22.17	27.58	29.08
Loan size at origination[2)]	17.10	25.33	62.01	93.51	21.65	29.12	52.27	60.70

Notes: This table shows the summary statistics of the data used in the empirical analysis. See the appendix for the definitions of variables. [1)] years, [2)] amount in euro, [3)] percent. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

After the *Datio in Solutum* law had been enacted, the Central Credit Registry started to keep track of borrowers' requests by recording a special flag in the month of their application for debt forgiveness. During the period covered by our study, there were 7,500 requests recorded, namely 6,172 unique borrowers. After excluding all consumer loans, we identify 2,542 requests filled by borrowers with a mortgage loan, representing 2,396 unique borrowers.[48] Figure B.4 in the Appendix shows the evolution of *Datio in Solutum* requests for the mortgage and secured consumer loans. We exclude from our dataset the requests for *Datio in Solutum* associated with non-performing mortgage loans that were experiencing repayment difficulties before introducing the law (1,185 requests). After applying these filters, our dataset includes 1,312 unique requests representing 51% of the borrowers with mortgage loans who requested *Datio in Solutum*. Figure B.5 depicts the number of loans included in each vintage, as well as the number of loans included in our dataset for which *Datio in Solutum* has been requested. We observed the highest number of *Datio in Solutum* requests in September 2016.

Figure B.6 illustrates the strong relationship between a *Datio in Solutum* request and the probability of a loan becoming non-performing. On average, over the period June 2016 to June 2017, 12% of borrowers in our sample who requested *Datio in Solutum* defaulted on their loans. The highest default rate (i.e., 32%) was observed in 2016 Q3. This compares with an average delinquency rate of 0.2% among borrowers with standard mortgage loans who did not request *Datio in Solutum* and 0.03% for borrowers with *First Home* loans.

The evolution of credit volume of standard mortgage loans across time has been strongly correlated with changes in credit market regulations. Romania introduced borrower-based macroprudential policies in 2003 by implementing a DSTI cap for both mortgage (35%) and consumer (30%) loans and an LTV cap at the origination of 75%. Together with high-interest rates prevailing at that time, these restrictive measures harmed credit supply and real estate prices. Standard mortgage loans granted before 2007 represent only 13% of our sample. These loans are almost exclusively denominated in euro, a consequence of large interest rate differential between domestic currency RON- and euro-denominated loans. After joining the European Union in 2007, Romania introduced an approach based on self-regulation, which allowed banks to set credit standards following their in-house models rather than using the central bank's restrictive limits. Loans granted between 2007 and 2008 represent around 30% of our sample. These loans were issued during the peak of the housing boom and just before the effects of the Global Financial Crisis were felt in Romania. They have the largest

[48] Our dataset includes 250 borrowers that requested *Datio in Solutum* for both mortgage and consumer loans. We exclude all other secured consumer loans (which are eligible for requesting *Datio in Solutum*) because of their limited impact on the real estate market.

unconditional probability of default, as well as the highest rate for *Datio in Solutum* requests (Figure B.7). Furthermore, these loans have the largest median amount at origination (due to high real estate prices at that moment) and the highest median current LTV ratio (due to loosen credit standards at origination combined with the collapse of real estate prices during the crisis) (Figure B.8). Finally, loans issued over 2007-2008 were almost exclusively denominated in foreign currency (92%), with 23% of foreign currency loans being granted in Swiss francs (Figure B.9).

In the aftermath of the Global Financial Crisis, risk-averse lenders tightened their credit standards while borrowers suffered from debt overhang. This combination of supply and demand factors depressed the volume of new loans issued after 2008. Both the lower median amount at origination and lower median LTV ratio for loans granted after 2008 reflect the fall in property prices.

Under the European Systemic Risk Board's recommendations on lending in foreign currencies, the National Bank of Romania implemented in 2012 a differentiated LTV-cap based on the type of borrower (i.e., hedged or unhedged regarding FX risk) and loan currency.[49] The LTV cap was set at 85% for domestic-currency loans. For euro-denominated foreign-currency loans issued to unhedged borrowers, the cap was set at 75% to increase collateralization and reduce borrower's default incentives triggered by a fall in real estate prices. In our sample, the share of loans denominated in domestic currency increased from 6% in 2011 to 30% in 2012 and further to 84% in 2014 (Figure B.9). Loans granted between 2012 and 2016 have lower unconditional default and *Datio in Solutum* request rates (Figure B.7) than those granted before 2012. Explanations for this pattern relate to favorable macroeconomic conditions and the enhanced supervision of the National Bank of Romania, ensuring that banks maintain high credit standards and limit foreign currency lending to unhedged borrowers.

Most of the loans in our standard mortgage sample were issued in euro (60%), followed by loans in domestic currency (30%), with loans in Swiss francs making up only 10% of the sample. Borrowers with RON-denominated loans have the lowest probability of default (0.12%), followed by borrowers with euro-denominated loans (0.26%). Borrowers with Swiss francs-denominated loans have the highest probability of default (0.7%) and the largest percentage of *Datio in Solutum* requests (1.6%) (Figure B.10). The high risk of Swiss francs-denominated loans is mainly due to the decision of the Swiss National Bank to unpeg the franc in January 2015 and scrap the euro 1.2 per Swiss franc floor. These actions triggered the

[49] NBR Regulation No. 17/2012 on certain lending conditions.

appreciation of the Swiss franc versus the local currency and led to an increase in the debt service for borrowers with credit exposures in Swiss francs.

Regarding the loan amount at origination, 33% of borrowers have loans under 30,000 euro, while 40% have loans between 30,000 euro and 60,000 euro. Only 11% of loans are above 90,000 euro. Nevertheless, we observe that borrowers with the highest amounts at origination have the highest percentage of *Datio in Solutum* requests and the highest probability of default (Figure B.11).

From the distribution of the number of loans conditional on the current LTV ratio, we observe that around 25% of loans have an LTV ratio below 50%, with an additional 40% between 50% and 100%. A quarter of loans have a current LTV greater than 100%. These loans also have the highest delinquency and *Datio in Solutum* request rates (Figure B.12). Note that the LTV indicator is available only for mortgages with a residence as the primary collateral (i.e., 88% of loans in our sample). Banks update the value of collateral in the credit register every 2 years. Therefore, the current LTV ratio represents the ratio between the loan's current outstanding amount and the collateral's updated value, allowing us to identify borrowers with negative equity (i.e., where the residual amount of the loan exceeds the collateral value). Mortgages with other types of collateral receive a special dummy in our empirical model to single them out when using the LTV ratio as an explanatory variable.

Regarding the income category, borrowers with incomes below the medium wage represent the largest category (approximately 30%), followed by those with income between medium and double medium wage, and above double the medium wage, with each category representing approximately 25% of borrowers. The category of borrowers with unrecorded income represents approximately 20% of the sample (Figure B.13). As expected, borrowers with low or no recorded income have the highest probability of default, while those with the highest income have the lowest probability of default. However, these borrowers have similar rates of requesting *Datio in Solutum* (approximately 0.35%). This pattern suggests that changes in recourse legislation did not benefit only the less well-off borrowers facing affordability problems (Figure B.13 and Figure B.14).

Finally, around 45% of standard mortgage borrowers in our sample have a DSTI below 50% (Figure B.15). Unsurprisingly, the probability of default increases with indebtedness. Borrowers with DSTI greater than 100% have the highest delinquency rates (0.6%) and have a larger percentage of *Datio in Solutum* requests than the other groups (Figure B.15). Debtors with unrecorded income represent around 20% of the sample and have a similar probability of default compared to those with DSTI greater than 100%.

Appendix A.3. Distribution of non-performing borrowers by income and equity shocks

The tables below display the distribution of borrowers categorized by income shock and current LTV intervals in the four quarters before and after the introduction of *Datio in Solutum*. We have categorized borrowers as follows:

- Negative equity: Borrowers with a current LTV greater than 100%, including those with unrecorded LTV (details on mortgages with non-real estate collateral are provided on page 19). Borrowers with unrecorded LTV were grouped with those having negative equity due to their higher risk profile.
- Positive equity: Borrowers with with a current LTV lower than 100%.
- Negative income shock: Borrowers experiencing a decrease in income of more than 25%, (details on this classification are provided on page 19).
- No income shock: Borrowers with an income change between (-25%,0], or those whose income increased.

We chose the -25% threshold for income change because we believe only substantial income shocks would lead a borrower to consider defaulting on their loan.

As shown in the tables below, the share of borrowers with a negative income shock remains constant at 24% across both periods. The most significant change is observed among those with no income shock, particularly a shift from borrowers with positive equity (from 36% to 28%) to those with negative equity (from 40% to 48%). This highlights that despite a period of rising incomes, borrowers with negative equity had stronger incentives to default under the new recourse regime.

Distribution of non-performing borrowers before *Datio in Solutum* period

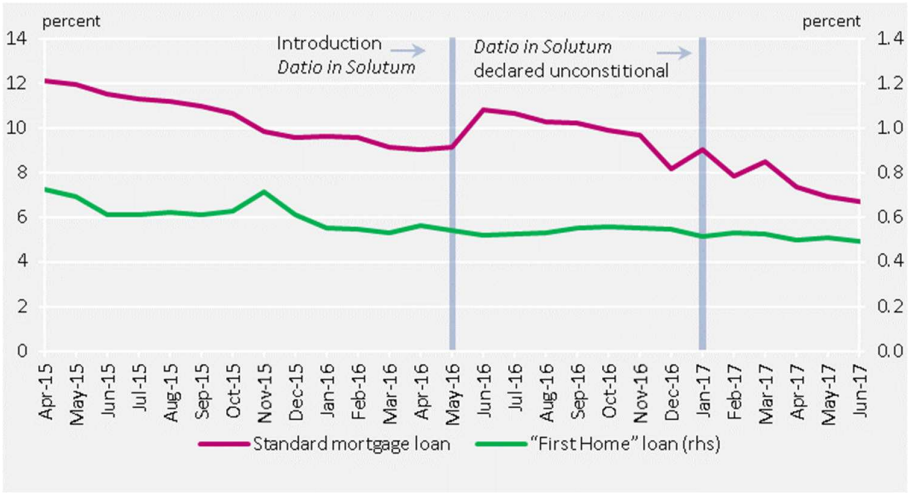
	Negative equity	Positive equity
Negative income shock	15%	9%
No income shock	40%	36%

Distribution of non-performing borrowers during for *Datio in Solutum* period

	Negative equity	Positive equity
Negative income shock	15%	9%
No income shock	48%	28%

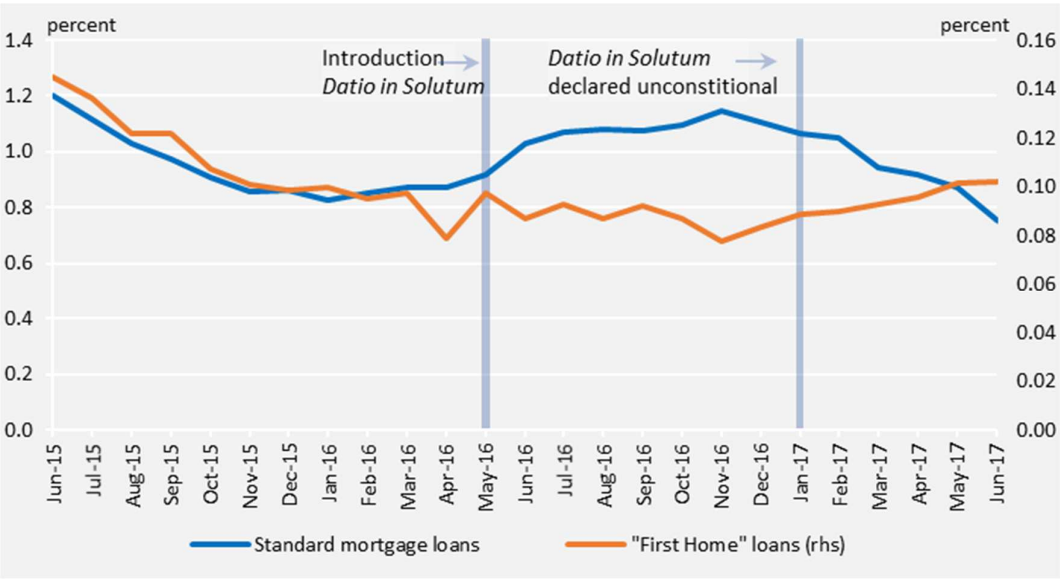
Appendix B. Figures

Figure B.1. NPLs rate by mortgage type



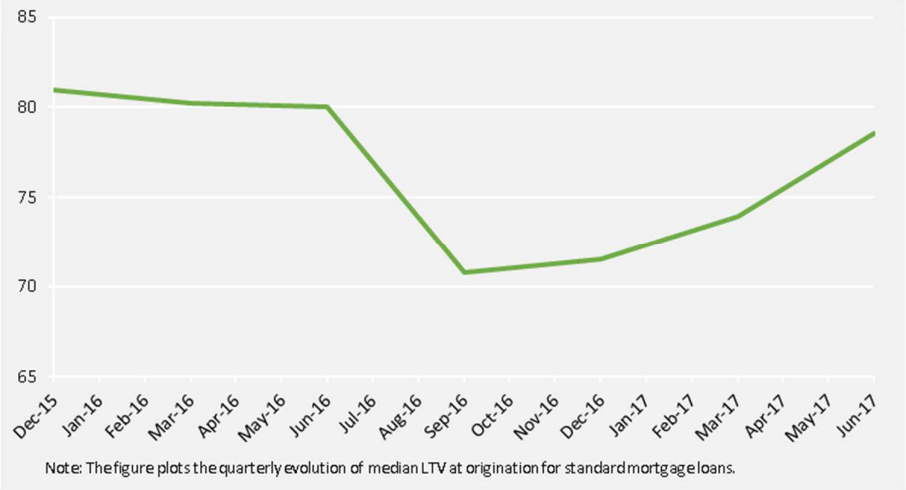
Notes: The figure plots the evolution of monthly NPLs rate conditional on the mortgage type. The NPLs rate is computed using the European Banking Authority definition that considers loans with delays above 90 days and loans flagged as unlikely to pay.

Figure B.2. Probability of default by loan type



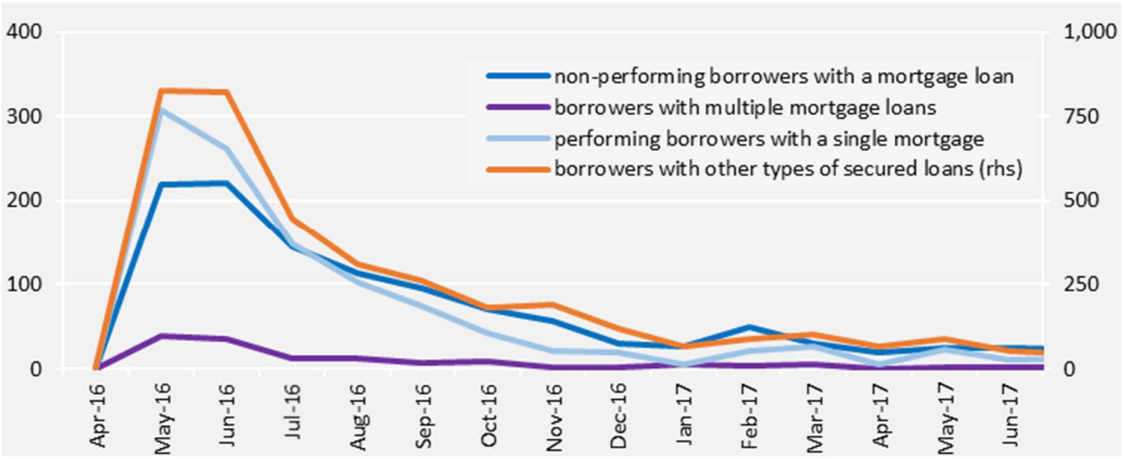
Notes: The figure plots the evolution of yearly probability of default conditional on the type of mortgage loan. The probability of default is estimated on a one-year horizon, representing the share of borrowers who transitioned from being performing to having 90 days delays four quarters afterwards.

Figure B.3. Median LTV of new standard mortgage loans



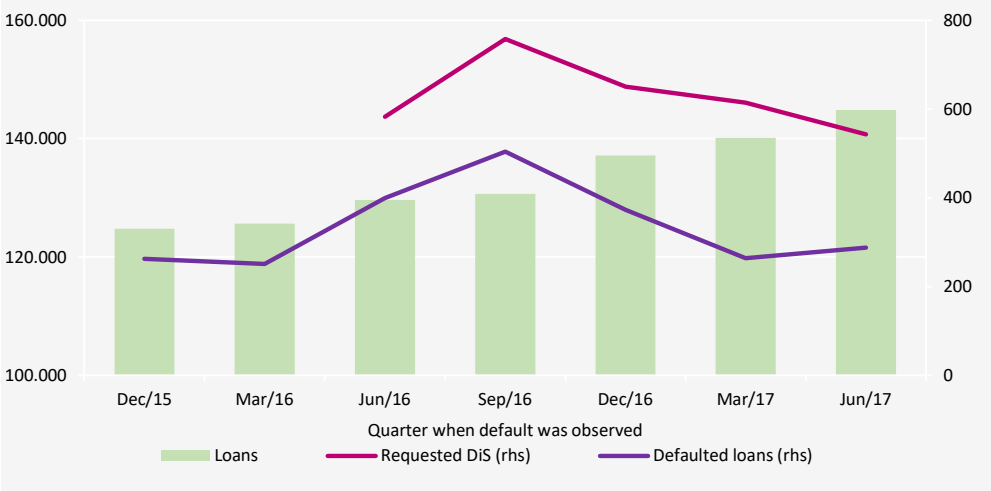
Notes: The figure plots the quarterly evolution of median LTV at origination for standard mortgage loans.

Figure B.4. *Datio in Solutum* requests by borrower type



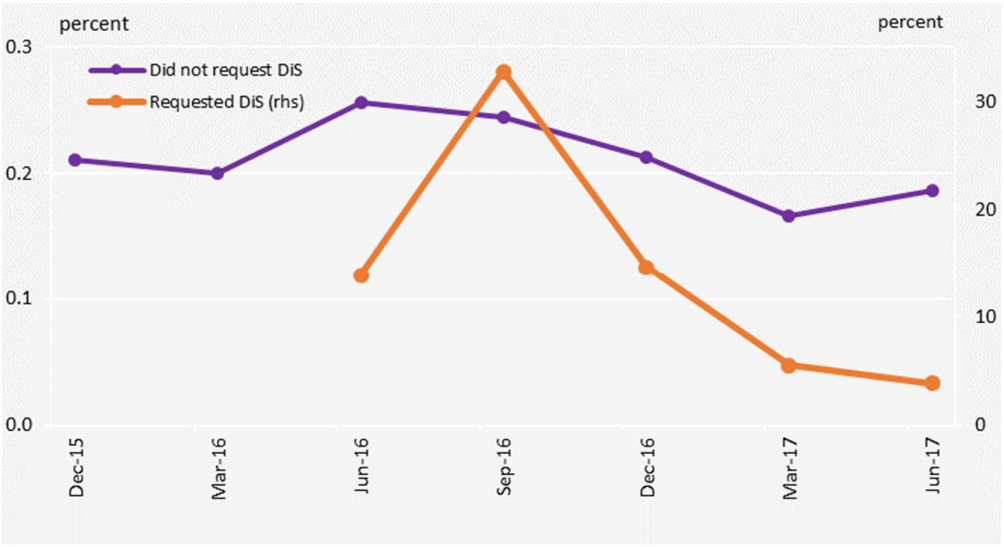
Notes: The figure plots the evolution of *Datio in Solutum* requests for different borrower categories. *Non-performing borrowers with a mortgage loan* captures the number of monthly requests from borrowers with loans that were 90 days past-due before the law was introduced. *Borrowers with multiple mortgage loans* captures the number of monthly requests from borrowers with multiple mortgage loans. *Performing borrowers with a single mortgage* captures the number of monthly requests from borrowers with one performing mortgage loan at the time of the request. *Borrowers with other types of secured loans* captures the monthly requests from borrowers with consumer loans secured by real estate assets.

Figure B.5. Performing loans, non-performing loans, and *Datio in Solutum* requests



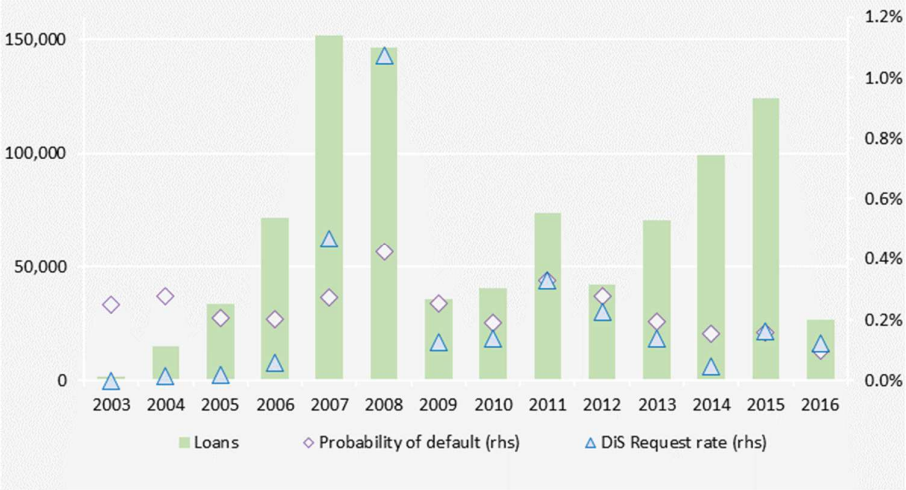
Notes: The figure plots the quarterly evolution of performing and non-performing loans and the number of *Datio in Solutum* requests. *Loans* captures the number of loans included in each vintage. *Requested DiS* captures the number of loans for which *Datio in Solutum* has been requested within 12 months after the vintage was created. *Defaulted loans* captures the number of loans that recorded delays greater than 90-days 4 quarters after the creation of the vintage.

Figure B.6. Probability of default by *Datio in Solutum* request



Notes: The figure plots the quarterly evolution of probability of default for loans with and without requests for *Datio in Solutum*. The probability of default is estimated on a one-year horizon and captures the share of loans that recorded delays greater than 90-days 4 quarters after the creation of the vintage.

Figure B.7. Number of loans, probability of default, and *Datio in Solutum* request rate by year of origination

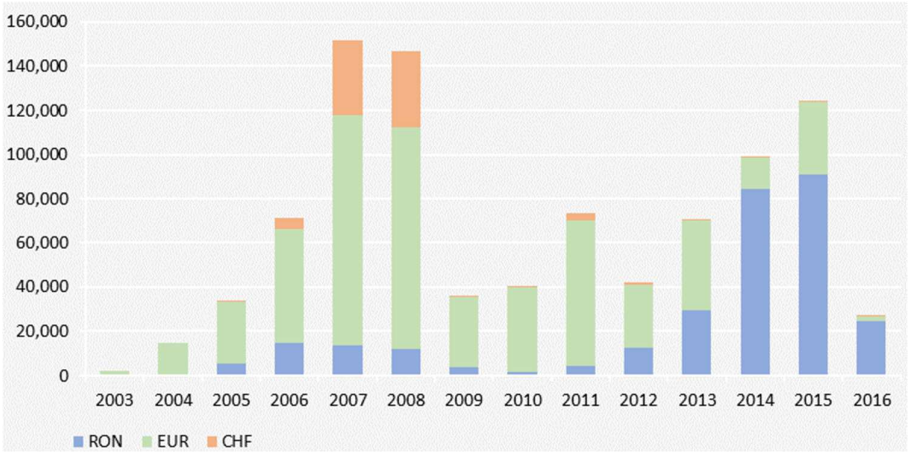


Notes: The figure plots the evolution of the number of loans, probability of default, and *Datio in Solutum* request rate conditional on the year of loan origination. *Loans* captures the number of loans per year. *Probability of default* captures the share of non-performing loans in the total number of loans issued in that year. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans issued in that year.

Figure B.8. Median amount at origination and median current LTV ratio by year of origination

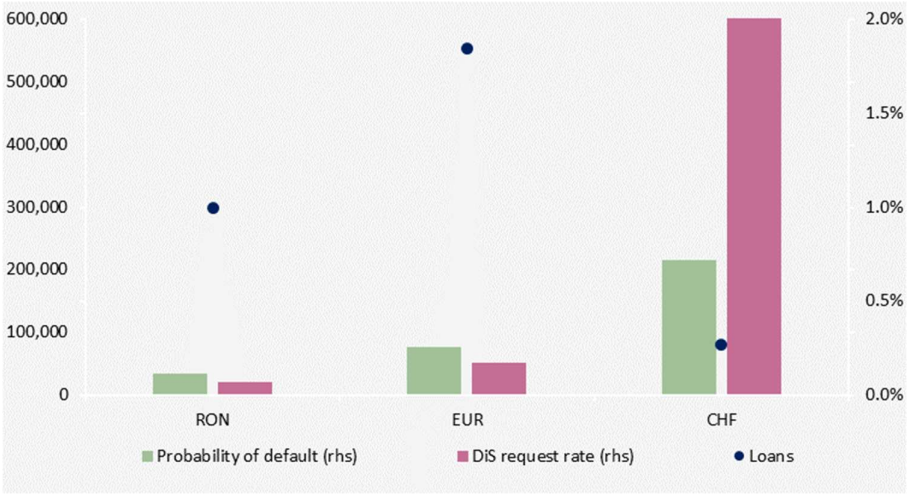
Notes: * Amount in euro. The figure plots the evolution of median amount at origination, median current LTV ratio, and the real estate price index conditional on the year of loan origination. *Median amount* captures the median amount at origination in euro (we use the euro average exchange rate of the respective month for loans issued in other currencies). *Median LTV* captures the median value for the ratio between the outstanding amount and the latest value of the collateral for loans issued in a given year. *RRE index* captures the real price index. The index is computed using information from the Romanian National Institute of Statistics (before 2010) and from Eurostat (from 2010 onwards).

Figure B.9. Number of loans by year of origination and currency



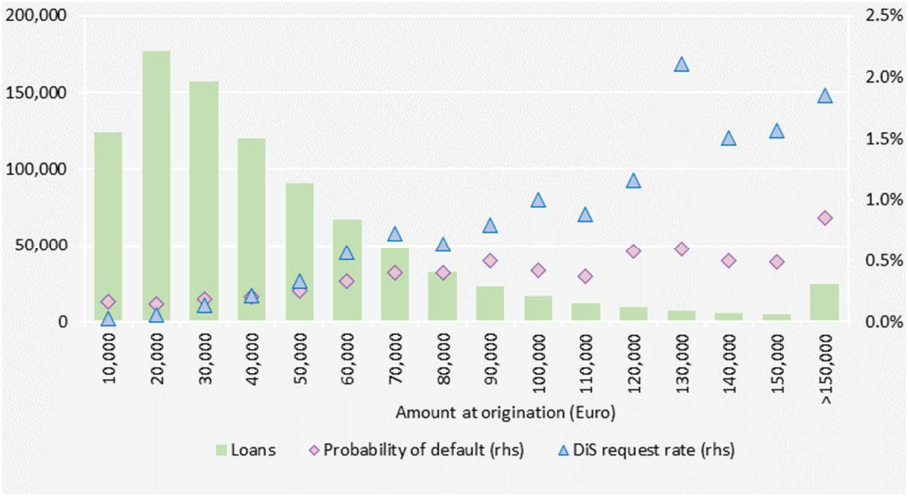
Notes: The figure plots the evolution of the number of loans per year conditional on loan currency.

Figure B.10. Number of loans, probability of default, and *Datio in Solutum* request rate by currency



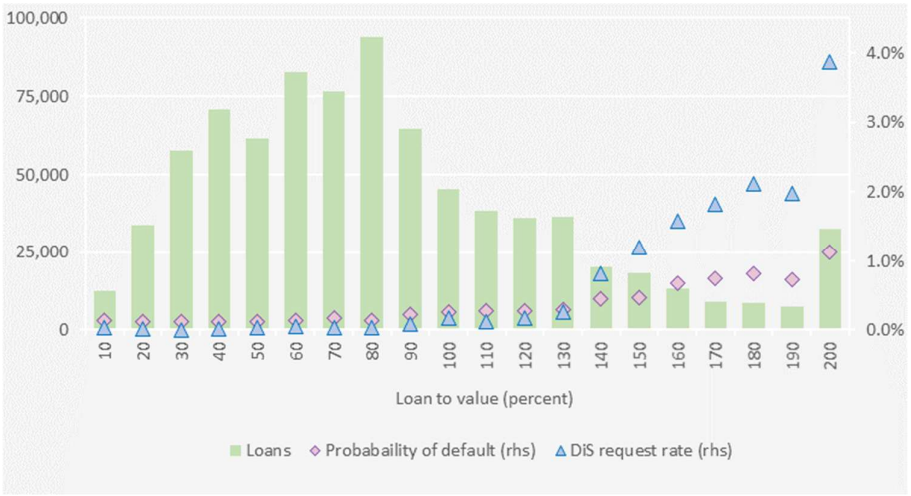
Notes: The figure plots the number of loans, probability of default, and *Datio in Solutum* request rate conditional on loan currency. *Loans* captures the total number of loans denominated in a specific currency. *Probability of default* captures the share of non-performing loans in the total number of loans denominated in a specific currency. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans denominated in a specific currency.

Figure B.11. Number of loans, probability of default, and *Datio in Solutum* request rate by amount at origination



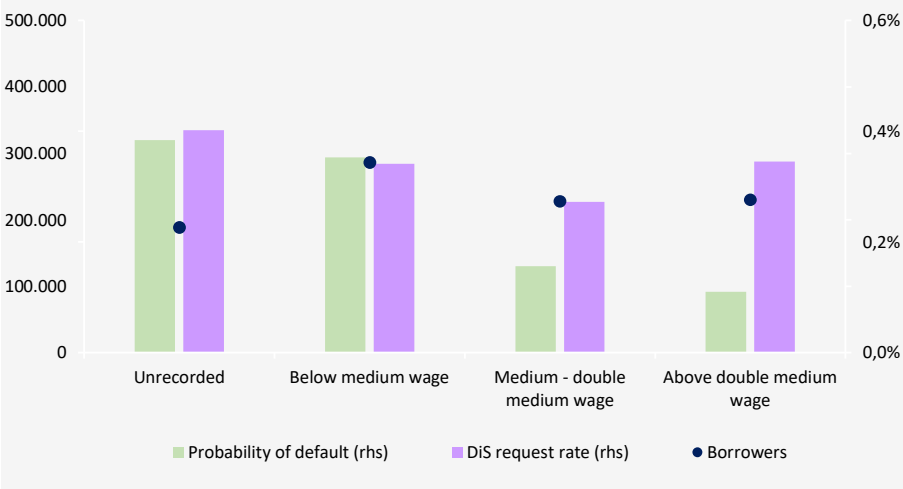
Notes: The figure plots the evolution of the number of loans, probability of default, and *Datio in Solutum* request rate conditional on loan amount at origination. *Loans* captures the total number of loans with size at origination in a specific interval. *Probability of default* captures the share of non-performing loans in the total number of loans with size at origination in a specific interval. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans with size at origination in a specific interval.

Figure B.12. Number of loans, probability of default, and *Datio in Solutum* request rate by LTV



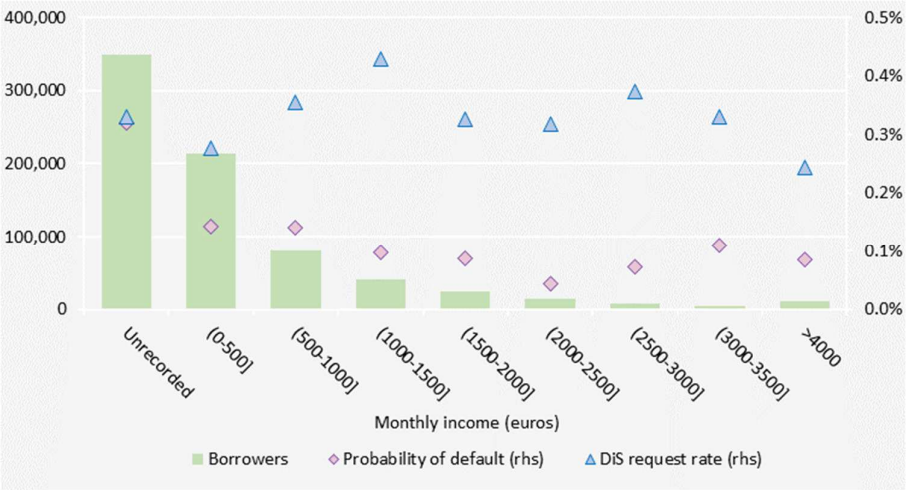
Notes: The figure plots the distribution of the number of loans, probability of default, and *Datio in Solutum* request rate conditional on the level of the current LTV. *Loans* captures the total number of loans with the current LTV in a specific LTV bracket. *Probability of default* captures the share of non-performing loans in the total number of loans with current LTV in a specific LTV bracket. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans with current LTV in a specific LTV bracket.

Figure B.13. Number of borrowers, probability of default, and *Datio in Solutum* request rate by income category



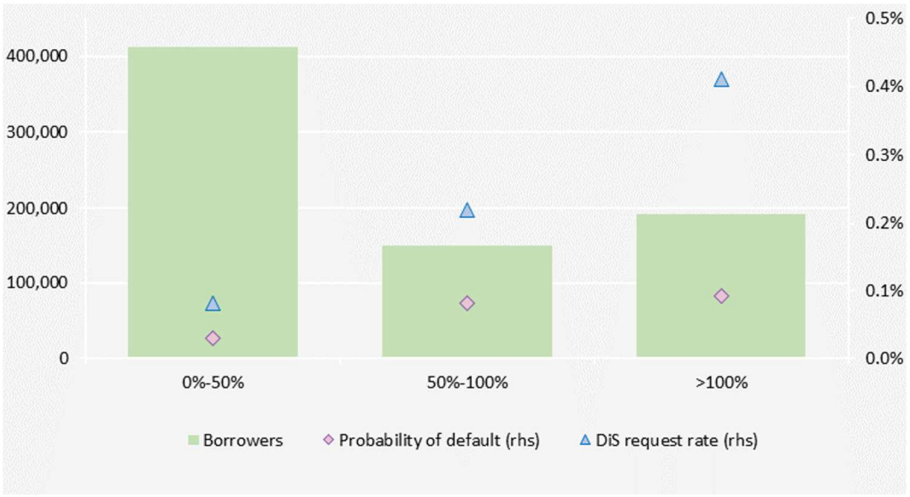
Notes: The figure plots the number of borrowers, probability of default, and *Datio in Solutum* request rate conditional on income group. *Borrowers* captures the total number of borrowers within a specific income group. *Probability of default* captures the share of non-performing loans in the total number of loans taken by borrowers from a specific income group. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans taken by borrowers from a specific income group.

Figure B.14. Number of borrowers, probability of default, and *Datio in Solutum* request rate by monthly income



Notes: The figure plots the borrowers' distribution, probability of default, and *Datio in Solutum* request rate conditional on monthly income (expressed in euro). *Borrowers* captures the total number of borrowers with a monthly income in a specific bracket. *Probability of default* captures the share of non-performing loans in the total number of loans taken by borrowers with a monthly income in a specific bracket. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans taken by borrowers with a monthly income in a specific bracket.

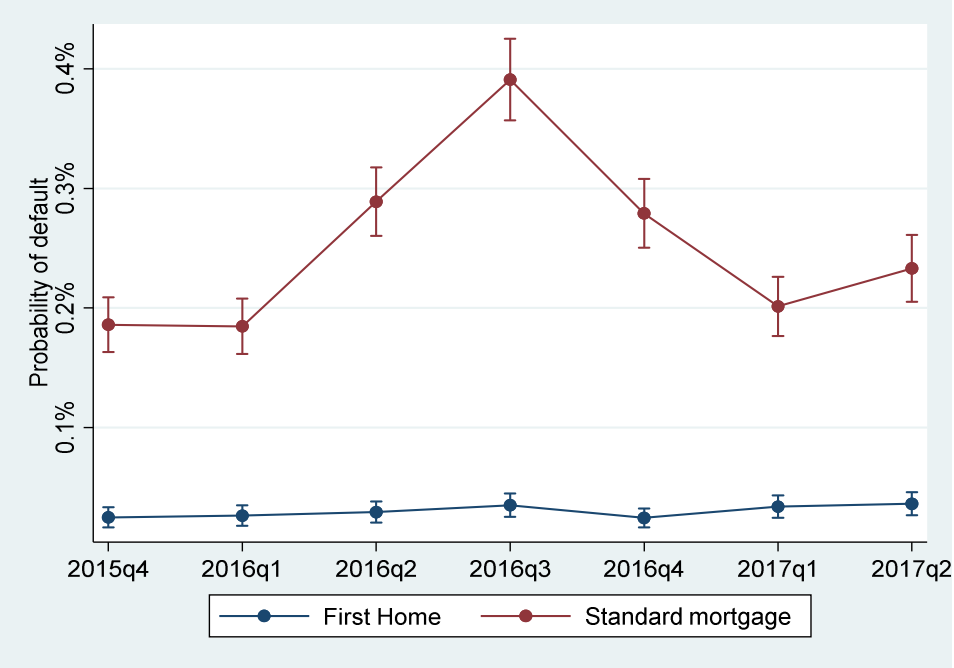
Figure B.15. Number of borrowers, probability of default, and *Datio in Solutum* request rate by DSTI level



Notes: The figure plots the borrowers' distribution, probability of default, and *Datio in Solutum* request rate conditional on the DSTI level. *Borrowers* captures the total number of borrowers with DSTI in a specific DSTI bracket. *Probability of default* captures the share of non-performing loans in the total number of loans taken by borrowers with DSTI in a specific DSTI bracket. *DiS request rate* captures the share of loans with *Datio in Solutum* request in the total number of loans taken by borrowers with DSTI in a specific DSTI bracket.

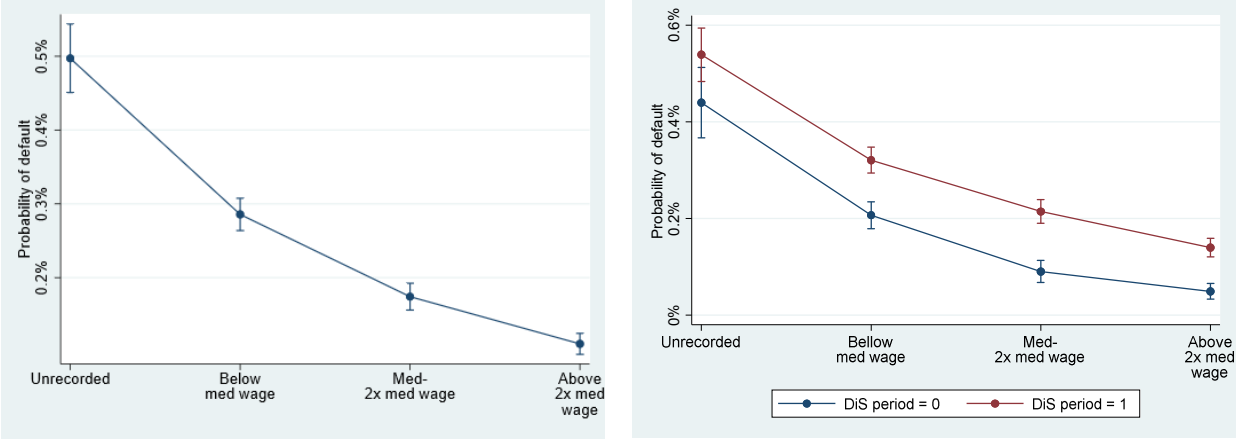
Appendix C. Marginal effects

Figure C.1 Average probability of default by quarter



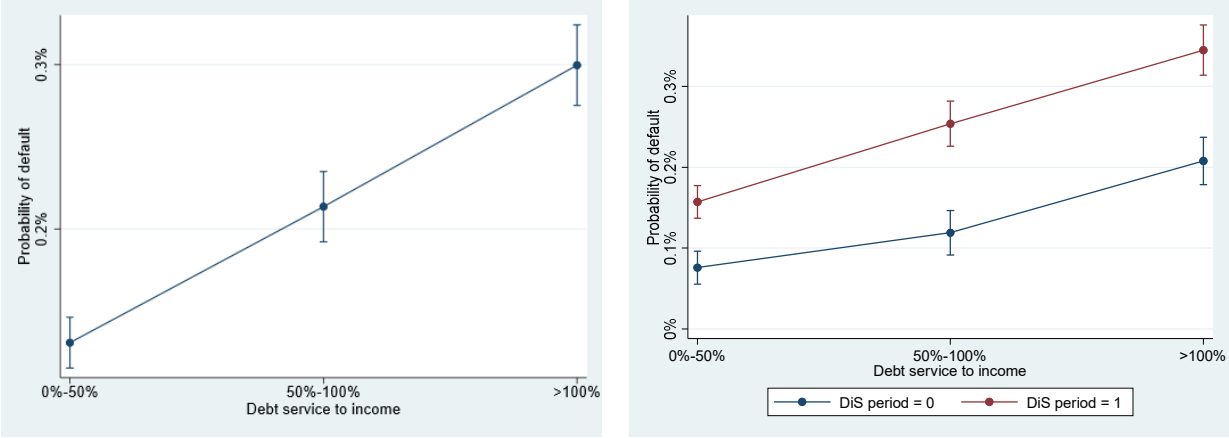
Notes: The figure plots the average probability of default by quarter and type of mortgage loan.

Figure C.2 Income marginal effect



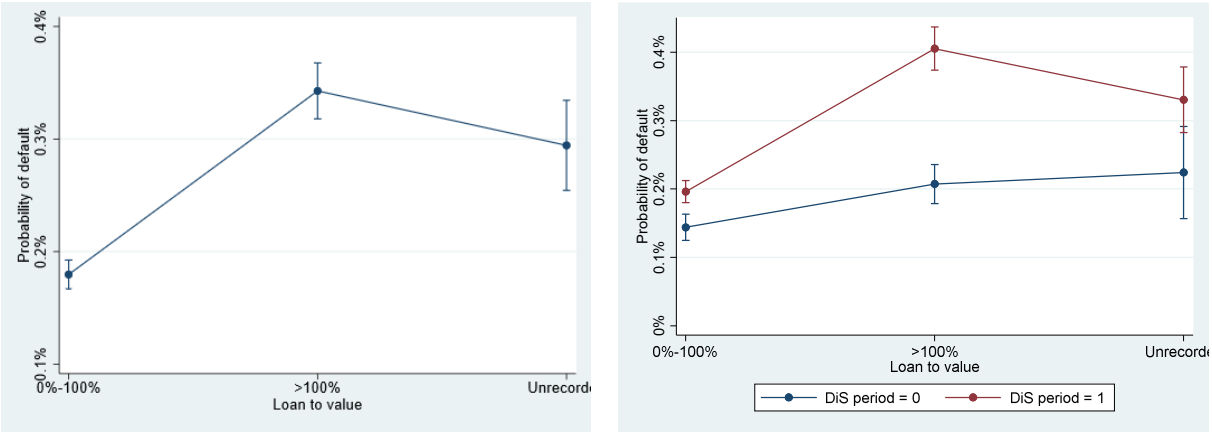
Notes: The left panel plots the marginal effect of income. The right panel plots the marginal effect of income conditional on *Datio in Solutum* period dummy.

Figure C.3 DSTI marginal effect



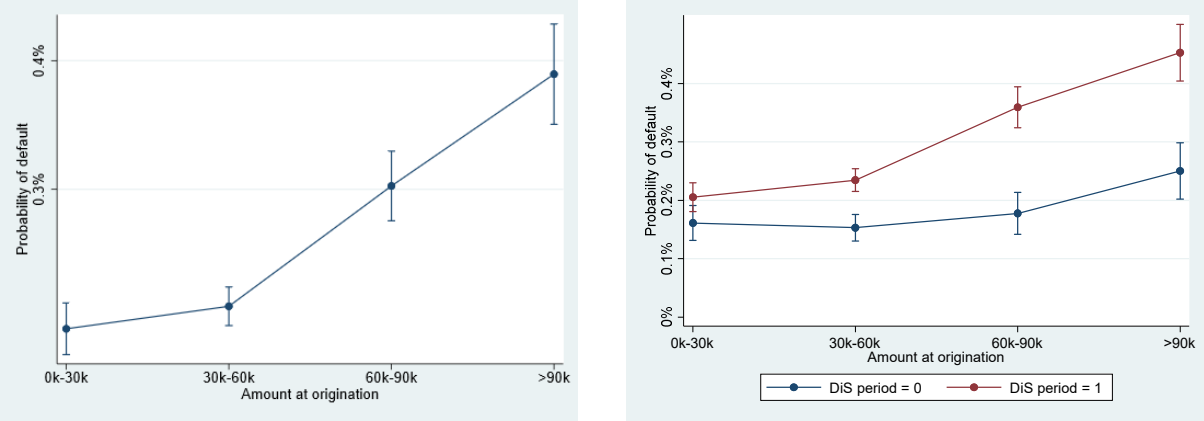
Notes: The left panel plots the marginal effect of DSTI. The right panel plots the marginal effect of DSTI conditional on *Datio in Solutum* period dummy.

Figure C.4 Current LTV ratio marginal effect



Notes: The left panel plots the marginal effect of current LTV ratio. The right panel plots the marginal effect of current LTV ratio conditional on *Datio in Solutum* period dummy.

Figure C.5. Amount at origination marginal effect



Notes: The left panel plots the marginal effect of amount at origination. The right panel plots the marginal effect of amount at origination conditional on *Datio in Solutum* period dummy.