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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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

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Abstract

We study the impact of changes in recourse legislation on mortgage defaults. Romania provides us with an ideal experimental setting to identify this impact. Using a large dataset of mortgage loans granted between 2003 and 2016, we exploit an exogenous variation in Romanian recourse policy and analyze the behavior of borrowers with mortgages issued under a recourse regime after a change in policy limited lender recourse. We find robust evidence that eliminating penalties for default raises the delinquency probability of existing borrowers, particularly those traditionally considered least likely to default. Our findings highlight the ex-post effects of a switch from a creditor-friendly to a debtor-friendly recourse policy. Broadly, our results point to the importance of assessing borrowers' default incentives before introducing recourse legislation with retroactive applicability.

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 the affected households and, more generally, for financial stability.[1] Mortgage defaults affect the solvency of lending institutions, impeding their capacity to extend credit. In the aftermath of the Global Financial Crisis, housing markets, and particularly mortgage debt, have been identified as the main drivers of the spillover effects to the real economy (Mian and Sufi, 2014a). Many borrowers defaulted on their mortgage obligations on both sides of the Atlantic. However, the default rates in Europe were markedly lower than in the U.S. One of the key reasons for this observed pattern has been the contrast between the European and U.S. recourse laws. In all European countries, mortgages are recourse loans. When the market value of a borrower's house upon foreclosure does not cover the mortgage debt, the lender can claim the borrower's personal (unsecured) assets, as well as their future income. In contrast, many U.S. states are non-recourse.[2] Lenders are limited in their claims to the secured asset only. Thus, borrowers are not further liable for any losses incurred by the lenders when the foreclosure sales proceedings do not cover their debts. Arguably, the borrowers' limited liability in non-recourse jurisdictions may contribute to a higher likelihood of mortgage default. This paper presents new evidence on how the provisions of recourse legislation influence default on mortgages.

Understanding the relationship between recourse procedures, as a form of credit forbearance, and borrower default is important for policymakers and financial institutions alike. The widespread policy of credit forbearance during the pandemic crisis of 2020 and the associated difficulties in estimating potential credit losses highlight this relationship's current relevance. Uncertainty about borrowers' attitudes towards repayment - caused by a moratorium on their payment obligations - could incentivize lenders to tighten credit conditions when credit defaults rise, amplifying spillover effects to the real economy. The existing literature provides valuable insights on the impact of recourse procedures on borrowers' attitudes towards default. Yet, most studies take a static approach: they examine various aspects of the default process by contrasting recourse vs. non-recourse states or countries. Relatively little is known about the dynamic effects of changes in recourse legislation in a given jurisdiction and the extent to which

[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.

these changes are associated with the variation of mortgage default rates. The reason is that estimates of the moral hazard effects are difficult to obtain since natural experiments such as time variation in recourse procedures for individual jurisdictions are rare.[3]

Our paper addresses this gap and provides empirical evidence on the incidence of mortgage arrears in a dynamic setting.[4] We study the case of Romania, where we can exploit the event of a change in the housing market laws, an event that is uniquely suited to study the incentives for mortgage default in a dynamic setting as the new law modified the status of *existing* mortgages from recourse to non-recourse loans. The introduction of the *Datio in Solutum* law (Giving in Payment law) and its retroactive applicability provisions allowed all borrowers to fully settle their liabilities by simply transferring the mortgage ownership to the lender (i.e., "walk away") without any deficiency judgments. Broadly, the introduction of non-recourse legislation has two potential implications. The first is an ex-ante effect. Banks become risk-averse as their likelihood of losing money increases. The non-recourse regime can be seen as beneficial, as the risk is borne by economic agents that are better equipped to manage it. The second considers the ex-post effect of legislation: non-recourse increases moral hazard by reducing borrowers' skin in the game (i.e., the potential loss in case of default). Our unique dataset allows us to focus on the latter effect. We use a large dataset of mortgage loans provided by the National Bank of Romania's credit registry for our analysis. Our dataset consists of over 200 thousand unique mortgages originated between 2003 and 2016.[5] In addition, we complement the information from the credit registry with individual data from the Ministry of Public Finance. This permits us to derive affordability indicators reflecting borrowers' indebtedness.

We start by identifying borrowers requesting to discharge their mortgage obligations under the *Datio in Solutum* law. Then, we analyze how borrowers' requests affect their mortgage repayment behavior. We consider a mortgage as delinquent when it is over 90 days past due. Furthermore, we relax the assumption that mortgage probability of default responds uniformly to the introduction of *Datio in Solutum* law and assess the potential asymmetric effects of several borrower and loan characteristics under the new recourse regime.

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[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.

[5] The loan-level data from the credit registry contains information about loan size at origination, the currency of denomination, current loan delay, 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.

Our main results can be summarized as follows. First, we complement the existing literature and show that low income, high indebtedness, large loan amounts at origination, foreign-currency denomination, high-interest rates, and negative equity have strong positive associations with default. Second, we find robust evidence that switching from recourse to non-recourse leads to an increase in mortgage default probability, with borrowers requesting *Datio in Solutum* being five times more likely to become delinquent in the subsequent quarter. Third, our results suggest that the relationship between borrower and loan characteristics, on the one hand, and mortgage default, on the other hand, is non-monotonic. We observe the strongest effects on non-repayment for less-financially constrained borrowers requesting *Datio in Solutum* and those with negative equity. These findings are consistent with the idea of strategic default. Borrowers that are less leveraged (either because of higher income or lower debt) are expected to default less. At the same time, in a non-recourse environment, borrowers with negative equity stand to gain more from the difference between the outstanding mortgage debt and the current value of the collateral.

Our paper adds to two main strands in the literature. First, it contributes to the growing literature on the determinants of mortgage default and especially to the literature studying the impact of recourse procedures on borrowers' probability of default. The empirical evidence on mortgage default points to a strong relationship between mortgage delinquencies and two important housing variables: home equity and recourse procedures.[6] Several papers indicate that borrowers with low or negative home equity (i.e., the outstanding mortgage exceeds the market value of the house) are more likely to default (Guiso et al., 2013; Demiroglu et al., 2014; Foote and Willen, 2018). However, few papers argue that negative equity is a necessary but not a sufficient condition for default (Foote et al., 2008). Financially-constrained borrowers with negative equity default sooner than unconstrained borrowers as they value the immediate budget relief from default more highly relative to the longer-term costs (Campbell and Cocco, 2015). These papers show that besides negative equity, adverse macroeconomic (e.g., unemployment) or personal (e.g., reduction of income, job loss, illness, divorce) shocks that worsen borrowers' liquidity constraints may explain borrowers' default behavior.[7] We add to this literature by not only showing that negative equity is positively associated with default, but

[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 dual-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).

also by providing evidence that the switch from recourse to non-recourse legislation leads to a ten-fold increase in the probability of default for underwater borrowers.

In addition to negative equity, another critical determinant of the mortgage default is the recourse legislation.[8] When considering specific recourse legislation, policymakers face the following trade-off: On the one hand, in a creditor-friendly recourse regime, borrowers bear all the default risk. When macroeconomic uncertainty arises, fearing financial distress, people start saving more because default is not an option. This may affect the aggregate demand and, subsequently, the business cycle. On the other hand, in a borrower-friendly recourse regime, lenders bear all the risk. Borrowers' limited liability may incentivize risk-taking in the housing market. The effects are twofold. First, the increase in moral hazard amplifies the housing price cycle. Second, lenders adjust their lending behavior to insure themselves against future delinquencies. They will impose higher costs (e.g., higher interest rates or larger down payments) on all borrowers to compensate for the potential losses. Higher financing costs may, in turn, limit housing consumption and affect the real economy. Although the recourse is perceived as an efficient tool for deterring (strategic) defaults (Ambrose et al., 1997), empirical and theoretical findings are inconclusive. Several papers find 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). A few papers show that the effect of recourse on default rates is non-monotonic (Hatchondo et al., 2015) and may, in fact, incentivize risk taking in the housing market (Gete and Zecchetto, 2018). Stricter recourse policies may create conditions for lax lending standards that raise the loan-to-value ratios and, therefore, may increase borrowers' indebtedness and probability of default. Additionally, a creditor-friendly recourse lowers the financing costs for borrowers with a high-risk profile and may cause more profound and persistent recessions. Our paper contributes to this literature and provides novel evidence on the impact of changes in recourse legislation on mortgage default. We differ from the existing papers by focusing on the dynamic effects of recourse policy. We are first to show the ex-post impact of a change from a creditor-friendly to a debtor-friendly recourse policy in the context of retroactive applicability of the new legislation.

Second, our paper relates to the literature on the impact of debt relief programs. The event studied in this paper shares some similarities with the US refinancing programs (e.g., the Home Affordable Refinancing Program – HARP, and the Home Affordable Modification

[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, 2020), housing consumption (Hatchondo et al., 2015), lending activity (Meador, 1982; Pence, 2006; Li and Oswald, 2017), and economic recovery (Gete and Zecchetto, 2018).

Program – HAMP) introduced in the aftermath of the Global Financial Crisis as a response to the widespread financial distress triggered by the housing market downturn.[9] However, there is an important distinction between the provisions of the Romanian recourse law and those of the U.S. programs. The main difference relates to the party that may request the modification of the loan agreement. While under the Romanian *Datio in Solutum* recourse law, the decision to terminate the loan contract and discharge mortgage obligations by transferring the property was in the borrowers' hands, the U.S. programs were implemented voluntarily by the financial intermediaries.[10] In the U.S., to qualify for the refinancing programs, a borrower had to satisfy beforehand several relevant eligibility criteria as a proof of financial hardship, including a specific loan-to-value ratio (for HARP) or a specific debt-to-income ratio (for HAMP). In contrast, in Romania, all existing and new borrowers with mortgages below 250,000 euro were eligible under the new recourse law, except for the borrowers that benefited from governmental guarantees under specific lending programs. As no specific prerequisites were specified regarding borrowers' indebtedness or payment delays, *Datio in Solutum* encouraged moral hazard as borrowers who could pay their debt were presented with an alternative option – to walk away from their mortgage obligations. Earlier studies focusing on loan modifications and refinancing programs report mixed results. Some papers find that these policies reduce mortgage default and prevent excessive foreclosures (Agarwal et al., 2017b; Gabriel et al., 2021). Conversely, there is evidence that a foreclosure moratorium does not limit the default rates among borrowers who benefit from loan modification (Collins and Urban, 2018), or that mortgage modification programs are associated with a substantial strategic response among homeowners (Mayer et al., 2014). The closest papers to ours are Artavanis and Spyridopoulos (2021) and O'Malley (2021). Artavanis and Spyridopoulos (2021) exploit the simultaneous introduction of a foreclosure moratorium and a new personal bankruptcy law in Greece and find that one-third of defaulters are strategic after the introduction of these programs. Similarly, O'Malley (2021) studies the introduction of a repossession law in Ireland that prohibited collateral enforcement on delinquent residential mortgages originated before a particular date and reports a significant increase in default rates for borrowers that could benefit from the legal ruling. Our paper differs from these papers in that our natural experiment setup allows us to study the behavior of borrowers with mortgages granted under a recourse regime at a later point when the recourse legislation (which is supposed to have *permanent* applicability from the

[9] 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), California Foreclosure Prevention Laws (2008).

[10] For details on the application of U.S. programs, see Agarwal et al. (2017a, 2017b), Foote and Willen (2018), and Piskorski and Seru (2018).

moment of enactment) changed. In these other papers, the focus is on a *temporary* suspension of collateral enforcement.

The rest of the paper proceeds as follows. Section 2 describes the institutional environment and provides an overview of Romanian recourse law. Section 3 presents a stylized theoretical framework that shows how the variation of recourse intensity may affect a borrower's repayment decision. Section 4 describes the construction of our dataset and presents stylized facts. Section 5 outlines the methodology. Section 6 presents the results and Section 7 concludes.

2. Legal framework

Datio in Solutum law no. 77/2016 was published in the Official Gazette of Romania no. 330 on 28 April 2016. The law introduced the 'giving in payment' as a form of satisfying outstanding credit obligations. It gave mortgage borrowers the possibility to fully settle their liabilities with a credit institution by simply transferring the mortgage ownership without any deficiency judgments instead of repaying their debt. Put differently, the law introduced a form of mortgage debt relief (i.e., walk away), publicly announced as a social program for distressed borrowers.[11] All retail mortgage loans were eligible, except for loans over 250,000 euro and those granted under the *First Home* program.[12, 13]

Datio in Solutum law has created a series of challenges for the Romanian banking sector. Economists, politicians, and the general public alike hotly debated the law's provisions. On the one hand, the law's promoters argued that many financially constrained borrowers would benefit from requesting *Datio in Solutum*, with expectations running as high as 80,000 potential requests. However, the opposite was the case. Initially, the mortgage NPLs rate increased rapidly by 1.6 percentage points between May 2016 and June 2016 (Figure B.1), with the increase being mainly driven by the delinquency of mortgages denominated in foreign currencies (Figure B.2). However, despite this short-term reaction, less than a tenth of the forecasted requests materialized in real actions over 2016-2018. Second, the proponents thought

[11] Under the Romanian Fiscal Code (i.e., the law no. 227/2015) amended by the government's emergency ordinance no. 32/2016, individuals giving in payment immovable property under the *Datio in Solutum* law are not subject to taxes when transferring property rights.
[12] 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.
[13] The *First Home* program represents a governmental initiative introduced in 2009 that facilitates individuals' access to the purchase or construction of a dwelling by contracting state-guaranteed loans. The guarantees cover 50 percent for new dwellings and 40 percent for dwellings older than 5 years. The program brings several benefits for borrowers, such as preferential interest rates and LTV ratios, lower down payments, and longer mortgage maturities.

that the law might enable a more efficient risk-sharing between lenders and borrowers, which may prevent future credit crises and enhance financial stability (Macovei, 2019).[14]

On the other hand, the law faced criticism on several grounds. The critics highlighted that one of the law's main shortcomings was its retroactive applicability to all existing loans. They pointed out that enacting the law with a backward-looking provision may have unintended consequences for new borrowers concerning the increased cost of credit, reduced approval rates, and lower size for loans, thus reducing borrowers' access to finance.[15] As expected, banks tightened their credit standards as soon as the law was enacted by increasing the required down payments for mortgage loans to discourage new borrowers from walking away from their mortgage obligations. The median LTV for new mortgage loans decreased from 80 percent in March 2016 to 74 percent in September 2016 (Figure B.3).[16] Second, critics argued that the law might create moral hazard and give existing borrowers incentives for strategic behavior. Considering this (potential) undesired impact that the law might have on borrowers' attitude towards repayment, the National Bank of Romania strongly advocated that the law should be based on clear principles that would distinguish between borrowers facing genuine affordability problems and opportunistic borrowers. As a result of the introduction of *Datio in Solutum* law, one of the most important systemic risks identified by NBR for 2016 was the uncertain and unpredictable legislative framework in the financial and banking sectors (NBR, 2016).

Few months after the law had been enacted, lending institutions claimed that *Datio in Solutum* law was not in accordance with the Romanian Constitution and Civil Code and presented their unconstitutional objections to the Romanian Constitutional Court. The main arguments brought forward were the law's non-compliance with the principle of separation of power, the right to ownership, the non-retroactivity principle, the right to legal certainty, and freedom of commerce (Bulgaru and Lepădatu, 2016).

In October 2016, the Romanian Constitutional Court announced its decision on the credit institutions' objections of unconstitutionality related to the *Datio in Solutum* law. The Constitutional Court's decision no. 623/2016 was published in the Romanian's Official Gazette

[14] 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).

[15] Increased protection for borrowers in default in the form of no deficiency judgments generates losses for lenders that are, in turn, indirectly transferred to new borrowers. Lenders reduce approval rates or restrict lending volumes (Lin and Oswald, 2017) and increase credit costs in the long run (Agarwal et al., 2017b).

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

in January 2017 and stipulated that borrowers had the right to discharge their debt and give in payment their real estate property only if certain unforeseeability conditions, as certified by the Court of Law, were met. The Constitutional Court has also stated that the credit agreement's real object is the amount of money that borrowers have to pay back and not the real estate assets. An immediate and important consequence of this ruling was that borrowers could not use the price devaluation of the real estate acquired through a credit agreement as a reason to discharge their debt by using *Datio in Solutum* law. This decision contributed to decreasing the mortgage NPLs rate by 1.1 percentage points between January 2017 and February 2017 (Figure B.1). The Constitutional Court's ruling brought some clarity about the legislative framework around the law, reducing the uncertainty for the banking sector.

Within two years after the law had been enacted, there were 7,918 notifications to give in payment, out of which 79 percent of requests were submitted in 2016, 18 percent in 2017, and the remaining 3 percent in 2018. The lending institutions contested 70 percent of all the requests and approved only 14 percent, while the remaining requests' status was still pending as of April 2018. Most of the requests for *Datio in Solutum* were for loans denominated in euro and Swiss francs (i.e., 50 and 40 percent, respectively). Most of the requests for euro-denominated loans were approved (i.e., 72 percent), while only 20 percent of Swiss francs loan requests and 7 percent of the requests for loans in the domestic currency leu were accepted.[17] The number and rate (i.e., the number of requests divided by total eligible customers) of requests for giving in payment has significantly decreased over the years.

3. Theoretical framework

We present a stylized theoretical framework to study how the variation of recourse intensity may affect a borrower's default decision. The interaction between recourse policy and borrower incentives might depend on the borrower's wealth, the value of the property and outstanding mortgage balance, and the cost of bankruptcy.[18] To understand this interaction, we develop a simple one-period model that helps us derive empirical predictions.

Set-up

Consider a zero-interest, risk-neutral environment. In this economy, there is a borrower with a personal wealth W (for simplicity, we consider that the income is a component of this wealth,

[17] Data sources: National Bank of Romania, Central Credit Registry.

[18] For simplicity, we abstract in our model from house price expectations (Foote et al., 2008) and idiosyncratic adverse shocks (such as job loss or health shock) specific to double-trigger models of default.

in addition to other assets). The borrower has a house that is currently worth H in market prices. The house was financed with a mortgage, and the borrower has a remaining balance M on this mortgage. Since the strategic default on the mortgage is not optimal when $H>M$ (because in this case, the borrower can sell the house and repay the mortgage), we assume that the borrower is underwater (or put differently, the borrower has negative equity because of a house price decline):

$$H < M. \tag{1}$$

We also assume that

$$W > M-H, \tag{2}$$

so that the borrower has enough (liquid) wealth to repay the outstanding debt in case of default.

There are non-zero costs for foreclosure (reflecting inefficiencies of the bankruptcy procedures), given by a parameter θ_C, with $0\leq \theta_C \leq 1$: how much the lender can recover on the collateral. Basically, we assume that only a fraction $\theta_C H$ can be obtained upon borrower's default by selling the property in the market.[19]

The laws governing the housing market are given by a parameter θ that captures recourse intensity. Put differently, θ is a measure of how much recourse the lender has in case of borrower's default when proceeds from taking and selling the property (i.e., the collateral) are not sufficient to cover the borrower's debt.[20] We distinguish between two cases: recourse and non-recourse. In the recourse case, $\theta=\theta_R \in (0,1]$. The lender can pursue the borrower up to an amount $\theta_R(M-\theta_C H)$, representing the difference between the remaining balance on the loan, M, and the recovery price of the collateral, $\theta_C H$. The recourse procedure allows the lender to recover the partial loss of the outstanding loan. In the non-recourse case, $\theta=0$. The lender cannot recover anything from the borrower's personal wealth.

[19] An alternative interpretation for parameter θ_C is the fire sales effect: although the property's market price is H, the lender can realize the sale on short notice only at a discount.

[20] We abstract from general equilibrium considerations. For example, we ignore the fact that θ might influence H, the house's market price. Intuitively, when the recourse is more creditor-friendly (i.e., θ is larger), lenders might take more risk and increase risky lending as the borrowers bear most of the default risk. Such behavior may, in turn, increase the pressure on house prices. Our partial equilibrium approach is more appropriate to derive empirical predictions since our dataset consists exclusively of existing loans (i.e., we exclude loans granted after law enactment). Thus, the relationship between θ and H is less of a concern.

Equilibrium default decision for the recourse case

The borrower decides whether to continue paying the mortgage or default on their credit obligations. The purpose of our model is to show how various factors can affect the default decision. When the borrower repays their mortgage, the payoff is:

$$\Pi^{R}_{pay}=W+(H-M), \tag{3}$$

where W is the borrower's wealth, and H-M is the loss due to the negative equity.

Now consider the borrower's payoff when they default on their payment obligations. Recall that when recourse is possible, the lender (partially) recovers the loan by selling the collateral at market price. In addition, the lender has recourse to the borrower's assets other than the property securing the mortgage. When the borrower defaults, they incur an opportunity cost C, reflecting a loss of reputation (e.g., due to negative impact on borrower's credit score) that may limit access to future funding. We assume that this cost is decreasing in wealth: $C(W)=C_R(1+1/W)$, $C_R>0$.[21] The intuition for this functional form is as follows: for wealthier people, the loss of reputation is less critical than for the less affluent. Better-off people are less dependent on future borrowing because they can finance their consumption and investments from their wealth.[22] Then, the borrower's payoff from default is:

$$\Pi^{R}_{default}=W-\theta_R(M-\theta_C H)-C_R(1+1/W), \tag{4}$$

where $W-\theta_R(M-\theta_C H)$ is the borrower's remaining wealth net of repayment to their creditor,[23] and $C_R(1+1/W)$ is the opportunity cost of default.

The borrower has incentives to default instead of repaying their debt for $\Pi^{R}_{default} \geq \Pi^{R}_{pay}$, corresponding to (use (3) and (4)):

$$H \leq H_R^{*} = \frac{1-\theta_R}{1-\theta_R\theta_C} M - \frac{C_R}{1-\theta_R\theta_C}(1+\frac{1}{W}). \tag{5}$$

The expression (5) suggests that the default strategy can only dominate the repay strategy when the market house price H is sufficiently low. The intuition is that the benefit to the borrower of choosing to default strategically is proportional to negative equity (which

[21] In the absence of reputational considerations, our results would be stronger. Borrowers would have higher moral hazard incentives when information about their past actions is not shared among lenders. The lack of reputational costs corresponds to $C_R=0$. In Section 6 we empirically test whether wealthy people behave differently.

[22] Note non-pecuniary costs (see Guiso et al.,2013, among others) are ignored in this model.

[23] Upon default, the lender takes the collateral and sells it at a discounted market price $\theta_C H$. The realized negative equity $\theta_C H$-M is then claimed from the borrower's wealth W, and its recovery depends on the intensity of recourse procedure θ_R.

increases when the house prices are low, other things equal). The cost of defaulting is invariant to the scale of negative equity.

We can demonstrate that the borrowers' decision towards repayment is as follows:

- For θ_R=1 (i.e., full recourse on borrower's wealth), the borrower repays their mortgage regardless of the recovery rate (i.e., for any 0≤ θ_C ≤1) and the market value of the house, H.
- For 0<θ_R<1 (i.e., partial recourse on borrower's wealth), the borrower defaults strategically regardless of the recovery rate (i.e., for any 0≤ θ_C ≤1), but only when the market value of the house is low enough (i.e., $H \leq H_R^*$, with H_R^* given in (5)). For $H > H_R^*$, the borrower repays the mortgage.

This leads to an important empirical prediction about the recourse procedure's implication: the absence of full recourse creates incentives for strategic default when house prices are low.

Next, we show how the borrower's strategy (i.e., the decision on whether to default strategically or not) depends on the recourse intensity, on their wealth, on the residual mortgage balance, on the cost of default, and the recovery rate.

First, strategic default is less attractive under stricter recourse legislation.[24] The intuition for this result is that borrowers are less likely to default when lenders can collect a larger share of debt that is not covered by the foreclosures' proceedings, or when lenders are more likely to deny borrowers fully settlement of their liabilities by simply transferring the mortgage ownerships without any deficiency judgments. In other words, stronger creditor rights are associated with fewer incentives for strategic default. Second, the range of parameter values for which the borrower chooses to default strategically is strictly increasing in borrower's wealth W.[25] This result shows that, in our framework, wealthier borrowers have higher strategic incentives. The reason is that a higher wealth reduces the opportunity cost of default associated with the loss of reputation (that may, in turn, impede access to future credit), making default more attractive. Third, a higher outstanding mortgage balance M has a positive relationship with the likelihood of default.[26] The reason for this association is that, ceteris paribus, a larger debt obligation increases the payoff from default. Fourth, a lower opportunity cost of default

[24] By taking derrivative $\frac{\partial H_R^*}{\partial \theta_R}$ we can show that $\frac{\partial H_R^*}{\partial \theta_R} = \frac{\theta_C - 1}{(1-\theta_R\theta_C)^2} - \frac{\theta_c C_R}{(1-\theta_R\theta_C)^2} \cdot (1 + \frac{1}{W}) < 0$.

[25] By taking derrivative $\frac{\partial H_R^*}{\partial W}$ we can show that $\frac{\partial H_R^*}{\partial W} = \frac{C_R}{1-\theta_R\theta_C} \cdot \frac{1}{W^2} > 0$.

[26] By taking derrivative $\frac{\partial H_R^*}{\partial M}$ we can show that $\frac{\partial H_R^*}{\partial M} = \frac{1-\theta_R}{1-\theta_R\theta_C} > 0$.

C_R expands the range of parameter values for which the borrower defaults.[27] Low cost of default may result from a weaker institutional environment (e.g., with less information sharing across creditors), which makes the penalty associated with default less severe. Finally, the recovery rate θ_C expands the range of parameter values for which a borrower chooses to default strategically.

Equilibrium default decision for the non-recourse case

Recall that our baseline model allows for a strictly positive parameter θ_R:$0<\theta_R\leq 1$. Consider now the effect of eliminating the possibility of recourse: $\theta_R=0$. When the borrower repays their mortgage, the payoff is similar to (3):

$$\Pi^{NR}{}_{pay}=W+(H-M), \tag{6}$$

where W is the borrower's wealth, and H-M is the loss due to the negative equity. Now consider the borrower's payoff when they default on their payment obligations. When recourse is not possible anymore, the lender cannot recover anything from the borrower's assets beyond the property securing the mortgage. We assume that the opportunity cost of default remains the same as in the baseline model: $C_R(1+1/W)$.[28] The borrower's payoff from default is (similar to (4)):

$$\Pi^{NR}{}_{default}=W-C_R(1+1/W), \tag{7}$$

where W is the borrower wealth (which remains unaffected by default), and $C_R(1+1/W)$ is the opportunity cost of default.

The borrower has incentives to default instead of repaying their debt for $\Pi^{NR}{}_{default} \geq \Pi^{NR}{}_{pay}$, corresponding to (use (6) and (7)):

$$H \leq H^*_{NR} = M - C_R(1+\tfrac{1}{W}). \tag{8}$$

Similar to (5), the expression (8) suggests that the default strategy can only dominate the repay strategy when the market house price H is sufficiently low. We can show that the threshold value H^*_{NR} (given in (8)) is larger than H^*_R (given in (5)).[29] Accordingly, the borrower

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[27] By taking derrivative $\frac{\partial H^*_R}{\partial C_R}$ we can show that $\frac{\partial H^*_R}{\partial C_R} = -\frac{1}{1-\theta_R\theta_C}\cdot(1+\frac{1}{W}) < 0$.

[28] In a non-recourse environment, the opportunity cost of default might be higher than in a recourse economy as lenders would restrict access to credit in anticipation of strategic defaults (e.g., they may require higher up-front payments or limit the size of loans). Choosing a higher cost C_R into the model would not qualitatively affect our results.

[29] We can rewrite the inequality $H^*_R \leq H^*_{NR}$ as $-\theta_R\theta_C C_R\left(1+\frac{1}{W}\right) \leq \theta_R(1-\theta_C)M$.

chooses to default for a wider range of parameter values. This is the main prediction of our model. It suggests that in the absence of a recourse procedure, borrowers are more likely to default strategically. The evolution of H_{NR}^* in response to changes in W, M, and C_R is similar to the evolution of H_R^*, confirming our theoretical predictions from the scenario with recourse. A borrower is more likely to default when their wealth W, or outstanding mortgage balance M, are higher, as well as when the opportunity cost of default C_R is lower.[30]

4. Data

To study the relationship between changes in the recourse procedure and mortgage defaults, we exploit the loan-level data from the Central 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 quarterly vintages from September 2014 to June 2017, thus providing an adequate time frame to study the potential effects triggered by the implementation of *Datio in Solutum* law. We classify a debtor as being in default when the borrower's loan becomes non-performing (i.e., when they encounter delays of more than 90 days in repaying credit obligations after the loan is included in a specific vintage). The loan-level data contains information about loan size at origination, the currency of denomination, current loan delay, residual maturity, current interest rate, as well as the name of the originating bank and the year of origination.[31] The registry also collects a selective number of borrowers' socio-economic characteristics (e.g., age, income, county of residence). This detailed information about borrower and loan characteristics allows for granular analysis of the impact that the recourse law has 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.

We apply several restrictions on this dataset to obtain the data used for our empirical investigation. First, we exclude the *First Home* loans from our dataset. These specific loans benefit from government guarantees, and they are not eligible for *Datio in Solutum.* Put differently, the law's implementation does not impact the payment discipline of borrowers with

[30] One can verify that $\frac{\partial H_{NR}^*}{\partial W} = C_R \cdot \frac{1}{W^2} > 0$, and $\frac{\partial H_{NR}^*}{\partial M} = 1 > 0$, and that $\frac{\partial H_{NR}^*}{\partial C_R} = -(1 + \frac{1}{W}) < 0$.

[31] The current delay represents the loan's payment status as reported by banks and is based on different time periods (e.g., 0-15 days, 16-30 days, 31-60 days, and 60-90 days). The residual maturity is the period in years from the moment of our analysis to the loan's contractual maturity. The interest rate is updated monthly, pointing to the current credit conditions. Approximately 90 percent of mortgage loans have a variable rate; therefore, the current interest rate is a better indicator of affordability problems than the interest rate at origination. Appendix A sets forth the definitions for the main variables used in the empirical analysis.

First Home loans. Second, we exclude borrowers with multiple mortgage loans at the moment of creating specific vintages as they do not represent a typical borrower that acquires a property for residential purposes. Rather, they are motivated by speculative or buy-to-let investment strategies (Kelly et al., 2015).[32] Third, we exclude the loans that "disappeared" from banks' balance sheets from September 2014 to June 2017, since we cannot determine their non-performance status. Finally, 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 *Datio in Solutum* on 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. Overall, our dataset contains 1.6 million mortgage-data points and covers 203 thousand unique borrowers representing approximately 50 percent of the standard mortgage loans on banks' balance sheets at the time of the analysis.

We complement the information from the Central Credit Registry with individual income data from the Ministry of Public 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).[33] We classify borrowers in four different income categories: those earning below the minimum wage, those earning between the minimum wage and the average wage, those earning between the average wage and double the average wage, and those earning above double the average wage.[34] Borrowers that are not in the Ministry of Public Finance's database are included in the category "unrecorded income" to distinguish them from borrowers with recorded information. Borrowers with unrecorded income represent 22 percent 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 individual debt-service-to-income (DSTI) ratio.

[32] Borrowers with multiple mortgages account for approximately 5 percent of total housing loans. The requests for *Datio in Solutum* from borrowers with multiple mortgages make up 6 percent of the total requests for mortgage loans. Excluding these borrowers from our dataset does not significantly impact the number of borrowers analysed or the main results.
[33] Approximately 25 percent of borrowers in our sample have consumer loans in addition to their mortgages.
[34] The Ministry of Public 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. This would explain the presence of borrowers with incomes below the minimum wage.

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.[35] 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). Likewise, we exclude the requests from borrowers with multiple mortgage loans (137 requests) as those requests did not comply with provisions of the law. After applying these filters, our dataset includes 1,116 unique requests representing 45 percent 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. In September 2016, we observed the highest volume *Datio in Solutum* requests. In Figure B.6, we illustrate the strong relationship between a *Datio in Solutum* request and the likelihood of a loan becoming non-performing. On average, over the period April 2016-June 2017, 13.7 percent of borrowers in our sample who requested *Datio in Solutum* defaulted within the next 3 months. This compares with an average delinquency rate of 0.33 percent among borrowers who did not request *Datio in Solutum*.

Descriptive statistics

We present the 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 current LTV; (v) by income group; (vi) by the level of DSTI and (vii) by current loan delay.

The evolution of credit volume 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 percent) and consumer (30 percent) loans and an LTV cap at the origination of 75 percent. Together with high-interest rates prevailing at that time, these restrictive measures harmed credit supply and real estate prices. Loans granted before 2007 represent only 13 percent of our sample. These loans are almost

[35] 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.

exclusively denominated in euro, a consequence of large interest rate differential between domestic currency leu- 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 2007-2008 represent around 30 percent 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 unconditional default rate, 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 loose 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 percent), with 23 percent 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.[36] The LTV cap was set at 85 percent for domestic-currency loans. For euro-denominated foreign-currency loans issued to unhedged borrowers, the cap was set at 75 percent 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 – leu – increased from 5 percent in 2011 to 32 percent in 2012 and further to 85 percent 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 favourable 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 sample were issued in euro (57 percent), followed by loans in domestic currency leu (35 percent), with loans in Swiss francs making up only 8 percent of the

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

sample. Borrowers with leu-denominated loans have the lowest default rate (0.2 percent), followed by borrowers with euro-denominated loans (0.4 percent). Borrowers with Swiss francs-denominated loans have the highest default rate (1.1 percent) and the largest percentage of *Datio in Solutum* requests (1.6 percent) (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 appreciation of the Swiss franc versus the local currency leu and led to an increase in the debt service for borrowers with credit exposures in Swiss francs.

Regarding the loan amount at origination, 50 percent of borrowers have loans under 30,000 euro, while 33 percent have loans between 30,000 euro and 60,000 euro. Only 7 percent of loans are above 100,000 euro. Nevertheless, we observe that borrowers with the largest amounts at origination have the highest percentage of *Datio in Solutum* requests and the highest default rate (Figure B.11).

From the distribution of the number of loans conditional on the current LTV ratio, we observe that the most loans have an LTV ratio below 80 percent. These loans have the lowest delinquency and *Datio in Solutum* request rates. Conversely, loans with an LTV rate above 140 percent 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 percent 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 are relatively evenly split across the following three categories: unrecorded income, between average and double average wage, and above double the average wage, with each category representing approximately 25 percent of borrowers. The category of borrowers with income below the minimum wage is the smallest (Figure B.13). On the one hand, we observe that, as expected, borrowers with low or no recorded income have the highest default rate, while those with the highest income have the lowest default rate. On the other hand, borrowers with income above double the average wage have the second highest rate of requesting *Datio in Solutum* after borrowers with unrecorded income. 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, most borrowers in our sample have a DSTI below 80 percent, and their loans are below 15 days past due (Figure B.15 and Figure B.16). Unsurprisingly, the default rate increases with indebtedness and with the current loan delay. Borrowers with DSTI greater than 100 percent have the highest delinquency rates and a larger percentage of *Datio in Solutum* requests than the other groups (Figure B.15). Likewise, loans with more than 60 days past due exhibit the highest delinquency and *Datio in Solutum* requests rates (Figure B.16).

Table 1 sets out sample characteristics for the main variables used in our empirical analysis. The borrower's median monthly income and DSTI ratio are 556 euro and 38 percent, respectively. Distributions are skewed towards borrowers with lower monthly incomes and DSTI ratios. The average loan is around 45,000 euro, has a residual maturity of approximately 18 years, and a current interest rate of 4.2 percent. The mean current LTV ratio is 81 percent, with the distribution skewed towards borrowers with lower LTV ratios. On average, properties financed with a mortgage increased in value by approximately 14,000 euro.

Table 1. Summary statistics for main variables of interest

	N	Mean	St. dev	Percentile 25	Median	Percentile 75
Monthly income [1)]	1,241,000	859.30	1,032.00	294.40	556.10	1,025.00
Current debt-service-to-income ratio [2)]	1,241,000	66.42	75.03	22.50	38.02	71.45
Loan size at origination [1)]	1,602,000	45,345.00	48,309.00	22,328.00	35,303.00	55,425.00
Current loan-to-value ratio [2)]	1,401,000	80.96	45.01	47.00	74.00	105.00
Residual maturity [3)]	1,602,000	18.39	7.59	12.75	19.33	23.83
Interest rate [2)]	1,602,000	4.20	0.79	3.66	4.10	4.73
Negative equity [1)]	1,400,000	13,752.00	42,584.00	-1,360.00	8,994.00	22,365.00

Notes: This table shows the summary statistics of the data used in the empirical analysis. See the appendix for the definitions of variables. [1)] amount in euro, [2)] percent, [3)] years.

Table 2 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 two times larger than for non-performing borrowers (861 euro vs. 435 euro). Surprisingly, the average monthly income for borrowers requesting *Datio in Solutum* is significantly larger than that of borrowers who did not request *Datio in Solutum* (1,021 euro vs. 859 euro), suggesting that not only the worse-off borrowers have tried to obtain debt relief. Performing borrowers are significantly less indebted (as indicated by the DSTI ratio) than non-performing borrowers (66 vs. 141). Likewise, borrowers that did not request *Datio in Solutum* are significantly less indebted than borrowers that requested *Datio in Solutum* (66 vs. 119). Non-performing borrowers took out, on average, larger loans than performing borrowers

(65,300 euro vs. 45,266 euro), have longer residual maturity (20 vs. 18 years), and higher current LTV ratios (111 vs. 81).

Table 2. Mean values for main variables by performance status and *Datio in Solutum* request

	Performing borrowers	Non-performing borrowers	Two-sided p-value	DiS not requested	DiS requested	Two-sided p-value
Monthly income [1)]	860.61	435.34	0.00	859.01	1,021.01	0.00
Current debt-service-to-income ratio [2)]	66.19	141.21	0.00	66.33	119.29	0.00
Loan size at origination [1)]	45,265.54	65,300.31	0.00	45,258.56	85,889.98	0.00
Current loan-to-value ratio [2)]	80.84	110.69	0.00	80.78	164.42	0.00
Residual maturity [3)]	18.38	19.55	0.00	18.38	22.47	0.00
Interest rate [2)]	4.20	4.35	0.00	4.20	4.08	0.00
Negative equity [1)]	13,813.97	-1,990.63	0.00	13,843.56	-27,994.05	0.00

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.

A similar pattern emerges when we compare the median 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* (85,890 euro vs. 45,259 euro), with longer residual maturity (22 vs. 18 years), and higher current LTV ratios (164 vs. 81). Non-performing borrowers are slightly underwater. On average, the value of their property is lower than the outstanding mortgage by almost 2,000 euro. The situation is much worse for borrowers requesting *Datio in Solutum*: their outstanding mortgage is, on average, 28,000 euro above the current value of their property.

5. Methodology

In this section, we present the methodology used to assess the impact of requesting *Datio in Solutum* on the borrower's probability of default and to test the empirical predictions from Section 3. Our paper builds upon probability default models from previous studies (see, e.g., Nier et al., 2019, among others). The probability of default is calculated using a pooled logit model where the dependent variable is a dummy-type variable y_{it} which equals 1 if the borrower has delays longer than 90 days. The regressors are 3-month lagged borrower and loan characteristics *(t-1)*. The baseline model is as follows:

$$y_{i,t} = \alpha + \beta DiS_{it,} + \gamma' Z_{i,t-1} + \mu' L_{it-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{it}\ , \tag{9}$$

where the indices *i* and *t* stand for borrower and time, respectively, *DiS* is a dummy which equals 1 if borrower *i* requested *Datio in Solutum* at time *t*, *Z* and *L* are vectors of borrower and loan characteristics, respectively, and ε_{it} is a scalar disturbance term which is assumed to be i.i.d.. We control for borrower characteristics such as current income, indebtedness (i.e., DSTI), and age. The vector of loan characteristics consists of loan size at origination, the currency of denomination, number of days the loan is past due, current LTV, residual maturity, and current interest rate.

The estimated probability of default for borrower *i* at vintage *t* is calculated as:

$$PD_{it} = \frac{e^{y_{i,t}}}{1+e^{y_{i,t}}}. \quad (10)$$

The main coefficient of interest is β as we seek to isolate the impact of requesting *Datio in Solutum* on the borrower's probability of default. We include bank and year of origination fixed effects to control for different risk policies across banks and macroeconomic conditions at origination, respectively. County fixed effects account for regional differences in the housing market. Finally, we pool the data across different vintages and include vintage fixed effects to control for changes in macroeconomic conditions and other aggregate shocks.

We extend the baseline model to validate our theoretical model's predictions by including interaction terms between the *Datio in Solutum* dummy with borrower and loan characteristics. In the first extension, borrower characteristics are interacted with the *Datio in Solutum* dummy to test whether they are significantly associated with an increase in the probability of default following the enactment of the law:

$$y_{i,t} = \alpha + \sum_{j=1}^{k} \beta^j \, Borrower\_dummy_{i,t-1}^{j} * DiS_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{i,t-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{i,t}\ , \quad (11)$$

where $Borrower\_dummy_{i,t-1}^{j}$ equals 1 if the variable of interest (e.g., income or DSTI) is in a specified category and 0 otherwise. If the β_j coefficients are statistically different, we interpret this as evidence of an asymmetric effect of the *Datio in Solutum* request for different borrower characteristics. While *Income* and *DSTI* variables are continuous in our dataset, we construct dummy variables to identify non-linear effects across different groups. For example, by interacting the dummy *Income group* with *Datio in Solutum* request, we can test for the presence of wealth effect following the assumption that higher-income borrowers have a lower opportunity cost of defaulting. For income, we consider five distinct groups. Likewise, for DSTI, we consider four groups that are constructed using 25 percent increments. This allows us to control whether the impact of requesting *Datio in Solutum* was stronger either for borrowers with financial difficulties (i.e., as proxied by a high DSTI) or incentivized strategic default (i.e., for borrowers with low DSTI who could, at least in theory, comfortably service their debt).

We use a similar specification to test the interactions between the *Datio in Solutum* dummy and several loan characteristics:

$$y_{i,t} = \alpha + \sum_{j=1}^{k} \beta^j \, Loan\_dummy_{i,t-1}^{j} * DiS_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{i,t-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{i,t}, \tag{12}$$

where $Loan\_dummy_{i,t-1}^{j}$ equals 1 if the variable of interest (e.g., loan size at origination, the currency of denomination, number of days the loan is past due, and current LTV) is in a specified category and 0 otherwise. For example, for the current LTV, we consider first the group of borrowers with LTV below 75 percent (i.e., the safest group of borrowers), followed by the group of borrowers with LTV between 75 and 100 percent (i.e., borrowers with an average-risk profile) and, finally, the group of borrowers with current LTV above 100 percent. The latter category encompasses borrowers for whom the outstanding loan exceeds their house value. This specification allows us to test whether having the legal possibility to default without recourse (following the enactment of *Datio in Solutum*) increases the probability of default for borrowers with negative equity (i.e., when current LTV>1).

6. Results

Main results

Table 3 presents the estimates obtained for the effects of *Datio in Solutum* request on the borrower's probability of default based on the baseline model (equation (9)). The first column of Table 3 depicts the results without *Datio in Solutum* variable. Our results show how borrower and loan characteristics affect the probability of default when we do not control for recourse legislation. A positive sign indicates that an increase in a given variable increases the probability of default. All coefficients in column (1) have the expected sign. In line with the results of previous 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 (most of them unemployed) are the most likely to default. Consistent with previous studies (see, e.g., Kelly and O'Toole, 2018; Kim et al., 2018; de Haan and Mastrogiacomo, 2020), our results reveal that borrowers' indebtedness (as proxied by DSTI) has a strong positive association with default. Moreover, our baseline results show that larger mortgage loans and those with higher current LTV are significantly associated with an increase in the probability of default.[37] Likewise, higher interest rates and higher loan delay (i.e., when the loan is past-due for more than 15 days) are significantly associated with a rise in the delinquency probability. Our results show that borrowers with mortgage loans in foreign currencies are more likely to default than borrowers with loans in domestic currency.

In column (2), the *Datio in Solutum* request is added as an explanatory variable. We expect that default is more likely when a borrower requests *Datio in Solutum*. The coefficient of our main variable of interest is positive and strongly significant, suggesting that performing borrowers requiring *Datio in Solutum* are five times more likely to become delinquent in the subsequent quarter.[38] Our results complement the findings from the literature (see, e.g., Jones, 1993; Demiroglu et al., 2014; and Chan et al., 2016), by showing that a change in recourse regime leads to higher rates of default. Column (3) considers an alternative proxy for the negative equity constructed as the difference between the collateral and the principal outstanding value. The coefficient for this proxy is also significantly positive, suggesting that the probability of a borrower going into 90 days arrears is larger for higher negative equity, a result consistent with Elul et al. (2010).

Finally, in columns (4)-(6), we use alternative measures for DSTI, current LTV, and the amount at origination and report our baseline specification results. We confirm the results in column (2) and show the non-monotonic effects of these variables. The results in column (4) reveal that the marginal effect of DSTI is non-linear, statistically and economically significant. The coefficient for DSTI between 25% and 50% is not statistically significant, indicating that an increase in the DSTI does not impact the borrower's probability of default at low levels of indebtedness. On the other hand, an increase in the DSTI from between 25% and 50% to a range between 50% and 100% raises the probability of default by 18 percent, a result consistent with Nier et al. (2019) (see Figure C.1, left panel). This suggests that borrower's indebtedness is harmful to the repayment probability, particularly when the ratio is higher than 50%. We obtain similar results for the current LTV ratio in column (5). Our LTV measure captures both the impact of changes in the collateral value and the role of loan amortization. The marginal effect of high LTV (i.e., higher than 100%) on the probability of default is 20 percent higher than for low LTV (i.e., LTV below 75%), while there is no significant difference between those with

[37] 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).

[38] Controlling for all other characteristics, requesting *Datio in Solutum* leads to an increase in probability of default from 0.37 percent to 1.93 percent for an average borrower.

LTV below 75% and between 75% and 100%. The marginal effects are even larger (by 28 percent) for the category LTV Unrecorded than the baseline category of borrowers with LTV below 75% (see Figure C.2, left panel). These results are consistent with those reported in Foote et al. (2009), Ellul et al. (2010), and Goodstein et al. (2017). The impact of the loan amount at origination is also non-monotonic (column 6), yet much smaller in magnitude than those of DSTI and LTV. The marginal effects exhibit a U-shaped pattern with the highest probability of default being observed for the largest (i.e., above 90,000 euro) and smallest (below 30,000 euro) loans (see Figure C.3).

Table 3. Mortgage default probability. Baseline model.

This table reports the results of logit regressions that examine the impact of requesting *Datio in Solutum* on the mortgages' probability of default. We use data over the September 2014-September 2017 period and estimate alternative versions of the following regression specification: $y_{i,t} = \alpha + \beta DiS_{it,} + \gamma' Z_{i,t-1} + \mu' L_{it-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{it}$, where the indices *i* and *t* stand for borrower and time, respectively, *DiS* is a dummy which equals 1 if borrower *i* requested *Datio in Solutum*, *Z* and *L* are vectors of borrower and loan characteristics, respectively, and ε_{it} is a scalar disturbance term. The dependent variable is a dummy-type variable y_{it} which equals 1 if the borrower's loan is more than 90 days past due. The regressors are 3-month lagged (*t-1)*. We control for the borrower (i.e., current income, DSTI, and age) and loan (i.e., loan size at origination, the currency of denomination, number of days the loan is past due, current LTV, residual maturity, and current interest rate) characteristics. We include bank, year of origination, county, and vintage fixed effects. Robust standard errors are shown in brackets. We use ∗∗∗, ∗∗, and ∗ to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	(1)	(2)	(3)	(4)	(5)	(6)
Datio in Solutum = 1, Requested DiS		2.228***	2.132***	2.560***	2.267***	2.216***
		(0.076)	(0.081)	(0.099)	(0.075)	(0.076)
Income group = 0, Unrecorded	0.361***	0.316***	0.339***		0.322***	0.358***
	(0.049)	(0.049)	(0.052)		(0.049)	(0.050)
Income group = 1, Below minimum wage	0.092*	0.107**	0.093	0.154***	0.098*	0.075
	(0.052)	(0.053)	(0.057)	(0.049)	(0.052)	(0.053)
Income group = 3, Average - double average wage	-0.198***	-0.234***	-0.224***	-0.212***	-0.230***	-0.217***
	(0.050)	(0.051)	(0.054)	(0.053)	(0.051)	(0.051)
Income group = 4, Above double average wage	-0.373***	-0.461***	-0.416***	-0.401***	-0.454***	-0.426***
	(0.063)	(0.063)	(0.068)	(0.071)	(0.063)	(0.064)
DSTI	0.084***	0.065**	0.078***		0.071***	0.097***
	(0.025)	(0.025)	(0.028)		(0.025)	(0.026)
Age	0.001	0.003	0.003	0.004	0.003	0.004*
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Amount at origination	0.001***	0.001***	0.001***	0.001***	0.001***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Currency = 2, EUR	0.118**	0.167***	0.182***	0.242***	0.181***	0.181***
	(0.054)	(0.055)	(0.059)	(0.070)	(0.054)	(0.055)
Currency = 3, CHF	0.274***	0.205***	0.286***	0.236***	0.277***	0.227***
	(0.070)	(0.071)	(0.073)	(0.091)	(0.070)	(0.072)
Past due = 2, 16-30 days	3.185***	3.129***	3.127***	3.130***	3.136***	3.128***
	(0.068)	(0.068)	(0.074)	(0.089)	(0.068)	(0.069)
Past due = 3, 31-60 days	4.685***	4.637***	4.641***	4.728***	4.646***	4.633***
	(0.046)	(0.046)	(0.050)	(0.060)	(0.046)	(0.046)
Past due = 4, 61-90 days	6.070***	6.050***	6.088***	6.189***	6.062***	6.052***
	(0.044)	(0.044)	(0.047)	(0.057)	(0.044)	(0.044)
LTV	0.384***	0.294***		0.365***		0.319***
	(0.039)	(0.040)		(0.051)		(0.041)
No LTV information = 1	0.573***	0.479***		0.619***		0.512***
	(0.059)	(0.060)		(0.077)		(0.060)
Residual maturity	0.000	-0.001	0.005	-0.003	0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Current interest rate	0.084**	0.045	0.076*	0.098**	0.041	0.045
	(0.035)	(0.035)	(0.041)	(0.047)	(0.035)	(0.035)
Negative equity			0.213***			
			(0.045)			
DSTI = 2, 25%-50%				0.096		
				(0.076)		
DSTI = 3, 50%-100%				0.270***		
				(0.078)		
DSTI = 4, >100%				0.242***		
				(0.087)		
LTV = 2, 75%-100%					0.047	
					(0.047)	
LTV = 3, >100%					0.213***	
					(0.045)	
LTV = 4, Unrecorded					0.298***	
					(0.053)	
Amount at origination = 2, 30k -60k						-0.103***
						(0.038)
Amount at origination = 3, 60k -90k						-0.124**
						(0.050)
Amount at origination = 4, >90k						0.023
						(0.057)
Observations	1,601,003	1,601,003	1,399,341	1,239,382	1,601,003	1,601,003
Banks FE	Yes	Yes	Yes	Yes	Yes	Yes
Origination FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Vintage FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.443	0.452	0.454	0.462	0.452	0.452
Likelihood	-23,026	-22,640	-19,692	-14,034	-22,654	-22,646

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Next, we provide the logit regressions results when *Datio in Solutum* interacts with borrower and loan characteristics. Table 4 shows the estimation results of interactions between *Datio in Solutum* dummy and borrower characteristics, based on the estimation of the model depicted in equation (11). Column (1) shows the interaction effects of *Datio in Solutum* request and borrower's income. Regardless of the level of income, borrowers requesting *Datio in Solutum* are more likely to default. The effect is more pronounced for borrowers with the highest income. Figure C.4 in the Appendix illustrates the marginal effects of borrower's income on the probability of becoming delinquent. On the one hand, as shown in the left panel in Figure C.4, there is a negative relationship between income and probability of default. On the other hand, requesting *Datio in Solutum* leads to a five-fold increase in the probability of default for borrowers with income between the minimum and average wage. In contrast, for the highest-income borrowers (i.e., above double the average wage), it increases the probability of default by 13 times (Figure C.4, right panel). This result supports our theoretical model's predictions and suggests that better-off borrowers may have incentives for strategic default potentially because their higher wealth reduces the opportunity cost of default.

In column (2), we interact the *Datio in Solutum* request with DSTI. Our results uncover a surprising pattern: the strongest impact on non-repayment is for the less-financially constrained borrowers. As shown in Figure C.1 (right panel), requesting *Datio in Solutum* increases eight-fold the probability of default for borrowers with DSTI between 50 percent and 100 percent, while for less indebted borrowers (i.e., DSTI below 25 percent) it leads to a 23-fold increase. This is also the largest increase in the probability of default in absolute terms (i.e., 5 percent). These findings are again consistent with the idea of strategic default because less-leveraged borrowers (either because of higher income or lower debt) are expected to default less.

Table 4. Mortgage default probability. Borrower characteristics and *Datio in Solutum.*

This table reports the results of logit regressions that examine the potential asymmetric effects of specific borrower attributes on mortgage default under *Datio in Solutum*. We use data over the September 2014-September 2017 period and estimate alternative versions of the following regression specification: $y_{i,t} = \alpha + \sum_{j=1}^{k} \beta^j \, Borrower\_dummy_{i,t-1}^{j} * DiS_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{i,t-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{i,t}$, where the indices i and t stand for borrower and time, respectively, *DiS* is a dummy which equals 1 if borrower i requested *Datio in Solutum*, $Borrower\_dummy_{i,t-1}^{j}$ equals 1 if the variable of interest (e.g., income or DSTI) is in a specified category and 0 otherwise, Z and L are vectors of borrower and loan characteristics, respectively, and ε_{it} is a scalar disturbance term. The dependent variable is a dummy-type variable y_{it} which equals 1 if the borrower's loan is more than 90 days past due. The regressors are 3-month lagged (*t-1)*. We include bank, year of origination, county, and vintage fixed effects. Robust standard errors are shown in brackets. We use $***$, $**$, and $*$ to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	(1)	(2)
Income group = 0, Unrecorded	0.331***	
	(0.049)	
Income group = 1, Below minimum wage	0.129**	
	(0.053)	
Income group = 3, Average - double average wage	-0.241***	
	(0.052)	
Income group = 4, Above double average wage	-0.585***	
	(0.068)	
Requested DiS * Income group = 0	1.781***	
	(0.113)	
Requested DiS * Income group = 1	1.876***	
	(0.203)	
Requested DiS * Income group = 2	2.330***	
	(0.184)	
Requested DiS * Income group = 3	2.331***	
	(0.182)	
Requested DiS * Income group = 4	3.400***	
	(0.162)	
DSTI = 2, 25%-50%		0.166**
		(0.080)
DSTI = 3, 50%-100%		0.356***
		(0.082)
DSTI = 4, >100%		4.468***
		(0.244)
Requested DiS * DSTI = 1		4.468***
		(0.244)
Requested DiS * DSTI = 2		3.077***
		(0.199)
Requested DiS * DSTI = 3		2.832***
		(0.184)
Requested DiS * DSTI = 4		1.597***
		(0.152)
Observations	1,601,003	1,239,870
Banks FE	Yes	Yes
Origination FE	Yes	Yes
County FE	Yes	Yes
Vintage FE	Yes	Yes
Borrower and loan characteristics	Yes	Yes
Pseudo R2	0.453	0.464
Likelihood	-22,604	-14,007

Table 5 provides the results of the model described in equation (12) when the *Datio in Solutum* dummy interacts with loan characteristics. The first column shows the impact of loan currency on the probability of default. With loans in local currency as the baseline category, we find significantly higher probabilities of default for loans issued in foreign currencies, with the effect being more pronounced for Swiss franc loans (see Figure C.5, left panel). Borrowers requesting *Datio in Solutum* are more likely to become delinquent regardless of their mortgage loan currency (see Figure C.5, right panel). The association is stronger for mortgages denominated in euro. This result is not surprising as 22 percent of borrowers with euro-denominated loans are non-performing, compared to 11.7 percent for leu-denominated loans and 9.6 percent for Swiss franc-denominated loans. Thus, even though a larger share of borrowers with Swiss franc loans have requested *Datio in Solutum*, borrowers with loans in euro that requested *Datio in Solutum* are more likely to default on their payment obligations.

Column (2) shows that requesting *Datio in Solutum* has a non-linear impact on the probability of default conditional on the value of current LTV. The effect is stronger for borrowers with higher LTV ratios and those without real estate as primary collateral (i.e., unrecorded LTV category). A high current LTV ratio can result from either a sharp drop in the value of dwellings or/and a higher LTV at origination and less principal amortization. As shown in Figure C.2 (right panel), requesting *Datio in Solutum* leads to a four-fold increase in the probability of default for borrowers with LTV ratio between 75 percent and 100 percent, while for those with LTV above 100 percent it leads to a five-fold increase. The impact is the highest for borrowers with other collateral types: requesting *Datio in Solutum* leads to a ten-fold increase for these borrowers. These findings are consistent with our theoretical model's predictions - negative equity, as proxied by a current LTV higher than 1, has a positive and significant association with default.[39]

Finally, column (3) presents logit regression results when *Datio in Solutum* dummy interacts with the loan delay. With loans with less than 15 days past due the excluded category, we find significantly higher probabilities of default for loans that record longer delays. The effect is more pronounced for 60-90 days past due loans (see Figure C.6, left panel). The interaction results suggest that the association between the loan delay and the probability of becoming 90 days past due after 3 months is stronger for borrowers that requested *Datio in Solutum*. Surprisingly, the effect of *Datio in Solutum* is more pronounced for safer borrowers. As shown in Figure C.6 (right panel), for borrowers with delays of up to 15 days, requesting *Datio in Solutum* leads to a 60-fold increase in the probability of the default, while for those with delays between 60-90 days there is only a two-fold increase.[40]

[39] Ghent and Kudlyak (2011) and Demiroglu et al. (2014) report similar results for underwater homeowners in non-recourse states in the US.

[40] We also examined whether the interaction of *Datio in Solutum* with different loan sizes at origination is associated with default probability. We did not find a significant impact on that interaction.

Table 5. Mortgage default probability. Loan characteristics and *Datio in Solutum.*

This table reports the results of logit regressions that examine the potential asymmetric effects of specific loan attributes on mortgage default under *Datio in Solutum*. We use data over the September 2014-September 2017 period and estimate alternative versions of the following regression specification: $y_{i,t} = \alpha + \sum_{j=1}^{k} \beta^j \, Loan\_dummy_{i,t-1}^{j} * DiS_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{i,t-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + \varepsilon_{i,t}$, where the indices i and t stand for borrower and time, respectively, DiS is a dummy which equals 1 if borrower i requested *Datio in Solutum*, $Loan\_dummy_{i,t-1}^{j}$ equals 1 if the variable of interest (e.g., the currency of denomination, current LTV, and the number of days the loan is past due) is in a specified category and 0 otherwise, Z and L are vectors of borrower and loan characteristics, respectively, and ε_{it} is a scalar disturbance term. The dependent variable is a dummy-type variable y_{it} which equals 1 if the borrower's loan is more than 90 days past due. The regressors are 3-month lagged (*t-1)*. We include bank, year of origination, county, and vintage fixed effects. Robust standard errors are shown in brackets. We use $***$, $**$, and $*$ to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Probability of default	(1)	(2)	(3)
Currency = 2, EUR	0.132**		
	(0.055)		
Currency = 3, CHF	0.351***		
	(0.072)		
Requested DiS * Currency = 1	2.399***		
	(0.249)		
Requested DiS * Currency = 2	3.775***		
	(0.124)		
Requested DiS * Currency = 3	1.304***		
	(0.102)		
LTV = 2, 75%-100%		0.054	
		(0.047)	
LTV = 3, >100%		0.222***	
		(0.046)	
LTV = 4, Unrecorded		0.260***	
		(0.054)	
Requested DiS * LTV = 1		1.911***	
		(0.485)	
Requested DiS * LTV = 2		1.749***	
		(0.353)	
Requested DiS * LTV = 3		2.162***	
		(0.082)	
Requested DiS * LTV = 4		3.432***	
		(0.225)	
Past due = 2, 16-30 days			3.176***
			(0.073)
Past due = 3, 31-60 days			4.748***
			(0.048)
Past due = 4, 61-90 days			6.197***
			(0.046)
Requested DiS * Past due = 1			4.213***
			(0.122)
Requested DiS * Past due = 2			2.762***
			(0.172)
Requested DiS * Past due = 3			2.229***
			(0.106)
Requested DiS * Past due = 4			1.079***
			(0.118)
Observations	1,601,003	1,601,003	1,601,003
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	0.455	0.452	0.456
Likelihood	-22,514	-22,638	-22,495

Robustness tests

We conduct several robustness tests to investigate whether our results are robust to alternative modeling specifications. We re-estimate the model described in equation (9) using the linear probability ordinary least squares model and the Cox proportional-hazards model. Table 6 presents the results. Similar to Gerardi et al. (2018) and O'Malley (2021), we run two alternative linear probability ordinary least squares models (OLS). In column (2), we use an OLS specification with banks, year of origination, county, and vintage fixed effects. In column (3), we provide the OLS estimates without fixed effects. Furthermore, in column (4), we report the Cox proportional-hazards model results without assumptions about the functional form of the baseline hazard (Foote et al., 2009). Unlike the logit model that treats the status of the loan in each period as a separate observation, the hazard model treats the time to default as the dependent variable and thus accounts for the fact that we observe only one outcome for each loan (i.e., the point in time when the loan defaults) (Bajari et al., 2008). Additionally, in column (5), we control for the fact that borrowers were not able to request *Datio in Solutum* before the law was introduced in April 2016 by interacting the *Datio in Solutum* dummy with a period dummy. The results show that the probability of default of borrowers who did not request *Datio in Solutum* after April 2016 is not significantly different from that estimated before the law's implementation. This confirms our main finding that default is more likely when a borrower requests *Datio in Solutum*. The coefficient for borrowers who did request *Datio in Solutum* after April 2016 is positive and strongly significant.

Finally, we implement a difference-in-difference approach using our logit model. As borrowers who have taken out a *First Home* loan cannot apply for *Datio in Solutum*, we can consider them a control group. The difference-in-difference specification estimates the probability of default for both *First Home* and standard mortgages. This approach contrasts with previous regressions where we included only borrowers with standard mortgages - they were eligible to apply for *Datio in Solutum* and thus likely to be affected by the new law.

Table 6. Robustness to different estimation methods.

This table reports the results of robustness tests for our main model that examines the impact of requesting *Datio in Solutum* on the mortgage's probability of default. Model 2 shows the results of OLS estimation with banks, year of origination, county, and vintage fixed effects. Model 3 shows OLS estimates without fixed effects. Model 4 shows the Cox proportional-hazards model estimates. We estimate the following regression specification: $y_{i,t} = \alpha + \beta DiS_{it,} + \gamma' Z_{i,t-1} + \mu' L_{it-1} + Bank\ FE + Origination\ FE + County\ FE + Vintage\ FE + e_{i,t}$, where the indices i and t stand for borrower and time, respectively, DiS is a dummy which equals 1 if borrower i requested *Datio in Solutum*, Z and L are vectors of borrower and loan characteristics, respectively, and ε_{it} is a scalar disturbance term. In model 5 we estimate a logit model where we interact *Datio in Solutum* request with the period when the law was in effect, using the following specification $y_{i,t} = \alpha + \beta DiS_{it,} * DiS\_period\_dummy^{j}_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{it-1} + Bank\ FE + Origination\ FE + County\ FE + e_{i,t}$, where $DIS\_period\_dummy^{j}_{i,t}$ equals 0 before April 2016 and 1 afterwards. In model 6 we employ a difference-in-difference approach, using the following specification $y_{i,t} = \alpha + \beta * Standard\ mortgage\ dummy * DiS\_period\_dummy^{j}_{i,t} + \gamma' Z_{i,t-1} + \mu' L_{it-1} + Bank\ FE + Origination\ FE + County\ FE + e_{i,t}$ where $Standard\ mortgage\ dummy$ equals 1 for borrowers with a standard mortgage loan and 0 for those with a *First Home* loan. The regressors are 3-month lagged (*t-1*). Robust standard errors are shown in brackets. We use ∗∗∗, ∗∗, and ∗ to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	-1 Logit	-2 OLS	-3 OLS	-4 COX	-5 Logit	-6 Logit
Datio in Solutum = 1, Requested DiS	2.228***	0.106***	0.106***	0.902***		
	-0.076	0	0	0		
Datio in Solutum = 0, * *DiS_period* dummy = 1					0.006	
					-0.036	
Datio in Solutum = 1, * *DiS_period* dummy = 1					2.220***	
					-0.076	
Standard mortgage = 0 DiS_period dummy = 0*						-1.654***
						(0.085)
Standard mortgage = 0 DiS_period dummy = 1*						-1.579***
						(0.076)
*Standard mortgage =1 * DiS_period dummy = 1*						0.129***
						(0.033)
Income group = 0, Unrecorded	0.316***	0.001***	0.001***	-0.542***	0.311***	0.366***
	-0.049	0	0	0	-0.049	(0.045)
Income group = 1, Below minimum wage	0.107**	0.001***	0.001***	0.411***	0.117**	0.134***
	-0.053	0	0	0	-0.052	(0.049)
Income group = 3, Average - double average wage	-0.234***	-0.000***	-0.000***	-0.309***	-0.237***	-0.224***
	-0.051	-0.001	-0.001	0	(0.051)	(0.047)
Income group = 4, Above double average wage	-0.461***	-0.001***	-0.001***	-0.559***	-0.468***	-0.355***
	-0.063	0	0	0	-0.063	(0.058)
DSTI	0.065**	0	-0.000***	-0.131***	0.063**	0.072***
	-0.025	-0.306	-0.003	0	-0.025	(0.024)
Age	0.003	0	0	-0.003	0.003	0.002
	-0.002	-0.585	-0.51	-0.167	-0.002	(0.002)
Amount at origination	0.001***	0.000***	0.000***	0.001***	0.001***	0.001***
	0	0	0	0	0	(0.000)
Currency = 2, EUR	0.167***	0.000***	-0.000***	-0.011	0.155***	0.056
	-0.055	-0.004	0	-0.774	-0.054	(0.049)
Currency = 3, CHF	0.205***	0.001***	-0.001***	-0.141***	0.199***	0.242***
	-0.071	0	-0.001	-0.004	-0.071	(0.065)
Past due = 2, 16-30 days	3.129***	0.012***	0.012***	3.175***	3.117***	3.338***
	-0.068	0	0	0	-0.068	(0.062)
Past due = 3, 31-60 days	4.637***	0.059***	0.059***	4.663***	4.630***	4.862***
	-0.046	0	0	0	-0.046	(0.043)
Past due = 4, 61-90 days	6.050***	0.197***	0.197***	5.818***	6.026***	6.229***
	-0.044	0	0	0	-0.044	(0.042)
LTV	0.294***	0.001***	0.001***	0.314***	0.309***	0.369***
	-0.04	0	0	0	(0.040)	(0.037)
No LTV information = 1	0.479***	0.001***	0.001***	0.373***	0.485***	0.613***
	-0.06	0	0	0	(0.060)	(0.056)
Residual maturity	-0.001	-0.000**	-0.000***	0	-0.001	0.002
	-0.003	-0.015	0	-0.937	(0.003)	(0.003)
Current interest rate	0.045	0.000*	0.001***	0.485***	0.077**	0.087***
	-0.035	-0.094	0	0	(0.033)	(0.031)
Observations	1,601,003	1,601,685	1,601,685	1,601,685	1,601,003	3,564,952
R-squared	0.452	0.13	0.129		0.450	0.472
Banks FE	Yes	Yes	No	No	Yes	Yes
Origination FE	Yes	Yes	No	No	Yes	Yes
County FE	Yes	Yes	No	No	Yes	Yes
Vintage FE	Yes	Yes	No	No	No	No
Likelihood	-22,640	2,27E+09	2,27E+09	-67,158	-22,732	-27,373

Results in column (6) show that borrowers with a *First Home* loan have a lower risk than borrowers with standard mortgage loans, irrespective of the *Datio in Solutum* law implementation. As expected, the probability of default for borrowers with a *First Home* loan does not change after introducing the *Datio in Solutum* law, as they were not eligible to apply. However, the law's enactment led to a 12 percent increase in the probability of default for borrowers with standard mortgages[41], as is indicated by the positive and significant coefficient of the interaction between *Standard mortgage* and *DiS period dummy.* The difference-in-difference analysis confirms our main result that the possibility to give in payment increases the moral hazard of affected borrowers and leads to a deterioration of payment discipline for borrowers applying for debt forgiveness.

7. Conclusions

We empirically investigate whether and how changes in recourse legislation affect the mortgage default. Using a large and unique dataset of mortgage loans originated over 2003-2016, we analyze the impact of the introduction of a new recourse law that has changed overnight the status of all existing mortgage loans from recourse to non-recourse. We find that defaults are more likely to occur when the recourse procedure becomes more debtor-friendly, with negative equity and borrowers' indebtedness being significantly associated with default. After enacting the new law, the rate of NPLs for standard mortgages increased by 1.6 percentage points in the following two months, pointing to an economically significant impact. Importantly, our results suggest that the *Datio in Solutum* law, enacted to offer debt relief to borrowers in financial distress, bears unintended consequences. Namely, the law incentivized (some) borrowers to default strategically. Our findings indicate that better-off, less-leveraged borrowers exhibit the highest increase in the probability of default in the new non-recourse regime. These results suggest that legislators should carefully assess (before implementation) all the critical aspects (e.g., eligibility criteria, moral hazard considerations) of recourse laws to enhance the social benefits while containing the undesirable potential costs.

[41] The average probability of default increases from 2.4 percent before introducing the law to 2.69 percent afterward.

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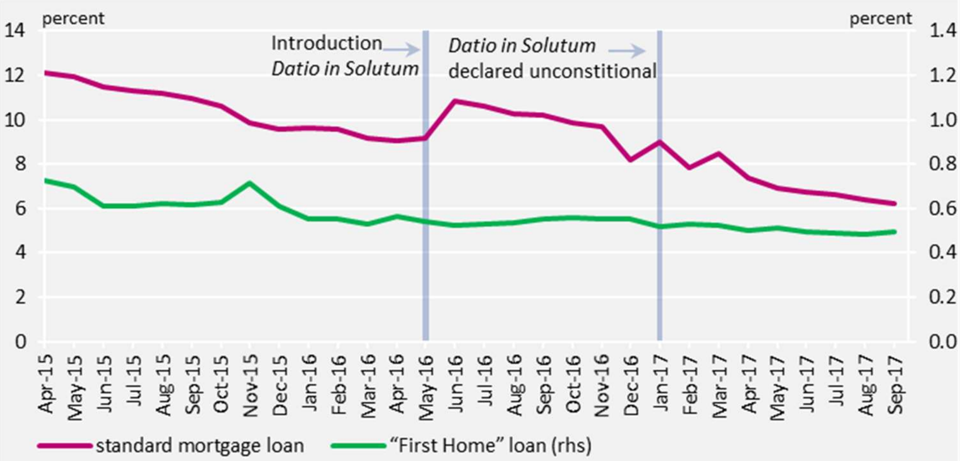
Appendix A. Variables definitions and data sources

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 5 categories: unrecorded income, below minimum wage, minimum-average 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 4 categories according to the individual DSTI ratio: below 25%, 25%-50%, 50%-100%, and no information. 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.	Central Credit Registry
Loan size at origination	Amount at origination	Loan amount at origination. We construct 5 loan categories: below 40k, 40k-60k, 60k-80k, 80k-100k, above 100k. 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-denominated), euro (EUR), and Swiss francs (CHF).	Central Credit Registry
Loan payment delay	Past due	The number of days a loan is past due. We construct 4 categories: below 16 days, 16-30 days, 31-60 days, 61-90 days.	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 4 categories: below 75%, 75%-100%, above 100%, and no information. Winsorized at 200%.	Central Credit Registry
Residual maturity	Maturity	The number of years until maturity.	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).	Monetary Balance Sheet
Negative equity	Negative equity	The difference between the outstanding loan amount and the current value of the property (in thousands of euro).	Central Credit Registry

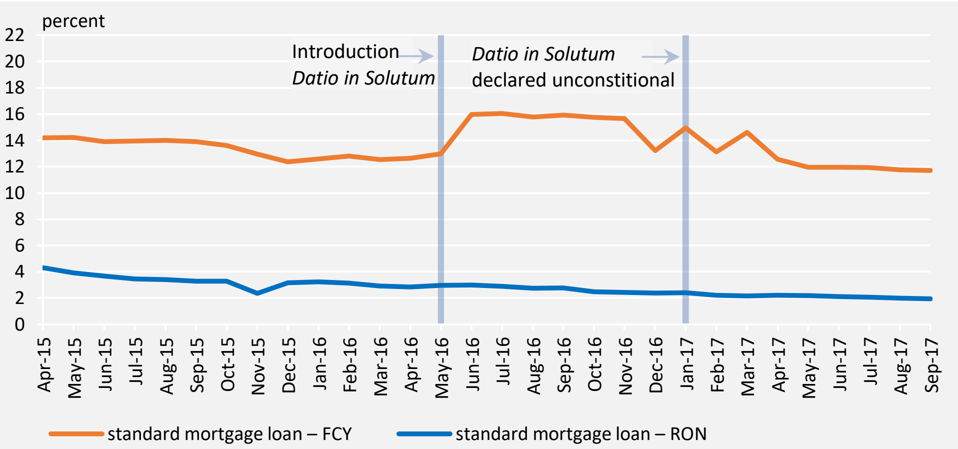
Appendix B. Figures

Figure B.1. NPLs rate by mortgage type



Note: 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. NPLs rate by loan currency

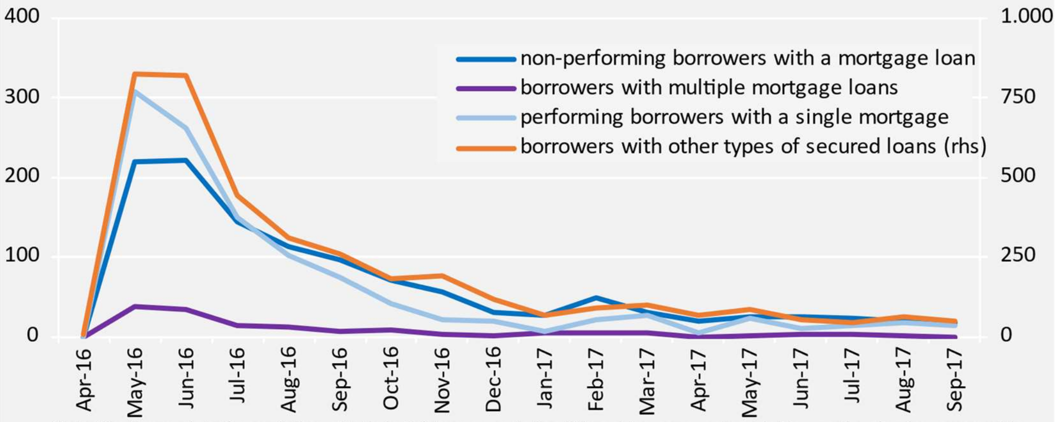


Note: The figure plots the evolution of monthly NPLs rate conditional on the currency of mortgage loan. The NPLs rate is computed using the European Banking Authority defintion that considers loans with delays above 90 days and loans flagged as unlikely to pay.

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

Note: 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

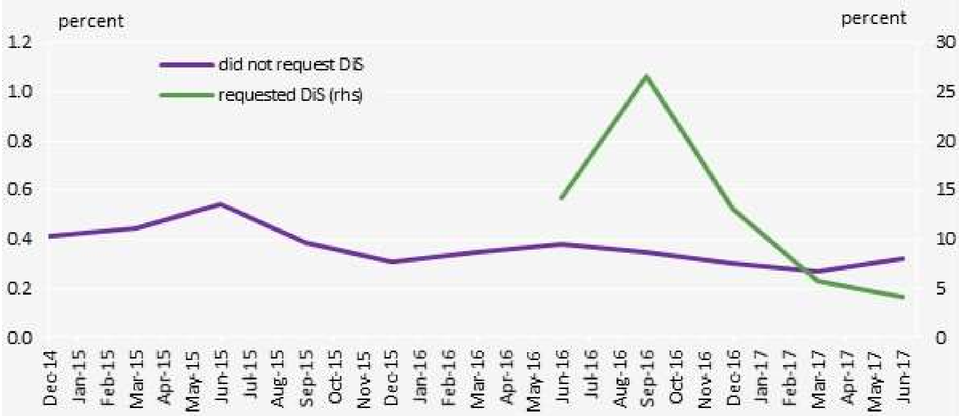


Note: The figure plots the evolution of *Datio in Solutum* requests for different borrower categories. *Non-performing borrowers with a mortgage loan* captures the number of monthly requests from borrowers with loans that were 90 days past due before the law was introduced. *Borrowers with multiple mortgage 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

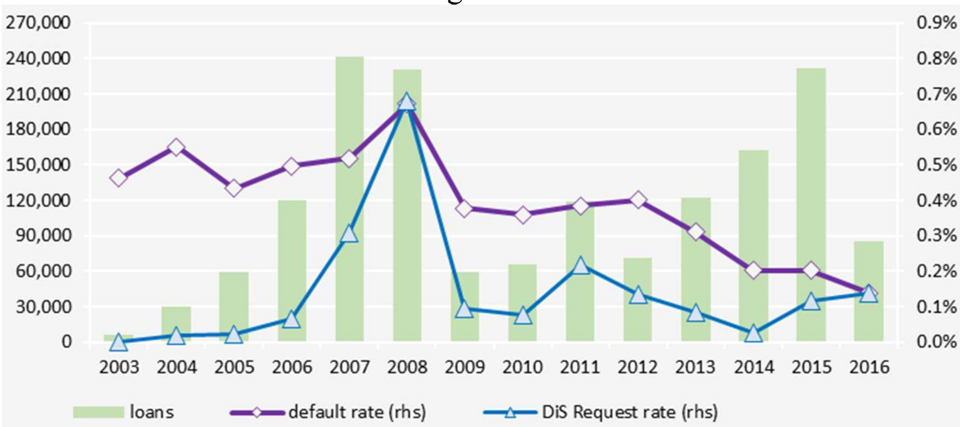
Note: The figure plots the quarterly evolution of performing and non-performing loans and the number of *Datio in Solutum* requests from our sample. *Loans* captures the number of loans included in each vintage. *Requested DiS* captures the number of loans for which *Datio in Solutum* has been requested within 3 months after the vintage was created. *Defaulted loans* captures the number of loans that recorded delays greater than 90-days 3 months after the creation of the vintage. *Defaulted loans with DiS request* captures the number of loans that are 90-days past due and for which *Datio in Solutum* has been requested 3 months after the creation of the vintage.

Figure B.6. Default rate by *Datio in Solutum* request



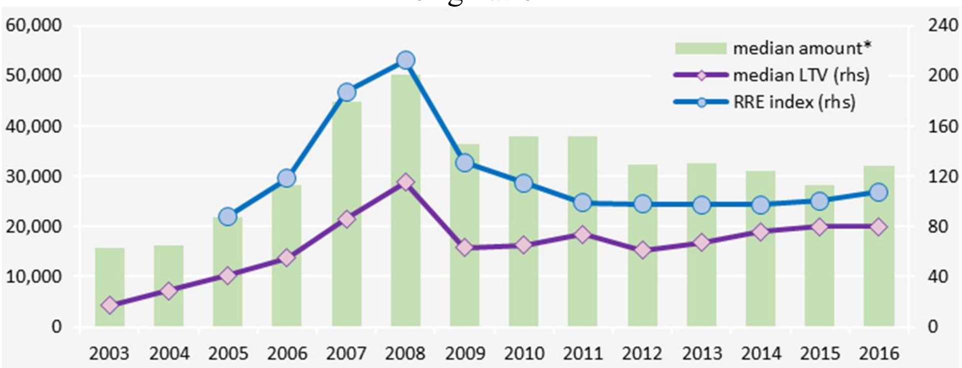
Note: The figure plots the quarterly evolution of default rate for loans with and without requests for *Datio in Solutum*. *Did not request DiS* captures the share of non-performing loans in the total number of loans without a request for *Datio in Solutum* in a quarter. *Requested DiS* captures the share of non-performing loans in the total number of loans that requested *Datio in Solutum* until the end of that specific quarter.

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



Note: The figure plots the evolution of the number of loans, default rate, and *Datio in Solutum* request rate conditional on the year of loan origination. *Loans* captures the number of loans per year. *Default rate* 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.

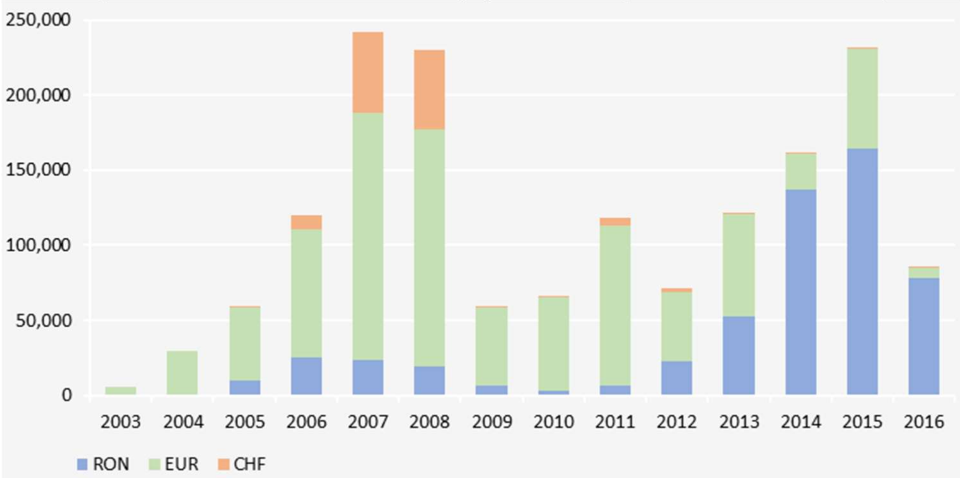
Figure B.8. Median amount at origination and median current LTV ratio by year of origination



*) amount in euro

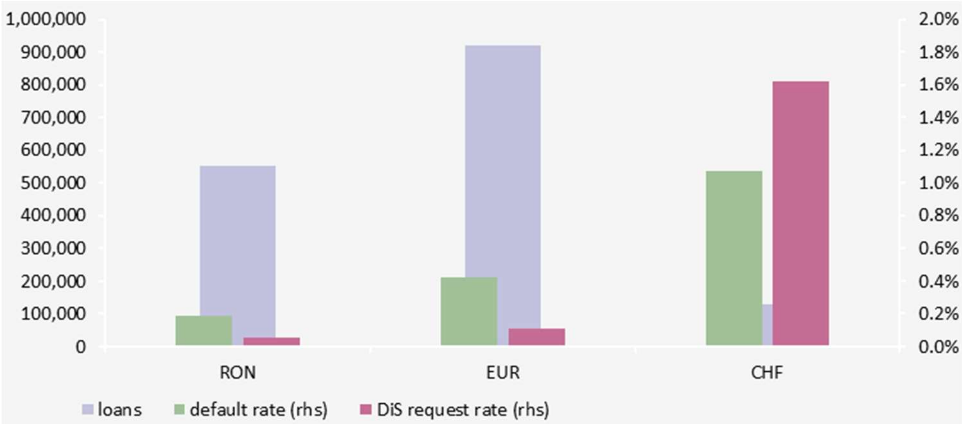
Note: The figure plots the evolution of median amount at origination, median current LTV ratio, and the real estate price index conditional on the year of loan origination. *Median amount* captures the median amount at origination in Euro (we use the Euro average exchange rate of the respective month for loans issued in other currencies). *Median LTV* captures the median value for the the ratio between the oustanding amount and the latest value of the collateral for loans issued in a given year. *RRE index* captures the real este 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



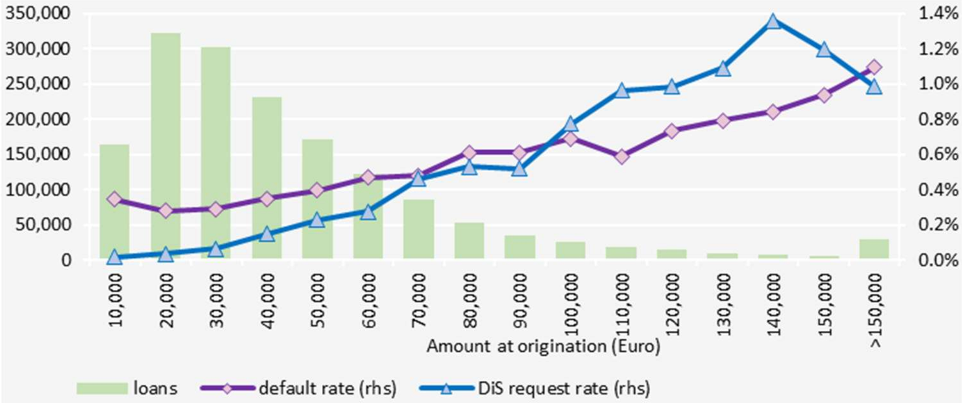
Note: The figure plots the evolution of the number of loans per year conditional on loan currency.

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



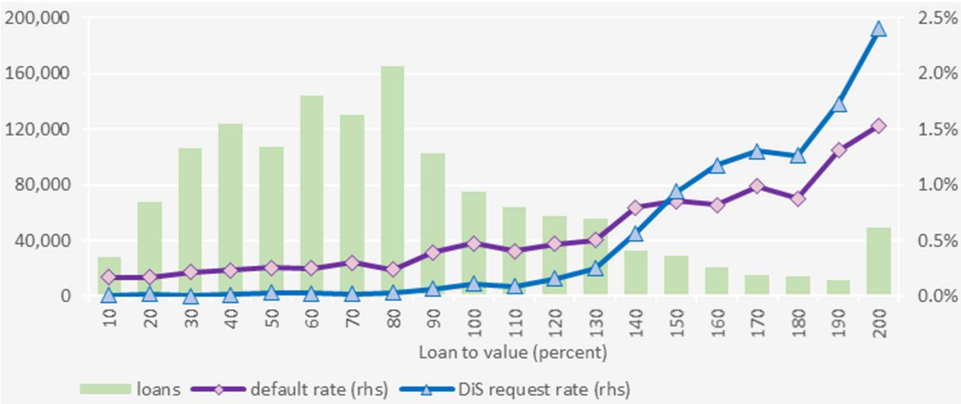
Note: The figure plots the number of loans, default rate, and *Datio in Solutum* request rate conditional on loan currency. *Loans* captures the total number of loans denominated in a specific currency. *Default rate* captures the share of non-performing loans in the total number of loans denominated 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, default rate, and *Datio in Solutum* request rate by amount at origination



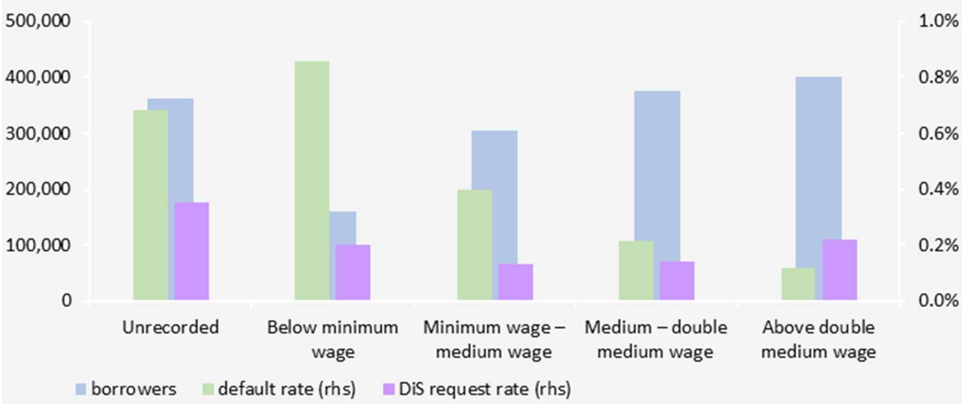
Note: The figure plots the evolution of the number of loans, default rate, and *Datio in Solutum* request rate conditional on loan amount at origination. *Loans* captures the total number of loans with size at origination in a specific interval. *Default rate* captures the share of non-performing loans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



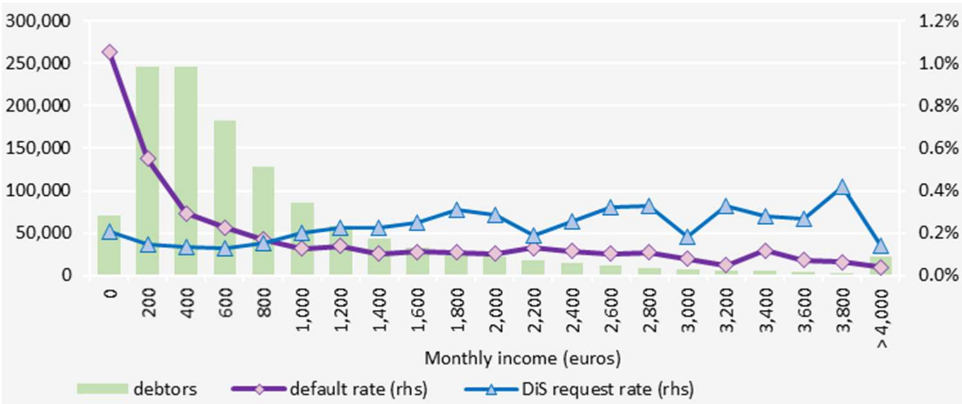
Note: The figure plots the distribution of the number of loans, default rate, and *Datio in Solutum* request rate conditional on the level of the current LTV. *Loans* captures the total number of loans with the current LTV in a specific LTV bracket. *Default rate* captures the share of non-performing 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, default rate, and *Datio in Solutum* request rate by income category



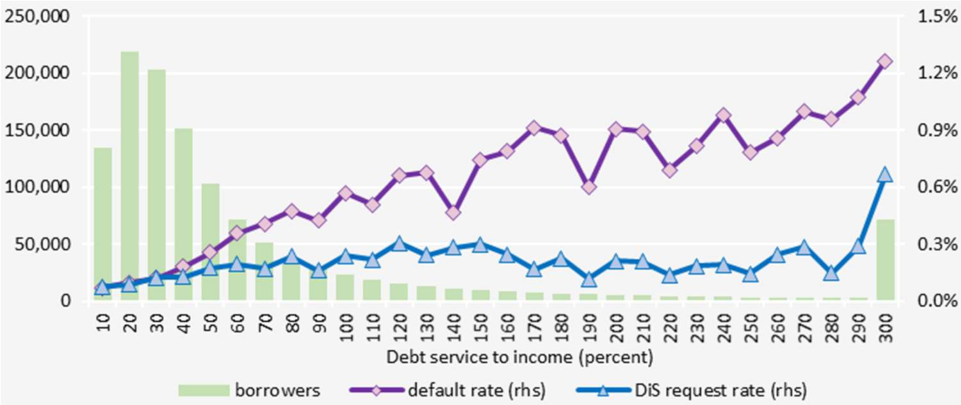
Note: The figure plots the number of borrowers, default rate, and *Datio in Solutum* request rate conditional on income group. *Borrowers* captures the total number of borrowers within a specific income group. *Default rate* captures the share of non-performing loans in the total number of loans taken 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, default rate, and *Datio in Solutum* request rate by monthly income



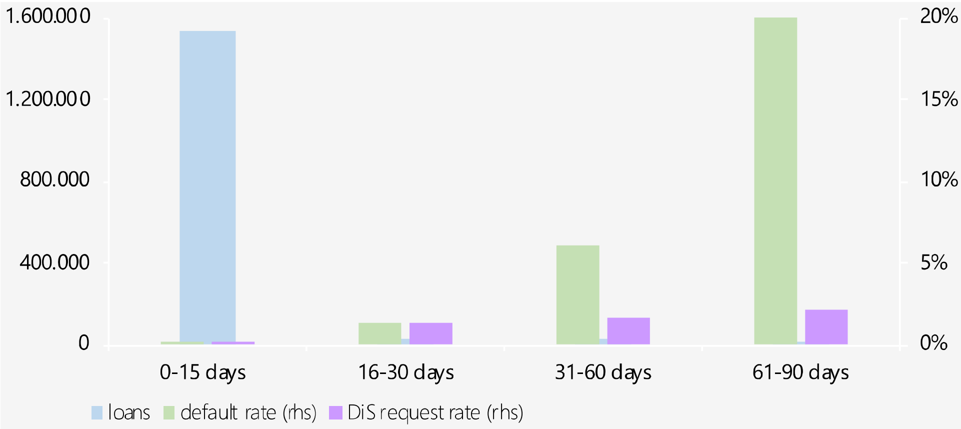
Note: The figure plots the borrowers' distribution, default rate, and *Datio in Solutum* request rate conditional on monthly income. *Borrowers* captures the total number of borrowers with a monthly income in a specific bracket. *Default rate* captures the share of non-performing loans in the total number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



Note: The figure plots the borrowers' distribution, default rate, 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. *Default rate* 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.

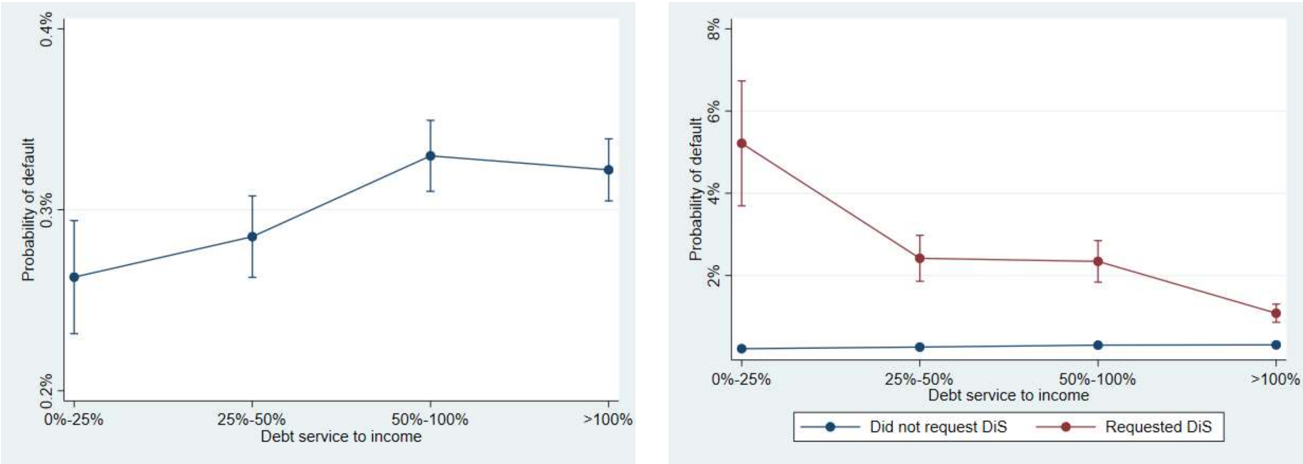
Figure B.16. Number of loans, default rate, and *Datio in Solutum* request rate by payment status



Note: The figure plots the number of loans, default rate, and *Datio in Solutum* requests rate conditional on the number of days a loan is past-due. *Loans* captures the total number of loans with specific payment status. *Default rate* captures the share of non-performing loans in the total number of loans with specific payment status. *DiS requests rate* captures the share of loans with *Datio in Solutum* request in the total number of loans with specific payment status.

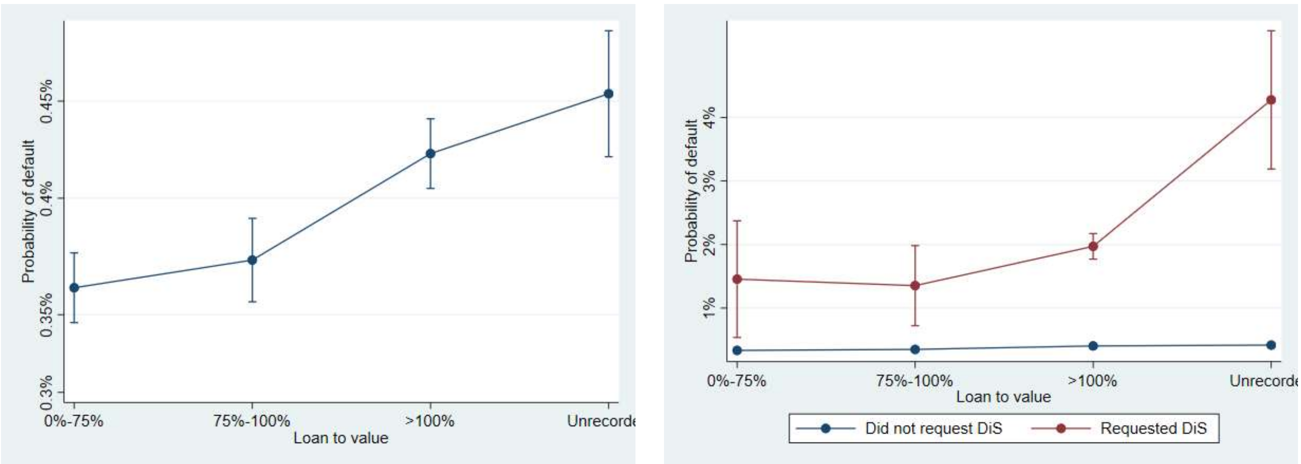
Appendix C. Marginal effects

Figure C.1. DSTI marginal effect



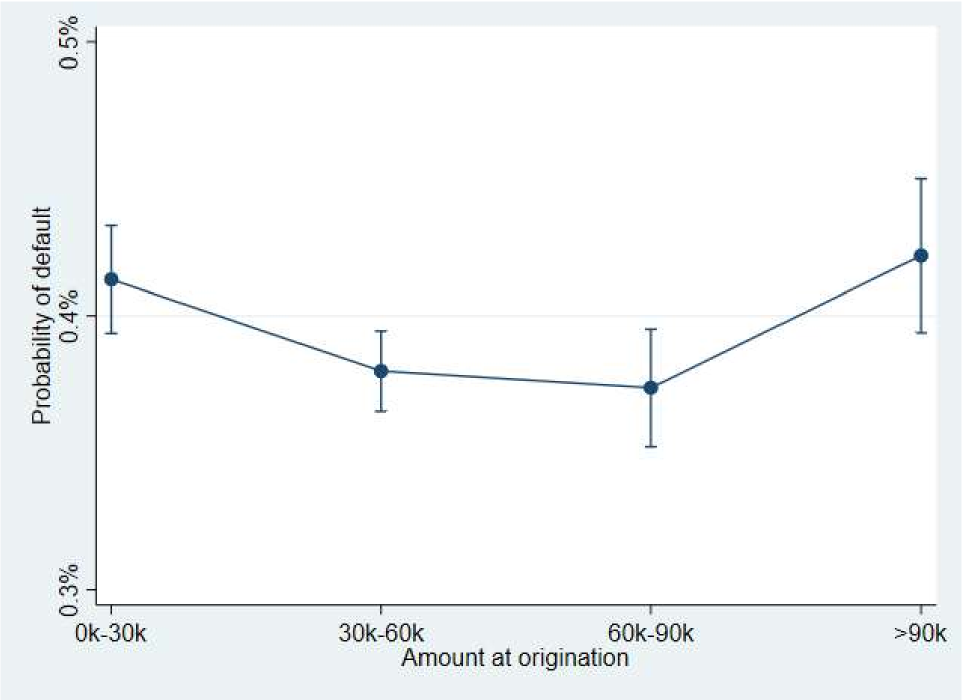
Notes: The left panel plots the marginal effect of DSTI. The right panel plots the marginal effect of DSTI conditional on *Datio in Solutum* request.

Figure C.2. Current LTV ratio marginal effect



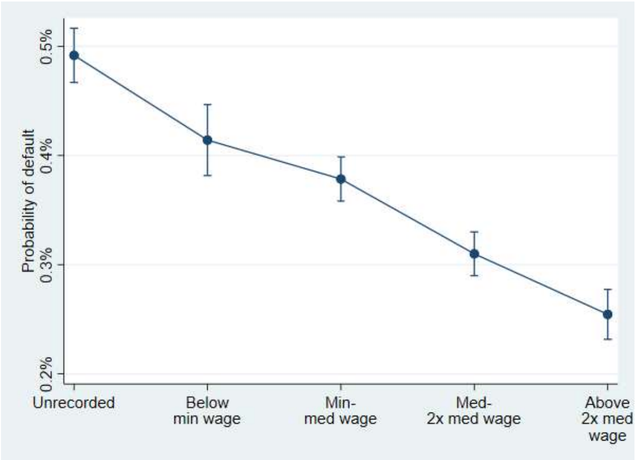
Notes: The left panel plots the marginal effect of current LTV ratio. The right panel plots the marginal effect of current LTV ratio conditional on *Datio in Solutum* request.

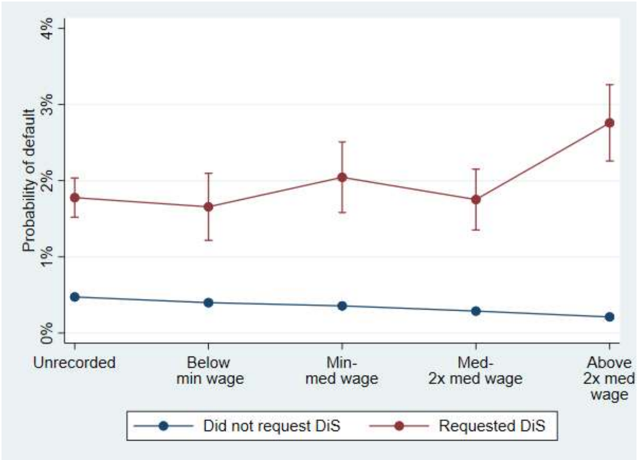
Figure C.3. Amount at origination marginal effect



Notes: The panel plots the marginal effect of loan amount at origination.

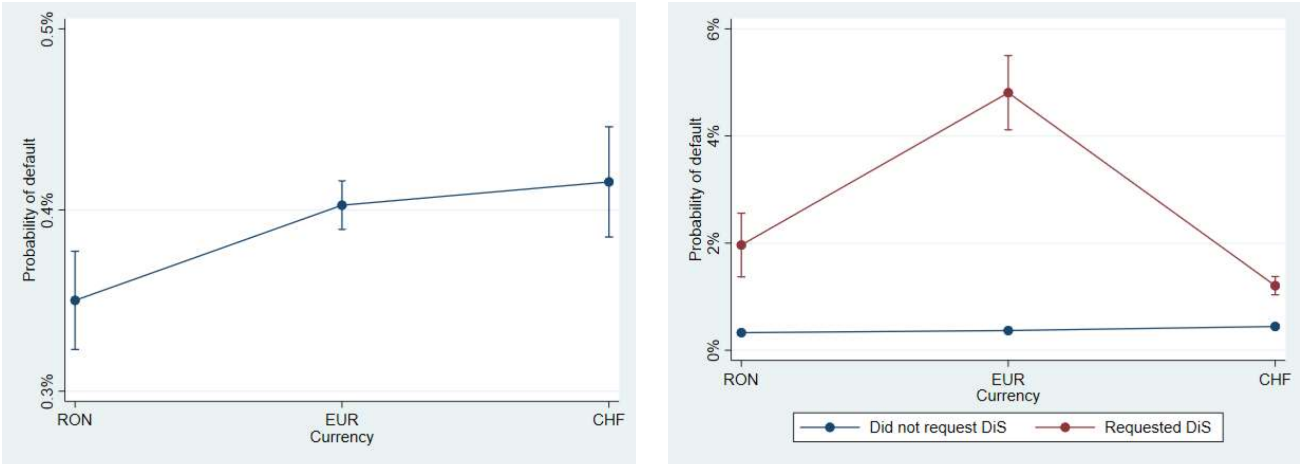
Figure C.4. Income marginal effect





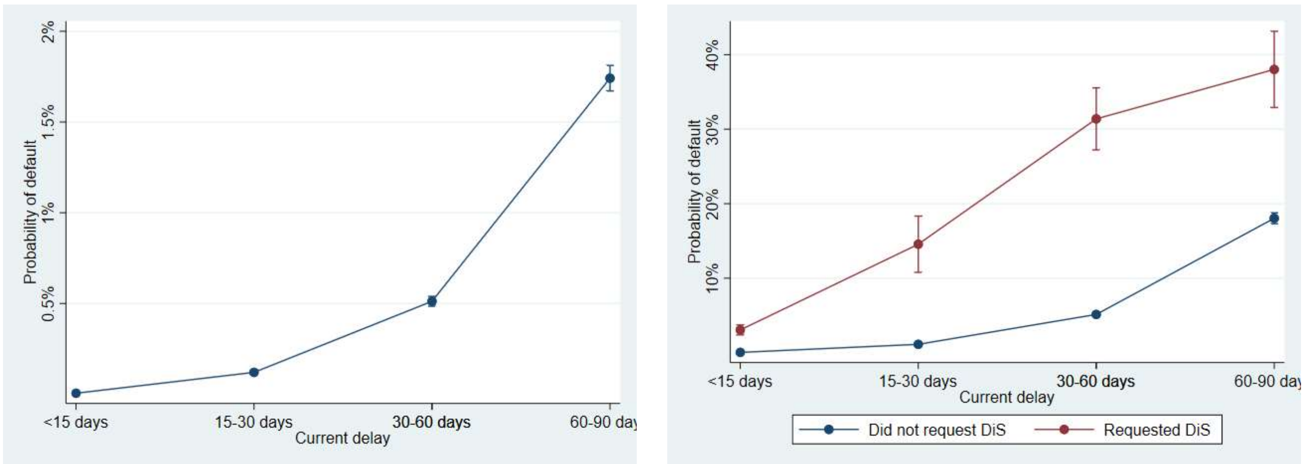
Notes: The left panel plots the marginal effect of income. The right panel plots the marginal effect of income conditional on *Datio in Solutum* request.

Figure C.5. Loan currency marginal effect



Notes: The left panel plots the marginal effect of loan currency. The right panel plots the marginal effect of loan currency conditional on *Datio in Solutum* request.

Figure C.6. Current delay marginal effect



Notes: The left panel plots the marginal effect of loan current delay. The right panel plots the marginal effect of loan current delay conditional on *Datio in Solutum* request.

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