Does a Larger Menu Increase Appetite? Collateral Eligibility and Credit Supply

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We examine a change in the European Central Bank's collateral framework, which significantly lowered the rating requirement for eligible residential mortgage-backed securities (RMBS), and its impact on bank lending and risk-taking in the Netherlands. Banks most affected by the policy increase loan supply and lower interest rates on new mortgage originations. These lower-interest-rate loans serve as collateral for newly issued RMBS with lower-rated tranches and subsequently experience worse repayment performance. The performance deterioration is pronounced among loans with state guarantees, which suggests that looser collateral requirements may lead to undesired credit risk transfer to the sovereign. (*JEL* E58, G21, G28)

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In recent financial crises, central banks provided liquidity to financial intermediaries, aiming to stabilize the financial sector and stimulate the economy. Liquidity provision took place against lower-quality collateral as requirements loosened in response to deteriorating market conditions.[1] Conceptually, when high-quality collateral is scarce and constraints on collateralized borrowing in private markets bind, looser collateral requirements in central bank facilities can alleviate banks' funding constraints and support lending (Heider and Hoerova 2009; Koulischer and Struyven 2014). When central bank collateral frameworks favor illiquid collateral, however, this may reduce discipline in money and asset markets, which could spill over to the real economy through an overproduction of illiquid real assets (Nyborg 2016). Consequently, changes in central bank collateral policy and their effects on financial markets and the economy have become a controversial aspect of monetary policy.

In this paper, we show how this loosening of collateral policy can produce significant real effects by increasing bank lending and risk-taking. We focus on a relaxation of the European Central Bank's collateral eligibility criteria in December 2011, which allowed residential mortgage-backed securities (RMBS) rated as low as BBB– (Class 3) to become eligible as collateral for the first time.[2] Until that time, only Class 1 RMBS were eligible. We hypothesize that, by lowering eligibility requirements, the European Central Bank (ECB) stimulated the production of lower-rated RMBS—particularly among banks actively issuing such securities—leading to an increase in the supply and reduction in the cost of mortgage debt for households.

Our empirical tests are based on proprietary loan-level data for a large fraction of the mortgage market in the Netherlands. This unique data set allows us to observe the terms of originations and subsequently track whether a given loan is securitized or retained on the balance sheet, as well as loan repayment performance. We conduct a difference-in-differences analysis around the ECB's decision to lower collateral requirements on RMBS. We compare changes in the behavior of banks actively issuing lower-rated, newly eligible RMBS relative to a control group of banks that are historically less active in this segment of the market. We analyze mortgage interest rates and volumes, securitization activity, and risk-taking (that is, ex post performance, as measured by payment arrears) within a postal code and origination month controlling for a host of loan, borrower, and bank characteristics.

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[1] Asset-backed securities and non-marketable assets made up the lion's share of collateral pledged in the Federal Reserve's lending facilities in 2008 and 2009. The Federal Reserve began to accept illiquid asset-backed securities (ABS) in their credit operations once liquidity in private markets evaporated. In contrast, before 2007 the Fed's open market operations centered on buying and selling of liquid government securities. Similarly, the European Central Bank (ECB) removed credit rating thresholds for distressed government debt securities once private lenders refused to accept them as collateral.

[2] The ECB maps every external rating into a credit "class." For example, Class 1, 2, and 3 assets include AAA/AA+/AA/AA−−, A+/A/A−−, and BBB+/BBB/BBB−− rated securities at issuance, respectively, under Standard & Poor's long-term credit rating schedule (see Appendix B for details).

Our main findings are as follows. First, we find that banks more likely to be affected by the relaxed collateral requirements moderately increase the share of newly acceptable Class 2 and 3 tranches in RMBS issuances by about 3.83 percentage points (approximately €937 million per deal) following the policy change, as compared with the period before and also to other banks. Second, we provide micro-evidence that affected banks increase credit supply and reduce interest rates on mortgage originations, controlling for observable determinants of loan risk. The magnitude of the rate reduction is moderate, yet meaningful: on average, affected banks reduce rates by about 1.73% of the mean (4.39%) and 11.7% of the standard deviation (0.65%) in the period following the rule relative to other banks. Affected banks expand mortgage origination volumes by approximately 11.3% in the wake of the rule change, consistent with an increase in the supply of credit.

To better understand the mechanism underlying the results, we examine the direct impact of collateral eligibility on securitization. We compare securitization patterns of mortgage loans originated in the period following the rule change, and, in line with our main hypothesis, we find that affected banks are more likely to securitize newly originated loans, including those with lower interest rates. Conversely, we find no evidence of an increase in credit supply among two sets of nonstandard loans that are ex ante unlikely to be securitized. This indicates that banks do not grant loans likely to remain on balance sheet, which is consistent with the rule change operating through incentives to securitize.

In the final part of the paper, we analyze the repayment performance of these loans to discern whether the change in collateral requirements on RMBS led to a deterioration of underwriting standards or whether it allowed banks to pursue latent investment opportunities without any increase in risk. Examining payment arrears as the dependent variable, we find that the credit expansion among affected banks translates into worse repayment performance, particularly among loans with state guarantees. Loans originated without guarantees by affected banks, on the other hand, tend to perform just as well as similar loans originated by other banks. This suggests that the additional risk-taking induced by the collateral policy change could impose a negative externality on the state through loan guarantees.

Overall, our results highlight an important channel for transmission of central bank collateral policy to the real economy. The liquidity benefits of lower-rated RMBS provide greater incentives to securitize, leading to an increase in credit supply and decline in underwriting standards. This credit risk is not compensated with higher interest payments, and often ends up transferred to the state through loan guarantees. This latter effect suggests a potential undesirable consequence of this nontraditional monetary policy tool.

Our paper makes several contributions to the literature. First, we improve our understanding of collateral and credit. The classic literature on firm-level credit constraints connects collateral values to economic activity (for example,

Bernanke and Gertler 1989). Collateralized borrowing plays a crucial role for bank lending, as demonstrated empirically by Peek and Rosengren (2000) and Gan (2007) in the context of the 1990s Japanese land market collapse. Recent literature examines borrowing from central banks and the effects of collateral frameworks. Ashcraft, Garleanu, and Pedersen (2011) show theoretically that "haircuts"—margins imposed on the collateral seller—are important for asset values and required returns. They also provide supportive empirical evidence in the context of collateral haircuts in Eurosystem operations. Nyborg (2017, 2016) argues that, by distorting asset prices, changes in collateral eligibility may influence the investment and lending decisions of financial institutions. In this spirit, our paper shows that banks respond to ratings-based changes in RMBS eligibility criteria by expanding newly eligible tranches in securitizations and increasing the supply of the mortgages that provide the underlying collateral. In doing so, our paper also contributes to the research and policy debate on the use of external credit ratings in government policies.[3] Kisgen and Strahan (2010) argue that ratings-based regulations on bond investment translate better credit ratings into lower cost of debt capital for firms. Becker and Opp (2014) find that the elimination of ratings-based capital regulation reduced capital buffers and increased risk-taking among insurance companies. Our paper shows that having central bank policies that depend on credit ratings can be successful in stimulating credit supply.

We also contribute to the literature on the outcomes of policy responses during financial crises, particularly the outcomes of nontraditional central bank interventions. Several recent papers examine if and how central bank lending and asset purchase programs stimulate bank mortgage and commercial loan supply.[4] For example, Acharya et al. (2015) examine the bank deposit rates and corporate loan spreads, as well as subsequent real effects for firms, following the ECB's decision to switch to unlimited lender-of-last-resort lending on October 8, 2008. Moreover, Berger et al. (Forthcoming) find that Federal Reserve liquidity provision through the discount window and the Term Auction Facility led to increases in lending during the U.S. financial crisis. Our main contribution is to assess the importance of changes in central bank collateral frameworks during times of stress for bank lending and risk-taking in the mortgage market. Perhaps the closest paper in this regard is Duchin and Sosyura (2014), which shows that banks receiving bailouts from the U.S. Treasury in the form of equity capital injections as part of the Troubled Asset Relief Program (TARP) increased risk-taking in the U.S. mortgage market.[5] Our results suggest

[3] Notably, the U.S. Dodd-Frank Act mandates the removal of references to credit ratings from its regulations; see, for example, www.occ.gov/news-issuances/bulletins/2012/bulletin-2012-18.html.

[4] Among others, see Acharya, Pierret, and Steffen (2016), Carpinelli and Crosignani (2015), Chakraborty, Goldstein, and MacKinlay (2016), Darmouni and Rodnyansky (Forthcoming), Di Maggio, Kermani, and Palmer (2016), and Foley-Fisher, Ramcharan, and Yu (2016).

[5] Other work documents that the TARP stimulated credit supply among participating banks (Li 2013; Berger and Roman 2015), in line with our findings of increased lending. In terms of bank risk-taking, the evidence is less clear.

that nontraditional monetary policy tools may expand lending and thus have positive real effects. However, our results indicate that such policies may be costly to the extent that bank risk-taking could spill over to the sovereign via national loan guarantee programs. Our paper therefore complements recent work that relates government bailouts of the financial sector—that is, asset purchase programs, debt guarantees, or equity injections—to sovereign credit risk. Notably, Acharya, Drechsler, and Schnabl (2014) provide evidence that bank bailouts increased the credit risk of European countries in 2008.

1. Institutional Setting

The ECB allocates liquidity to financial institutions through repurchase agreements—that is, exchanging collateral for loans. The ECB selects a list of eligible securities that banks can post as collateral and corresponding haircuts that determine the amount that can be borrowed per unit of collateral. Both eligibility and haircuts have always been in part based on credit ratings provided externally by a recognized credit rating agency, which are mapped into a common internal rating scale. When the European interbank lending market came under stress in 2008, the ECB started allocating liquidity to fully meet banks' demands (Eberl and Weber 2014). As the eurozone sovereign debt crisis unfolded and conditions in financial markets worsened, collateral eligibility requirements on RMBS relaxed. As of December 19, 2011, the ECB made Class 2 RMBS temporarily eligible as collateral (ECB 2011/25). Shortly thereafter, in June 2012, the ECB made Class 3 RMBS temporarily acceptable at a higher haircut (26% for Class 3 compared with 16% for Class 2; see ECB 2012/11). These decisions were repealed and replaced on August 2, 2012, making Class 2 RMBS permanently eligible and keeping Class 3 RMBS temporarily eligible (ECB 2012/17). Importantly, not only did the ECB begin accepting lower-quality RMBS, but it did so at lower haircuts relative to the private market, thus providing implicit subsidies to banks.[6]

The proportion of ABS (particularly RMBS) that is used as ECB collateral has increased from 5% to almost 30% moving from 2004 to 2008, and remained at 15% in 2013 (Nyborg 2017). When RMBS can be used in collateralized borrowing with the ECB, this reduces banks' need to carry traditional liquid assets, thus allowing for an increase in the supply of bank lending (Loutskina 2011). Since 2008, the process of securitizing mortgage loans and keeping the newly created RMBS with no intent to sell to outside investors—commonly referred to as "self-securitization" or "retained securitization"—has gained

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Similar to Duchin and Sosyura (2014), Black and Hazelwood (2013) find that large participating banks increase risk-taking, whereas small participants do not (see also Berger, Makaew, and Roman 2015). Calomiris and Khan (2015) summarize the literature on the benefits and costs of the TARP.

[6] The difference between the central bank and private market haircuts on the same collateral is called the "haircut subsidy." Drechsler et al. (2016) argue that the haircut subsidy on collateral is increasing with its risk and therefore is likely to be significant for Class 2 and 3 RMBS.

prominence as a liquidity management technique. Currently, about two-thirds of all RMBS are retained within the banking sector via self-securitization or secondary market purchases for potential pledging to the ECB or national banks (Association for Financial Markets in Europe 2014). Thus, RMBS represent a meaningful source of liquidity, and the relaxation of collateral eligibility criteria may be particularly important for at least some European banks.

We examine how domestic banks that are active in the mortgage market in the Netherlands respond in terms of their lending activities. This is an attractive setting for our empirical analysis for at least three reasons. First, the ECB's decisions regarding collateral policy during this period were made at the Eurosystem level and directed toward the struggling economies of Greece, Ireland, Italy, Portugal, and Spain. It is therefore unlikely that the fundamentals or risk-taking opportunities of Dutch banks were central to the policy change, and therefore it represents a plausibly exogenous shock. Second, banks play an important role in credit intermediation in the Netherlands: domestic credit provided by Dutch banks (excluding credit to the government) amounts to more than 200% of GDP, and bank deposits are over 300% of GDP. Third, the extent of securitization activity is the highest in Europe, with the ratio of securitized assets to GDP equal to 16.15% and 7.47% in 2007 and 2012, respectively (Association for Financial Markets in Europe 2014).

Finally, the mortgage market in the Netherlands has some noteworthy features. Originators are typically banks and insurance companies. Mortgages are usually fixed rate with a maturity of 30 years, and interest rates reset every 10 years. Lenders can repossess and sell properties by public auction without a court order. They also have full recourse to the borrower, whereby any leftover debt (after foreclosure) remains enforceable until discharged. In part because of this, mortgage foreclosures amount to a mere 0.046% in 2013. Finally, high loan-to-value (LTV) ratios, often exceeding 100%, are the result of favorable interest deductibility from taxable income on the mortgage loan on a borrower's primary residence.

2. Data and Empirical Methodology

2.1 Data sources and sample selection

Our data on mortgage originations comes from a Dutch software company that provides a platform for banks to manage their loan portfolios. The software enables banks to identify pools of loans that they would like to remove from their balance sheet. When this takes place through a securitization program, the company also generates periodic investor reports on performance and investor payouts associated with the newly created securities. These reports are generally issued monthly. More recently, the software has begun facilitating compliance with the ECB's loan-level initiative to ensure that banks' securities are eligible as collateral in Eurosystem credit operations. Since January 2013, this has required transmitting loan-level information on a regular basis in a

standardized format provided by the ECB. When a bank first begins working with the company, all mortgage loans are read into the platform. These consist of two types of loans. The first is loans retained on the balance sheet. The second is the set of securitized loans that have been removed from the balance sheet, but remain in the system so that RMBS investor reports can be generated.

We download this data directly from the company, collecting banks' loan portfolios and RMBS as of January 2014. The data contain loan-, property-, and borrower-level identifiers, as well as related characteristics. The loan characteristics include the origination date, mortgage size, LTV ratio, interest rate, payment type, purpose, and whether the loan has a state guarantee or not. The data also indicate whether the loan is currently in default, payment arrears, or performing, as of the end of the sample in January 2014. The main property characteristics are the location (two-digit postal code) and valuation, but no further information about property features is given. The borrower characteristics include, for example, primary income and employment status. The identifier of the originating bank is also provided, which we use to merge the mortgage data onto bank and RMBS deal characteristics.

We focus on fixed-rate mortgage originations. The typical Dutch mortgage is a 30-year fixed rate loan (81.33% of the sample). These fixed-rate mortgages usually reset the interest rate every 10 years. In contrast, variable-rate and hybrid-rate mortgages (9.31% and 9.33% of the sample, respectively) have interest rates that depend on the reference rate, the reset periods, and other factors. Our choice ensures the initial interest rate is correct and avoids potential ambiguities arising from resetting rates over the life of the loan.

Our second source of mortgage data comes from the European Datawarehouse (ED), the repository of all loan-level information under the ECB's loan-level initiative. The ED provides data under the same format as the software company for loans used as collateral for eligible RMBS. While the ED does not contain data on balance sheet loans, the ED provides snapshots of the data over a period that is longer for some banks than the time series obtained from the software company—for instance, if a bank begins using the software at a later stage. We combine the ED and our proprietary data to reconstruct the loan portfolio back to January 2013, the beginning of the loan-level initiative. Thus, our second source contains data on securitization status for the stock of loans as reported in 2013.

We obtain data on banks' accounting variables and securitization activity from Bureau van Dijk's Orbis database and Concept ABS, respectively. Orbis provides balance sheet and income statement information collected from annual reports on Dutch banks, where balance sheet information is broken down to the bank (rather than the bank holding company) level. In terms of coverage, the market for Dutch mortgage suppliers is concentrated: in 2012, the five largest banks held 85% of the market. Our sample contains three of the four largest

banks and other smaller players.[7] Concept ABS provides data on RMBS drawn from deal prospectuses. This includes public information on the size and rating of each tranche (security), and whether an issue is retained by the issuing bank or sold.

We construct two loan-level samples. The first is a sample of mortgage originations, which we label the "originations" sample. It includes a list of matched mortgage loan, property, borrower, and bank characteristics at the time of origination, from January 2010 to January 2014. The 426,866 originations cover approximately €85 billion of assets and represent 49% of total originations in the Netherlands for this period.[8] We call our second sample the "loan portfolio" sample, and it classifies the stock of loans (578,097 loans) previously originated into two groups depending on whether the loan is securitized or not, as of January 2014. The €25 billion of securitized loans in our sample covers 65% of RMBS collateral over the same period (Association for Financial Markets in Europe 2014).

2.2 Variable construction and summary statistics

Our event window is defined as follows. In December 2011, the ECB declared that all RMBS rated Class 2 were temporarily eligible as collateral for Eurosystem credit operations, in addition to the previously eligible Class 1 RMBS (ECB 2011/25). In June 2012, the ECB ruled that Class 3 RMBS would also temporarily be accepted (ECB 2012/11). Therefore, we define the "before" period as the period from January 2010 to December 2011, when only Class 1–rated RMBS were eligible. The "after" period starts in January 2012, at which point the lower-rated securities became eligible. The after period ends in December 2013, which is the last month we obtain loan information from the software company.[9]

We classify banks into "affected" and "unaffected" groups as follows. The rule change relaxes eligibility criteria for RMBS with credit quality Class 2 or 3, which were previously not accepted as collateral in Eurosystem credit operations. These lower-rated securities were explicitly targeted by the rule change, as opposed to Class 1 securities, which were eligible since 2008. We assume that changes in eligibility matter more for banks that actively issue lower-rated RMBS. We identify such banks based on RMBS issuance data gathered from Concept ABS. We cumulate RMBS issuance by rating Class 1, 2, and 3 in the period prior to the rule change. We examine a three-year window, as this is the standard callable period for RMBS issued by Dutch banks, which guarantees that issuances before the rule change have not been canceled.

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[7] For confidentiality, we do not disclose information for any individual bank in our sample.

[8] Most originations occur in the densely populated center and west of the country (see Appendix IA.I).

[9] Due to data restrictions associated with the ED data, our analysis of securitization focuses on a shorter post-event window from January 2013 to December 2013.

We then sort banks according to share of RMBS rated Class 2 or 3 out of total issuance and classify banks as "Class 2/3 Issuer" (affected) banks if they have an above-median share and "Other Banks" (unaffected) otherwise.

We examine four dependent variables. First, we consider the *Interest Rate* on mortgage originations, which is provided in our mortgage data at the loan level. This variable captures an important dimension of the pricing of loan originations, since most loans have a 30-year tenure and are fixed rate. Second, we consider the *Loan Volume* of mortgage originations at the bank/postal code/month level, which is expressed in millions of euros. Third, to capture securitization activity, we look at a *Loan Securitized* indicator variable equal to one if a loan is securitized and zero otherwise. Fourth, we use a *Payment Arrears* indicator variable equal to one if a loan is in payment arrears at the end of our sample and zero otherwise. We use arrears to measure repayment performance (for example, Keys et al. 2010), as foreclosures occur infrequently among loans originated in our short event window (less than 0.05%).

To account for observable differences among loans in our regressions, we control for standard loan-, property-, and borrower-level characteristics commonly used in the mortgage lending literature. These variables are described here and precisely defined in Appendix A. We consider the following continuously measured characteristics: *Loan-to-Value* (LTV), *Debt-to-Income* (DTI), and *Log(Mortgage Size)*. These variables are winsorized at the 1% and 99% levels to eliminate the influence of outliers. We consider the origination month of the mortgage and the location (postal code) of the property. We also consider categorical variables for the borrower's employment status, payment type, and mortgage purpose. The employment status categories include whether a borrower is employed or the loan is fully guaranteed, or if a borrower is unemployed, self-employed, and so on. The payment type categories indicate whether a part of that loan repayment is made during the life of the loan (annuity or linear) and/or at maturity (bullet). The mortgage purpose categories include whether the loan was made for purchase, remortgage, renovation, or less common purposes, including equity release or debt consolidation. We also control for bank fixed effects and the following time-varying bank fundamentals: bank size (*Log(Assets)*), leverage (*Equity Ratio*), performance (*Return-on-Equity*), and liquidity on both the asset (*Cash Ratio* and *Liquidity Ratio*) and liability sides (*Core Deposits Ratio*) of the balance sheet.

The unit of observation in our analysis is a mortgage. Properties are often financed with multiple smaller mortgage loan parts. We do not observe loan parts straddling different property/date/borrower combinations, so we aggregate and define a "loan" as the set of loans on a single borrower and property, originated at the same date (to avoid bundling subsequent refinancing or second-lien mortgages by the same borrower). We aggregate loans in two ways. For mortgage size, DTI, and LTV, we take the sum across loan parts at origination. Other loan variables—for example, the interest rate—are loan-weighted averages.

Table 1
Summary statistics

Panel A: Loan-level summary statistics

	N (1)	Mean (2)	Std.a (3)	p25 (4)	Med. (5)	p75 (6)	*N* (7)	Mean (8)	Std. (9)	p25 (10)	Med. (11)	p75 (12)
Originations by affected status												
	Class 2/3 issuer						Other banks					
Interest Rate	201,945	4.51	0.69	4.10	4.59	4.95	224,921	4.57	0.59	4.20	4.60	4.95
Payment Arrears	201,945	0.03	0.17	0	0	0	224,921	0.03	0.16	0	0	0
Loan-to-Value	200,767	80.12	26.19	62.41	86.66	101.9	221,627	88.51	24.03	76.19	95.88	105.00
Debt-to-Income	134,880	1.39	0.65	1.25	1.53	1.78	186,600	1.35	0.58	1.22	1.48	1.63
Log(Mortgage Size)	198,473	11.93	0.72	11.62	12.05	12.39	222,471	12.04	0.61	11.81	12.12	12.42
State Guarantee	201,945	0.44	0.50	0	0	1	224,921	0.55	0.50	0	1	1
Originations of all banks by time period												
	Before period						After period					
Interest Rate	213,657	4.39	0.65	3.95	4.45	4.80	213,209	4.70	0.58	4.35	4.72	5.06
Payment Arrears	213,657	0.02	0.15	0	0	0	213,209	0.03	0.17	0	0	0
Loan-to-Value	212,127	84.96	25.35	69.60	94.16	104.00	210,267	84.07	25.50	69.42	90.11	102.70
Debt-to-Income	149,362	1.35	0.58	1.18	1.46	1.67	172,118	1.37	0.64	1.28	1.52	1.71
Log(Mortgage Size)	211,207	11.98	0.64	11.70	12.06	12.39	209,737	12.00	0.69	11.78	12.11	12.43
State Guarantee	213,657	0.49	0.50	0	0	1	213,209	0.51	0.50	0	1	1
Loan portfolio by affected status												
	Class 2/3 issuer						Other banks					
Interest Rate	315,635	4.71	0.79	4.25	4.70	5.17	262,464	4.78	0.81	4.30	4.76	5.26
Payment Arrears	315,635	0.04	0.19	0	0	0	262,464	0.04	0.20	0	0	0
Loan-to-Value	311,591	74.19	30.71	49.02	80.47	101.80	249,438	80.28	30.24	59.70	84.05	103.90
Debt-to-Income	171,101	1.47	0.52	1.30	1.54	1.81	145,547	1.27	0.57	1.02	1.42	1.62
Log(Mortgage Size)	308,035	11.85	0.68	11.48	11.96	12.31	257,465	12.00	0.68	11.65	12.09	12.44
State Guarantee	315,635	0.40	0.49	0	0	1	262,464	0.27	0.44	0	0	1
Loan portfolio of all banks by securitization status												
	Loan securitized						Loan not securitized					
Interest Rate	113,827	4.72	0.70	4.30	4.70	5.10	464,272	4.75	0.82	4.25	4.75	5.25
Payment Arrears	113,827	0.02	0.13	0	0	0	464,272	0.04	0.21	0	0	0
Loan-to-Value	113,533	84.65	24.86	68.77	91.50	103.20	447,496	74.93	31.66	49.73	79.97	102.10
Debt-to-Income	82,810	1.54	0.46	1.35	1.56	1.84	233,838	1.32	0.57	1.10	1.46	1.68
Log(Mortgage Size)	112,913	12.06	0.55	11.79	12.11	12.40	452,587	11.88	0.71	11.48	11.99	12.36
State Guarantee	113,827	0.52	0.50	0	1	1	464,272	0.29	0.46	0	0	1

(*continued*)

Table 1 presents summary statistics of the variables used in the analysis. We find significant variation in all the key variables. Panel A shows that the average interest rate on mortgage originations of all banks in the before period is 4.39%, with a standard deviation of 0.65%. The fraction of mortgages in payment arrears in the after period is 3%. Around one-third of loans are securitized, and these loans tend to have more state guarantees (52% versus 29%) and better repayment performance (2% versus 4% of loans in arrears). Panel B indicates that mortgages for purchase with a single final payment (bullet) structure are most common. In Panel C, we find no statistically significant differences in the before period between affected banks (Class 2/3 issuer) and the other banks along observable dimensions, including size, leverage, performance, and liquidity.

2.3 Empirical strategy

We assess the impact of the collateral eligibility on bank lending and risk-taking using a difference-in-differences methodology. The change in collateral

Table 1
Continued

Panel B: Loan-level summary statistics

		Loan portfolio		
	Origina-tions	All	Securitized	Not securitized
	(1)	(2)	(3)	(4)
Employment status				
Employed or full loan guaranteed	0.67	0.45	0.71	0.38
Unemployment	0.00	0.00	0.00	0.00
Self-employed	0.06	0.03	0.05	0.03
Student	0.00	0.00	0.00	0.00
Pensioner	0.02	0.01	0.02	0.01
Other	0.09	0.16	0.03	0.19
Unreported	0.16	0.34	0.18	0.38
Payment type				
Annuity	0.18	0.12	0.09	0.13
Linear	0.02	0.02	0.01	0.02
Bullet	0.78	0.75	0.76	0.75
Bullet plus saving deposit	0.56	0.42	0.63	0.37
Bullet plus life insurance	0.06	0.15	0.13	0.16
Bullet plus investment portfolio	0.02	0.08	0.06	0.08
Other	0.03	0.03	0.02	0.04
Mortgage purpose				
Purchase	0.74	0.76	0.81	0.74
Remortgage	0.07	0.07	0.07	0.07
Renovation	0.10	0.10	0.07	0.10
Equity release	0.03	0.02	0.01	0.02
Construction	0.02	0.02	0.01	0.02
Debt consolidation	0.00	0.00	0.00	0.00
Remortgage with equity	0.01	0.00	0.00	0.00
Remortgage with different terms	0.00	0.00	0.00	0.00
Investment mortgage	0.00	0.00	0.00	0.00
Other	0.04	0.03	0.03	0.04

Panel C: Bank-level summary statistics

	Class 2/3 issuer		Other banks		Diff. in	
	Means	Std.	Mean	Std.	means	(*t*-stat)
	(1)	(2)	(3)	(4)	(5)	(6)
Before period						
Log(Assets)	11.36	1.79	11.69	1.65	–0.34	(–0.32)
Return-on-Equity	0.04	0.03	0.10	0.09	–0.06	(–1.19)
Equity Ratio	0.03	0.01	0.04	0.02	–0.01	(–0.86)
Cash Ratio	0.01	0.02	0.04	0.02	–0.02	(–1.39)
Liquid Assets Ratio	0.17	0.03	0.16	0.11	0.08	(0.10)
Core Deposits Ratio	0.57	0.10	0.37	0.32	0.20	(0.83)
After period						
Log(Assets)	11.78	1.51	11.03	1.83	0.75	(0.72)
Return-on-Equity	0.08	0.02	0.08	0.06	0.00	(0.04)
Equity Ratio	0.03	0.01	0.05	0.02	–0.02*	(–2.04)
Cash Ratio	0.04	0.01	0.06	0.03	–0.02	(–0.68)
Liquid Assets Ratio	0.23	0.03	0.18	0.13	0.05	(0.52)
Core Deposits Ratio	0.56	0.20	0.37	0.28	0.18	(0.89)

This table provides sample summary statistics for the mortgage and bank data. Panel A provides statistics on mortgage originations and the loan portfolio. The originations sample contains loan originations from the before (January 2010 to December 2011) and after (January 2012 to December 2013) periods. The loan portfolio sample contains both the stock of loans as of January 2012 and the flow of loans originated in the after period. The unit of observation in Panel A is a loan. Panel B provides a breakdown of the equally weighted fraction of mortgage loans in the originations (Column (1)) and loan portfolio (Columns (2) to (4)) samples across employment status, payment type, and mortgage purpose. Panel C provides statistics on banks in the before and after periods. The unit of observation in Panel C is a bank. Class 2/3 issuer banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively. All variables are measured at time of origination. All variables are defined in Appendix A.

eligibility affects all Eurosystem banks, so we do not have a natural partition of banks in our analysis. Nevertheless, since the reform does not affect all banks in the same way, it is possible to construct affected and control groups. Under the assumption that banks actively issuing lower-rated RMBS are more likely to be affected, we can classify banks into affected and control groups. Specifically, banks with an above-median share of RMBS rated Class 2 or 3 out of total issuance are the affected group (Class 2/3 issuers), and others form the control group.

To examine the effect of the collateral eligibility rule change, we estimate the following cross-sectional regression using ordinary least squares (OLS) on loan originations data:

$$y_{ijklt} = \alpha_l \times \alpha_t + \alpha_k + \beta\ After_t \times Class\ 2/3\ Issuer_k + \theta' \mathbf{X}_{ijkt} + \epsilon_{ijklt}, \qquad (1)$$

where i indexes loans, j indexes borrowers, k indexes banks, l indexes locations (postal codes), and t indexes time (months). The dependent variable is y_{ijklt}, which will be $Interest\ Rate_{ijklt}$ on new originations or subsequent $Payment\ Arrears_{ijklt}$. $After_t$ is an indicator variable equal to one in the months in our sample following the rule change (January 2012 to December 2013), and zero otherwise (January 2010 to December 2011). $Class\ 2/3\ Issuer_k$ is an indicator variable equal to one if the bank belongs to the affected group and zero if it belongs to the control group. α_k, α_l, and α_t denote bank, location, and time fixed effects, respectively. The postal code by month fixed effects control for changing economic conditions that may influence mortgage demand in a given location in a given month. The bank fixed effects control for time-invariant differences between banks individually and across the affected and the control groups, the location fixed effects control for regional differences, and the time (origination month) fixed effects control for aggregate trends.[10] $\mathbf{X}_{ijkt}$ is a vector of control variables, and ϵ_{ijklt} is the error term. Since individual loans only appear in the sample once in a cross-sectional regression (that is, at the time of origination), we cluster all our standard errors at the origination month level (Petersen 2009).

To estimate the response of affected banks in terms of mortgage credit growth, we also estimate this model on data aggregated to the bank/postal code/month level. The dependent variable $Loan\ Volume_{klt}$ is the volume of mortgage originations in millions of euros. $\mathbf{X}_{klt}$ includes control variables that are either the bank condition ratios or loan characteristics, averaged (unweighted) across loans within a given bank/postal code/month.

The coefficient of interest, β, measures how affected banks respond to the change in collateral requirements relative to control banks. If Class 2/3 issuers cut rates (increase loan volume) in the after period, the coefficient β will be strictly negative (positive). The null hypothesis that collateral policy is

[10] Appendix IA.II shows the aggregate trends in Dutch mortgage lending during the event window.

irrelevant for bank lending behavior (say, because banks can easily restructure RMBS without changing lending) corresponds to β equal to zero.

Our main specification controls for unobservables that might have a similar influence on the loan supply of the affected and control banks. However, identification of β requires controlling for any variation in the characteristics of the affected group that systematically correlates with the rule change. Put differently, we need to control for other shocks that might be correlated with the choice to issue lower-rated RMBS and the timing of the policy change, including changes in risk-taking opportunities, financial condition, or credit demand.

We tackle such endogeneity concerns as follows. First, to control for changes in risk-taking opportunities, we account for a large number of loan, borrower, and property characteristics in $\mathbf{X}_{ijkt}$. These include LTV, DTI, and mortgage size, as well as categorical variables for borrower employment status, payment type, and mortgage purpose. In our preferred specification, we include postal code by month fixed effects, therefore comparing lending behavior in very similar geographical and product markets. Second, we include bank-level control variables for size, profitability, leverage, and liquidity, since healthy banks or those with ample liquidity need not benefit from the relaxation in collateral eligibility. We control for these differences both in a linear framework and nonparametrically using matching estimators. Third, we conduct falsification tests on the behavior of undercapitalized or ex post liquidity-constrained banks, as well as cyclical lending patterns. Fourth, while our main approach partitions the set of banks, in some tests we partition the set of loans within banks on the basis of ease of securitization. In particular, we consider nonstandard loan types that are ineligible for securitization and thus unlikely to be affected by the rule change.

It is important to note that we do not observe any control banks "switching" to the affected group after the rule change by ramping up lower-rated RMBS issuance. This suggests that there are nontrivial costs of lower-rated RMBS issuance such that the liquidity benefits are not large enough to induce control banks to issue these securities for the first time.

We emphasize three main frictions that could explain inertia among control banks and thus justify our empirical approach.[11] First of all, we consider regulatory constraints. Since Dutch mortgage originators face capital regulation and lower-rated RMBS have relatively high capital charges, some banks may prefer to issue only Class 1 securities. Under Basel III, risk weights range from as low as 20% for Class 1 and up to 105% for Class 3 five-year maturity, senior RMBS exposures (Bank for International Settlements 2014). In the past, Dutch banks almost always retain some of the RMBS, possibly to overcome information frictions (Leland and Pyle 1977), and do not simply originate,

[11] Erel, Nadauld, and Stulz (2014) provide empirical evidence in the U.S. context that RMBS holdings largely reflect fixed differences between banks, including bank size and securitization activity.

securitize, and distribute mortgages in their entirety without incurring any capital charges. More recently, credit risk retention rules imposed by Dutch regulators now explicitly require that issuers retain an economic interest in each RMBS (Committee of European Banking Supervisors 2010).

Second, there may be fixed costs associated with issuing these securities. It may be costly to modify an existing securitization program, gain access to a mortgage broker network to acquire collateral, or switch to marketing lower-rated RMBS to a different clientele after the rule change. The latter cost may be pronounced if bond market investor demand is segmented across risk classes (Becker and Ivashina 2015; Chernenko and Sunderam 2012).

Third, originators may be reluctant to begin issuing low-rated RMBS after the rule change to take advantage of the ECB's assistance either out of concerns that regulators, depositors, creditors, or analysts could interpret it as a signal of weakness (Armantier et al. 2015), or due to persistent differences in business models or risk cultures (Fahlenbrach, Prilmeier, and Stulz 2012).

In summary, our empirical approach is designed to alleviate concerns regarding unobservables that might jointly influence selection into the affected group and lending behavior after the rule change. However, to the extent that banks are not randomly assigned into treated and control groups, the coefficient β may be interpreted as the average effect of the rule change among banks that choose to issue lower-rated RMBS. While our control variables and various robustness tests help reduce concerns regarding unobservables, in the absence of a true experiment we cannot rule out this alternative interpretation.

3. Empirical Results

3.1 Effect of collateral eligibility on bank securitization activity

We first estimate the effect of the change in collateral eligibility on the securitization activity of banks. Our empirical analysis is based on the premise that the change in collateral eligibility policy increased the liquidity of lower-rated RMBS. Banks active in this segment of the market should increase the share of Class 2 and 3 RMBS, relative to other periods and relative to other banks, as these securities were the focus of the rule change.

We collect data from Concept ABS on the universe of RMBS deals associated with banks headquartered in the Netherlands for the years 2010 to 2013. This data consists of 74 deals with a total value of €249.44 billion, of which €179.87 billion was issued prior to the rule change and the remainder after.[12] Each deal corresponds to an off-balance sheet vehicle that holds mortgages and is funded by RMBS issues. On average, each deal has 5.39 RMBS issues ranging from Class 1–rated to unrated. For each deal, we aggregate issues by credit rating according to the ECB's harmonized rating scale. Over the event window, the

[12] We exclude three RMBS deals collateralized solely by state-guaranteed mortgages. Such deals are riskless and always Class 1–rated, and the ECB rule is therefore irrelevant.

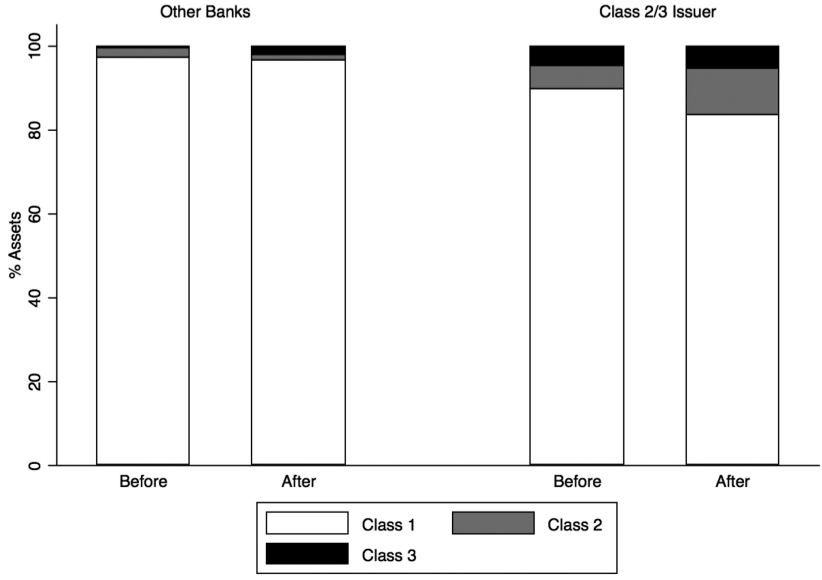

Figure 1
Collateral eligibility and bank securitization activity
Share of assets funded by Class 1, 2, and 3 residential mortgage-back securities (RMBS) issued by banks from the Netherlands before (January 2010 to December 2011) and after (January 2012 to December 2013) the December 2011 change in ECB collateral eligibility. Class 1, 2, and 3 securities correspond to AAA/AA+/AA/AA−, A+/A/A−, and BBB+/BBB/BBB− securities, respectively, under Standard & Poor's long-term credit rating schedule (see Appendix B). Class 2/3 issuer banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period.

bulk of these securities are highly rated: €226.65 billion Class 1 versus €10.59 billion Class 2 or 3.

We next show a substantial variation over time and by affected bank status in issuance behavior. In Figure 1, we first provide graphical evidence of changes in securitization activity before and after the rule change by affected bank status. The figure shows the distribution of RMBS across the Class 1, 2, and 3 ratings categories aggregated across banks in each group. For the affected banks, two notable facts emerge. First, banks in the affected group have a nontrivial allocation of assets to Class 2 and 3 securities, about 5% and 6% of assets, respectively. Second, following the rule change, these banks exhibit an increase in the issuance of both Class 2 and 3 tranches; notably, the allocation to these securities increases to about 18% of issuance. In contrast, the total issuance of Class 2 and 3 securities by the other banks is small and remains constant through the rule change.

We next provide corresponding regression evidence. We simply estimate:

$$y_{skt} = \alpha_k + \beta\ After_t \times Class\ 2/3\ Issuer_k + \epsilon_{skt}, \tag{2}$$

where s indexes deals, k indexes banks, and t indexes time. The dependent variable, y_{skt}, is either the value (in billions of €) or the percentage of Class 2

Table 2
Collateral eligibility and bank securitization activity

Dependent variable:	*Class 2/3 Amount*		*Class 2/3 Share*	
	(1)	(2)	(3)	(4)
After × Class 2/3 Issuer	1.037*	0.937*	4.721***	3.829*
	(0.511)	(0.462)	(1.280)	(1.815)
After	−0.695	−0.431	−0.306	0.536
	(0.433)	(0.437)	(0.283)	(0.415)
Class 2/3 Issuer	−0.193		3.966***	
	(0.452)		(1.096)	
Bank fixed effects	N	Y	N	Y
N	74	74	74	74
R^2	0.141	0.548	0.481	0.592

This table presents estimates of the impact of the change in European Central Bank (ECB) collateral eligibility policy on securitization activity at the bank level. The unit of observation in each regression is a securitization (that is, a special finance vehicle). Columns (1) and (2) define the dependent variable as the value of securities issued of Class 2 or 3 credit rating in billions of euros (see Appendix B for the ECB's harmonized rating scale). Columns (3) and (4) define the dependent variable as the ratio of the value of securities of rating Class 2 or 3 to total issuance size. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. The before period is from January 2010 to December 2011, and the after period is from January 2012 to December 2013. Where indicated, regressions control for bank fixed effects. All regressions are estimated using weighted least squares (weighted by total issuance size). All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the bank level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

or 3 securities in the current deal. The α_k variable corresponds to bank fixed effects. The estimation is performed using least squares weighted by issue size. Standard errors are clustered at the bank level to account for correlations across deals. The coefficient of interest, β, measures how affected banks respond to the change in collateral eligibility in terms of issuance of Class 2 or 3 securities.

Table 2 presents the results. Column (1) shows that deals originated by affected banks following the rule change contain a greater funding from Class 2 or 3 securities. Column (2) controls for bank fixed effects, which allows us to better control for differences between banks. Columns (3) and (4) consider the percentage of Class 2 or 3 securities in deals originated by affected banks, which is our preferred specification, as it allows us to additionally control for deal size. These last two columns indicate that the affected banks structure deals to include a larger fraction of Class 2 or 3 securities after the rule change, corroborating the graphical evidence in Figure 1.[13] With the inclusion of bank fixed effects, these results remain statistically significant, and the economic magnitudes are moderate, yet meaningful. Indeed, affected banks increase issuance of newly eligible securities by €937 million or 3.83 percentage points of the issuance per deal relative to the unaffected banks' deals.

3.2 Effect of collateral eligibility on mortgage credit supply

We now estimate the effect of the collateral eligibility rule change on interest rates and loan volumes. In Figure 2, we first provide a graphical representation

[13] Year-by-year estimates of Class 2/3 securities issuance are shown graphically in Appendix IA.III.

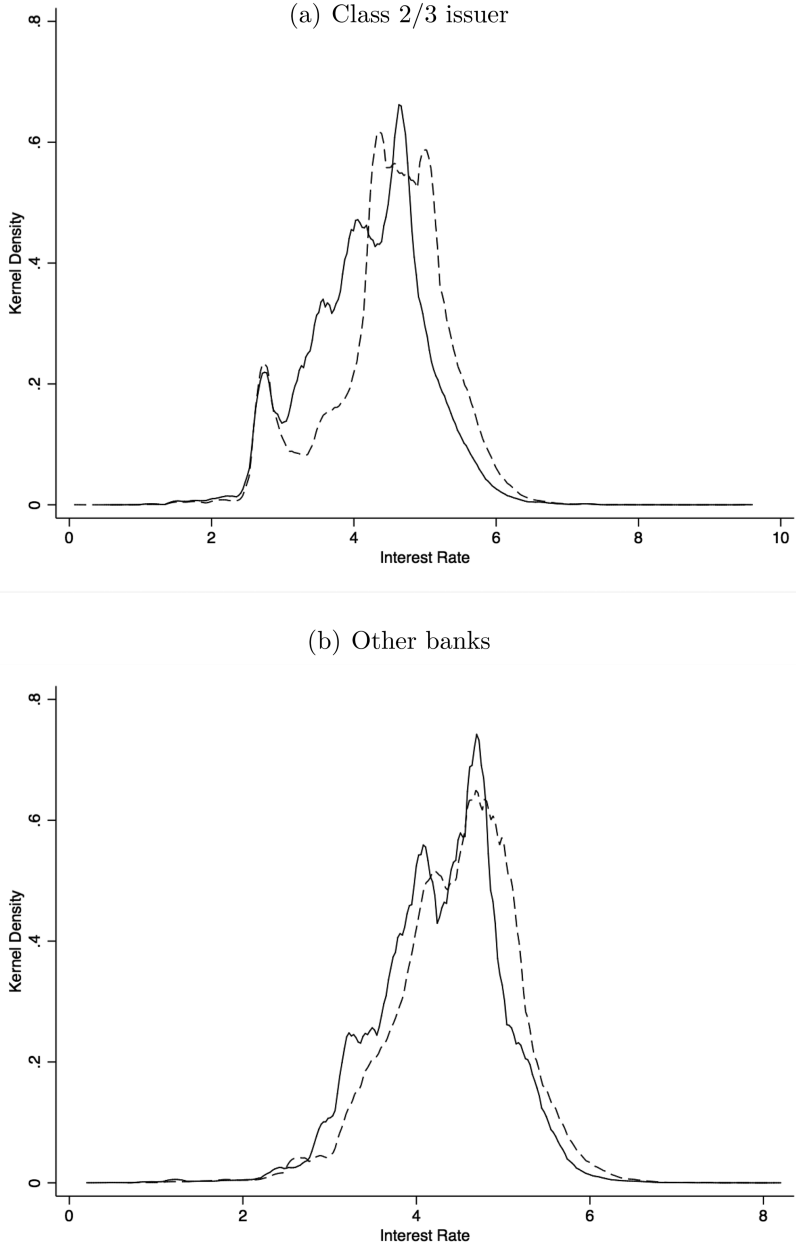

Figure 2
Collateral eligibility and mortgage interest rates
This figure shows the Epanechnikov kernel density of interest rate on mortgage originations for both the Class 2/3 issuer and other bank groups for the period before (January 2010 to December 2011, dashed line) and after (January 2012 to December 2013, solid line) the December 2011 change in ECB collateral eligibility. Class 2/3 issuer banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period.

of the effect on interest rates. The figure plots the unconditional distributions of mortgage interest rates for both the affected and control groups before and after the change in collateral policy. The figure depicts a leftward shift of the kernel density for the affected group after the rule, and thus the distribution of interest rates shifts downwards. There is no such shift for the control group. We formally describe the relation between the policy change and interest rates based on the estimation of Equation (1). We show that the finding in the figure is statistically robust in a multivariate regression framework that accounts for heterogeneity across loans and borrowers (that is, conditional on loan risk), as well as differences among banks.

Table 3 shows the results. Column (1) shows the estimate of β without including any control variables. It can be seen that the average interest rates decreased by 0.179% for affected banks relative to the control group after the rule change. The point estimate is statistically significant at the 1% confidence level. In Column (2), we include employment status, payment type, and mortgage purpose fixed effects along with lender and postal code fixed effects to account for loan, borrower, bank, and location heterogeneity. Lender fixed effects control for time-invariant bank factors that may be correlated with affected bank status and ensure our estimates are identified from within-bank changes in behavior around the rule change. The estimate changes to -0.110 and remains significant at the 1% level.

We further control for aggregate economic shocks through the inclusion of origination month fixed effects in Column (3). In Column (4), we control nonparametrically for any observed or unobserved location/time-specific shocks that may be correlated with affected bank status by augmenting the model with the interaction between postal code and origination month fixed effects. Columns (3) and (4) show that the estimated effect of the rule change drops to between -0.076 and -0.079. Column (5) controls for the *Loan-to-Value* and *Debt-to-Income* ratios, and *Log(Mortgage Size)*—common measures of credit risk—and we find the estimate remains unchanged at -0.077 and significant at the 1% level.

Column (6) further adds a control variable for whether the loan receives a state guarantee or not. This is an indicator variable equal to one if any part of the loan is documented to have a state guarantee and zero otherwise. This corresponds to roughly 50% of the loans in the sample. The estimated effect of the rule change on interest rates is essentially unchanged in terms of size and statistical significance. The coefficient on *State Guarantee* is negative and significant, indicating that guaranteed loans have lower interest rates. This is reassuring since the state guarantee by itself implies higher recovery rates in case of default.

Finally, we rerun the analysis with bank controls for beginning-of-year size (*Log(Assets)*), profitability (*Return-on-Equity*), leverage (*Equity Ratio*), and liquidity (*Cash Ratio*, *Liquidity Ratio*, and *Core Deposits Ratio*). We see in

Table 3
Collateral eligibility and credit supply: Interest rates

Dependent variable: *Interest Rate*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
After × Class 2/3 Issuer	−0.179***	−0.110***	−0.076***	−0.079***	−0.077***	−0.097***	−0.200***
	(0.034)	(0.025)	(0.023)	(0.023)	(0.022)	(0.023)	(0.066)
Loan-to-Value					0.001***	0.002***	0.002***
					(0.000)	(0.000)	(0.000)
Debt-to-Income					−0.067***	−0.009	−0.002
					(0.006)	(0.006)	(0.007)
Log(Mortgage Size)					−0.064***	−0.106***	−0.113***
					(0.005)	(0.005)	(0.005)
State Guarantee						−0.281***	−0.306***
						(0.008)	(0.008)
Log(Assets)							−0.525*
							(0.267)
Equity Ratio							−130.6***
							(39.98)
Return-on-Equity							−0.079**
							(0.031)
Cash Ratio							0.033***
							(0.008)
Liquid Assets Ratio							−0.053**
							(0.030)
Core Deposits Ratio							0.297
							(1.858)
After	−0.221***	−0.234***					
	(0.061)	(0.046)					
Class 2/3 Issuer	0.046						
	(0.031)						
Employment status fixed effects	N	Y	Y	Y	Y	Y	Y
Payment type fixed effects	N	Y	Y	Y	Y	Y	Y
Mortgage purpose fixed effects	N	Y	Y	Y	Y	Y	Y
Bank fixed effects	N	Y	Y	Y	Y	Y	Y
Postal code fixed effects	N	Y	Y	N	N	N	N
Origination month fixed effects	N	N	Y	N	N	N	N
Postal code × origination month fixed effects	N	N	N	Y	Y	Y	Y
N	426,866	426,864	426,864	426,864	426,864	426,864	366,029
R^2	0.065	0.161	0.250	0.259	0.267	0.294	0.310

This table presents estimates of the impact of the change in European Central Bank collateral eligibility policy on the interest rates of new mortgage originations. The unit of observation in each regression is a loan. The dependent variable is the *Interest Rate*. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. The before period is from January 2010 to December 2011, and the after period is from January 2012 to December 2013. Where indicated, regressions control for loan characteristics at origination and various fixed effects. Regressions containing loan characteristics also include corresponding indicator variables equal to one whenever the characteristic is missing. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

Column (7) that the estimate increases to −0.200 and remains significant at the 1% confidence level.

The results so far indicate that there is a reduction in interest rates on mortgage originations following the collateral eligibility rule change and that a conservative estimate of the size of this reduction is 7.6 basis points in absolute terms. Importantly, in terms of economic magnitudes, this represents a moderate, yet meaningful reduction in rates in the period after the rule change, 1.73% of the unconditional mean (4.39%) and 11.7% of the standard deviation (0.65%) from the period before.

We next examine how the rule change affected the volume of mortgage originations among banks actively issuing these newly eligible lower-rated RMBS. We estimate the analog of Equation (1) on origination data aggregated to the bank/postal code/month level.

Table 4 presents the results of the estimation. Columns (1) to (7) show the estimate of β including progressively more control variables. The point estimate is positive and always statistically significant at the 1% confidence level. It can be seen that, in a given postal code and month, the average loan volume increased between €740,000 and €2.6 million for affected banks relative to the control group after the rule change. The average bank during the event window from 2010 to 2011 issues roughly €6.7 million in loan volume per postal code in a given month. Our most conservative estimate therefore indicates an increase of about 11.3% in loan volume for the affected banks relative to the control group per postal code over a given month in the wake of the policy change.

These credit supply results survive an array of robustness tests reported in the Internet Appendix. First, they are robust to clustering errors at the postal code, bank/month, bank/postal code, and month/postal code levels (Appendix IA.IV).[14] Second, we obtain similar results when we collapse the month dimension of our data into "pre" and "post" periods following the Bertrand, Duflo, and Mullainathan (2004) methodology (Appendix IA.V). Third, the estimates are not driven by outliers (Appendix IA.VI). Fourth, we rule out alternative explanations based on bank capital and liquidity constraints, as well as cyclical lending patterns. Finally, our results hold for complementary measures of bank exposure (Appendix IA.VII) and an alternative timing that allows for stepwise changes in collateral eligibility (Appendix IA.VIII).

3.2.1 Dynamics of mortgage credit supply. In the baseline estimation, we split 2010 to 2013 into before and after periods. The point estimates capture time averages across each event window. To verify that these estimates are significant because of the rule change, we examine the relation between the policy change and credit supply on a year-by-year basis by estimating our model separately for each year. Here, we drop the time and bank fixed effects due to collinearity.

The results are shown in Table 5. Columns (1) to (4) show that the reduction in interest rates on new originations occurs only after the policy change. Prior to the policy change, the point estimates are statistically insignificant. In contrast, 2012 and 2013 show a negative and statistically significant difference-in-differences estimate. Column (5) pools all of the data into a single regression and interacts *Class 2/3 Issuer* with year dummies and yields similar results

[14] In untabulated results, we cluster by bank and (double-cluster) by bank × month. For these tests, our estimates remain significant at conventional levels for rates, but become marginally insignificant for volumes (p-values of 14.4 and 11.1% for bank and bank × month clustering, respectively). We interpret these findings with caution given the number of banks in our sample (16) and therefore low power of these tests.

Table 4
Collateral eligibility and credit supply: Loan volume

Dependent variable: *Loan Volume*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
After × Class 2/3 Issuer	0.740***	0.787***	0.795***	0.847***	1.201***	1.357***	2.559***
	(0.161)	(0.174)	(0.176)	(0.192)	(0.232)	(0.238)	(0.671)
Loan-to-Value					0.009***	0.002*	0.002
					(0.001)	(0.001)	(0.002)
Debt-to-Income					0.205***	−0.045	−0.088
					(0.061)	(0.047)	(0.055)
Log(Mortgage Size)					0.274***	0.488***	0.446***
					(0.072)	(0.068)	(0.076)
State Guarantee						1.461***	1.302***
						(0.124)	(0.177)
Log(Assets)							−7.642***
							(2.457)
Equity Ratio							584.7
							(355.5)
Return-on-Equity							0.580**
							(0.263)
Cash Ratio							0.268**
							(0.111)
Liquid Assets Ratio							0.712***
							(0.245)
Core Deposits Ratio							50.55***
							(15.27)
After	−0.615***	−0.725***					
	(0.139)	(0.152)					
Class 2/3 Issuer	−1.851***						
	(0.126)						
Bank fixed effects	N	Y	Y	Y	Y	Y	Y
Postal code fixed effects	N	Y	Y	N	N	N	N
Origination month fixed effects	N	N	Y	N	N	N	N
Postal code × origination month fixed effects	N	N	N	Y	Y	Y	Y
N	41,597	41,595	41,595	41,595	33,129	33,129	27,209
R^2	0.035	0.499	0.506	0.518	0.535	0.541	0.569

This table presents estimates of the impact of the change in European Central Bank collateral eligibility policy on banks' volume of mortgage originations. The unit of observation in each regression is a bank/postal code/month. *Loan Volume* is the total value (in millions of euros) of new mortgage originations. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. The before period is from January 2010 to December 2011, and the after period is from January 2012 to December 2013. Where indicated, regressions control for various fixed effects, and loan characteristics at origination averaged across loans within a given bank/postal code/month cell. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

to the year-by-year estimates. Columns (6) to (10) show results on volume dynamics. The estimates from these regressions are consistent with a response to the policy change, as opposed to some ongoing differential trend in lending between Class 2/3 issuer and other banks.[15]

Figure 3 further describes the dynamics of mortgage credit supply by graphing quarter-by-quarter estimates based on the models shown in Columns (5) and (10). The estimates confirm that Class 2/3 issuer banks respond sharply to the policy change; however, there is some evidence of an increase in credit supply in 2011:Q4, suggesting that banks may have anticipated

[15] *F*-tests based on the pooled regressions confirm the lack of preexisting differential trends between affected and control banks, and a statistically significant increase in credit supply around the policy change. Annual dynamics based on these pooled regressions are graphed in Appendix IA.IX.

Table 5
Dynamics of credit supply

Dependent variable:	*Interest Rate*					*Loan Volume*				
Year:	2010 (1)	2011 (2)	2012 (3)	2013 (4)	All years (5)	2010 (6)	2011 (7)	2012 (8)	2013 (9)	All years (10)
Class 2/3 Issuer	−0.022	0.081	−0.043**	−0.080***		−2.440***	−2.536***	−1.202***	−0.521**	
	(0.013)	(0.048)	(0.018)	(0.024)		(0.183)	(0.334)	(0.186)	(0.221)	
Class 2/3 Issuer × 2010					−0.016					−2.337***
					(0.014)					(0.170)
Class 2/3 Issuer × 2011					0.052					−2.544***
					(0.049)					(0.313)
Class 2/3 Issuer × 2012					−0.061***					−1.248***
					(0.017)					(0.154)
Class 2/3 Issuer × 2013					−0.094***					−0.516**
					(0.019)					(0.193)
Loan controls	Y	Y	Y	Y	Y	Avg.	Avg.	Avg.	Avg.	Avg.
Employment status fixed effects	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A
Payment type fixed effects	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A
Mortgage purpose fixed effects	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A
Postal code × origination month fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	102,824	110,384	111,431	102,225	426,864	9,329	8,261	8,016	7,523	33,219
R^2	0.285	0.178	0.122	0.241	0.239	0.303	0.297	0.304	0.285	0.294

This table examines the dynamics of the estimates of the impact of the change in European Central Bank collateral eligibility policy on mortgage credit supply. The unit of observation in each regression is either a loan or bank/postal code/month, and the dependent variable is either the *Interest Rate* or *Loan Volume* (Columns (1) to (5) and (6) to (10), respectively). *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. Where indicated, regressions control for loan characteristics at origination and various fixed effects. Loan-level regressions include indicator variables equal to one whenever a given loan characteristic is missing. Volume regressions control for loan characteristics at origination averaged across loans within each bank/postal code/month–level cell. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

Figure 3
Dynamics of mortgage credit supply for full sample (quarterly frequency)
This figure plots the estimated difference in lending behavior among Class 2/3 issuers and other banks over the event window. The top and bottom panels show the differences in loan-level interest rates (percentage points) and postal code–level loan volumes (millions of euros), respectively. Each series is normalized so that the first observation is equal to zero. The vertical line corresponds to the December 2011 change in ECB collateral eligibility. The point estimates correspond to the quarter-by-quarter interaction terms based on the regressions shown in Columns (5) and (10) of Table 5 with 95% confidence intervals around them.

the ECB's policy change, perhaps due to an announcement effect that is unobservable to the econometrician.[16] While anticipation by affected banks could be an innocuous form of pre-trends—in the sense that it would lead us to underestimate the effect of the policy change—we remain concerned that this anticipation might instead reflect systematic differences among banks' investment opportunities or loan risk. This concern is compounded by the fact that there are level differences in loan volumes in the before period.

As advocated by Roberts and Whited (2013), we tackle this issue by incorporating a difference-in-differences matching estimator that controls nonparametrically for differences among affected and control banks. This approach offers an alternative method to control for differences among banks and has the potential to mitigate anticipation effects. We first match control banks to Class 2/3 issuer banks based on observable characteristics (*Log(Assets)*, *Equity Ratio*, *Return-on-Equity*, *Cash Ratio*, *Liquid Assets Ratio*, and *Deposits Ratio*) from the beginning of 2010. We additionally match on loan-level characteristics to account for heterogeneity in loan portfolios. Each Class 2/3 issuer bank loan is matched with replacement to a unique control loan originated in the same postal code and month by the matched control bank. We conduct nearest-neighbor matching based on the Mahalanobis distance metric (Abadie and Imbens 2006). This metric captures the distance between attributes and accounts for the variance of individual attributes, as well as covariances between them. We impose that the difference in each matching variable be no more than 2.54 times the standard deviation of that variable, which is sufficient to ensure high-quality matches.

Panel A of Table 6 shows the summary statistics for the Class 2/3 issuer and matched control loan samples. The number of successful matches (N) drops due to a lack of eligible control loans as we include more covariates into the matching. These summary statistics indicate that our matching criteria are successful in achieving covariate balance among the two groups of banks along the dimensions we match on, with the exception of mortgage size, for which some economically small differences persist. Panel B verifies that the collateral eligibility shock continues to have an important effect on loan supply using our matched sample. This is true in terms of both economic and statistical significance for both volumes and interest rates, and holds regardless of the set of matching covariates. Our main findings are therefore unlikely to reflect nonlinearities in the relation between bank characteristics and loan outcomes. In addition, quarter-by-quarter credit supply estimates plotted in Figure 4 indicate that while anticipation effects persist in 2011:Q4 among Class 2/3 issuer banks, they are smaller in magnitude for both interest rates and loan volumes.

[16] The Governing Council of the ECB decided on December 8, 2011, to relax RMBS collateral eligibility (ECB 2011/25); this change was implemented on December 19, 2011, and published online in the *Official Journal of the European Union* on December 22, 2011.

Table 6
Matched sample analysis

Panel A: Summary statistics for matched samples

	Before period (2010–2011)				After period (2012–2013)			
	Class 2/3 issuer (1)	Matched control (2)	Diff. in means (3)	(*t*-stat) (4)	Class 2/3 issuer (5)	Matched control (6)	Diff. in means (7)	(*t*-stat) (8)
(i) Bank matching; no matching on loan characteristics (N = 39,730)								
Loan-to-Value	78.63	97.61	−18.97***	(−19.72)	79.51	96.75	−17.24***	(−8.21)
Debt-to-Income	1.07	1.62	−0.55***	(−17.43)	0.96	1.54	−0.58***	(−12.97)
Log(Mortgage Size)	12.02	12.12	−0.11***	(−3.92)	12.03	12.12	−0.09***	(−3.76)
State Guarantee	0.50	0.88	−0.38***	(−12.46)	0.46	0.81	−0.36***	(−8.69)
(ii) Bank matching; loan matching on *Loan-to-Value* (N = 37,784)								
Loan-to-Value	81.09	81.19	−0.10	(−0.20)	82.42	82.53	−0.10	(−0.16)
Debt-to-Income	1.11	1.45	−0.34***	(−14.05)	1.02	1.42	−0.40***	(−12.92)
Log(Mortgage Size)	12.06	11.99	0.07***	(4.38)	12.07	12.00	0.06***	(4.10)
State Guarantee	0.51	0.76	−0.24***	(−9.94)	0.49	0.77	−0.28***	(−10.34)
(iii) Bank matching; loan matching on all characteristics (N = 36,393)								
Loan-to-Value	80.00	80.37	−0.36	(−0.27)	79.58	80.13	−0.55	(−0.30)
Debt-to-Income	1.22	1.24	−0.02	(−0.30)	1.09	1.12	−0.03	(−0.49)
Log(Mortgage Size)	11.99	11.88	0.11**	(2.90)	11.95	11.89	0.07	(1.23)
State Guarantee	0.56	0.56	0.00	(0.00)	0.50	0.50	0.00	(0.00)

Panel B: Matching estimates for credit supply

Dependent variable:	Δ*Interest Rate*			Δ*Loan Volume*		
Loan matching:	(i) None (1)	(ii) LTV (2)	(iii) All (3)	(i) None (4)	(ii) LTV (5)	(iii) All (6)
After	−0.135**	−0.211***	−0.221***	1.709**	1.705**	1.736**
	(0.051)	(0.034)	(0.035)	(0.739)	(0.747)	(0.775)
Δ*Loan-to-Value*	0.002***	0.003	0.003***	0.042***	0.044***	0.045***
	(0.000)	(0.003)	(0.001)	(0.013)	(0.015)	(0.015)
Δ*Debt-to-Income*	0.088***	−0.002	0.263***	0.380	0.381	0.135
	(0.020)	(0.015)	(0.073)	(0.444)	(0.445)	(0.563)
Δ*Log(Mortgage Size)*	−0.088***	−0.049***	−0.066***	0.172	0.148	0.471
	(0.011)	(0.010)	(0.024)	(0.175)	(0.171)	(0.346)
Δ*State Guarantee*	−0.108***	−0.227***	-	1.939**	2.117**	2.001
	(0.023)	(0.014)	(-)	(0.920)	(0.905)	(1.200)
Employment status fixed effects	Y	Y	Y	N/A	N/A	N/A
Payment type fixed effects	Y	Y	Y	N/A	N/A	N/A
Postal code fixed effects	Y	Y	Y	Y	Y	Y
N	39,730	37,784	36,393	1,294	1,272	1,194
R^2	0.060	0.071	0.071	0.783	0.783	0.776

This table reports summary statistics and point estimates from a difference-in-differences matching estimator. Class 2/3 issuer banks are matched to candidate control banks using a nearest-neighbor match based on the Mahalanobis metric, matching on *Log(Assets)*, *Equity Ratio*, *Return-on-Equity*, *Cash Ratio*, *Liquid Assets Ratio*, and *Core Deposits Ratio* from the beginning of 2010. The affected loan sample consists of all standard loan types granted by Class 2/3 issuer banks between 2010 and 2013 with valid matching variables. The candidate control sample includes the loans granted by matched control banks with valid matching variables over the same time period. Affected loans are matched to the closest control loan originated in the month and postal code using the same nearest-neighbor matching methodology with replacement and a tolerance of 2.54 times the standard deviation of each matching variable. Three matching schemes are employed: (i) no matching on loan characteristics; (ii) matching on *Loan-to-Value* (LTV) only; and (iii) matching on *Loan-to-Value*, *Debt-to-Income*, *Log(Mortgage Size)*, and *State Guarantee* at origination. Panel A shows sample averages for the affected and matched control samples. N represents the number of affected (and matched control) loans. Panel B estimates the effect of the relaxation in collateral eligibility on the difference in interest rates and loan volumes for the matched samples controlling for differences in loan characteristics between the affected and control samples. For the volume regressions, the matched sample is aggregated to the bank/postal code/month–level and loan characteristics at origination are averaged within each cell. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively. All variables are defined in Appendix A.

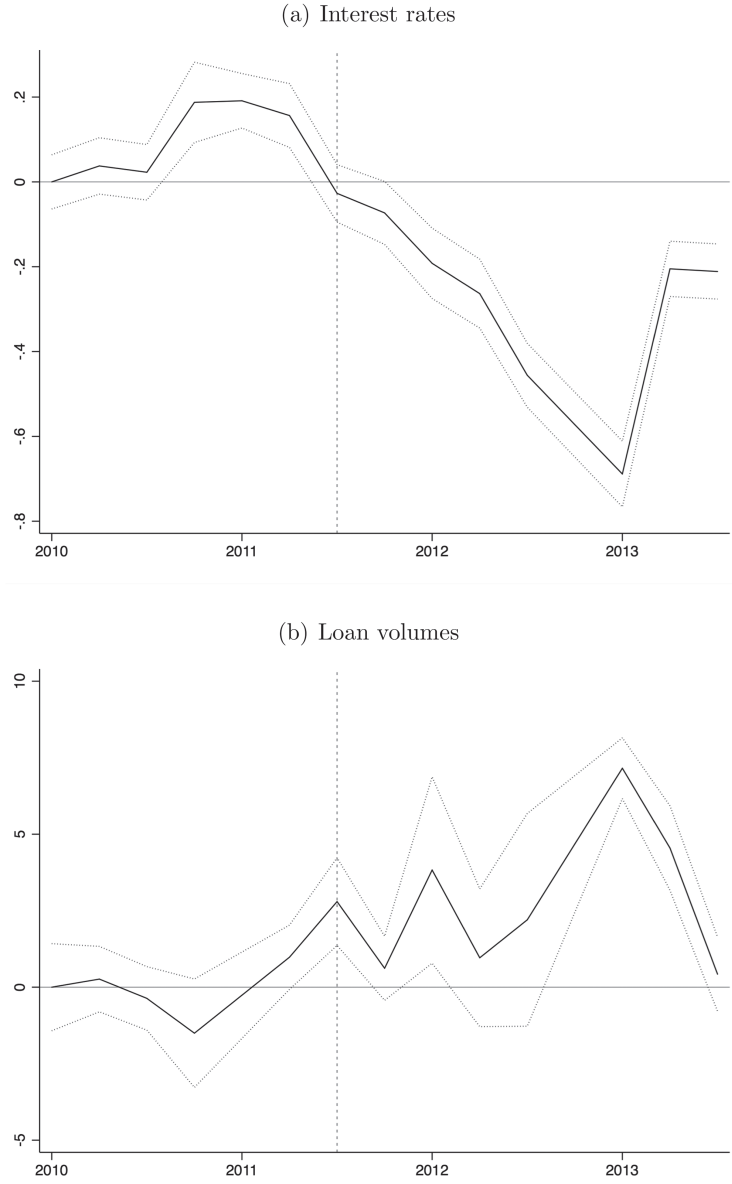

Figure 4
Dynamics of credit supply for matched sample (quarterly frequency)
This figure plots the estimated difference in lending behavior among Class 2/3 issuers and other banks over the event window for the matched sample. The top and bottom panels show the differences in loan-level interest rates (percentage points) and postal code–level loan volumes (millions of euros), respectively. Each series is normalized so that the first observation is equal to zero. The vertical line corresponds to the December 2011 change in ECB collateral eligibility. The point estimates correspond to the quarter-by-quarter interaction terms based on the difference-in-differences matching estimator shown in Columns (3) and (6) of Panel B of Table 6 (matching on all covariates) with 95% confidence intervals around them.

Table 7
Effects of collateral policy change accounting for anticipation effects

Dependent variable:	*Interest Rate*			*Loan Volume*		
	(1)	(2)	(3)	(4)	(5)	(6)
After × *Class 2/3 Issuer*	−0.097***	−0.121***	−0.126***	1.357***	1.496***	1.501***
	(0.023)	(0.021)	(0.023)	(0.238)	(0.236)	(0.255)
2011:Q4 × *Class 2/3 Issuer*		−0.162***	−0.168***		1.141***	1.145***
		(0.035)	(0.037)		(0.240)	(0.259)
2011:Q3 × *Class 2/3 Issuer*			−0.037			0.029
			(0.040)			(0.218)
Loan controls	Y	Y	Y	Avg.	Avg.	Avg.
Employment status fixed effects	Y	Y	Y	N/A	N/A	N/A
Payment type fixed effects	Y	Y	Y	N/A	N/A	N/A
Mortgage purpose fixed effects	Y	Y	Y	N/A	N/A	N/A
Bank fixed effects	Y	Y	Y	Y	Y	Y
Postal code × origination month fixed effects	Y	Y	Y	Y	Y	Y
N	426,864	426,864	426,864	33,129	33,129	33,129
R^2	0.294	0.295	0.295	0.541	0.542	0.542

This table examines the dynamics of the estimates of the impact of the change in European Central Bank collateral eligibility policy on credit supply while controlling for anticipation effects among affected banks. The unit of observation in each regression is either a loan or bank/postal code/month, and the dependent variable is either the *Interest Rate* or *Loan Volume* (Columns (1) to (3) and (4) to (6), respectively). *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. Where indicated, regressions control for loan characteristics at origination and various fixed effects. *2011:Q4* is an indicator variable equal to one for loans originated in this quarter, and similarly for *2011:Q3*. Loan-level regressions include indicator variables equal to one whenever a given loan characteristic is missing. Volume regressions control for loan characteristics at origination averaged across loans within each bank/postal code/month–level cell. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

In Table 7, we measure the effects of the policy change controlling directly for these anticipation effects. To this end, we take the baseline interest rate and loan volume models and progressively include *Class 2/3 Issuer* × *2011:Q4* and *Class 2/3 Issuer* × *2011:Q3* interaction terms to condition on affected banks' lending behavior in the preceding quarters. As shown in the table, for both rates and volumes, the *Class 2/3 Issuer* × *2011:Q3* interaction term is statistically insignificant, which is consistent with anticipation in 2011:Q4 only. Two important results emerge when we examine the coefficients of interest on *Class 2/3 Issuer* × *After*. First, the point estimates remain significant at the 1% level. Second, they increase in magnitude for both rates and volumes relative to the estimates that do not control for anticipation. For example, the interest rate point estimate increases from −0.097 to −0.126. This confirms that anticipation effects in our main tests yield conservative estimates of the policy shock.

3.2.2 Loan-level evidence on the securitization mechanism. We now investigate loan-level changes in securitization activity of banks around the rule change. We ask whether affected banks are more likely to securitize mortgages with low rates or loans originated in areas with greater increases in loan volume. We complement the bank-level evidence in Section 3.1 and corroborate our hypothesis that the additional origination activity by affected banks is funded through low-rated RMBS issuance.

To study the securitization decision of the banks in our sample, we now focus on the "loan portfolio" sample. This sample contains the stock of loans and indicates whether they have been securitized into an RMBS issued after the rule change or retained on the balance sheet, as of the end of 2013 (the end point of our analysis). We estimate the following cross-sectional linear probability model using OLS:

$$y_{ijklt} = \alpha_l \times \alpha_t + \alpha_k + \gamma \; Class\ 2/3\ Issuer_k \times Interest\ Rate_{ijklt} + \theta' \mathbf{X}_{ijkt} + \epsilon_{ijklt}, \quad (3)$$

where, as before, i indexes loans, j indexes borrowers, k indexes banks, l indexes locations (postal codes), and t indexes time (months). The dependent variable, y_{ijklt}, is an indicator variable equal to one if the loan is securitized into an RMBS issued after the rule change and zero otherwise, and all other variables are as before. We also estimate a model that replaces $Interest\ Rate_{ijklt}$ with $Loan\ Volume_{klt}$ to test whether loans originated in high loan volume areas are more likely to be securitized after the policy change.

The coefficient of interest, γ, measures how the securitization rate of a typical loan originated by affected banks depends on the interest rate (or loan volume), all else equal, as compared with other banks. If the rule change induces affected banks to increase securitization of relatively low interest rate loans, then γ will be strictly negative. The null hypothesis is that collateral policy is irrelevant for securitization activity, corresponding to a γ of zero.

Table 8 presents the results. Column (1) shows the basic result without including any control variables. Two important results emerge. First, the relation between interest rates and securitization is in general positive: loans with higher interest tend to have higher securitization rates, on average. This finding is consistent with the view that higher interest rate loans—by generating surplus income that tends to enhance the credit or can be paid out to investors of the RMBS—are more appealing to securitize. Second, it can be seen that this relation is flipped for affected banks. The point estimate of γ is negative (-0.057) and statistically significant at the 1% confidence level. This indicates that in the period after the rule change, affected banks were more likely to securitize loans with relatively low interest rates, as compared with other banks. Column (2) includes loan controls, lender fixed effects, and postal code by origination month fixed effects, and the same result holds.

Columns (3) and (4) examine the importance of loan volume for securitization activity. We find a strong positive association between the volume of originations in a given location-month and the loan securitization rate among Class 2/3 issuer banks only.

We next examine how affected banks respond to the change in collateral policy through the origination of loans that are ex ante unlikely to be securitized. The idea is that if the rule change operates through incentives to securitize, it should have no impact on loans ineligible for securitization. This approach also exploits within-bank variation in lending, alleviating concerns that our sorting of banks may conflate with unobservable bank-level shocks.

Table 8
Collateral eligibility, loan originations, and securitization

Dependent variable: *Loan Securitized*

	(1)	(2)	(3)	(4)
Class 2/3 Issuer × Interest Rate	−0.057***	−0.048***		
	(0.005)	(0.005)		
Interest Rate	0.048***	0.045***		
	(0.004)	(0.003)		
Class 2/3 Issuer × Loan Volume			0.010***	0.009***
			(0.001)	(0.001)
Loan Volume			0.001	−0.000
			(0.001)	(0.001)
Loan-to-Value		−0.000*		−0.000
		(0.000)		(0.000)
Debt-to-Income		0.063***		0.063***
		(0.009)		(0.009)
Log(Mortgage Size)		−0.006		−0.009*
		(0.005)		(0.005)
State Guarantee		0.086***		0.079***
		(0.011)		(0.011)
Employment status fixed effects	Y	Y	Y	Y
Payment type fixed effects	Y	Y	Y	Y
Mortgage purpose fixed effects	Y	Y	Y	Y
Bank fixed effects	Y	Y	Y	Y
Postal code × origination month fixed effects	Y	Y	Y	Y
N	578,097	542,792	578,097	542,792
R^2	0.243	0.261	0.244	0.262

This table presents estimates of the relation between the credit expansion at Class 2/3 issuer banks and the securitization rate after the change in European Central Bank collateral eligibility policy. The unit of observation in each regression is a loan. *Loan Securitized* is an indicator variable equal to one if the loan is securitized and zero otherwise. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. A cross-sectional regression is conducted as of December 2013. *Loan Volume* is calculated at the bank/postal code/month–level. Where indicated, regressions control for loan characteristics at origination and various fixed effects. Regressions containing loan characteristics also include corresponding indicator variables equal to one whenever the characteristic is missing. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

We identify two sets of loans that are unlikely to be securitized. First, we focus on nonstandard repayment structures of the mortgage. Specifically, we repeat our analysis including only "bullet plus life insurance" and "bullet plus investment portfolio" mortgages. These mortgage products reinvest the savings into risky assets until maturity and, hence, at maturity, savings may be lower (or higher) than the principal and interest to be repaid. Due to this uncertainty, these mortgages are not popular among RMBS investors and therefore less likely to be securitized. Second, we consider mortgages with a nonstandard purpose. As detailed in Panel B of Table 1, about 90% of originations have the stated purpose of a purchase, remortgage, or renovation. Column (3) indicates that loans with nonstandard payment or purpose types have relatively low probabilities of securitization.

We implement our test by reestimating Equation (1) separately on the sets of loans with nonstandard repayment schedules and purposes.[17] We find that both

[17] The results are deferred to Appendix IA.X.

of the difference-in-differences coefficients for interest rates and loan volumes with nonstandard payment types are statistically indistinguishable from zero, indicating that there is no difference in credit supply between affected and other banks in the period following the rule change. We repeat this analysis for nonstandard mortgage purposes and find similar results. Thus, for loans that are less likely to be securitized, the affected banks do not appear to increase credit supply, in contrast to the full sample (of predominantly standard loan types).

We therefore find evidence on the securitization activity of affected banks consistent with the rule change operating through incentives to securitize. Namely, following the eligibility rule change, affected banks increase issuance of Class 2 and 3 securities. We find that mortgage loans with lower interest rates and those originated in high-volume regions are more likely to enter the collateral pools for these securities in the period following the rule change. Finally, we do not find evidence of an increase in supply among loans that are unlikely to be securitized.

3.3 Loan repayment performance

It is unclear ex ante whether the lower interest rates on mortgage originations at some banks reflect additional risk-taking. On the one hand, banks may face a homogenous set of borrowers at the margin, providing profitable opportunities with relatively low risk. In this case, the collateral eligibility rule change may have increased loanable funds for affected banks to exploit these opportunities without increasing risk. On the other hand, if the marginal borrowers that were rationed out of the credit market in the previous equilibrium were of lower credit quality (Stiglitz and Weiss 1981), then the increase in loanable funds may flow to riskier borrowers, resulting in worse repayment performance down the line.

We examine the impact of the rule change on loan repayment performance by estimating Equation (1) as a linear probability model on the sample of loan originations. The dependent variable in the regression is a measure of repayment performance, $Payment\ Arrears_{ijklt}$, set equal to one if the loan is in payment arrears at the end of the event window.

In Columns (1) to (4) of Panel A of Table 9, we find strong evidence that the loans originated by affected banks after the rule change are more likely to enter into payment arrears. The point estimate is between 0.004 and 0.008 and statistically significant at the 1% level. This effect is robust to the inclusion of a large array of control variables, indicating that worse repayment performance cannot be entirely explained by observable measures of loan risk at origination. In terms of economic magnitudes, the most conservative estimate of 0.004 indicates an increase in the probability of arrears, constituting about 13.3% of the unconditional mean (0.03) in the period after the rule change. Thus, lending by the affected banks translates into a meaningful deterioration in repayment performance.

Table 9
Collateral eligibility and repayment performance

Panel A: Main results

Dependent variable: *Payment Arrears*	(1)	(2)	(3)	(4)
After × *Class 2/3 Issuer*	0.008***	0.004***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)
Loan-to-Value			0.001***	0.001***
			(0.000)	(0.000)
Debt-to-Income			0.008***	0.008***
			(0.001)	(0.001)
Log(Mortgage Size)			−0.011***	−0.011***
			(0.001)	(0.001)
State Guarantee				−0.002*
				(0.001)
After	−0.011***			
	(0.001)			
Class 2/3 Issuer	−0.002*			
	(0.001)			
Employment status fixed effects	N	Y	Y	Y
Payment type fixed effects	N	Y	Y	Y
Mortgage purpose fixed effects	N	Y	Y	Y
Bank fixed effects	N	Y	Y	Y
Postal code × origination month fixed effects	N	Y	Y	Y
N	426,866	426,864	426,864	426,864
R^2	0.001	0.019	0.026	0.026

Panel B: Dynamics of repayment performance

Dependent variable: *Payment Arrears*					
Year:	2010	2011	2012	2013	All years
	(1)	(2)	(3)	(4)	(5)
Class 2/3 Issuer	−0.000	−0.003	0.002	0.009**	
	(0.001)	(0.002)	(0.002)	(0.003)	
Class 2/3 Issuer × *2010*					−0.002**
					(0.001)
Class 2/3 Issuer × *2011*					0.001
					(0.002)
Class 2/3 Issuer × *2012*					0.002
					(0.001)
Class 2/3 Issuer × *2013*					0.007***
					(0.003)
Loan controls	Y	Y	Y	Y	Y
Employment status fixed effects	Y	Y	Y	Y	Y
Payment type fixed effects	Y	Y	Y	Y	Y
Mortgage purpose fixed effects	Y	Y	Y	Y	Y
Postal code × origination month fixed effects	Y	Y	Y	Y	Y
N	102,824	110,384	111,431	102,225	426,864
R^2	0.028	0.025	0.024	0.019	0.024

This table presents estimates of the impact of the change in European Central Bank collateral eligibility policy on the repayment performance of new mortgage originations. The unit of observation in each regression is a loan. *Payment Arrears* is an indicator variable equal to one if a loan enters payment arrears and zero otherwise. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. The before (after) period is from January 2010 to December 2011 (January 2012 to December 2013). Panel A shows the main results. Panel B provides the dynamics of repayment performance. Where indicated, regressions control for loan characteristics at origination and various fixed effects. Regressions containing loan characteristics also include corresponding indicator variables equal to one whenever the characteristic is missing. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

In Panel B of Table 9, we examine the annual dynamics of the estimates of the collateral policy change on arrears at the annual frequency.[18] The effect on arrears is positive in both 2012 and 2013, although statistically significant at conventional levels only in 2013 (p-value equals 0.108 for 2012, based on the point estimate shown in Column (5)). Importantly, we observe no such differential effects in the pre-event window from 2010 to 2011. Thus, the timing of the deterioration in the loan repayment performance among the loans granted by Class 2/3 issuer banks is consistent with greater risk-taking after the policy change. However, we interpret this finding as suggestive given the lack of a sharp change in loan performance around the policy change and the statistically insignificant coefficient for 2012.

3.3.1 State guarantees and repayment performance. This final section examines the impact of the collateral eligibility rule change on bank behavior across loans with and without state guarantees. If guaranteed loans experience worse repayment performance, then additional credit risk might be transferred to the government in response to the policy change, which may be an important unintended consequence.

In the Netherlands, state guarantees for mortgages (Nationale Hypotheek Garantie, NHG) are provided by the Homeownership Guarantee Fund. During the mortgage application, an underwriter can apply for an NHG and, if granted, the borrower has to pay a one-off, tax-deductible fee, which was equal to 0.55% of the mortgage amount at the beginning of our sample. In return, in case of default, the NHG guarantee covers the outstanding principal, accrued unpaid interest, and foreclosure costs. Borrowers are subject to certain acceptance conditions, including a conforming loan limit of €290,000 at the end of our sample. In 2013, about 90% of all mortgages within the conforming loan size limit were NHG-financed.

How might the presence of government guarantees interact with the incentives to securitize following changes in ECB collateral eligibility rules? We have already documented that affected banks have incentives to originate mortgages that end up in arrears when the ECB begins to accept lower-rated RMBS. This issue is likely to be more acute for state-guaranteed mortgages, for the following reasons. First, government guarantees on risky loans are likely to be underpriced because the fee for a Dutch government guarantee is fixed (and thus independent of mortgage default risk). Second, an originating bank may prefer to immediately realize the gain by packaging (default-free) loans with a state guarantee into an RMBS that is sold in the secondary market at the correct price. Hence, all else equal, guaranteed loans have a higher probability of being securitized (as we observe in Table 8). In light of these incentives, at least part of the additional risk may be transferred to the government.

[18] Appendices IA.XI and IA.XII graph the estimates at the annual and quarterly frequencies, respectively.

Table 10
Credit supply and performance effects among state-guaranteed loans

Dependent variable:	*Interest Rate*		*Loan Volume*		*Payment Arrears*	
State guarantee:	No (1)	Yes (2)	Low (3)	High (4)	No (5)	Yes (6)
After × *Class 2/3 Issuer*	–0.107*** (0.027)	–0.084*** (0.021)	0.300 (0.303)	1.759*** (0.321)	0.002 (0.002)	0.007*** (0.002)
Loan controls	Y	Y	Avg.	Avg.	Y	Y
Employment status fixed effects	Y	Y	N/A	N/A	Y	Y
Payment type fixed effects	Y	Y	N/A	N/A	Y	Y
Mortgage purpose fixed effects	Y	Y	N/A	N/A	Y	Y
Bank fixed effects	Y	Y	Y	Y	Y	Y
Postal code × origination month fixed effects	Y	Y	Y	Y	Y	Y
N	215,058	211,806	13,120	20,009	215,058	211,806
R^2	0.293	0.351	0.613	0.614	0.038	0.038

This table presents estimates of the impact of the change in European Central Bank collateral eligibility policy on credit supply and repayment performance of mortgage originations with and without a state guarantee. The unit of observation in each regression is either a loan or bank/postal code/month. *Class 2/3 Issuer* banks have an above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period. The before period is from January 2010 to December 2011, and the after period is from January 2012 to December 2013. Columns (1) and (2) define the dependent variable as the *Interest Rate*, (3) and (4) as *Loan Volume*, and (5) and (6) as *Payment Arrears*. Columns (3) and (4) partition postal codes depending on whether they have a below- ("low") or above-median ("high") share of state-guaranteed loans. Where indicated, regressions control for loan characteristics at origination and various fixed effects. Regressions containing loan characteristics also include corresponding indicator variables equal to one whenever the characteristic is missing. Volume regressions control for loan characteristics at origination averaged across loans within each bank/postal code/month–level cell. All variables are defined in Appendix A. Heteroscedasticity-robust standard errors are clustered at the origination month level and shown in parentheses. ***, **, and * denote 1%, 5%, and 10% statistical significance, respectively.

In Table 10, we repeat our estimation for loans with and without state guarantees. In Columns (1) and (2), we use the interest rate as the dependent variable, for both guaranteed and nonguaranteed loans. We see the coefficient of interest is negative for loans both with and without state guarantees and of a similar order of magnitude (-0.107 versus -0.084, respectively). In each case, the point estimate is statistically significant at the 1% level. Columns (3) and (4) partition postal codes according to their fraction of guaranteed loans and find affected banks increase loan volume only among locations with high proportions of guaranteed loans. Turning to repayment performance, a clear contrast emerges between the sets of loans. While the estimate for loans without a guarantee is indistinguishable from zero, it is positive (roughly, 0.007) and significant for guaranteed loans. The estimated performance effect for the state-guaranteed loans is about 50% larger than the baseline effect.

Our interpretation of this evidence is that increased risk-taking mostly occurred within the set of guaranteed loans, which may have increased the credit risk implicitly transferred to the state. We thus highlight a potential negative externality to the Dutch state stemming from the change in collateral eligibility at the Eurosystem level.

4. Conclusion

This paper examines a change in collateral policy by the ECB that, for the first time, allowed lower-rated RMBS to be accepted as collateral in central

bank credit operations. We study the impact on the mortgage market in the Netherlands. Consistent with the policy change increasing the liquidity of RMBS and therefore banks' funding ability, we document an expansion in mortgage credit in terms of both lower interest rates and greater loan volumes among banks that actively issue RMBS with lower-rated tranches.

In addition, and consistent with the change in collateral policy operating through incentives to securitize, we find these banks issue more low-rated securities that are more likely to contain these new lower interest rate originations. We also find that these cheaper loans subsequently experience worse repayment performance, suggesting that banks might be willing to lower underwriting standards to capture these liquidity benefits. Finally, the deterioration of repayment performance is present only for loans with state guarantees, which suggests some credit risk may be transferred to the state.

Overall, our results point to an important trade-off in the setting of central bank collateral policy. Naturally, looser collateral requirements may positively affect the real economy by stimulating bank lending. However, our results also suggest potential negative effects to the extent that risk-taking may be excessive and spills over to the state via guarantees.

Appendix A: Variable definitions

Variable	Definition	Source
Panel A: Loan-level variables		
Interest Rate	Value-weighted average interest rate across loan parts at origination	SC, ED
Payment Arrears	Indicator variable equal to one if any part of the loan is in payment arrears	SC, ED
Loan-to-Value	Total loan amount divided by total value of the property across loan parts at origination	SC, ED
Debt-to-Income	Natural logarithm of loan balance divided by primary income of the borrower at origination	SC, ED
Log(Mortgage Size)	Natural logarithm of total loan amount summed across all loan parts at origination	SC, ED
State Guarantee	Equal to one if any part of the loan is documented to have a state guarantee	SC, ED
Loan Securitized	Indicator variable equal to one if all loan parts are securitized and zero otherwise	SC, ED
Panel B: Bank-level variables		
Class 2/3 Issuer	Indicator equal to one if above-median share of RMBS rated Class 2 or 3 out of total issuance in the before period	Concept ABS
Log(Assets)	Natural logarithm of book value of assets	Orbis
Return-on-Equity	Net income divided by book value of equity	Orbis
Equity Ratio	Book value of equity divided by book value of assets	Orbis
Cash Ratio	Cash and non-earning assets divided by book value of assets	Orbis
Liquid Assets Ratio	Sum of cash and short-term investments divided by book value of assets	Orbis
Core Deposits Ratio	Retail deposits divided by total liabilities	Orbis

This appendix presents the definitions for the variables used throughout the paper. In the source column, "SC" and "ED" stand for "software engineering company" and the European Datawarehouse, respectively.

Appendix B: European Central Bank's harmonized rating scale

	Credit quality steps		
Rating agency	Class 1	Class 2	Class 3
DBRS	AAA/AAH/AA/AAL	AH/A/AL (R−1H/R−1M)	BBBH/BBB/BBBL (R−1L/R−2H/R−2M/R2−L)
Fitch Ratings	AAA/AA+/AA/AA−	A+/A/A− (P1+/P1)	BBB+/BBB/BBB− (P2)
Moody's	Aaa/Aa1/Aa2/Aa3	A1/A2/A3 (P1)	Baa1/Baa2/Baa3 (P−2)
Standard & Poor's	AAA/AA+/AA/AA−	A+/A/A− (A−1+/A−1)	BBB+/BBB/BBB− (A−2)

This appendix shows how different external long-term credit rating assessments map into Eurosystem rating grades. In order to be considered a particular class, at least two of these credit rating agencies must provide the listed rating (or better) at origination. The mapping for short-term credit ratings are shown in brackets. "DBRS" stands for Dominion Bond Rating Services.

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