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Bank capital, portfolio rating change and loan conditions[1]

by

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Abstract

Banks, in determining their loan conditions given internal and external constraints, typically use models involving ratings. Using unique supervisory data for individual corporate loans in the U.S., we show that exogenous changes in the credit ratings of banks' loan portfolio due to remappings of banks' internal rating system trigger adjustments in loan conditions. The effects are also asymmetric: downward remappings increase spreads by some 40 bp and decrease commitments and maturities, but upward remapping lead to much weaker (but opposite) effects. Furthermore, we find the effects are stronger for smaller, riskier, and poorly capitalized banks as well as for borrowers with poorer credit quality and unsecured loans. Our findings highlight the important role of capital in stabilizing a bank's loan provisioning following large amounts of credit rating changes in its loan portfolio.

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1. Introduction

Banks often use internal credit ratings to assess the default risk of their (corporate) borrowers (Carey and Tracey, 1998). Ratings of borrowers and change thereof can affect the conditions of loans that a bank offers, with the effects to depend in part on the size of the capital buffer a bank holds. A deterioration in the credit quality of its loan portfolios, as reflected in a lower average rating, can increase a bank's desired provision for future losses, raise its risk-weighted assets, and lower its capital ratio, thereby making its lending to lower risk-rated firms more costly. Conversely, an improvement in ratings can make lending less costly. These effects can result from a bank's own decisions, but can also reflect external pressures, as when lower ratings subject a bank to (greater) market discipline and regulatory actions, the latter as it can mean a failure to comply with risk-based capital adequacy requirements. A bank can respond to the adverse consequences of credit-quality deterioration and a worsening of its capital ratio by increasing the spread charged on loans to increase its margins, or by reducing the committed exposure or shortening the maturity of loans to reduce the amount of risk-weighted assets and required loss provision. Since banks' size, capitalization, portfolio composition, overall riskiness and exposure to possible regulatory actions vary, banks are likely react differently to changes in the credit ratings of their borrowers. By exploiting how various banks react to externally imposed changes in their borrowers' credit ratings one can potentially identify how bank characteristics drive corporate loan terms and in which magnitude.

Despite the importance of internal ratings, little evidence exists on their role in driving corporate lending terms and the related interplay between banks' portfolio credit risk and potential regulatory pressures. Do banks adjust the price (spread) charged and the volume made available after changes in borrowers' credit ratings? Alternatively, are lending terms and ratings determined

by similar factors and there are no independent effects of ratings on loan conditions? Do rating upgrades and downgrades have similar, but opposite effects on loan terms, or do they have asymmetric effects? Do certain banks react more to changes in borrowers' credit ratings and adjust loan terms more aggressively than other banks do? And, if so, is that because some banks are more sensitive to potential market discipline or regulatory pressure, with the latter related to them having to meet minimum capital requirements?

The limited empirical evidence on the role of credit ratings related to these questions reflects the many data and identification challenges one typically faces. For one, detailed data on borrowers' credit ratings are often confidentially guarded and managed within banks and not available by and large to outside researchers. Second, even when available, ratings are set in response to internal and external factors many similar to those used to set loan conditions (e.g., both its rating and spread will reflect a borrower's intrinsic riskiness, as well as the general demand for loans and the degree of competition). This makes it challenging to identify the independent effect of credit ratings on loan conditions e.g., to isolate, among others, the effects of banks' financial positions and sensitivity to market or regulatory pressures from changes in firms' demand and riskiness.

In this paper, we tackle both the data and the identification challenges. Specifically, we use a unique supervisory data set of individual corporate loans in the U.S. that includes banks' internal ratings. Banks assess borrowers' credit risk using these internal ratings and use them to set loan conditions. They also transform the rating to an externally comparable, uniform rating scale, such as those used by credit agencies, such as Moody's, Fitch or Standard & Poor's, to communicate credit risk externally, including in the context of underwriting or renegotiating loans with borrowers, and of disclosing ratings to market participants. Importantly, these uniform external

ratings are used by regulators to assess a bank's capital ratio and whether it may be violating regulatory thresholds. In this paper, we exploit a series of quasi-natural experiments of reinterpretations in the mapping between the various banks' raw internal risk rating scales and a standardized uniform rating to investigate the independent role of ratings.

Rating remapping happens in the context of communications between regulators and banks on how to interpret their internal rating systems (or a particular rating tranche) with the precise goal to enhance the overall external rating compatibility. These changes usually occur on the margin, i.e., a rating category in a remap typically moves only to the next higher or lower rating category. The setting is ideal as any change in borrowers' loan conditions comes about through banks' reactions to the remapping (of an entire internal rating category) rather than because of any changes in particular borrowers' intrinsic credit risk. In others words, using these events means we effectively hold the firm's characteristics, including its loan demand, constant. Yet, such changes likely have significant impact on banks and their lending conditions. For instance, if borrowers in a particular rating category are downgraded, then a bank's risk-weighted assets and provisions for future losses are likely to increase and its capital ratio will decline. In response to a downgrade, the bank would likely increase the interest rate (spread) on the loan, limit the size of exposure (i.e., the loan size), and decrease the maturity to continue satisfying its risk-based capital adequacy.

We can also distinguish between up and down adjustments, that is, whether the reinterpretation causes a given internal rating category to be mapped to a better-standardized uniform rating ("up") or worse standardized uniform rating ("down"), and investigate whether there are asymmetries in the effects on loan conditions. We hypothesize that banks are more sensitive in their loan conditions to downward remapping of ratings, as they affect a bank's capital adequacy position, possibly leading to greater market discipline and stricter regulatory scrutiny,

including potentially supervisory actions, which all make lending to the downgraded borrowers more costly. In contrast, these concerns do not apply to upgrades and the bank has more freedom on how much of the benefits from an upgrade to pass on to borrowers.[1]

In accordance with these arguments, we empirically investigate whether banks adjust their corporate lending conditions for borrowers after their rating category is remapped, focusing on changes in interest rates, spread, size of commitment, and maturity. Exploiting the quasi-experimental nature of changes in rating remapping across banks and over time, we use a difference-in-difference regression approach to identify the causal relationships between ratings changes and banks' adjustments of lending conditions.

After studying the effects of a remapping and asymmetries between up- and downgrades, we explore which bank-related factors influence the size of responses to rating changes. Besides a borrower's risk rating, loan conditions also depend on the bank's characteristics, such as its size, general business model, including its lending specialization, riskiness as measured by its degree of loss provisions, and importantly its capitalization. Little is known, however, on how these factors matter for loan conditions since many of the bank factors are determined at the same time as the bank's loan conditions are. For example, banks can specialize in certain lending markets and their capitalization and loan-loss provisioning will vary accordingly. By studying how banks differ in their response to remapping-driven changes in ratings, we can identify some of the factors, which are important to banks for setting loan conditions. In addition, we investigate how loan conditions are adjusted for borrowers with different riskiness. Here we hypothesize that banks facing more likely market discipline or regulatory pressure more likely adjust their lending conditions in response to remappings, especially for risky loans or loans to lower-rated borrowers.

[1] Our discussions with credit risk banking experts, including bank examiners, confirm these hypotheses and indicate that banks are more sensitive to downgrades in resetting loan terms than to upgrades.

We also expect that the bank's business model, proxied by how large its net interest income is relative to the securities markets of net interest and non-interest income, affects its response to a remapping.

Our first set of results is that remapping of ratings triggers adjustments in loan conditions, including pricing, volume, and maturity, and that these adjustments are asymmetric: banks react to remapping involving downward rating adjustments by increasing loan spreads by some 40 basis points, but respond to upward adjustments by decreasing spreads by only some 27-28 basis points. Similarly, volumes lent decline and maturities shorten with downward rating adjustments, but either remain statistically similar or increase marginally with upward adjustments. The strong asymmetric reaction provides evidence that rating map reinterpretations as exogenous events make banks change loan conditions to prevent adverse market or regulatory actions, including those related to capital falling below regulatory thresholds. In contrast, the limited response to upward adjustments suggests that banks not faced with market or regulatory pressures pass little of the benefits on to borrowers.

For our second set of results, where we relate the effects of the remapping to bank characteristics at the time of remapping, we find that various banks react differently to changes in borrowers' ratings. Larger banks increase their spreads less when their borrowers are downgraded, likely as they are more able to absorb related adverse consequences. For a "risky" bank, i.e., one with higher loan-loss provisions, a downgrade leads to more adverse effects on loan conditions, possibly as the bank now more likely faces market or regulatory scrutiny. We also find, however, banks that are poorly-capitalized display larger responses in resetting their loan conditions to downward remapping, which suggests that banks with little capital buffers are more prone to deterioration in their loan portfolio, i.e., are more attentive to possibly binding capital constraints

(including those related to Basel capital regulations). As such, we interpret our evidence as maintaining certain level of capital at a bank helps mitigating negative credit shocks to banks and further shielding shocks away from its borrowers through the lending channel. In addition, we find, as expected, that banks adjust loan conditions most aggressively for loans and borrowers that are riskier, i.e., non-government guaranteed loans and non-investment grade borrowers.

We control in all regressions for both individual time-varying bank and borrower characteristics to make sure results are not affected by those observable factors. And we include bank, rating, time and other fixed effects, some of which are also interacted with each other, to be sure that effects are not driven by other, time-invariant characteristics, including those not observable. Various other tests confirm the robustness of our results. We conduct regressions for those firms that borrow from a single and from multiple banks, with the latter regression controlling for changes in firm demand and riskiness, using the technique pioneered by Khwaja and Mian (2008), by including *firm*period* fixed effects. These results confirm our main findings. Additional tests further show banks react differently in regard to their existing loans compared to newly issued loans.

Additional tests further confirms the robustness of the results. First we exclude from the sample those firms which rating get reversed with one-quarter after the remapping. As noted, this is a very small fraction of the total sample. And indeed, the overall regression results (no reported) do not change in any material way. Second, in the regression with the interaction with bank characteristics, we weighted the various bank variables with the proportion of loan being affected by the remapping, as the bank's response may depend on the relative amount of loans affected. The regression results (not reported) were again largely unaffected. Third, we checked for the possibility of non-linearities in the adjustments of interest rate and spread. For this, we transform

these dependent variables into logs (note that the volume amounts are already in log). Regression results (not reported) show very similar effects of the down- and upgrades. Fourth, we checked if the remappings are correlated with those bank characteristics that we subsequently use to tease out the role of banks' balance sheet and business model structures. We do not find any evidence that rating remapping are in some systematic way correlated to the bank variables (not reported). As such, we can rule out the possibility of reverse causality.

Our analysis principally relates to two strands of literature. The first strand analyzes the effect of banks' internal ratings of borrowers on banks' lending spreads and other conditions. Machauer and Weber (1998), analyzing small- and medium-sized German firms, and find that borrowers with riskier internal ratings tend to have higher interest rate premiums. Nakamura and Roszbach (2016) use Swedish commercial banking data and find that internal ratings include useful private information on loans and that such information revelation varies with loan size. Additionally, some literature analyzes the relationships between internal rating and bank lending by focusing on the syndicated loan market (e.g., Aramonte, Lee, and Stebunovs, 2014; Balasubramanyan, Berger and Bouwman, 2016). See further also Berg, Puri, and Rocholl (2014).

This paper differs from the aforementioned and other works in several, critical ways. These other papers generally focus on smaller segments of the lending market. For example, some papers focus on syndicated loans, which are generally confined to relatively large corporations and thus may not be representative of broader credit markets. Indeed, the number of observations in these studies typically range from two to ten thousand. In contrast, our dataset has millions of observations and covers a much larger set of corporate sector lending, accounting for as much as 80% of the U.S. corporate loan market in dollar terms. Furthermore, many of these papers do not analyze the impact of regulatory effects or include bank-specific factors and may have difficulty

controlling for the endogeneity of ratings and loan conditions. Other studies, also of the syndicated loan market, mainly use DealScan data, but questions about internal ratings cannot be addressed using this data alone. Moreover, our paper differs from most existing ones studying banks' "internal rating" when in fact these use transformed "uniform internal ratings". [2]

There is also work on how public ratings affect lending markets and the pricing of various types of external financing. Weinstein (1977) finds that public ratings on corporate bonds do not affect pricing in the months before and after a rating change announcement, as such events can typically be foreseen with publicly available firm data. Cantor and Packer (1996) do find, however, that public rating changes can affect the pricing of non-investment-grade sovereign bonds. In addition, Kliger and Sarig (2000) find that announcements of downgrades of Moody's ratings tend to decrease the valuation of bonds. The focus of these studies differs from ours, as they typically involve public and broad information channels, while in our case the information tends to be of a private nature, even if some of it may become more widely disseminated.

There is cross-country literature that explores how the depth of financial markets varies with the presence (or lack thereof) of a rating bureau, and whether there are differences if the bureau is private or public (Djankov, McLiesh, and Shleifer, 2007; Peria and Singh, 2014). In addition, some papers discuss how the presence of a rating bureau (or changes in its rules) or lack thereof affects the quality of ratings and if banks use such ratings (e.g., Giannetti, Liberti, and Sturgess, 2017). These and other papers focus mainly on (strategic) inter-bank behavior and competitive conditions (e.g., Pagano and Jappelli, 1993; Padilla and Pagano, 1997). In our case, internal ratings are not shared among the banks (or with any other party outside the bank for that matter). And, as there is no formal credit registry in the U.S., American banks have less direct information on other banks'

[2] Different from banks' internal ratings, the term transformed "uniform internal ratings" refers to the standardized ratings obtained from the internal ratings using a uniform credit rating scale.

operations than do many banks in other countries. As such, we do not expect these (strategic) interactions to be important for our study.

The second strand is the broad literature on the effects of (adjustments in) capital and capital (and liquidity) requirements on lending and the price and volume of credit. Theoretical papers, such as Repullo and Suarez (2004), Ruthenberg, and Landskroner (2008), suggest that the implementation of Basel II, which meant a more risk-sensitive measure of loan pricing, could have led banks to reduce loan rates for highly-rated firms while lower-rated firms could have avoided price increases by moving to banks using less risk-sensitive measures. In his review, Thakor (2014) concludes that higher capital requirements led to moderate increases in spreads and small reductions in lending, especially during the transition, but with very heterogeneous effects across banks. Indeed, Hirtle, Kovner, and Plosser (2016) find that banks that are more robust tend to have both less risky loan portfolios and more conservative capital practices.

In general, this interpretation faces a number of constraints and challenges. For one, it is empirically hard to disentangle the different roles of capital identified theoretically – risk buffer, incentive mechanism, and resolution trigger – and how to analyze behavioral changes of capital (constraints). This literature has also found it hard to empirically disentangle the effects of capital and other banks' balance sheets and riskiness from macroeconomic, regulatory, and other factors affecting loan riskiness and consequently lending conditions. Second, given limited data availability to examine such issues, analyses frequently rely on bank level data, rather than loan level data. When using loan level data, it often has to be publicly available data, which cover a subsample of firms (e.g., Bridges et al. 2014). And even when many studies report that higher capital increases the cost of and reduces the volume of lending, estimates on the size of the effects

vary greatly and are not always reliable (Basel Committee on Banking Supervision, 2016, reviews).

The paper proceeds as follows. In section 2, we provide institutional background, an overview of our data and summary statistics. Section 3 presents our methodology and the results of our empirical analyses. Section 4 concludes.

2. Institutional Background and Data

2.1 Banks' internal risk rating and the reinterpretation of rating mapping

Banks typically assess borrowers' credit quality based on a bank's own internal rating scale, using scales that can vary across banks. For instance, the scale of Bank A's internal ratings could range from 1 to 10, with 1 as the highest rating, while Bank B could have a scale between A and E, where A is the lowest rating. To allow for external comparability, banks transform borrowers' internal ratings to a uniform rating scale. It is possible, and often the case, that the bank internal rating has a different number of categories of ratings than a standardized uniform, credit-agency type of scale, such that a bank can have multiple internal ratings that correspond to the same standardized uniform rating, or that the same standardized rating corresponds to multiple bank ratings. In this study, we exploit changes in the "concordance maps" between each bank-specific scale and the uniform external scale. At times, it can become clear that an internal rating category needs to be remapped to another uniform rating category to enhance the external rating comparability. Such rating remapping happens as regulators and a bank agree on a given date on how to interpret the bank's internal rating system (or a particular rating tranche) precisely. After such a mapping change, a whole tranche of loans of an internal rating category within a bank will then be "upgraded" or "downgraded" on an external uniform rating scale.

Example 1 shows a hypothetical example of such a rating remapping. The bank's three internal ratings were originally mapped to A, A, and B on the external uniform scale. After a mapping change, all loans in the middle rating tranche of 2 are remapped to B on the uniform scale. Therefore, all loans with internal rating of 2 appear to be "downgraded" on the external scale. The important aspect here is that the intrinsic credit risk of loans in category 2 remains unchanged, even when these loans appear to be riskier on the uniform rating scale and could be treated harsher for calculating banks' capital ratios and determining supervisory actions.

Example 1: Hypothetical example of a bank's concordance map before/after changes

Internal rating	External uniform rating	
	Before mapping changes	After mapping changes
1	A	A
2	A	B
3	B	B

We use these remappings of various banks' internal ratings to an external uniform scale as exogenous events. We differentiate between cases in which the remapping results in an "upward" or a "downward" adjustment of firms' internal rating. We find 63 upgrade and 56 downgrade mapping changes across all banks, which together amount to changes for 1% of all 35 banks' internal ratings over the full sample. As upgrades slightly exceed downgrades, remapping leads on average to higher uniform ratings.[3]

2.2 Ratings of corporate loan portfolios and banks' capital ratios

[3] We investigate whether the remappings can be predicted on the basis of bank-specific characteristics including balance sheet information using standard logit models and find no evidence whatsoever of predictive power, further supporting the exogenous nature of the events.

We discuss next how such changes in ratings can spur banks to take action. We do this for downgrades, as they may subject the bank to stricter market and regulatory scrutiny and potentially supervisory responses, while these concerns do not apply to upgrades. Specifically, upon the downgrade the bank likely needs to increase its loan-loss provisioning and sees its capital ratio decline. It may then take several actions. First, it could increase income earned through raising the interest rate (spread) charged on the downgraded loans. This increase in income can boost retained earnings, thereby increasing bank's capital. Second, banks could decrease their exposure to downgraded loans. This would allow the bank to reduce its required loan-loss provisioning. In addition, it also decreases the amount of risk-weighted assets, the denominator of the capital ratio. Third, banks could shorten the maturity of downgraded loans to again reduce required loan-loss provisioning (as shorter maturity loans require lower allowances for loan losses), which will again increase its retained earnings and capital.

2.3 Data on loans and bank characteristics

Our data primarily comes from the Federal Reserve's Y-14Q reports, a quarterly series of data collections meant to aid the Dodd-Frank Act Stress Tests and Comprehensive Capital Analysis and Review (CCAR) supervisory functions (Appendix Table 1 provides all the sources and definitions of the data we use). We specifically focus on data from the Schedule H.1 of Y-14, which is a quarterly snapshot of all commercial and industrial loans in excess of $1 million within bank holding companies that participate in the CCAR conducted by the Federal Reserve beginning in the fall of 2011. The loan size ranges from the $1 million reporting threshold to billions of dollars, thus covering the full spectrum of corporate lending from SMEs to large listed corporations. Each loan observation contains its bank internal rating, loan characteristics (e.g., interest rates, committed amount, maturity), and some financials for each borrower. The sample

size is 7.4 million observations over the period September 2011 to December 2016, with a maximum number of loans of 906,678 in a given quarter. At the end of 2016, the total loans in the database accounted for $1.52 trillion, or about 78% of total corporate sector lending by banks in the United States.

Additionally we use the Federal Reserve's Y-9C data collection composed of basic financial data for bank holding and U.S. intermediate bank companies, to obtain measures for the banks' balance sheets and riskiness. Banking institutions submit the Y-9C every quarter to the Federal Reserve and other appropriate supervisory agencies. This allows us to investigate how banks' characteristics, including their external financial constraints, affect differences in how loan down- and upgrades affect loan conditions. Altogether, the detailed loan and rating data, combined with the mapping reinterpretations of ratings, and the cross section of banks, provide an excellent way to identify how banks adjust loan pricing in response to rating adjustments.

Table 1, Panel A provides raw statistics on the main variables for the full sample of loans and of banks (coverage varies for some of the variables, which accounts for the differences in number of observations). Panel A shows the large dispersion in the loan conditions with interest rates, spreads, volumes, and maturities displaying wide ranges (note that all dollar amounts are in logs). The panel also reports the fraction of loans where the remapping gets reversed within the next quarter, which could be an indication that the bank is trying to undo the remapping. As can be seen, this reversal occurs only in a very small fraction of total up- or downgrades, and as such are unlikely to affect our main regression results (we do conduct robustness excluding these observations).

In terms of bank characteristics, Panel A show that the dispersion in size, in logs, is quite large, banks' capital ratio varies in a narrower range, but the loan-loss provisioning show greater

variability. The proxy for the bank's business model, the reliance on interest income as a fraction of total income, is considerable, showing that while for some banks, lending is the main business for others it is much smaller, for example, as they are more investment than commercial banks.

Panel B compares the samples for those observations for which there was a rating change in a specific quarter, i.e., the treated sample, with those that did not experience a change. It does so first on the loan level and then at the bank level. It also displays t-tests, with the standard error clustered at the bank level. We find a statistically significant difference between the two groups in interest rate and the size of the committed exposure. Panel B also compares the two samples of banks, i.e., for those banks that had rating changes with those banks that did not have rating changes, but now for bank-period observations. The t-tests show no statistically significant differences. In other words, the treatment and control group of banks do not vary systematically from each other. This is very reassuring in that it suggests that any differences we may find are not due to the sample of banks treated vs. non-treated. The comparisons between treated and non-treated observations, however, so far do not control for loan and bank characteristics that possibly also contribute to differences. For this, we use multivariate regressions.

3. Methodology and Empirical Results

3.1 Methodology

We want to investigate how adjustments in external ratings affect loan conditions in general and up and down adjustments specifically. We conjecture that banks react to downward adjustments in ratings by increasing the interest rate charged, decreasing the size of the commitment available, and shortening the maturity, while we expect opposite but weaker effects from upward adjustments. To do this, we use a difference-in-differences approach. As the

remappings are largely unexpected, this approach controls for any other (observed or unobserved) factor that may explain the pricing and other characteristics of the loans. Our first event indicator, DD_rating_changes, is a dummy variable whose value increases by one when the rating of a certain loan is adjusted upward in a quarter, and decreases by one when the rating of that loan is adjusted downward. To study the asymmetric reactions of rating upgrades and downgrades, we create two other indicators, DD_rating_upgrades and DD_rating_downgrades, which become one in the quarter in which the mapping is adjusted upwards and downwards respectively, and zero for all quarters preceding. Note that the intrinsic risk of loans within the internal rating category remains unchanged when the mapping is adjusted upward or downward, which means we control for possible demand-side changes affecting loan terms. We use four variables to capture adjustments to loan terms: interest rate, interest rate spread, committed exposure, and maturity. In its most general form, the specification we use is as follows:

$$\text{Loan_terms}_{l,b,r,t} = \alpha + \beta_1 \text{DD_rating_upgrades}_{r,b,t-1} + \beta_1' \text{DD_rating_downgrades}_{r,b,t-1} + \beta_2 \text{Bank Controls}_{b,t-1} + \text{Firm Industry FE} + \text{Loan Type FE} + \text{Bank FE} + \text{Year and Quarter FE} + \varepsilon_{l,s,b,t} \quad (1)$$

where $loan_term_{l,b,r,t}$ is one of the four dependent variables for the loan conditions, and l represents loan, b represents bank, r represents internal rating category, and t represents combination of year and quarter. We control for various lagged bank characteristics, including bank size, capitalization, loan-loss provisioning, and lagged reliance on lending, proxied by that quarter's share of bank interest income in total income. In addition, we include fixed effects for borrower industry, loan type, bank, and year quarter, to control for both time-invariant unobservable factors related to internal rating category, borrowers and types of loan, as well as

nationwide shocks that happened during a particular year quarter, which could affect loan terms. As the changes in mapping happen at the bank level, standard errors are clustered two ways at both the bank and year quarter level to address the potential concern of within-bank correlations of the regression residuals. We are then interested in the coefficients β_1 and β'_1, which provide the (differential) effect of the remapping on the affected bank(s)' loan terms.*3.2 Rating Remapping and Banks' Changes in Loan Conditions*

Table 2A presents the difference-in-differences regression results for the four variables that we use to proxy loan conditions. We start each set of regressions with a naïve univariate regression with only DD_rating_changes as the explanatory variable (column 1), and then expand the estimation model by including other controls in various steps to the fullest set of fixed effects in column 5, as described in Model (1). Since the fixed effects control for possible influences of unobservable characteristics (e.g., firm-industry fixed effects for industry-specific shocks, loan-type fixed effects for loan and bank-specific characteristics), this is a means to confirm (or not) the role of such unobservable characteristics, as suggested by Altonji et al. (2005). The results consistently show that there is a change in the opposite direction for the interest rate and spread, and a change in the same direction in the committed volume and maturity of the loan upon a rating adjustment. That is, after a drop in the loan ratings, the interest rate spread tends to increase while the committed exposure is likely to decrease. Effects are highly statistically significant and have a large economic impact. For example, in the specification with all fixed effects, a remapping leads to some 33 basis points change in the interest spread charged and an 18% change in the committed exposure. It is thus clear that there are strong treatment effects of the rating remapping on loan pricing and size.

Since changes in risk rating likely have asymmetric effects on loan terms, we next study differences between up- and downgrades. The regression results in Table 2B show strong evidence for asymmetric responses to upward versus downward rating changes on banks' loan terms. In the regressions with all fixed effects included, banks react to a downgrade by increasing spreads charged by some 41 basis points and reducing committed exposures by 29%. The maturity of loans also decreases by some 25%. There are in general much smaller impacts of upgrades on ratings. In fact only for the spread and size of commitment are there statistically significant results – although the magnitude of the effects is much smaller. The fact that there is a much weaker result associated with an upgrade suggests that the economic impact of the rating remapping comes about in downgrades because of consequences related to capital constraints.

In terms of control variables, the bank's reliance on interest income is most consistently significant for all the regressions in Table 2, suggesting that the business model matters for the bank's inclination to adjust loan conditions. Regression results are also generally consistent if we change the combinations and number of fixed effects.

3.3 Characteristics of Banks and Differential Effects of Rating Changes

We next study how banks differ in their responses to remapping-driven changes in borrowers' credit rating as we expect the treatment effect of rating changes on loan terms to vary based on the characteristics of banks and riskiness of borrowers and loans. The actual reaction of banks to rating changes is likely contingent on the banks' size, business model, and capital position, the latter in light of market and regulatory disciplines. For example, a smaller and less well capitalized bank which likely face more disciplines and can be expected to adjust their terms more aggressively upon a remapping than larger banks with healthier balance sheets do, especially

for lending to riskier borrowers. In addition, remapping effects should be greater for non-investment grade borrowers and non-government guaranteed loans.

To test these conjectures, we create four indicator variables that equal one if a bank belongs to the top tercile of all BHCs based on asset size, loan-loss provisioning, and reliance on lending business, and bottom tercile based on capital ratio in the past year respectively, and that equals zero otherwise. We also construct a variable that equals one if the borrower is investment grade or if the loan is guaranteed by the U.S. government or its agencies. We interact these indicator variables with various bank, borrower, and loan characteristics and the two DD indicators, and include all these in regression model (1) to investigate the differences among banks in the treatment effect of the rating changes on loan terms, differentiating between up- and downgrade. All the control variables and fixed effects used in the regression models of model (1) are also included, with robust standard errors clustered in two ways at the bank and year quarter level.

Table 3 reports how the various bank factors influence the adjustments in loan pricing, size, and maturity after the rating changes. The table shows that downgrades have generally more impact on lending conditions for banks that are smaller, have higher loan-loss provisioning, greater reliance on interest income, and lower capital ratios. Specifically, for the interest rate spreads and committed exposures, we find the adverse effects of downward adjustments to be statistically significantly greater for smaller banks, weaker banks with more loan-loss provisioning and with lower capital, and much less so for large banks. Downgrades and upgrades have less impact for loans to borrowers with investment grade and loans that are government guaranteed, even to the point that there is no economic impact of a downward adjustment (the coefficients on the interaction with the borrower and loan characteristics almost offset the general coefficients). In

addition, upgrades disproportionally affect interest rates for banks with large loan-loss provisioning and committed amounts for large banks.

The results confirm many of our hypotheses. Larger banks increase spreads less when loans of some of their borrowers are downgraded since the adverse consequences are more limited as they hold more other loans. For a bank with a riskier loan profile, i.e., that is already provisioning more for loan losses, the downgrading of an entire rating category can mean more market and regulatory governance pressures, making the bank's loan pricing more sensitive. In terms of costs and maturity, effects of downward adjustments are much weaker for borrowers that are investment grade and loans that are government guaranteed. Many of these differential impacts suggest that the main effect of the downgrade arise because the bank has a relatively weaker balance sheet or having a lower capital adequacy in the first place, i.e., the bank is more subject to market and regulatory pressures, which then leads to stronger reactions to changes in borrowers' credit risk ratings.

These same characteristics are often not significant in terms of upward adjustments, except that loan upgrades have more of an impact on committed exposures for banks with greater loan-loss provisions. This more limited effect of upgrades is suggestive of a potential communication channel whereby the borrower is made aware of the upgrade and, because of competitive effects, then asks for a greater loan, as documented in Carey and Tracey (1998). In terms of maturity, the effects of upward adjustments are statistically significant less so for banks that rely more heavily on interest income.

3.4 New origination vs. existing loans

Results so far show that downward adjustment of external uniform ratings after remapping trigger immediate reactions of banks adjusting the terms of loans within that rating tranche. Here

we explore whether the effects are different for new originations versus loans that are already on the bank's balance sheets. These tests help us to understand whether those results stem from banks adjusting the terms of existing loans on their balance sheets, or from changing the terms of new loans issued. The results for this sample split are shown in Table 4.

We find that the negative effects of downward changes in borrowers' credit ratings on committed exposure primarily arise because banks adjust the sizes of existing loans. In other words, banks limit the size of lines of credit available to borrowers upon the rating downgrade. This is consistent with our conjecture that in the short run, banks try to quickly reduce the exposure to loans within the category of rating downgraded to limit the required loss provisioning and mitigate the increase in risk-weighted assets. The absence of a quantity effect for new loans extended suggests that banks may rely on using increases in other terms (e.g., price terms, and amount and type of collateral) to limit new loans in that downgraded rating category. All other effects – on loan interest rate, spreads and maturity – are very similar for newly originated and existing loans in size and statistical significance.

3.5 Loans to firms borrow from multiple lenders

A potential concern is that the rating changes may not be fully exogenous. Specifically, time-varying supply-side bank characteristics or demand-side firm characteristics might affect both the remapping of the rating system and firm loan conditions, leading to spurious relations. We run a test to examine whether the timing and occurrence of the rating remapping might be influenced by time-varying bank characteristics – for example, a weaker bank with lower capital ratio may have the intention to remap its rating system upward. The results in Table A2 of the Appendix fail to depict a clear relationship between bank characteristics and the timing and

occurrence of rating remapping. This test helps addressing endogeneity concerns arising from the supply side. However, this test cannot rule out the potential effect of omitted time-varying demand-side firm characteristics on the rating remapping.

Given a fairly large share of borrowers (about 25%) have borrowed from more than one bank, by considering only these multi-bank firms, we can also easily control for any shock to the demand for external financing or other shock at the level of the individual firm that may have occurred around the time of the rating reinterpretations. This identification strategy has first been used by Khwaja and Mian (2008) and subsequently by many others, including in many domestic studies (e.g., Jiménez, Ongena, Peydró and Saurina, 2012), and in cross-border banking analyses (e.g., Cetorelli and Goldberg, 2011; Popov and Udell, 2012; Kalemli-Ozcan et al., 2013; Minoiu and Reyes, 2013; Cerutti, 2015; and Cerutti, Hale and Minoiu, 2015).[4] Here it amounts to a double difference-in-difference test as we investigate how in response to a mapping reinterpretation affecting one bank pricing and other loan characteristics vary across banks for the same borrower. For this test, the specification for all loan conditions then becomes:

$$\text{Loan_terms}_{l,b,t} = \alpha + \beta_1 \text{DD_rating_upgrades}_{r,b,t-1} + \beta_1 \text{DD_rating_downgrades}_{r,b,t-1} + \beta_2 \text{Controls}_{b,t-1} + \text{Industry FE} + \text{Loan Type FE} + \text{Bank-FE} + \text{Year and Quarter FE} + \text{Firm} \times \text{Year and Quarter FE} + \varepsilon_{l,s,b,t} \quad (2)$$

The model specification is similar as Model (1), except for the *firm i × year and quarter t* dummies added to control for any shocks to individual firm-specific demand or changes in

[4] See further Jakovljević, Degryse and Ongena (2015) for a review of empirical research on how best to assess the impact of regulations in the banking sector.

riskiness in a given quarter. Note that these multi-banks differ from the set of firms for which there is only one lender. They are obviously on average larger and have greater loan balances. They also tend to be more highly rated. As such, the effect for these borrowers need not mimic that of those firms for which there is only one bank and where the lending is more based on relationship and information. At the same time, we can control for firm-specific demand and other shocks. For these and other reasons, the multi-bank tests are best seen as both robustness tests and providing insight in the channels by which ratings affect loan conditions.

Table 5 provides the regression results for multibank firms. It is obvious that many of the base-line regression results are confirmed for multi-bank firms where the results show again that there is an increase in the interest rate and spread and a decrease in committed exposure of the loan upon a downgrade. These effects are again highly statistically significant and have a large economic impact. For upgrades, banks do not in a statistically significant way pass through the preferable loan terms to borrowers with multi-bank relationships. Running the baseline regression on samples of loans from firms borrow from multiple banks confirmed the robustness of the earlier results. Importantly, as the regressions for the multibank firms control for firm-specific demand and other shocks, we can be assured that these shocks do not affect results.

3.6 Loans experiencing rating offsetting

Internal rating remapping can cause material changes in credit quality of a sizable section of a bank's loan portfolio. In response to these changes, banks may have an incentive to modify the rating back and "offset" the credit quality changes made by the remapping. For example, when one rating tranche was downgraded (upgraded), a bank could reverse this change by upgrading (downgrading) internal rating after the change. If this action were to occur, it would complicate

our identification; the loan terms would likely not experience any change while the difference-in-difference indicators would identify the loans as remapped.

To address this concern, we identify the loans that are in remapped tranches, but are offset in the direction opposite of the remap within one quarter. As reported in Table 1, the median offset upwards (i.e., initial remap downwards, but an upwards reversal immediately on the loan) affects 8.1% of a bank's portfolio, while the median offset downward affects 2.6% of loans. We then re-estimate the baseline regression (i.e., Model (1)) without the offset loans; the results of the re-estimation are reported in Table A3. We find that even with these loans removed, the main results remain in line with the results of Model (1).

It is also worth noting that the observance of offsetting behavior also suggests that the rating remapping is largely exogeneous to banks. For example, the upward median offset is larger than the downward median offset by a factor of four in magnitude. The difference indicates that rating remapping comes at a surprise to the banks. This suggests that banks are more sensitive to downward rating remappings, likely because they reduce a bank's capital levels and pushing the bank closer to violating its capital requirements. On the contrary, an upward remap has no such incentive, as it increases the bank's capital levels and conformance with its capital constraints.

3.7 Non-linearity of the loan pricing curve

One concern may be that the asymmetric effects on interest rate and the interest rate spread from rating downgrades and upgrades are due to the inherent non-linearity of the pricing curve. To be specific, if the pricing curve of internal rating is concave, moving down on the rating categories would inherently have a larger effect in magnitude than would an upgrade. If such a phenomenon were to account for the differences in spreads, our results would be weakened.

We address this concern by re-estimating the regression in Model (1), replacing the dependent variables (interest rate, interest rate spread) with their log-transformations. As it appears on Appendix Figure A, a log-transformation is a suitable technique for accounting for the non-linearity; the pricing curve roughly follows a logarithmic function, as the actual pricing curve is plotted against and fits well on a logarithmic curve.

The results of the re-estimation are reported in Table A4. It is clear that the findings are similar to the main results reported in Table 3. The interest rate and interest rate spread are increased 11.8% and 22.1% on a downgrade and decreased by 6.8% and 13.2% by an upgrade, respectively. Like Model (1), the effect of a downgrade is larger in magnitude than the effect of an upgrade, which suggests that the non-linearity of the pricing curve is not driving the effect we observe.

4. Conclusion

Banks determine conditions on their loans based on the internal rating of the borrowers and considering internal and external constraints. Large rating changes in banks' portfolios can directly affect loan conditions by changing the size of capital buffers banks are required to hold. Yet, there has been little evidence that clearly identifies the independent effects of ratings on loan conditions as ratings are often set in response to factors similar to those of loan conditions, and it is thus challenging to isolate the supply effects of banks' sensitivity to changes in rating from changes in firms' demand and riskiness. Through the usage of a unique, supervisory dataset and an experimental design that exploit changes in borrowers' standardized uniform ratings due to the remapping of a certain rating category, we find that banks react to downward adjustments in the credit ratings by increasing the interest charged on the loan, and reducing the size of the loan and

its maturity. We show that the effects are highly asymmetric, such that we find limited effect of upgrades on rating changes.

We also find that downgrades have generally more impact on loan conditions for banks that are smaller, have higher loan-loss provisioning and higher capital ratios, and have less impact for loans to borrowers with investment grade and loans that are government guaranteed. This differential effect is consistent with the explanation that downgrades are potentially capital binding, whereas upgrades are not. The results also suggest that, in contrast to some other studies, that better capitalized banks adjust loan conditions more conservatively. Our findings highlight the interplay between borrowers' ratings and banks' regulatory pressure in driving corporate loan conditions.

References

Aramonte, Sirio, Seung Jung Lee, and Viktors Stebunovs, 2015, Risk Taking and Low Longer-term Interest Rates: Evidence from the U.S. Syndicated Loan Market, Finance and Economics Discussion Series, Federal Reserve Board, 2015-068.

Balasubramanyan, Lakshmi, Allen N Berger, Matthew Koepke, Christa HS Bouwman, 2016, How Do Lead Banks Use Their Private Information about Loan Quality in the Syndicated Loan Market?, Federal Reserve Bank of Cleveland Working Paper, 16-16.

Basel Committee on Banking Supervision, 2016, Literature review on integration of regulatory capital and liquidity instruments, WP No. 30.

Berg, Tobias, Manju Puri, and Jörg Rocholl, 2014, Loan officer incentives, internal ratings and default rates, Working Paper, Humboldt University of Berlin, European School of Management and Technology, and Duke University.

Board of Governors of the Federal Reserve System, 2016, Dodd-Frank Act Stress Test 2016: Supervisory Stress Test Methodology and Results, www.federalreserve.gov/newsevents/pressreleases/files/bcreg20160623a1.pdf

Bridges, Jonathan, David Gregory, Mette Nielsen, Silvia Pezzini, Amar Radia and Marco Spaltro, 2014, The impact of capital requirements on bank lending; Bank of England Working Paper No. 486.

Calomiris, Charles W., 2013, Reforming Banks without Destroying Their Productivity and Value; *Journal of Applied Corporate Finance,* 25(4), 14-20.

Cantor, Richard and Frank Packer, 1996, Determinants and Impact of Sovereign Credit Ratings, *Federal Reserve Bank of New York, Economic Policy Review,* Oct, 37-53.

Carey, Mark and William Tracey, 1998, Credit Risk Rating at Large U.S. Banks, *Federal Reserve Bulletin*, November, 897-921.

Cerutti, Eugenio, 2015, Drivers of cross-border banking exposures during the crisis, *Journal of Banking and Finance,* 55C, 340–357.

Cerutti, Eugenio, Galina Hale, and Camelia Minoiu, 2015, Financial crisis and the composition of cross-border lending, *Journal of International Money and Finance,* 52, 60–81.

Cetorelli, Nicola and Linda S. Goldberg, 2011, Global banks and international shock transmission: Evidence from the crisis, *IMF Economic Review* 59, 41–76.

Djankov, Simeon, Caroline McLeish, and Andrei Shleifer 2007, Private credit in 129 countries. *Journal of Financial Economics*, 842, 299–329.

FDIC 2014, TBTF Subsidy for Large Banks--Literature Review (updated). www.fdic.gov/news/news/speeches/literature-review.pdf

Giannetti, Mariassunta, José Liberti, and Jason Sturgess 2017, Information Sharing and Rating Manipulation, mimeo, Stockholm School of Economics.

Hirtle, Beverly, Anna Kovner, and Matthew Plosser 2016, The Effect of Supervision on Bank Performance. Federal Reserve Bank of New York Staff Report No. 768, March, Revised July 2016.

Jakovljević, Sanja and Degryse, Hans and Ongena, Steven, 2015, A Review of Empirical Research on the Design and Impact of Regulation in the Banking Sector. *Annual Review of Financial Economics*, 7, 423-443, 2015.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró and Jesús Saurina. 2012. "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications." *American Economic Review*, 1025: 2301-26.

Kalemli-Ozcan, Sebnem, Elias Papaioannou, and José-Luis Peydró, 2013 Financial regulation, financial globalization, and the synchronization of economic activity, *Journal of Finance* 68, 1179–1228.

Khwaja, Asim Ijaz and Atif Mian, 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *American Economic Review*, 984: 1413-42.

Kliger, Doron and Oded Sarig, 2000, The Information Value of Bond Ratings. *Journal of Finance*, 556, 2879-2902.

Machauer, Achim and Martin Weber 1998, Bank behavior based on internal credit ratings of borrowers, *Journal of Banking and Finance*, 22, (10-11), 1355-1383.

Martinez- Peria, Maria Soledad, and Sandeep Singh, 2014, The Impact of Credit Information Sharing Reforms on Firm Financing. Working Paper, World Bank.

Minoiu, Camelia and Javier Reyes 2013, A network analysis of global banking: 1978–2010, *Journal of Financial Stability* 9, 168–184.

Nakamura, Leonard. I. and Roszbach, Kasper, 2016, Credit Ratings, Private Information, and Bank Monitoring Ability. Working Paper, FRB of Philadelphia.

Padilla, A. Jorge and Marco Pagano, 1997, Endogenous Communication among Lenders and Entrepreneurial Incentives. *Review of Financial Studies*, 10(1), 205–36.

Pagano, Marco and Tullio Jappelli, 1993, Information sharing in credit markets. *Journal of Finance*, 485, 1693–1718.

Popov, Alexander and Gregory F. Udell, 2012, Cross-border banking, credit access, and the financial crisis, *Journal of International Economics*, 87(1), 147-161.

Rajan, Raghuram, 1992, Insiders and Outsiders: The Choice Between Informed and Arm's Length Debt, *Journal of Finance*, 47, 1367-1400.

Repullo, Rafael and Javier Suarez, 2004, Loan Pricing under Basel capital requirements, *Journal of Financial Intermediation.* 134, 496-521.

Ruthenberg, David and Landskroner, Yoram, 2008, Loan Pricing under Basel II in an Imperfectly Competitive Banking Market, *Journal of Banking and Finance*, 32 (12), 2725-33.

Thakor, Anjan V., 2014, Bank Capital and Financial Stability: an Economic Tradeoff or a Faustian Bargain? *Annual Review of Financial Economics,* 6, 1-487.

Weinstein, Mark I., 1977, The effect of a rating change announcement on bond price, *Journal of Financial Economics*, 5(3) 329-350.

Table 1. Descriptive Statistics

Table 1 reports summary statistics for the loan and bank characteristics used in this paper. For each variable, we show summary statistics of each variable for the whole period of analysis from September 2011 to December 2016. Panel A shows the summary statistics of the whole sample. Panel B shows the summary statistics of the sample, separated into a treatment and control group. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. All dollar amounts are in logarithmic terms. The t-statistics are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: General Summary Statistics

Variable					
	Mean	*Sd*	*Median*	*P25*	*P75*
Loan Characteristics	4.247	9.954	3.325	2.000	5.250
Interest rate	2.106	6.845	1.800	0.999	2.750
Interest rate spread	13.487	3.178	14.328	11.513	15.522
Committed exposure	8.191	2.679	7.512	6.819	8.236
Maturity	4.247	9.954	3.325	2.000	5.250
Bank Characteristics					
Bank size	20.103	1.269	19.732	18.964	21.394
Bank capital ratio	12.155	1.280	11.950	11.110	12.820
Bank loan loss provision	4.459	13.324	1.431	0.841	2.601
Bank's reliance on interest income	0.153	0.087	0.179	0.099	0.216
Portfolio Characteristics					
Percentage of upgraded loans reversed downwards (1-quarter)	0.044	0.052	0.026	0.003	0.075
Percentage of downgraded loans reversed upwards (1-quarter)	0.120	0.153	0.081	0.000	0.205

Table 2A. Difference-in-Differences Analysis of Changes in Firms' Ratings

Table 2A presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using one general DD shock variables that capture the cumulative changes in rating upgrades and downgrades. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Dep. Var.:	interest rate					Interest rate spread				
DD_Rating Changes	-0.643***	-0.653***	-0.025	-0.180**	-0.210***	-0.446***	-0.301***	-0.308***	-0.316***	-0.326***
	(0.110)	(0.180)	(0.082)	(0.071)	(0.051)	(0.095)	(0.042)	(0.062)	(0.063)	(0.066)
Controls										
Bank Size$_{t-1}$	-0.379*	0.653	-0.055	-0.467	-0.379*	0.128**	2.645***	2.525***	2.568***	0.128**
	(0.212)	(1.819)	(1.688)	(1.244)	(0.212)	(0.054)	(0.888)	(0.887)	(0.867)	(0.054)
Bank Capital Ratio$_{t-1}$	-0.460**	-0.359	-0.349	-0.140	-0.460**	-0.199***	-0.204***	-0.205***	-0.200**	-0.199***
	(0.181)	(0.444)	(0.426)	(0.290)	(0.181)	(0.058)	(0.078)	(0.077)	(0.083)	(0.058)
Bank Loan Loss provision$_{t-1}$	-0.017***	-0.006	-0.008	-0.005	-0.017***	0.001	0.009	0.009	0.008	0.001
	(0.006)	(0.010)	(0.009)	(0.006)	(0.006)	(0.005)	(0.008)	(0.008)	(0.008)	(0.005)
Bank's reliance on interest income$_{t-1}$	-12.336***	1.889	2.140	-1.260	-12.336***	-5.668***	-2.406**	-2.434**	-2.756**	-5.668***
	(2.794)	(6.599)	(6.294)	(3.949)	(2.794)	(1.553)	(1.161)	(1.166)	(1.192)	(1.553)
Bank FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Year and quarter FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Firm industry FE	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Loan type FE	No	No	No	No	Yes	No	No	No	No	Yes
Obs.	5,974,423	5,917,626	5,917,626	5,693,781	5,515,618	3,141,434	3,098,825	3,098,825	3,068,928	2,969,415
Adj. R2	0.000	0.017	0.072	0.069	0.068	0.001	0.010	0.018	0.020	0.021

Dep. Var.:	Committed exposure					Loan maturity				
DD_Rating Changes	0.618***	0.665***	0.202***	0.133***	0.180***	0.086	0.000	-0.028	0.133***	0.139***
	(0.129)	(0.152)	(0.037)	(0.031)	(0.025)	(0.075)	(0.136)	(0.069)	(0.048)	(0.046)
Controls										
Bank Size$_{t-1}$	0.209	0.409	-0.380	-0.229	0.209	-0.135	0.098	1.089**	-0.062	-0.135
	(0.188)	(0.580)	(0.514)	(0.510)	(0.188)	(0.120)	(0.703)	(0.446)	(0.481)	(0.120)
Bank Capital Ratio$_{t-1}$	0.873***	-0.015	0.006	-0.077*	0.873***	0.118	0.124**	0.136***	0.068	0.118
	(0.161)	(0.057)	(0.051)	(0.046)	(0.161)	(0.153)	(0.050)	(0.039)	(0.048)	(0.153)
Bank Loan Loss provision$_{t-1}$	0.031***	0.002	0.001	0.001	0.031***	0.008	-0.001	0.001	-0.000	0.008
	(0.008)	(0.002)	(0.002)	(0.002)	(0.008)	(0.008)	(0.002)	(0.001)	(0.002)	(0.008)
Bank's reliance on interest income$_{t-1}$	10.715***	2.523***	2.367***	2.599***	10.715***	1.972	4.627***	3.843***	3.942***	1.972
	(3.004)	(0.853)	(0.731)	(0.607)	(3.004)	(2.287)	(0.941)	(0.865)	(0.999)	(2.287)
Bank FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Year and quarter FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Firm industry FE	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Loan type FE	No	No	No	No	Yes	No	No	No	No	Yes
Obs.	5,962,156	5,905,712	5,905,712	5,682,055	5,504,259	6,005,361	5,927,273	5,927,273	5,706,957	5,528,944
Adj. R2	0.004	0.226	0.621	0.627	0.654	0.000	0.013	0.386	0.327	0.349

Table 2B. Difference-in-Differences Analysis of Changes in Ratings: Upgrades vs. Downgrades

Table 2B presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using two DD shock variables that measure the rating upgrades and downgrades separately. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Dep. Var.:	interest rate	Interest rate spread	Committed exposure	Loan maturity
DD_Rating Upgrades	0.073	-0.279**	0.090***	0.022
	(0.129)	(0.124)	(0.026)	(0.084)
DD_Rating Downgrades	0.539***	0.414***	-0.290***	-0.253***
	(0.089)	(0.086)	(0.057)	(0.075)
Controls				
Bank Size$_{t-1}$	-0.608	2.555***	-0.187	-0.006
	(1.224)	(0.851)	(0.506)	(0.464)
Bank Capital Ratio$_{t-1}$	-0.141	-0.199**	-0.077*	0.068
	(0.291)	(0.083)	(0.046)	(0.048)
Bank Loan Loss provision$_{t-1}$	-0.005	0.008	0.001	-0.000
	(0.006)	(0.008)	(0.002)	(0.001)
Bank's reliance on interest income$_{t-1}$	-1.518	-2.811**	2.682***	4.035***
	(3.891)	(1.179)	(0.611)	(1.011)
Bank FE	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Obs.	5,515,618	2,969,415	5,504,259	5,528,944
Adj. R2	0.068	0.021	0.654	0.349

Table 3. Differential effects of rating changes by bank characteristics

Table 3 presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms using panel data regressions interacted with different bank characteristics. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using two DD indicators that capture upgrades and downgrades of the rating changes separately. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Loan Pricing

Dep. var.	Interest rate					Interest rate spread				
DD_Rating Upgrades × top tercile Bank size	-0.193					0.170				
	(0.156)					(0.242)				
DD_Rating Downgrades × top tercile Bank size	-0.390**					-0.420**				
	(0.181)					(0.197)				
DD_Rating Upgrades × top tercile Bank loan loss provisioning		0.469**					0.057			
		(0.187)					(0.361)			
DD_Rating Downgrades × top tercile Bank loan loss provisioning		0.156					0.458**			
		(0.194)					(0.231)			
DD_Rating Upgrades × top tercile Bank's reliance on interest income			0.446**					0.282		
			(0.195)					(0.194)		
DD_Rating Downgrades × top tercile Bank's reliance on interest income			0.613***					0.245*		
			(0.199)					(0.131)		
DD_Rating Upgrades × bottom tercile Bank capital ratio				0.040					-0.271**	
				(0.242)					(0.133)	
DD_Rating Downgrades × bottom tercile Bank capital ratio				0.378**					0.237*	
				(0.160)					(0.143)	
DD_Rating Upgrades × Investment grade borrower/Government guaranteed loans					-0.445**					0.038
					(0.221)					(0.210)
DD_Rating Downgrades × Investment grade borrower/Government guaranteed loans					-0.806***					-0.917***
					(0.188)					(0.172)
DD_Rating Upgrades	0.121	-0.046	-0.119	0.052	0.434**	-0.363**	-0.273***	-0.386**	-0.172	-0.080
	(0.153)	(0.114)	(0.094)	(0.200)	(0.169)	(0.141)	(0.053)	(0.192)	(0.138)	(0.221)
DD_Rating Downgrades	0.717***	0.509***	0.301***	0.430***	0.773***	0.636***	0.226***	0.314***	0.347***	0.582***
	(0.146)	(0.120)	(0.081)	(0.108)	(0.110)	(0.100)	(0.069)	(0.120)	(0.119)	(0.084)
Controls										
Bank Size$_{t-1}$	-0.062	-0.499	-0.826	-0.531	-0.721	2.449***	1.991***	2.459***	2.580***	2.259***
	(1.486)	(1.226)	(1.190)	(1.284)	(1.221)	(0.897)	(0.708)	(0.864)	(0.851)	(0.803)
Bank Capital Ratio$_{t-1}$	-0.162	-0.147	-0.140	-0.070	-0.132	-0.195**	-0.193**	-0.212**	-0.185**	-0.198**
	(0.306)	(0.292)	(0.286)	(0.244)	(0.294)	(0.081)	(0.075)	(0.085)	(0.087)	(0.081)
Bank Loan Loss provision$_{t-1}$	-0.004	-0.004	-0.005	-0.004	-0.005	0.008	0.003	0.008	0.008	0.008
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Bank's reliance on interest income$_{t-1}$	-1.205	-1.533	-1.147	-1.163	-1.409	-2.784**	-2.520**	-3.130**	-2.734**	-2.586**
	(4.024)	(3.897)	(4.212)	(4.135)	(3.902)	(1.163)	(1.019)	(1.232)	(1.123)	(1.149)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,515,618	5,515,618	5,515,618	5,515,618	5,515,618	2,969,415	2,969,415	2,969,415	2,969,415	2,969,415
Adj. R2	0.069	0.068	0.068	0.068	0.069	0.021	0.022	0.021	0.021	0.023

Panel B. Loan Amount

Dep. var.	Committed Exposure					Maturity				
DD_Rating Upgrades × top tercile Bank size	0.169***					0.513***				
	(0.062)					(0.120)				
DD_Rating Downgrades × top tercile Bank size	-0.041					0.367***				
	(0.107)					(0.120)				
DD_Rating Upgrades × top tercile Bank loan loss provisioning		-0.151**					0.405***			
		(0.075)					(0.153)			
DD_Rating Downgrades × top tercile Bank loan loss provisioning		-0.335***					0.257**			
		(0.092)					(0.126)			
DD_Rating Upgrades × top tercile Bank's reliance on interest income			-0.052					-0.580***		
			(0.060)					(0.146)		
DD_Rating Downgrades × top tercile Bank's reliance on interest income			-0.062					-0.380***		
			(0.115)					(0.126)		
DD_Rating Upgrades × bottom tercile Bank capital ratio				-0.045					-0.358**	
				(0.067)					(0.140)	
DD_Rating Downgrades × bottom tercile Bank capital ratio				-0.011					-0.404***	
				(0.091)					(0.143)	
DD_Rating Upgrades × Investment grade borrower/Government guaranteed loans					0.021					0.237***
					(0.104)					(0.073)
DD_Rating Downgrades × Investment grade borrower/Government guaranteed loans					0.142					0.396***
					(0.142)					(0.134)
DD_Rating Upgrades	0.023	0.120***	0.112***	0.111***	-0.082	-0.155	-0.077	0.256***	0.185***	-0.087
	(0.035)	(0.030)	(0.034)	(0.043)	(0.050)	(0.100)	(0.082)	(0.063)	(0.064)	(0.101)
DD_Rating Downgrades	-0.259***	-0.200***	-0.266***	-0.284***	-0.309***	-0.417***	-0.311***	-0.095	-0.124	-0.380***
	(0.066)	(0.048)	(0.077)	(0.077)	(0.086)	(0.071)	(0.087)	(0.087)	(0.081)	(0.070)
Controls										
Bank Size$_{t-1}$	-0.182	-0.327	-0.164	-0.147	-0.115	0.022	0.186	0.197	0.062	0.027
	(0.579)	(0.550)	(0.506)	(0.511)	(0.504)	(0.527)	(0.429)	(0.436)	(0.446)	(0.459)
Bank Capital Ratio$_{t-1}$	-0.079*	-0.073*	-0.077*	-0.053	-0.087*	0.062	0.060	0.070	0.075	0.068
	(0.046)	(0.044)	(0.046)	(0.075)	(0.046)	(0.047)	(0.047)	(0.047)	(0.061)	(0.048)
Bank Loan Loss provision$_{t-1}$	0.001	-0.000	0.001	0.001	0.001	-0.000	0.001	0.000	-0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Bank's reliance on interest income$_{t-1}$	2.650***	2.707***	2.663***	2.769***	2.670***	3.811***	4.008***	3.813***	3.949***	3.978***
	(0.608)	(0.610)	(0.646)	(0.669)	(0.624)	(0.960)	(0.971)	(0.955)	(1.021)	(1.012)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,504,259	5,504,259	5,504,259	5,504,259	5,504,259	5,528,944	5,528,944	5,528,944	5,528,944	5,528,944
Adj. R2	0.654	0.654	0.654	0.654	0.659	0.350	0.350	0.351	0.350	0.350

Table 4. The effects of rating changes on new originations versus existing loans

Table 4 presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings on newly originated loans and on existing loans. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using two DD indicators that capture upgrades and downgrades of the rating changes separately. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. New originations

Dep. Var.:	Interest rate	Interest rate spread	Committed exposure	Loan maturity
DD_Rating Upgrades	-0.095	-0.201	0.046	0.137
	(0.092)	(0.148)	-0.048	-0.089
DD_Rating Downgrades	0.508***	0.337***	-0.047	-0.217***
	(0.090)	(0.076)	(0.078)	(0.061)
Controls				
Bank Size$_{t-1}$	-1.263	0.489	0.739	-0.350
	(0.895)	(1.036)	(0.708)	(0.500)
Bank Capital Ratio$_{t-1}$	0.020	-0.016	-0.080	0.091*
	(0.114)	(0.087)	(0.063)	(0.052)
Bank Loan Loss provision$_{t-1}$	-0.003	0.007	0.002	0.003
	(0.002)	(0.016)	(0.002)	(0.002)
Bank's reliance on interest income$_{t-1}$	-0.432	-2.303	3.803***	2.848***
	(1.809)	(1.696)	(0.904)	(0.874)
Bank FE	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Obs.	590,768	263,620	592,604	594,012
Adj. R2	0.231	0.016	0.765	0.256

Panel B. Existing loans

Dep. Var.:	Interest rate	Interest rate spread	Committed exposure	Loan maturity
DD_Rating Upgrades	0.086	-0.284**	0.092***	0.025
	(0.137)	(0.129)	(0.026)	(0.084)
DD_Rating Downgrades	0.529***	0.406***	-0.301***	-0.254***
	(0.091)	(0.085)	(0.054)	(0.076)
Controls				
Bank Size$_{t-1}$	-0.595	2.586***	-0.242	-0.073
	(1.260)	(0.885)	(0.508)	(0.465)
Bank Capital Ratio$_{t-1}$	-0.168	-0.213**	-0.075*	0.076
	(0.314)	(0.084)	(0.045)	(0.047)
Bank Loan Loss provision$_{t-1}$	-0.005	0.009	0.001	-0.000
	(0.006)	(0.008)	(0.002)	(0.002)
Bank's reliance on interest income$_{t-1}$	-1.552	-2.834**	2.514***	4.022***
	(4.125)	(1.232)	(0.610)	(1.018)
Bank FE	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Obs.	4,924,850	2,705,795	4,911,655	4,934,932
Adj. R2	0.062	0.023	0.630	0.350

Table 5. The effects of rating changes for firms with multi-bank relationships

Table 5 presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms borrowing from multiple banks using panel data regressions. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using two DD indicators that capture upgrades and downgrades of the rating changes separately. We control for lagged bank characteristics, loan characteristics, bank fixed effects, and firm by year quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

	Interest rate	Interest rate spread	Committed exposure	Loan maturity
DD_Rating Upgrades	0.012	-0.111	0.096**	0.069
	(0.083)	(0.126)	(0.037)	(0.112)
DD_Rating Downgrades	0.378***	0.289***	-0.390***	-0.128
	(0.070)	(0.082)	(0.056)	(0.099)
Controls				
Bank Size$_{t-1}$	-1.574	3.662***	-0.766	-0.874*
	(1.177)	(1.058)	(0.549)	(0.517)
Bank Capital Ratio$_{t-1}$	0.182	-0.058	-0.193***	-0.046
	(0.144)	(0.074)	(0.067)	(0.051)
Bank Loan Loss provision$_{t-1}$	-0.009**	-0.003	0.005***	0.001
	(0.003)	(0.008)	(0.002)	(0.001)
Bank's reliance on interest income$_{t-1}$	-7.094***	-1.732	4.643***	4.010***
	(1.942)	(1.153)	(0.951)	(0.817)
Bank FE	Yes	Yes	Yes	Yes
Firm * year quarter FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Obs.	2,642,218	1,115,592	2,619,594	2,645,625
Adj. R2	0.136	0.020	0.745	0.337

Appendix

Table A1: Variable Description and Sources

Loan Characteristics	Data Source: FR Y-14Q (Corporate Loan Schedule)
Committed exposure	Logarithm of dollar amount that a borrower contractually can borrow
Interest rate	Interest rate charged on a loan as of the reporting date
Interest rate spread	Spread over risk-free rate
Bank Characteristics	Data Source: FR Y9-C
Bank Size	Natural log of total assets
Bank Capital Ratio	Tier 1 capital ratio
Bank Loan Loss provision	Allowance for loan loss / loans and leases held for sale
Bank's reliance on interest income	Net interest income / (interest income + noninterest income)
Portfolio characteristics	Data Source: FR Y-14Q (Corporate Loan Schedule)
Proportion of portfolio that experienced mapping upgrades or downgrades	Refers to upgraded or downgraded rating tranches. A higher proportion indicates a bank has a higher volume of loan amounts that are exposed to remapping. This variable is set to zero prior to the rating remapping and the remains constant after the remapping.
Percentage of upgraded (downgraded) loans reversed downwards (upwards)	Refers to percentage of loans that exhibit rating reversal behavior, which is identified if the rating of a loan is revised in the opposite direction relative to the direction of the remapping (i.e., a tranche in which a loan resides is upgraded, but that loan is downgraded). We look for rating reversal 1Q or 2Q after the remapping.

Table A2. Bank characteristics and the rating remappings

Table A2 presents estimated coefficients from logistic analyses of the effects of bank characteristics on remapping outcomes. The dependent variables are the dummy variable that equals to one when the external rating of a specific tranche in a loan quarter is remapped upward or downward. We use bank size, capital ratio, loan loss provisioning, and reliance on interest income as the main explanatory variables and control for year and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Dep. var.	Upward rating remapping	Downward rating remapping
	-0.151	0.161
Bank size	(0.146)	(0.190)
	-0.175	-0.084
Tier1 Capital Ratio	(0.145)	(0.158)
Ratio of bank Loan Loss provision of total loan amount	-0.008	-0.016
	(0.007)	(0.015)
Bank's reliance on interest income	2.194	2.803
	(3.080)	(2.811)
Constant	4.617	-1.370
	(3.208)	(3.827)
Year-Quarter FE	YES	YES
Observations	279	259
Pseudo R2	0.124	0.180

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3. Baseline regressions excluding offsetting loans

Table A3 presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms, excluding loans that experience rating reversal behavior. The dependent variable are the interest rate, interest rate spreads of the loan, total committed exposure, and maturity. We measure the changes in firms' mapping-induced internal ratings using two DD shock variables that measure the rating upgrades and downgrades separately. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

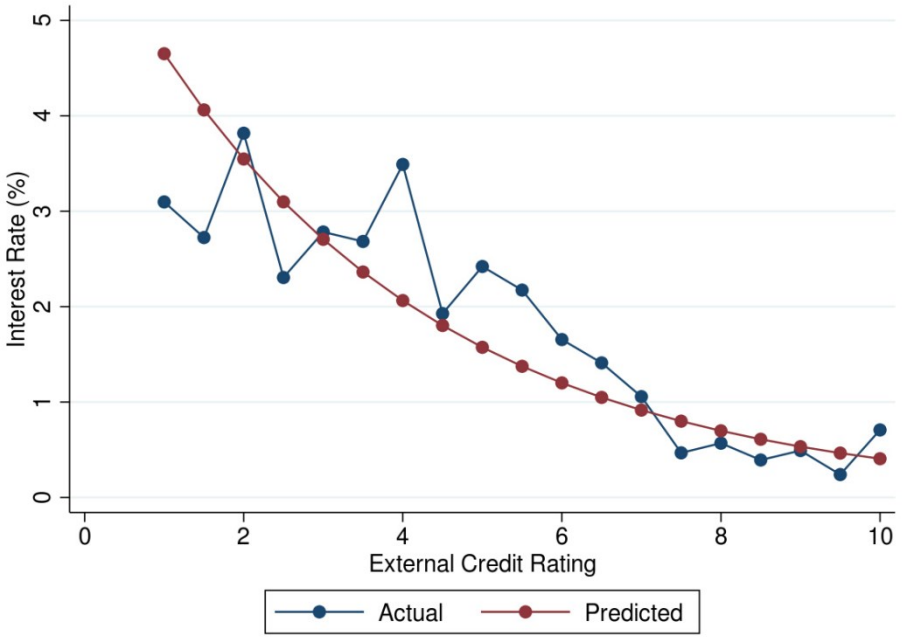
Dep. Var.:	Interest rate	Interest rate spread	Committed exposure	Maturity
DD_Rating Upgrades	0.079	-0.264**	0.087***	0.020
	(0.133)	(0.127)	(0.027)	(0.085)
DD_Rating Downgrades	0.536***	0.393***	-0.284***	-0.255***
	(0.091)	(0.087)	(0.057)	(0.077)
Controls				
Bank Size$_{t-1}$	-0.635	2.521***	-0.171	-0.009
	(1.230)	(0.847)	(0.508)	(0.462)
Bank Capital Ratio$_{t-1}$	-0.141	-0.200**	-0.078*	0.068
	(0.293)	(0.083)	(0.046)	(0.048)
Bank Loan Loss provision$_{t-1}$	-0.005	0.008	0.001	-0.000
	(0.006)	(0.008)	(0.002)	(0.002)
Bank's reliance on interest income$_{t-1}$	-1.510	-2.777**	2.699***	4.030***
	(3.919)	(1.181)	(0.613)	(1.007)
Bank-specific rating category FE	Yes	Yes	Yes	Yes
Year and quarter FE	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Obs.	5,457,477	2,928,242	5,446,126	5,470,810
Adj. R2	0.068	0.021	0.655	0.352

Table A4. Non-linearity test of the effects of the interest rate on rating remapping

Table A4 presents estimated coefficients from difference-in-differences (DD) analyses of the effects of changes in loan ratings for firms. The dependent variables are the logarithm of interest rate and the logarithm of interest rate spreads of the loan. We measure the changes in firms' mapping-induced internal ratings using one general DD shock variables that capture the cumulative changes in rating upgrades and downgrades. We control for lagged bank characteristics, loan characteristics, firm industry fixed effects, bank fixed effects, and quarter fixed effects in all regressions. The analyses are conducted using quarterly panel data that cover the period from September 2011 to December 2016. Detailed description of the variables is presented in Appendix Table A1. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are clustered at the bank-quarter level to account for within-bank correlations in regression residuals and are shown in parentheses. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Dep. var.	Log of interest rate	Log of interest rate spread
DD_Rating Upgrades	-0.068***	-0.132***
	(0.016)	(0.038)
DD_Rating Downgrades	0.118***	0.221***
	(0.015)	(0.058)
Bank Sizet-1	-0.136	1.358***
	(0.127)	(0.452)
Bank Capital Ratio t-1	0.025*	-0.020
	(0.014)	(0.042)
Bank Loan Loss provision t-1	0.000	0.011***
	(0.000)	(0.004)
Bank's reliance on interest income t-1	-0.726***	-0.484
	(0.196)	(0.347)
Constant	4.229*	-26.612***
	(2.469)	(8.923)
Year and quarter FE	YES	YES
Loan type FE	YES	YES
Firm industry FE	YES	YES
Observations	5,216,070	2,554,020
Adjusted R-squared	0.273	0.166

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix Figure A1

This chart shows the average interest rate at each credit rating, with 10 as AAA, 9 as AA, etc. The blue line shows the actual average interest rate at each credit rating, with the red line showing the best-fit log curve, of the actual average interest rates.