Industry Heterogeneity in the Risk-Taking Channel

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16 May 2020

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Abstract

We examine the transmission of the risk-taking channel to different industries using syndicated loans to U.S. borrowers from 1984 to 2018. We find that a one percentage point decrease in the shadow rate increases loan spreads by more than 30 basis points in the mining & construction and manufacturing sectors. The equivalent effect is lower in the services and trade industries, whereas the effect on the transportation & utilities and finance industries is less pronounced. Our results survive in several sensitivity tests and are immune to time-varying demand-side explanations. The identified differences in the potency of the risk-taking channel explain a significant part of the inferior performance of highly affected sectors compared to less-affected sectors in the year after a loan origination.

JEL codes: G21, G01, E43, E52
Keywords: Bank risk-taking; Monetary policy; U.S.; Syndicated loans; Different industries

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1. Introduction

In the aftermath of the global financial crisis, there is increasing interest in the links between monetary policy and the soundness of the financial system. A vivid academic and policy debate pertains to the risk-taking channel of monetary policy (Borio and Zhu, 2012; Jimenez et al., 2014). The basic idea is that when monetary policy is lax for a prolonged period of time, the incentive for banks to take more risk increases. Thus, monetary policy affects not just the quantity of bank credit, but also its quality. In this paper, we ask two new questions with respect to the operation of the risk-taking channel. The first concerns whether the risk-taking channel is potent across different industries. The second asks whether industry heterogeneity in the potency of the risk-taking channel affects firms' performance and thus has real implications.

The answers to these questions are important for two interrelated reasons. First, industry asymmetries related to how monetary policy affects banks' risk-taking might have real implications for investments and performance. Specifically, if lax monetary policy induces increased credit supply and riskier bank lending, there could be more liquidity to firms in industries that have inherently different risk profiles. These industry risk profiles might be different because of different types of capital employed, different horizons in investment materialization, different access to alternative sources of finance, etc.

Second, asymmetries in the propagation of the risk-taking channel and any concomitant real effects have implications for economic policy. If monetary policy affects banks' risk-taking in specific sectors, it is important for monetary policymakers to consider these asymmetries, especially as monetary policy moves toward unconventional tools that apply differently to different sectors and given that fiscal policy faces limitations in the presence of high sovereign debt.

The risk-taking channel operates via four inextricable mechanisms. The first relates to the effect of monetary policy innovations (conventional or unconventional) on real valuations, incomes, and cash flows. For example, lower policy rates boost asset and collateral values and reduce price volatility, thereby downsizing bank estimates of probabilities of default and encouraging higher risk positions (Borio and Zhu, 2012). The second is the search-for-yield mechanism, with monetary expansions increasing the incentives for financial intermediaries with long-term liabilities and shorter-term assets to invest in riskier (and higher-yielding) assets in order to counteract decreasing profits (Rajan 2005). The third is the risk-shifting channel (Valencia 2014), whereby lax monetary policy reduces banks' funding costs and increases the monopolistic surplus they can extract from their borrowers. Under limited liability, this increased profitability leads banks to take excessive risks. Last, monetary policy may also affect risk-taking through the central bank's reaction to negative shocks. For example, a central bank commitment of lower (future) interest rates in the case of a threatening shock reduces the probability of large downside risks, thereby encouraging banks to assume greater risk (transparency effect).

Theory points to the role of market inefficiencies in an environment of falling interest rates and increasing asset prices, and it relates bank risk-taking with mispriced risk perceptions. Dubecq et al. (2009), for example, show that lower interest rates increase the scale of the underestimation of risk and amplify the overpricing of risky assets. In a similar vein, Acharya and Naqvi (2012) argue that when markets become flush with liquidity, banks tend to misprice downside risk, relax their lending standards, and increase credit availability. Afanasyeva and Güntner (2019) also show that after monetary policy expansions, profit-maximizing banks tend to lower their lending standards, relative to borrower collateral, to obtain a larger "share of the pie," even if this raises the probability of firms to default *ex post*. All in all, misperceptions of firms' riskiness result in a "lending boom" that allows borrowers with bad credit histories and riskier projects to benefit from higher risk tolerance, especially when interest rates remain low for a prolonged period of time.

In the presence of cross-industry differences in risk, reflecting *inter alia* their different degrees of sensitivity to changes in economywide factors (such as interest rates and unconventional policy tools), we conjecture that bank risk-taking behavior affects economic activity asymmetrically, with some sectors more vulnerable to a shift in banking-sector credit conditions. Specifically, Compustat data shows important differences in the leverage ratios or Tobin's q of different industries. Leverage is higher in industries requiring more physical capital and making longer-term investments (e.g., manufacturing).

We use data on all syndicated credit facilities (from DealScan) granted to borrowers in the United States from 1984 to 2018 and merge it with information on bank characteristics (from Call Reports) and firm characteristics (from Compustat). To account for unconventional monetary policy environments, we use the shadow short rate (SSR) of Krippner (2016). Empirical identification of the risk-taking channel poses four key challenges. The first is the observation of new risk (new loans), and this is the essence of using loan-level data. The second is distinguishing shifts in loan supply from shifts in loan demand. We control for loan demand by fielding our empirical model with firm × year fixed effects (controlling for firm-year variations in firm characteristics, including loan demand) and triple-interaction terms between our monetary policy variable with bank capital and firm risk (Jimenez et al., 2014; Ioannidou et al., 2015). Last, monetary policy is endogenous to other time-varying macroeconomic developments within a given year. To control for this type of endogeneity, we use Taylor residuals (constructed from the shadow rate) that are free of within-year variation in inflation and the output gap. Fourth, as an important robustness test, we consider a Heckman-type model, which accounts for the probability of a firm using the syndicated loans market (and associated selection).

We first identify the risk-taking channel in our full sample and show that the results are consistent with those of the extant literature. We note that less capitalized banks lend to riskier firms following a monetary policy expansion. Economically, these effects are large: a 1% decrease in the shadow rate increases the cost of loans by 25 basis points or $1.7 million USD for loans of average size and maturity. These results are robust to the use of Taylor residuals, the Heckman-type model, distinguishing between term loans and credit lines, and other robustness tests.

Subsequently, we distinguish between different industries using Standard Industrial Classification (SIC) codes. SIC codes are the most common industry classification system, also used by governments and the U.S. Securities and Exchange Commission (SEC). On this basis, we distinguish among firms in the mining & construction, manufacturing, transportation & utilities, trade (wholesale and retail), finance, and services industries.

Applying our empirical model separately to these industries, we find that banks take on more risk in the mining & construction and manufacturing sectors. The estimated marginal effects show that a 1% decline in the shadow rate increases the cost of loans in these industries by approximately 30 basis points. We argue that these sectors are more vulnerable to the risk-taking channel because of their idiosyncrasies related to their intertemporal production decisions and high interest rate sensitivity. The corresponding effect is also considerable in the services and trade sectors (approximately 25 basis points), lower in transportation & utilities (approximately 16 basis points), and statistically insignificant in the financial sector. These results are again robust to several respecifications and robustness tests, and they are in fact stronger when using Taylor residuals as the monetary policy measure.

Importantly, we find that bank risk-taking in the most affected sectors leads to significant underperformance in these sectors due to the higher cost of lending. We find that that a 1% rise in the predicted cost of loans leads to a decline in Tobin's q by 0.246, which is about 26% of its standard deviation. Thus, we document a new mechanism through which monetary policy shocks alter performance in different industries and thus potentially alter the accumulation of investment and resources in different industries.

Our paper naturally relates to the risk-taking channel literature. The empirical evidence on the strength of the risk-taking channel flourished in the post-crisis period using mainly micro-level data in a panel dimension. Although these empirical works differ in how they gauge bank risk (expected default frequencies, proportion of risky assets, corporate loan spreads, confidential loan ratings, risk tolerance from bank lending surveys), their results indicate that monetary expansions induce banks to assume riskier behavior in different countries, including the United States (De Nicolò et al., 2010; Dell' Ariccia et al., 2017; Delis et al., 2017; Paligorova and Santos, 2017), the Eurozone (Delis and Kouretas, 2011; Maddaloni and Peydró, 2011; Altunbas et al., 2014), Spain (Jimenez et al., 2014), and Bolivia (Ioannidou et al., 2015). A few studies examine the risk-taking channel from a macroeconomic perspective that endogenizes risk-taking behavior and relates it to monetary policy. These studies verify that expansionary monetary policy shocks raise bank risk tolerance (Angeloni et al. 2015), and this effect is stronger for smaller domestic banks (Buch et al., 2014). As an extension to this literature, Colletaz et al. (2018) investigate the existence of a systemic risk-taking channel at the macroeconomic level for the euro area. Based on causality measures, they find that causality from monetary policy to systemic risk accounts for 75% to 100% of the total dependence between the two variables in the long run.

These studies use mainly loan- or bank-level data, which cover the whole spectrum of economic activity, thereby ignoring industry heterogeneity in the transmission of the risk-taking channel. Nevertheless, the universality of the channel calls for a more detailed exploration of how banks' risk appetite, resulting from accommodative monetary policy, affects different sectors of economic activity. Yet, evidence on this matter is very scarce.

The rest of the paper is organized as follows: Section 2 discusses the identification strategy, while section 3 presents the econometric model. Section 4 reports and discusses the empirical findings, and section 5 concludes.

2. Data and empirical model

2.1. Identifying the risk-taking channel

Empirical identification of the risk-taking channel involves identifying compositional changes in credit supply toward higher credit-risk levels stemming from expansionary monetary policy (e.g., Jimenez et al., 2014; Ioannidou et al., 2015). The basic empirical model is of the general form:

$$Risk\text{-}taking_{bt} = f(MP_{t-1}, C_{bt}; \beta), \tag{1}$$

where the risk-taking of bank *b* in quarter *t* is a function of a monetary policy variable (*MP*) at quarter *t*-1, other variables *C* affecting bank risk-taking, and a vector of parameters *β*. There are three interrelated problems to identify the causal effect of monetary policy on bank risk-taking (Jimenez et al., 2014; Ioannidou et al., 2015; Delis et al., 2017). The first is identifying the effect of monetary policy innovations on risk-taking (new risk) as opposed to pre-existing risk. This is important because we examine how lending policy changes with monetary conditions, as opposed to restructuring existing bank assets. The second is distinguishing shifts in loan supply (the willingness of banks to make loans) from shifts in loan demand (loan demand by borrowers). The third is identifying exogenous changes in monetary policy (i.e., accounting for omitted variable bias stemming from other macroeconomic developments), which is increasingly difficult given the new monetary policy tools that emerged in the post-crisis period.

To tackle these problems, we use loan-level data from DealScan and closely follow the identification strategy in the recent literature on the risk-taking channel. We impose the following structure on the syndicated loan data. We observe loan facilities to a firm by one or more lead banks. The lead banks decide the price and nonprice lending terms. We thus conduct our analysis at the lead-bank level, which implies that for one loan facility we might have more than one observation (corresponding to the number of lead banks for that loan facility). We keep all these observations because the lead bank reflects the supply-side loan decisions. The number of observations is 103,725, reflecting loan facilities originated by lead banks from 1984 to 2018. The number of unique loan facilities is 57,159, the number of lead banks is 676, and the number of firms is 8,472.

The loan facilities are newly originated loans, corresponding to new risk. We can match the dates of loan originations with the dates of monetary policy announcements and solve the first identification problem (observing new risk). Further, the loan-level data significantly reduce concerns of identifying changes in loan demand along with changes in loan supply, especially when the data include repeated lending to the same borrowers within a given year. This allows saturating our baseline specification with firm × year fixed effects. The inclusion of firm × year fixed effects implies that following a change in monetary policy, within a year we observe changes in bank behavior (the supply side) while controlling for all firm characteristics that remain constant within-year (including unobserved time-varying heterogeneity in firm loan demand). In this respect, a complementary level of identification resides in assessing the heterogeneity in lending from different banks to the same firm, thus also controlling for loan demand and other annually varying firm characteristics. In that sense, we also fully control for annual changes in the macroeconomic environment. Any remainder unobserved time-varying macroeconomic elements affecting our results should be time-varying within-year (we discuss this below). We also add bank fixed effects to account for unobserved, time-invariant bank characteristics affecting loan pricing.

Next, and given the set of fixed effects, we interact our monetary policy variable with the bank capital ratio and firm risk (a triple-interaction term). We focus on the bank capital ratio, as this is the bank characteristic with the most significant bearing on the decision to lend (Holmstrom and Tirole 1997; Jimenez et al. 2014). Triple interactions control exhaustively for banks' heterogeneous response in supplying credit to riskier firms in times of loose of monetary policy. Further, these interaction terms significantly add to the identification power of our model (heterogeneous responses), which might be limited due to the use of many fixed effects (especially the firm × year fixed effects).

Based on these empirical identification choices, our model becomes:

$$Loan\ cost_{lfbt} = a_0 + a_1 MP_{t-1} + a_2 Capital_{b,t-1} + a_3 Firm\ risk_{f,t-1} + a_4 MP_{t-1} Capital_{b,t-1} + a_5 MP_{t-1} Firm\ risk_{f,t-1} + a_6 Capital_{b,t-1} Firm\ risk_{f,t-1} + a_7 MP_{t-1} Capital_{b,t-1} Firm\ risk_{f,t-1} + \beta X_{lfbt} + \varepsilon_{l,f,b,t}. \quad (2)$$

Equation (2) suggests that a loan's total cost (*Loan cost*) is a function of monetary policy in quarter *t*-1, measures of bank capital (*Capital*), firm risk (*Firm risk*), the double- and triple-interaction terms of these variables, a vector of control variables *X* (including interaction terms with bank capital and firm risk where necessary), and the disturbance ε. Also, the parameter a_0 includes the several types of fixed effects discussed earlier. In what follows, we discuss the variables in equation (2).

Our coefficient of interest is a_7, which captures the heterogeneous policy effects of lending to risky borrowers ascribed to the heterogeneity in banks' capitalization. Specifically, a positive coefficient a_7 implies more risk-taking (higher loan spreads) from poorly capitalized banks lending to riskier firms when *MP* declines. We estimate equation (2) using OLS. In accordance with the focus of our analysis and data variation, we cluster standard errors at the year, bank, and firm level.[1]

A wrinkle to OLS estimation might come from a special case of selection bias, to the extent that the estimated effect of monetary policy on banks' risk-taking depends on the decision to borrow (i.e. whether the variables that determine such an impact are the same as those explaining the decision to borrow) (Dass and Massa 2011; Delis et al. 2018). To correct for this bias, we conduct a robustness test by employing Heckman's (1979) two-stage regression technique. The first stage is a probit regression of the probability to initiate a new loan (i.e., the dependent variable is a dummy that equals 1 in the year when the firm initiates a loan, and 0 otherwise). Then, we estimate with OLS the augmented version of equation (1), including Heckman's (1979) lambda from the first-stage probit model. To the extent that the risk-taking channel is a two-step process (establish lending relationships and then determine loan terms), the selection model provides robust estimates.

[1] Our results are robust to clustering only at the bank level, as well as at the bank and firm levels. The chosen three-way clustering is the most restrictive and produces the most conservative results.

2.2. Measures of bank risk-taking and monetary policy

Loan cost is the all-in-spread drawn (spread over LIBOR plus loan fees) and is an *ex ante* measure of what banks think the riskiness of a borrower is at the time of loan issuance. The literature uses loan-pricing variables to identify the risk-taking channel of monetary policy, assuming that profit-maximizing banks charge higher loan spreads to riskier borrowers (Delis et al. 2017; Paligorova and Santos 2017). Further, *Loan cost* measures new risk by definition (the riskiness of a new loan). Part of the literature on syndicated loans also considers other loan fees in banks' pricing decisions (e.g., commitment, utilization, cancellation, and upfront fees) and finds a significant effect of these fees in many respects (Berg et al. 2016). Thus, we opt for the measure in Berg et al. (2016), which includes all loan fees (where available); we provide a full definition for the construction of our variable in Table 1.

(Please insert Table 1 about here)

Identifying the monetary policy stance is put to a great test when interest rates approach the zero lower bound (ZLB) (Hakkio and Kahn, 2014). From December 2008 to December 2015, the federal funds rate was essentially stuck at the ZLB, and the Federal Open Market Committee (FOMC) deployed the unconventional tools of forward guidance and quantitative easing. From this period onward, most of the relevant empirical literature measures monetary policy with the shadow short rate from the yield curve model (Krippner 2016). The shadow rate offers an indication of how the Fed's actions, both conventional and unconventional, influence market expectations about monetary policy (rather than being considered to embed all policy actions directly). In this respect, the shadow rate is equal to the policy interest rate in non-ZLB/conventional monetary policy environments (in the pre-financial crisis period), but it can take on negative values in ZLB/unconventional environments (in the post-2008 period). Thus, the shadow rate combines data from the ZLB period with data from the non-ZLB period.

Concerning the exogeneity of the effect of the shadow rate on bank risk, using firm × year fixed effects saturates the estimates from annually varying unobserved macroeconomic effects. However, there could be within-year variations affecting our estimate on a_7. We have two remedies for this problem. The first is to use a full array of quarterly macroeconomic control variables in our regressions and do so symmetrically with the monetary policy variable (i.e., including the interaction terms with bank capitalization and firm risk). We find that using expectations on GDP growth and inflation, as well as the mean *Loan cost* of the loan facilities by quarter, is sufficient in the sense that adding more variables (e.g., consumer and producer expectations, stock market volatility indices, etc.) does not affect our results and the additional variables have no statistical power.

Second, we identify (exogenous) monetary policy shocks by estimating Taylor-rule residuals (Taylor 1993) from the regression on output gap and inflation. According to Adrian and Shin (2008), Taylor rule residuals are discretionary monetary policy. At the same time, they may signal the Fed's intentions to the financial markets, thereby influencing banks' perceptions about the stance of monetary policy (Delis et al. 2017). In other words, banks lend on the basis of whether they perceive the federal funds rate (or the shadow short rate after the financial crisis) is lower than the rate implied by the Taylor benchmark.

2.3. Measures of bank capital and firm risk

As indicated in section 2.1, we focus on the triple-interaction term *MP*× *Bank capital* × *Firm risk* to assess the compositional changes in the supply of credit at the bank-firm level. *Bank capital* is the ratio of Tier 1 plus Tier 2 bank capital to total risk-weighted assets. It is widely accepted that the relationship between interest rates and bank risk-taking depends on bank capital. Both the risk-shifting channel of monetary policy and the search-for-yield mechanism are rooted in moral hazard problems, which are intuitively more severe for poorly capitalized banks (e.g., Dell'Ariccia et al., 2017). Therefore, undercapitalized banks are more sensitive to interest rate changes and take excessive risks when monetary easing compresses their intermediation margins (Delis and Kouretas, 2010; Jimenez et al., 2014; Ioannidou et al., 2015).

Firm risk is Altman's (1968) inverse modified Z-score, with higher values implying a riskier firm. The Z-score is widely used to measure firm risk because it uses multiple variables to measure the financial health and creditworthiness of a borrower. We do not include other firm-year characteristics as controls, because the inclusion of firm × year fixed effects renders these redundant.

2.4. Control variables

Sufi (2007) and Ivashina (2009) identify adverse selection and moral hazard specifically in the syndicated loans market. Adverse selection occurs before loan syndication because the lead bank has an incentive to originate high-risk loans in order to nurture a relationship with the borrower and/or to reap underwriting fees. Moral hazard arises after syndication, when the lead arranger puts less effort into monitoring, especially when it retains a smaller loan portion. Both agency problems suggest that syndicate participants may demand higher loan spreads as compensation for the risk of wrongdoing by the lead bank.

To account for these agency problems, we include a set of loan controls and lead-bank characteristics. Specifically, loan controls include loan amount, time to maturity, number of lenders in the syndicate, the requirement of performance and collateral provisions, and the use of financial and other covenants.[2] The first three variables are continuously quantifiable, but the remaining variables are qualitative in nature (i.e., they indicate the presence of any provision or covenant assigned to the loan).

We also use loan-type fixed effects, which are very important, as loan facilities include credit lines and term loans; they have fundamental differences in their contractual arrangements and pricing (Berg et al. 2016). For example, term loans usually do not include several types of fees, and some are structured to appeal more to institutional investors rather than banks.[3] Further, we include loan purpose fixed effects.

Finally, bank controls measure the lead lenders' financial soundness and include liquidity, nonperforming loans, size, and return on assets (*ROA*). We expect that these variables saturate the effect of the triple-interaction terms from other supply-side characteristics.

(Please insert Table 1 about here)

2.5. Summary statistics

Table 2 reports summary statistics for the variables used in our empirical analysis. The average cost of loans is 235.43 basis points over LIBOR, with a standard deviation of 123.25, reflecting the fact that our sample covers syndicated loans to firms of various risk levels. The average syndicated loan facility is approximately $156 million, with a loan maturity of 52 months and 12 lenders.

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[2] In robustness checks, we show that our findings are not subject to a bad controls problem.

[3] We find that the loan-type fixed effects are sufficient to control for the heterogeneity between term loans and credit lines. In unreported robustness tests, we estimate our models separately for term loans and credit lines. We find that the risk-taking channel is somewhat stronger for credit lines (as expected) but remains statistically significant also in the sample of term loans.

The lead arrangers have a capital ratio of 12.2% on average, but the dispersion is significant, with a standard deviation of 6%. Lead banks do not significantly vary in size (as indicated by the relatively small standard deviation) and are on average profitable (with an average ROA equal to 1%), albeit the variation in pretax profits to total assets is substantial (2.2%).

The average borrowing firm in our sample is leveraged around 37% of its total assets and is profitable (the average ROA equals 2.4%), but the variation is large. The average (inverse) Z-score is 1.59 with a high degree of variation across firms, reflecting significant differences in credit risk. In addition, it appears that most syndicated loans are deals between borrowers and lead banks without a recent prior relationship.

The shadow rate also displays substantial variation over the sample period, averaging 2.53% but with a standard deviation of 3%. Finally, about one-fifth of quarters in the sample correspond to ZLB/unconventional monetary policy periods.

(Please insert Table 2 about here)

2.6. Analysis by industry

We offer insight on the potency of the risk-taking channel by industry. As risk varies among industries, we expect to find cross-industry heterogeneous responses to the risk-taking channel of monetary policy. We distinguish between different industries using Standard Industrial Classification (SIC) codes. The syndicated loans for agriculture, forestry, and fishing firms are very few; thus, we exclude this group. SIC codes from 1000 to 1799 are for firms in the mining & construction industries (codes from 1800 to 1999 are not used). Codes from 2000 to 3999 represent the manufacturing industry; 4000 to 4999 transportation, communications, electric, gas, and sanitary services; 5000 to 5999 trade (wholesale and retail); 6000 to 6999 finance; and 7000-8999 services.

Table A1 in the Appendix provides summary statistics for key loan features (cost of loans, loan amount, and maturity) by industry. Manufacturing and service companies face on average the highest funding costs (255.57 and 254.88 basis points over LIBOR, respectively), while finance companies pay the lowest spreads (203.71 basis points over LIBOR). Loans also vary significantly in maturity, ranging from 34.47 months (finance sector) to 51.22 months (transportation & utilities sector), indicating cross-industry differences in financing horizons. In contrast, the variation in average loan amount is relatively small across industries.

As expected, the financial sector stands out when comparing leverage ratios (0.42); however, this is also a sector that by nature has alternative sources of financing (from internal capital to central bank facilities). The manufacturing and mining & construction sectors also report high leverage ratios (0.39 and 0.38, respectively), reflecting high investment needs in machinery and other assets, as well as their relative riskiness.

3. Estimation results

3.1. Results from the full sample

We first identify the risk-taking channel in our full sample, following the paradigm of previous literature (Delis et al. 2017; Paligorova and Santos 2017). Table 3 reports the results. We include only the coefficient estimates on the triple interactions, as these are the important estimates for identification purposes. Importantly, we report the marginal effect in basis points of a one-percentage-point decrease in *MP* for firms with mean inverse Z-scores and banks with mean capital.

(Please insert Table 3 about here)

The effect of our control variables (not reported due to space considerations, but available on request) is fully in line with expectations and the associated literature (e.g., Delis et al. 2018; Hasan et al. 2014; Bae and Goyal 2009; Sufi 2007). Consistent with the estimation of a reduced form loan demand and supply equation, *Loan amount* bears a negative and statistically significant coefficient. *Collateral* has a positive effect, reflecting riskier loans, whereas covenants and *Performance provisions* have negative coefficients reflecting the tradeoff between higher loan spreads and more stringent covenants. The effect of the number of lenders is also positive, consistent with the premise that more lenders are involved in high-risk loans.

The firm × year fixed effects absorb the main terms of firm characteristics. The marginal effect of the inverse Z-score is positive and significant, showing that riskier firms borrow at higher cost. The coefficient on bank characteristics is also in line with expectations. For example, the marginal effect of bank capital is positive and statistically significant, showing that better capitalized banks originate riskier loans. This is a standard moral-hazard argument, consistent with previous studies of the syndicated loan market (Iosifidi and Kokas, 2015).

The triple-interaction term carries a positive and statistically significant (at the 5% level) coefficient, suggesting that lower short-term rates strongly encourage risk-taking among poorly capitalized banks. In other words, loose monetary policy incentivizes poorly capitalized banks to ease riskier firms' access to credit, albeit at a higher cost. Specifically, the estimated marginal effect in column 1 indicates that a one-percentage-point decline in the shadow rate increases the cost of credit by 25 basis points. This is economically significant, as it represents more than 20% of the standard deviation of *Cost of loans* (123.25).[4] Given the average syndicated loan size ($156

[4] We also experiment with alternative measures of firm risk and manifestations of bank agency problems. Specifically, in Table A2 in the Appendix we interact *Shadow rate* with *Bank capital* and *Firm leverage* (instead of the *Z*-score),

million), the total cost of borrowing among risky firms rises by $0.39 million (=$156.000.000 x 25 basis points) per year on average when the shadow rate declines by one percentage point. Considering that the average time to maturity for syndicated loans is 4.4 years, this represents approximately $1.7 million in extra interest expense over the loan's duration.

In column 2 we drop bank controls and include bank × year fixed effects to account for time-varying bank heterogeneity. In this case, we obtain identification from comparing changes in bank lending during the same quarter to firms with different levels of creditworthiness. The triple-interaction term continues to exert a statistically significant, positive impact on loan cost. The estimated marginal effect actually increases in size by 1.8 basis points.

Next, we correct for the selection bias using Heckman's lambda and saturate progressively with firm × year and bank × year fixed effects to account for all time-varying observed and unobserved firm and bank heterogeneity (columns 3 and 4). The first-stage probit results indicate that poorly capitalized banks are more likely to lend to riskier firms in times of loose monetary policy. The second-stage results verify the presence of the risk-taking channel, as the coefficient on the triple-interaction term retains its sign and statistical and economic significance. In addition, lambda carries significant positive estimates, implying that selection bias exists and thus we should appropriately account for it. [5]

[Insert Table 3 around here]

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where *Firm leverage* is the ratio of a firm's total debt to its total assets. The estimated positive coefficients on the triple-interaction terms provide evidence (at the 5% significance level) of the presence of the risk-taking channel for both the whole sample and for firms in the mining-construction and manufacturing sectors. In Table A3, we use *Bank liquidity* (instead of *Bank capital*) to account for bank agency problems and obtain similar results: banks resort to excessive risky lending to mining & construction and manufacturing firms when faced with liquidity shortages.

[5] In Table A4 in the Appendix, we also account for a special version of selection bias, namely a bad controls problem. Specifically, we investigate whether loan characteristics (described in Table 1) are bad controls in that they might as well be dependent variables in our empirical specifications (Angrist and Pischke, 2009). The results indicate that including quantitative loan variables (column 1), qualitative loan characteristics (column 2), or both (column 3) does not significantly alter the estimated marginal effect of a 1% decrease in the monetary policy rate on loan cost. We obtain similar findings when employing Heckman's two-step correction (columns 4 – 6).

3.2. Results by industry

In this section, we examine the potency of the risk-taking channel by industry. We estimate all specifications in Table 4 using OLS and include the same set of right-hand-side variables as in column 1 of Table 3. Focusing on the triple-interaction terms, we observe that the coefficient is highly significant in the mining & construction sector and the manufacturing sector. The estimated marginal effects of a one-percentage-point decline in our monetary policy variable on the cost of credit are significantly larger (29.7 and 30 basis points, respectively) compared with the estimates for the full sample in Table 3. In the remaining sectors, the effect is either weaker (in descending order: trade, services, and transportation & utilities) or insignificant (finance).

Importantly, these results hold even after controlling for selection bias using Heckman's model (Table 5). The first-stage probit results are similar to those in the full sample across all industries: poorly capitalized banks are more likely to lend to riskier firms in times of loose monetary policy. Although banks with more agency problems lend more to riskier firms when monetary policy is loose, their actions are consistent with excessive risk-taking mainly in the mining & construction and manufacturing industries.

[Insert Tables 4 and 5 around here]

We conduct several robustness tests on these results. In Table 6 we use Taylor rule residuals as monetary policy shocks (instead of the shadow rate) and find strong evidence in favor of the risk-taking channel both in the whole sample of firms (column 7) and in the industry subsamples of columns 1 (mining & construction) and 2 (manufacturing). Furthermore, these industry-level effects are even larger in magnitude than the corresponding ones in Tables 4 and 5. For instance, the estimated marginal effect of a 1% decline in Taylor rule residuals on loan pricing equals 34.5

basis points in column 7, which corresponds to approximately 28% of the standard deviation of loan cost. The stronger risk-taking effect in Table 6 suggests that banks tend to assess the future path of monetary policy and formulate accordingly their risk-taking behavior based on observed monetary conditions such as the ones incorporated in the standard Taylor rule (i.e. output gap and inflation).

[Insert Table 6 around here]

Next, we examine whether the documented effects are different during periods of conventional monetary policy. Therefore, we run a series of regressions focusing on the pre-financial crisis period (i.e., up to 2007) and present the results in Table 7. Importantly, the estimated coefficients on the triple-interaction terms remain positive and statistically significant for the full sample, as well as for the mining & construction and manufacturing sectors (as in Tables 3 and 4). The marginal effect of monetary policy shocks on loan costs is somewhat larger for the full sample (28.8 instead of 25 basis points reported in Table 3), and the manufacturing sector seems to drive this increase (33.2 instead of 30 basis points reported in Table 4). This finding implies that the adoption of unconventional monetary policy actions in the post-2008 period has not significantly altered banks' risky lending decisions.

[Insert Table 7 around here]

Summing up, the results so far show that regardless of the estimation approach, there is strong evidence of a risk-taking channel for the U.S. economy as a whole with a stronger effect in the mining & construction and manufacturing sectors. The natural question that follows is why these industries are riskier borrowers in times of loose monetary policy, thereby attracting the risk-taking appetite of undercapitalized banks.

The existing literature provides only fragmented insights on this matter. Leamer (2007) argues that both construction and (durable) manufacturing firms face intertemporal production decisions in the sense that previous production creates assets that compete with current production. Therefore, low interest rates tend to lead to unsustainably high levels of output, inevitably followed by long periods of low levels of output to bring the stock back to equilibrium. In other words, monetary policy affects mostly the timing of production in these sectors rather than total volume of production. Consequently, risk in these sectors stems from the fact that booms do not simply precede busts, but rather cause them.[6]

Willis and Cao (2015) identify another source of idiosyncratic risk. They argue that mining & construction and manufacturing are the most interest-sensitive industries in the U.S. economy. Thus, in times of easing monetary policy, firms in these sectors tend to activate previously planned, big, long-term projects (such as building or buying factories and equipment or purchasing land), and they expose themselves to greater risks.[7]

Although, the aforementioned propositions point primarily to credit demand effects, they also relate to the risk-taking channel to the extent that poorly capitalized banks allocate credit to riskier borrowers. Our strategy to further disentangle supply from demand effects and identify the pure risk-taking channel is as follows: if (undercapitalized) banks lend more to mining & construction and manufacturing firms because of their higher idiosyncratic risk, our measure of the risk-taking channel (i.e., the triple interaction of shadow rate, bank capital, and firm risk) should retain its sign and economic significance in a regression that exhaustively controls for loan

[6] This is close in spirit to the concept of financial cycle, which can be a sequence of "self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts” (Borio 2014).
[7] Other sectors, such as the financial and services sectors, typically do not undertake long-term projects that are sensitive to interest rate changes.

conditions associated with an increase in credit demand. For instance, higher demand from nonprime borrowers may lead banks to reduce credit, demand more performance provisions or covenants, and/or shorten maturities in an attempt to mitigate their exposure to liquidity risk. Therefore, we augment equation (2) with triple interactions of bank capital, firm risk, and quantitative/qualitative loan characteristics, and we report the results in Tables 8 and 9, respectively.

Two key insights emerge from this exercise. First, we observe that the triple interaction shadow rate × bank capital × firm risk is positive and statistically significant (at the 5% level or better) in mining & construction and manufacturing sectors. The estimated marginal effects are slightly lower than those in Table 4 but they do retain their economic relevancy. Second, the estimated coefficients on the additional triples suggest that undercapitalized banks tighten loan conditions when monetary policy is loose and the potential pool of borrowers (or projects) is larger and riskier by shortening maturities (columns 1 and 2 of Table 8) and adding performance-pricing provisions (column 1 of Table 9). These findings are in line with Strahan (1999), who documents that banks use price and nonprice terms as complements in dealing with borrower risk and that observably riskier firms face tighter nonprice terms in their loan contracts. Furthermore, and more important in the context of the present study, these findings suggest the potency of a pure credit risk-taking channel in the mining & construction and manufacturing sectors after controlling for adjustments in loan conditions stemming from higher loan demand by riskier borrowers in these sectors and the concomitant liquidity risk.

[Insert Tables 8 and 9 around here]

3.3. Real effects of industry heterogeneity in the potency of the risk-taking channel

Do the identified asymmetries in the potency of the risk-taking channel have real implications? To answer this question, we examine how the risk-taking channel affects borrowers' future performance, as measured by Tobin's q and return on assets (*ROA*). Specifically, we regress firm performance (at time $t+1$) on the predicted cost of loans (at time t) from the partial prediction of loan cost to the shadow rate. If there is no effect on firm performance in the face of bank risk-taking channel shocks, then the estimated coefficient on the predicted cost of loans should be statistically insignificant.

We first report the results of this exercise for the full sample of firms and for all years (column 1 of Table 10). We find that for both dependent variables, an increase in predicted loan cost significantly decreases firm performance in the following year. For instance, the estimate of -0.246 in column 1 of panel A implies that a 1% increase in loan cost leads to a decline in Tobin's q of 0.246, which is about 26% of its standard deviation. Thus, lax lending standards lead to significant negative performance effects at the firm level.

Columns 2-4 of Table 10 repeat the analysis for specific subperiods. Interestingly, while predicted loan costs remain negative and highly statistically significant in the precrisis period (2002-2006), there is weaker evidence of performance effects in the postcrisis period (2010-2018), indicating that the amplification effect is asymmetric on the real side. Thus, adopting unconventional monetary policies during and after the 2007-2008 financial crisis weakens the negative real effects by softening credit terms. This might stem from the fact that unconventional monetary policy announcements (e.g., Fed announcements for large-scale purchases of long-term assets) represent a type of information shock whose impact on the real economy is highly questionable (Chen et al. 2012; Jawadi et al. 2017) and potentially against corrective monetary policy in the short run (Nakamura and Steinsson 2018).

Most important, we examine whether specific industries drive these findings. In particular, we run the same regression as in Table 10 for the six industrial sectors and report the results in Table 11. The estimated negative coefficients on the predicted cost of loans suggest that credit supply booms and the concomitant increased risk-taking capacity of U.S. banks exert significant deteriorating effects on the mining & construction, manufacturing, and, to a lesser extent, services sectors. These are precisely the sectors that the risk-taking channel mostly affects, as per our previous analysis. Thus, industry asymmetries in the transmission of the risk-taking channel cause asymmetries in the relative performance of different sectors post-loan origination.

This is an important result, highlighting that monetary policy can have varying economic implications for different industries, at least in the short run. The performance effects seem especially damaging in sectors that exhibit high variation in growth opportunities, as measured by the standard deviation of their Tobin's q (see Table A1 in the appendix). The explanation is that higher growth variability in these sectors may be attractive to risk-seeking banks because of the potential for higher returns. This is consistent with Borio and Zhu (2012), who argue that risk tolerance increases with wealth. Because sectors with highly variable growth prospects experience significant increases in asset and collateral values, as well as in income and profits in prolonged expansionary monetary periods, banks lower their risk perceptions and/or increase their risk tolerance. Greater credit availability, however, may affect the financial behavior of economic agents. Specifically, according to the free cash flow hypothesis (Jensen 1986), liquidity abundance incentivizes firm managers to overinvest (i.e., to invest in projects with negative net present value) in order to increase the resources under their control. In other words, firm managers have both the incentive and the opportunity to make potentially wasteful investments, thereby triggering a problem of corporate overinvestment that damages firm performance and value.

[Insert Tables 10 and 11 around here]

4. Concluding remarks

Conventional and unconventional monetary policy easing has produced considerable research on how these policies affect bank risk-taking. In this paper, we use loan-level data on newly syndicated loans and assess the potency of monetary policy's risk-taking channel across different industries. We report three main findings.

First, we find robust evidence of the risk-taking channel in the U.S. economy over 1984 – 2018. Our baseline empirical results show that a 1% decline in the shadow rate results in an increase of 25 basis points in risk premium on new loans to riskier borrowers. Moreover, consistent with the risk-shifting and search-for-yield channels, we find that this effect is more pronounced for poorly capitalized banks. Second, and most important, we document that the risk-taking channel exhibits significant heterogeneity across industries, though the mining & construction and manufacturing sectors are the most affected and the financial sector is the least affected. Third, this asymmetric potency of the risk-taking channel yields performance differences: we find that the higher cost of credit yields lower firm performance in the most-affected industries, especially in times of conventional monetary policy (aka, before the subprime crisis).

Our results are practical for monetary policy implementation and can help central banks better understand the multidimensional aspects and heterogeneous strength of the bank risk-taking channel on the real economy. An important implication emerging from our results is that central banks should consider whether the asymmetric real implications of the risk-taking channel by industry call for fine-tuning unconventional monetary policy tools to level the field for credit costs across industries (e.g., credit easing in vulnerable sectors). This should especially be the case if higher credit cost is not due to inefficiencies but due to the inherently risky nature of the industries.

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Table 1. Variable definitions

Variable	Definition
Cost of loans	For term loans: Total cost of borrowing = Upfront Fee / Loan Maturity in Years + (Facility Fee + Spread) + Prob(Utilization>Utilization Threshold | Usage > 0) x Utilization Fee + Prob(Cancellation) x Cancellation Fee For revolvers without letter of credit: Total cost of borrowing = Upfront Fee / Loan Maturity in Years + (1-PDD) x (Facility Fee + Commitment Fee) + PDD x (Facility Fee + Spread) + PDD x Prob(Utilization>Utilization Threshold | Usage > 0) x Utilization Fee + Prob(Cancellation) x Cancellation Fee where PDD is the likelihood that the credit line is drawn down; Prob(Utilization>Utilization Threshold | Usage > 0) is the probability that the utilization of the credit line is higher than the thresholds specified in the loan contract conditional on observing utilization. Prob(Cancellation) is the probability that the loan is going to be cancelled. We follow the program/code in the website of Berg, Saunders and Steffen (2016) to calculate the measure.
Shadow rate	The quarterly shadow short rate (estimates from Krippner, 2016).
Taylor residuals	The residuals of the regression of the shadow short rate on output gap and inflation.
Loan initiation	Dummy equal to one for the firm-years a loan is initiated, zero otherwise.
Bank capital	The ratio of Tier 1 + Tier 2 bank capital to total risk-weighted assets.
Bank liquidity	The ratio of liquid assets (cash and short-term securities) to total assets.
Non-performing loans	The ratio of a bank's non-performing loans (90 days) to total loans.
Bank size	The natural logarithm of a bank's total assets.
Bank ROA	The ratio of a bank's pre-tax profits to total assets.
Firm inverse Z-score	Modified Altman's (1968) Z-score (= (1.2*working capital + 1.4*retained earnings + 3.3*EBIT + 0.999*sales)/total assets). We multiply the Z-score with -1, so that a higher value reflects a more risky firm.
Firm leverage	The ratio of a firm's total debt to the firm's total assets.
Firm Tobin's q	Calculated as (Equity market value + Liabilities book value)/(Equity book value + Liabilities book value).
Firm ROA	The ratio of a firm's pre-tax profit to total assets.
Firm current ratio	The ratio of current assets to current liabilities.
Firm cash flow	The ratio of cash flow to total sales.
Firm size	The natural logarithm of total assets.
Firm inefficiency	The ratio of cost of goods sold to total sales.
Loan amount	Log of the loan facility amount in U.S. dollars.
Loan maturity	Loan duration in months.
Number of lenders	The number of banks involved in the syndicated loan.
Collateral	Dummy equal to one if the loan is secured with collateral, zero otherwise.
Performance provisions	Dummy equal to one if the loan has performance pricing provisions, zero otherwise.
Financial covenants	The number of financial covenants in the loan contract.
Other covenants	Dummy equal to one if the loan has other covenants (besides financial covenants), zero otherwise.
Bank-firm relationship	The number of loan deals between a bank and a firm in the five years prior to the current loan deal.

Table 2. Summary statistics

The table reports summary statistics (mean, standard deviation, minimum and maximum) for the sample used in our baseline regressions. The number of observations is 103,725. These observations correspond to lead banks involved in syndicated loan deals.

	Mean	Std. dev.	Min.	Max.
Cost of loans	235.43	123.25	2.100	1,100
Shadow rate	2.529	3.011	-2.922	11.390
Taylor residuals	-1.313	2.716	-6.450	6.774
Loan initiation	0.207	0.410	0	1
Bank capital	12.203	6.014	0.004	63.173
Bank liquidity	5.031	0.092	0.000	0.857
Non-performing loans	0.020	0.023	0.000	0.376
Bank size	12.028	1.529	4.843	19.545
Bank ROA	0.010	0.022	-0.019	0.523
Firm Z-score	1.590	1.465	-3.205	14.999
Firm leverage	0.368	0.517	0.000	126.71
Firm Tobin's q	1.540	1.335	0.155	9.994
Firm ROA	0.024	0.096	-0.599	0.337
Firm current ratio	2.148	2.167	0.273	30.480
Firm cash flow	9.380	24.321	-53.180	211.32
Firm size	13.021	3.170	5.407	19.255
Firm inefficiency	44.180	22.152	0.928	511.13
Loan amount	18.867	1.581	9.18	24.635
Loan maturity	42.299	30.136	3	1,020
Number of lenders	12.283	14.968	1	290
Collateral	0.414	0.492	0	1
Performance provisions	0.280	0.449	0	1
Financial covenants	0.818	1.294	0	8
Other covenants	0.099	0.299	0	1
Bank-firm relationship	0.302	1.470	0	80

Table 3. Identifying the risk-taking channel in the full sample

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. Specifications (1) and (2) report the results from the estimation of equation (1) using OLS; specifications (3) and (4) report the results from the estimation of equations (2) and (3) using Heckman's model. The dependent variable in the first-stage of Heckman's model is *Loan initiation*. Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ** denote statistical significance at the 5% level.

	OLS model		Heckman's model	
	(1)	(2)	(3)	(4)
Shadow rate × Bank capital × Firm risk	1.286**	1.381**	1.347**	1.399**
	(0.581)	(0.602)	(0.584)	(0.606)
Marginal effect	25.0	26.8	26.1	27.1
First stage				
Shadow rate × Bank capital × Firm risk			-5.430**	-5.742**
			(2.107)	(2.203)
Observations	88,436	87,538	88,436	87,538
Adjusted R-squared	0.883	0.882		
Bank controls	Y	N	Y	N
Loan controls	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y
Firm effects	N	N	N	N
Bank effects	Y	N	Y	N
Firm × year effects	Y	Y	Y	Y
Bank × year effects	N	Y	N	Y

Table 4. Identifying the risk-taking channel by industry: OLS regressions

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services
Shadow rate × Bank capital × Firm risk	1.532***	1.544**	0.979*	1.498*	0.582	1.443*
	(0.470)	(0.643)	(0.531)	(0.802)	(0.837)	(0.801)
Marginal effect	29.7	30.0	16.0	25.1	11.3	24.0
Observations	5,630	27,965	14,780	10,752	13,883	15,426
Adjusted R-squared	0.844	0.871	0.905	0.844	0.931	0.874
Bank controls	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y

Table 5. Identifying the risk-taking channel by industry: Heckman regressions

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using Heckman's model on equations (1) and (2). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services
Shadow rate × Bank capital × Firm risk	1.555*** (0.488)	1.578** (0.656)	0.949* (0.487)	1.449 (0.884)	0.174 (0.474)	1.374* (0.804)
Marginal effect	30.2	30.6	15.4	24.1	3.4	24.7
<u>First stage</u>						
Shadow rate × Bank capital × Firm risk	-6.110** (2.428)	-5.830** (2.344)	-5.207** (2.094)	-5.449** (2.256)	-4.120* (2.780)	-5.120*** (1.880)
Observations	5,630	27,965	14,780	10,752	13,883	15,426
Bank controls	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y

Table 6. Using Taylor residuals as the monetary policy variable

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. The monetary policy variable is the Taylor residuals obtained from regressing the *Shadow rate* on output gap and inflation in the period 1960Q1-2016Q4. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services	(7) Full sample
Taylor residuals × Bank capital × Firm risk	1.991*** (0.626)	2.039*** (0.659)	1.468* (0.779)	1.369* (0.750)	0.169 (0.572)	1.350** (0.549)	1.780*** (0.618)
Marginal effect	38.6	39.6	18.5	24.6	3.3	27.2	34.5
Observations	5,630	27,965	14,780	10,752	13,883	15,426	88,436
Adjusted R-squared	0.844	0.871	0.905	0.844	0.931	0.874	0.883
Bank controls	Y	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y	Y

Table 7. Results from the pre-crisis period

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans* and our sample covers 1984-2007. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services	(7) Full sample
Shadow rate × Bank capital × Firm risk	1.592**	1.710**	0.927*	1.644*	-0.280	1.509*	1.485**
	(0.630)	(0.788)	(0.495)	(0.905)	(0.516)	(0.884)	(0.665)
Marginal effect	30.9	33.2	18.0	27.9	5.4	26.3	28.8
Observations	2,378	11,779	6,868	5,915	7,116	8,464	42,520
Adjusted R-squared	0.860	0.860	0.892	0.832	0.921	0.835	0.868
Bank controls	Y	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y	Y

Table 8. The role of loan amount and maturity

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services
Shadow rate × Bank capital × Firm risk	1.371*** (0.462)	1.255** (0.640)	0.843 (0.520)	1.244 (0.768)	0.444 (0.830)	1.258 (0.806)
Marginal effect	26.6	24.4	16.4	24.1	8.6	24.4
Loan amount × Bank capital × Firm risk	9.114* (5.061)	8.090 (7.968)	10.080 (8.175)	5.045 (6.096)	4.003 (5.659)	6.011 (6.362)
Loan maturity × Bank capital × Firm risk	1.573** (0.729)	2.582*** (0.518)	1.470** (0.610)	1.991*** (0.341)	1.364** (0.625)	1.872*** (0.526)
Observations	5,630	27,965	14,780	10,752	13,883	15,426
Adjusted R-squared	0.850	0.875	0.911	0.867	0.930	0.876
Bank controls	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y

Table 9. The role of loan guarantees

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services
Shadow rate × Bank capital × Firm risk	1.332***	1.240**	0.768	1.113	0.217	1.125
	(0.472)	(0.627)	(0.552)	(0.748)	(0.797)	(0.749)
Marginal effect	25.8	24.1	14.9	21.6	4.2	21.8
Performance provisions × Bank capital × Firm risk	-2.631***	0.916	-1.060**	-0.022	0.014	0.548
	(0.911)	(3.185)	(0.485)	(0.514)	(0.539)	(0.460)
General covenants x Bank capital × Firm risk	-9.679	-1.026**	0.365	-1.257*	0.059	-1.443***
	(1.058)	(0.412)	(0.918)	(0.741)	0.061	(0.545)
Observations	5,630	27,965	14,780	10,752	13,883	15,426
Adjusted R-squared	0.853	0.876	0.925	0.853	0.925	0.882
Bank controls	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y

Table 10. Response of firm performance to the potency of the risk-taking channel

The table reports coefficient estimates and standard errors (in parentheses) clustered by firm and year. Dependent variable in Panel A is *Firm Tobin's q* in in year *t*+1 and in Panel B *Firm ROA* in year *t*+1. *Predicted cost of loans* is the partial prediction of *Cost of loans* to the *Shadow rate*, as obtained from the specifications of Table 4 for each industry. All specifications are estimated using OLS on equation (3). The lower part of the table reports the control variables and the fixed effects used in each specification. The controls include *Firm cash flow, Firm leverage, Firm current ratio, Firm size,* and *Firm inefficiency*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Full sample	(2) 2002-2006	(3) 2007-2010	(4) 2010-2018
Panel A: Dependent variable is Firm Tobin's q				
Predicted cost of loans	-0.246**	-0.267***	-0.238**	-0.203*
	(0.098)	(0.086)	(0.107)	(0.106)
Adjusted R-squared	0.317	0.533	0.378	0.370
Panel B: Dependent variable is Firm ROA				
Predicted cost of loans	-0.006**	-0.011***	-0.007**	-0.010**
	(0.0027)	(0.0042)	(0.0033)	(0.0040)
Adjusted R-squared	0.235	0.287	0.261	0.203
No. of firms	2,806	1,083	536	983
Observations (firm-year)	71,335	26,711	13,271	24,317
Firm controls	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y

Table 11. Response of firm performance by industry to the potency of the risk-taking channel

The table reports coefficient estimates and standard errors (in parentheses) clustered by firm and year. Dependent variable in Panel A is *Firm Tobin's q* in in year *t*+1 and in Panel B *Firm ROA* in year *t*+1. *Predicted cost of loans* is the partial prediction of *Cost of loans* to the *Shadow rate*, as obtained from the specifications of Table 4 for each industry. All specifications are estimated using OLS on equation (3). The lower part of the table reports the control variables and the fixed effects used in each specification. The controls include *Firm cash flow, Firm leverage, Firm current ratio, Firm size,* and *Firm inefficiency*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services
Panel A: Dependent variable is Firm Tobin's q						
Predicted cost of loans	-0.311***	-0.348***	-0.105	-0.117*	-0.022	-0.229**
	(0.065)	(0.089)	(0.094)	(0.061)	(0.126)	(0.111)
Adjusted R-squared	0.295	0.388	0.226	0.311	0.185	0.447
Panel B: Dependent variable is Firm ROA						
Predicted cost of loans	-0.015***	-0.018***	-0.005	-0.008*	0.003	-0.008**
	(0.0037)	(0.0051)	(0.0062)	(0.0046)	(0.0068)	(0.0032)
Adjusted R-squared	0.229	0.294	0.188	0.340	0.197	0.306
No. of firms	168	845	478	362	471	482
Observations	4350	21516	11925	9867	12251	11426
Firm controls	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y

Online Appendix
Industry Heterogeneity in the Risk-Taking Channel

This appendix, intended for online use only, provides more summary statistics (by industry) and robustness checks on our empirical results.

Table A1. Key summary statistics by industry

	Mean	Std. dev.
Mining & construction		
Cost of loans	245.08	133.04
Loan amount	18.38	1.49
Loan maturity	41.18	30.27
Firm Tobin's q	1.48	1.85
Firm leverage	0.38	0.67
Manufacturing		
Cost of loans	255.57	136.98
Loan amount	17.76	1.65
Loan maturity	43.50	31.37
Firm Tobin's q	1.51	2.54
Firm leverage	0.39	0.69
Transportation & utilities		
Cost of loans	213.52	123.02
Loan amount	18.91	1.62
Loan maturity	51.22	30.50
Firm Tobin's q	1.61	1.81
Firm leverage	0.33	0.28
Trade		
Cost of loans	224.33	122.03
Loan amount	18.09	1.50
Loan maturity	43.57	29.30
Firm Tobin's q	1.59	1.45
Firm leverage	0.33	0.30
Finance		
Cost of loans	203.71	102.79
Loan amount	18.76	1.50
Loan maturity	34.47	28.95
Firm Tobin's q	1.35	0.96
Firm leverage	0.42	0.98
Services		
Cost of loans	254.88	119.92
Loan amount	17.92	1.62
Loan maturity	44.32	32.14
Firm Tobin's q	1.79	1.28
Firm leverage	0.32	0.31

Table A2. Using firm leverage as firm risk in the triple interaction

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services	(7) Full sample
Shadow rate × Bank capital × Firm leverage	-4.571**	-4.355**	-3.710*	-3.805*	-1.662	-2.727	-3.794**
	(2.021)	(1.914)	(2.005)	(1.949)	(1.934)	(2.310)	(1.853)
Marginal effect	20.5	19.6	11.7	17.1	7.5	12.2	17.0
Observations	5,630	27,965	14,780	10,752	13,883	15,426	88,436
Adjusted R-squared	0.859	0.894	0.911	0.852	0.950	0.883	0.894
Bank controls	Y	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y	Y

Table A3. Using bank liquidity in the triple interaction

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. All specifications are estimated using OLS on equation (1). Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. The loan controls include *Loan amount, Loan maturity, Number of lenders, Collateral, Performance provisions, Financial covenants, Other covenants*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	(1) Mining & construction	(2) Manufacturing	(3) Transportation & utilities	(4) Trade	(5) Finance	(6) Services	(7) Full sample
Shadow rate × Bank liquidity × Firm risk	4.031***	3.855***	2.690*	2.048**	0.545	2.235*	2.916**
	(1.371)	(1.281)	(1.396)	(1.060)	(0.462)	(1.195)	(1.244)
Marginal effect	32.2	30.8	16.5	16.4	4.4	17.9	23.3
Observations	5,630	27,965	14,780	10,752	13,883	15,426	88,436
Adjusted R-squared	0.844	0.871	0.905	0.844	0.931	0.874	0.883
Bank controls	Y	Y	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y	Y

Table A4. Are loan controls bad controls?

The table reports coefficient estimates and standard errors (in parentheses) clustered by bank, firm, and year. Dependent variable is *Cost of loans*. Specifications (1) to (3) report the results from the estimation of equation (1) using OLS; specifications (4) to (6) report the results from the estimation of equations (2) and (3) using Heckman's model. The dependent variable in the first-stage of Heckman's model is *Loan initiation*. Marginal effect is the impact (in basis points) of a 1 pp decrease in the monetary policy variable for the firm with the mean soundness and the bank with a mean capital. The lower part of the table reports the control variables and the fixed effects used in each specification. The bank controls include *Bank liquidity*, *Non-performing loans*, *Bank size*, and *Bank ROA*. Definitions for all variables are in Table 1 and summary statistics in Table 2. The ***, **, and * marks denote statistical significance at the 1%, 5%, and 10% levels.

	OLS model			Heckman's model		
	(1)	(2)	(3)	(4)	(5)	(6)
Shadow rate × Bank capital × Firm risk	1.339**	1.324**	1.301**	1.396**	1.370**	1.347**
	(0.593)	(0.579)	(0.594)	(0.597)	(0.582)	(0.598)
Marginal effect	26	25.7	25.2	27.1	26.6	26.1
Maturity	0.804***		0.805***	0.802***		0.803***
	(0.181)		(0.180)	(0.180)		(0.180)
Loan amount	-7.550***		-7.230***	-7.530***		-7.211***
	(0.821)		(0.820)	(0.821)		(0.819)
Number of lenders	-0.465***		-0.381***	-0.466***		-0.382***
	(0.145)		(0.132)	(0.144)		(0.131)
Collateral		-0.894	-2.052		-0.914	-2.069
		(3.980)	(4.001)		(3.976)	(3.997)
Performance provisions		-20.004***	-17.837***		-19.933***	-17.772***
		(2.649)	(2.331)		(2.649)	(2.331)
Financial covenants		-1.733	-0.850		-1.752	-0.868
		(1.445)	(1.457)		(1.455)	(1.466)
General covenants		15.784***	16.509***		15.846***	16.570***
		(4.347)	(4.224)		(4.346)	(4.221)
First stage						
Shadow rate × Bank capital × Firm risk				-6.642***	-6.530***	-6.591***
				(2.435)	(2.410)	(2.420)
Observations	88,436	88,436	88,436	88,436	88,436	88,436
Adjusted R-squared	0.880	0.883	0.880	0.880	0.883	0.880
Bank controls	Y	Y	Y	Y	Y	Y
Loan type effects	Y	Y	Y	Y	Y	Y
Loan purpose effects	Y	Y	Y	Y	Y	Y
Bank effects	Y	Y	Y	Y	Y	Y
Firm × year effects	Y	Y	Y	Y	Y	Y