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Evidence from the Loan Book

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The Fed Put and Bank Risk-Taking: Evidence from the Loan Book*

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Abstract

This paper shows that monetary policy influences bank credit policy through the risk-taking channel. Using option prices on FOMC announcement days, we measure the impact of monetary policy on bank equity tail risks and link them to loan-level regulatory data. Banks that experience a decline in tail risk lend more to riskier firms and ease loan terms in the three weeks after the FOMC announcement. These effects are concentrated among banks with short-term compensation structures and in competitive credit markets. Our results isolate the impact of bank risk-taking in loan supply from confounding forces such as endogenous credit demand and highlight how institutional frictions mediate the risk-taking channel of monetary policy.

Keywords: Fed put, risk-taking channel, credit policy, monetary policy, bank equity tail risk.
JEL Classification: E52, G12, G21

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This paper studies the impact of monetary policy on banks' credit policy. A growing literature suggests that monetary policy may in part gain traction in the economy by altering risk perceptions or risk tolerance — commonly referred to as the risk-taking channel of monetary policy.[1] The risk-taking channel comprises a range of mechanisms, but in the case of banks, one specific pathway is that expansionary monetary policy or dovish central bank communication, such as promises to "keep rates low for long," can lead banks to believe that downside risks to their near-term equity values have declined. This perceived monetary policy "insurance" against future equity losses or "left censoring" of the distribution of future outcomes, often referred to as the "Fed put," can in turn induce banks to loosen their credit standards and lend to riskier firms.

Furthermore, the risk-taking channel can depend on a bank's competitive environment as well as on agency frictions within the bank. For instance, when the loan market is competitive, management might aggressively use high-powered incentive contracts, like cash bonuses, to motivate loan officers to meet market share and profit targets. However, these incentives, combined with the belief that monetary policy offers downside protection to the bank's equity, may encourage loan officers to approve a larger number of higher-risk loans to meet performance targets and enhance their compensation. Moreover, because shareholders observe profitability and loan volumes, but not the loan risk itself, increased risk-taking in the corporate loan book rather than in the more visible bond portfolio can be an attractive response to a perceived Fed put on the bank's equity.[2]

The risk-taking channel is thus a potentially consequential feature of monetary policy, but credible estimates of the risk-taking channel are difficult to obtain. One fundamental challenge is that monetary policy affects the supply of bank credit through many different

[1]See Borio and Zhu (2012), Rajan (2006), and the surveys in Bauer et al. (2023) and Kashyap and Stein (2023).

[2]See Rajan (1992), Stein (1989), Holmstrom and Milgrom (1991) and recent evidence in Falato and Scharfstein (2025).

channels (Kashyap and Stein, 2000; Drechsler et al., 2017). And because neither banks nor policymakers disclose their beliefs about the degree of monetary policy insurance on banks' equity, it is difficult to discern changes in credit policy driven specifically by the risk-taking channel. Identification is further complicated by the fact that monetary policy responds to the same possibly latent economic conditions that influence bank lending. For example, expansionary policy is typically implemented when the economic outlook is expected to weaken, but a weakening economy might also prompt banks to tighten credit standards, biasing downwards any estimated relationship between monetary policy and banks' lending standards (Romer and Romer, 2004).[3]

The endogenous matching between banks and firms in response to changes in economic conditions can bias estimates in the opposite direction. Both monetary policy announcements and their associated shocks or surprises are public information, and their realization can endogenously influence the composition of firms seeking credit from a given bank. For example, an expansionary monetary policy shock may disproportionately increase credit demand among riskier firms. If these firms coincidentally turn to banks perceived to benefit the most from the central bank put, then observing a bank originating riskier loans after such a shock could reflect both the risk-taking channel and the endogenous shift in the composition of credit demand.

We address these identification challenges by combining bank equity put option returns on scheduled Federal Open Market Commitee (FOMC) announcement days with a "high-frequency" research design using time-stamped loan-level commercial and industrial (C&I) data from the Y-14Q — the US credit register for large loans made by the largest banks. This empirical setting allows us to both extract the impact of FOMC announcements on market beliefs about the future distribution of banks' equity returns and study the consequences of

[3]There is also extensive evidence that monetary policy reacts to asset prices as well — see for example Cieslak and Vissing-Jorgensen (2021).

these beliefs for banks' credit policy, while holding credit demand fixed. We explain each piece of the research design in turn.

Put options are financial derivatives that pay off when the price of the underlying asset falls below a pre-specified threshold — the option's strike price. Thus, because option prices reflect investors' willingness to pay for state-contingent claims, the cross-section of option prices across strike prices for a fixed expiration date reveals the risk-neutral distribution of the underlying asset's value (Breeden and Litzenberger, 1978). Changes in equity option prices therefore provide information about changes in the perceived distribution of a bank's future equity value. Intuitively, put options with strike prices near the current stock price (at-the-money, or ATM) reflect beliefs about all downside risks — both moderate and large declines in the price of the stock — while out-of-the-money (OTM) put options — those with much lower strike prices — are especially sensitive to the likelihood of large downside moves in the price of the underlying equity.

We can thus use banks' option prices around scheduled FOMC announcements to identify the impact of monetary policy shocks on the expected distribution of bank equity values. Consider an FOMC announcement that triggers a disproportionately large decline in a bank's OTM option prices relative to its ATM options. This dispersion in OTM and ATM prices would suggest that monetary policy has reduced the perceived risk of sharp equity declines (tail risk) more than the risk of moderate declines (diffusive risk). Following this logic, we compute, for each bank in our sample, a measure of the bank's tail risk shock on each FOMC announcement day as the slope of the bank's option returns with respect to the option's delta — a measure of how far an option is out-of-the-money. This measure captures the market's view of the state-contingent implications of the FOMC announcement for each bank's equity.

To wit, if a bank's tail risk declines after an FOMC announcement, markets interpret the announcement as reducing downside risks to that bank's near-term equity value — the

"Fed put" or the left censoring of the distribution of future equity returns. Conversely, an increase in the price of a bank's OTM put options relative to its ATM put options suggests that the stance of monetary policy has increased the odds that the bank's near-term equity value might fall into the left tail of the distribution.[4] This approach helps to quantify the impact of the same FOMC announcement on different banks' equity tail risk, facilitating cross-sectional tests to understand the factors that mediate the impact of monetary policy on bank tail risk and risk-taking.

The second step in the research design uses the loan time-stamp and risk rating to study the relationship between each bank's perceived tail risk following the FOMC announcement and its loan origination decisions in the subsequent 25-day window. The C&I loans in the Y-14Q dataset are large, and banks typically take several weeks to process and originate them. This lengthy processing time, coupled with our short 25-day window, ensures that a bank's origination decisions in the 25 days following each FOMC meeting are based on the stock of loan applicants who applied before the announcement. Combined with borrower firm-by-quarter fixed effects, this design helps rule out explanations based on latent firm credit demand.

We find evidence consistent with the risk-taking channel of monetary policy: A decrease in a bank's tail risk following an FOMC announcement is associated with increased risk-taking in its loan book. A one percentage point decline in tail risk is associated with a 1.6 percent decrease in the odds of originating the safest loans, and a corresponding 1.5 percent increase in the odds of originating loans with the highest probability of default–the average loan size is around $29.8 million. These effects are highly non-linear and concentrated in the bottom of the distribution. A realization of tail risk in the bottom quartile is associated with a 1.2 percent increase in the odds of originating the riskiest loans relative to banks with

[4]Similar to the existing literature on the interest rate sensitivity of bank equity, we show that leverage and the asset-liability maturity gap help shape the impact of monetary policy on banks' tail risk–see English et al. (2018), Gomez et al. (2021).

higher tail risk realizations; but beyond the bottom quartile, the effects are not different across the tail risk distribution.

Our research design allows for a daily event study approach that can make transparent key identification assumptions. To help rule out the concern that our findings are influenced by persistent option return dynamics rather than the FOMC announcement itself, we compute each bank's tail risk shocks on the days before and after the FOMC announcement day in addition to the FOMC day itself. This shows directly that the impact of tail risk on loan origination decisions is specific to the FOMC day and does not reflect broader trends in banks' option prices adjacent to the FOMC announcement day. We can also show that there is no anticipatory bias or latent trend in credit policy by regressing a bank's realized tail risk observed on the FOMC announcement day on past and future loan originating decisions. There is no evidence that a bank's pre-FOMC credit policy anticipates its FOMC tail risk realizations, while the post-FOMC effect on credit policy peaks around 10-14 days afterwards, as this information gradually filters into lending decisions.

More generally, these results are robust to a wide range of parametric and non-parametric controls, including changes in a bank's FOMC day stock return, diffusive risk proxied using banks' ATM option returns on the FOMC day, firm tail risk, firm-by-year-quarter, bank-by-year-quarter, individual FOMC meeting, and other fixed effects. We also find that banks' sensitivity to tail risk affects other dimensions of loan contract terms. For example, banks that experience an increase in tail risk after the FOMC meeting, shorten loan maturities when lending to the riskiest borrowers and increase their use of collateral to hedge against borrower default risk. There is also evidence that an increase in bank tail risk is associated with higher interest rates for the riskiest borrowers.

To better understand the mechanisms that mediate the risk-taking channel in credit policy, we first examine interactions with banks' executive compensation structure. Because risk-taking in the loan book is largely hidden compared with a bank's bond portfolio and hedging choices, moral hazard between long-term shareholders and bank management may be exacerbated when compensation contracts reward short-term performance. This can lead to stronger incentives to approve higher-yield loans when banks perceive a large reduction in tail risk. Consistent with this mechanism, we find that the risk-taking channel is stronger for banks with short-term oriented compensation structures, such as salaries and bonuses, relative to long-term oriented, option-based compensation.

We also leverage the detail in the regulatory data to calculate the competitive pressures each bank faces in its C&I lending. Because the Y-14Q identifies the city in which each borrower is located and covers the universe of most large bank corporate lending, we can compute the C&I loan Herfindahl-Hirschman Index (HHI) for each bank-quarter to study how time-varying spatial competitive pressures mediate the impact of monetary policy on bank risk-taking. Although this measure of competition is imperfect, as it omits private credit, we find that spatial competition significantly amplifies the effect of tail risk sensitivity on banks' risk-taking. Among banks that experience a bottom-quartile tail risk shock on the FOMC day—that is, the largest reductions in tail risk—credit significantly shifts toward the riskiest loan category if the bank also operates in the top quartile of competition. In contrast, there is no significant effect on loan risk if the bank operates in the bottom quartile of competition.

Taken together, this evidence implies that monetary policy works in part by altering market perceptions of bank equity tail risk, which in turn changes the risk tolerance of these banks and their credit policy in the corporate loan market. Short-term based compensation as well as spatial competition in this loan market also appear to mediate this particular monetary policy transmission channel. These results are useful for policy, and can inform models aimed at quantifying the connections between the macro economy and finance. In particular, these results are consistent with elements of the "credit view" argument, most often associated with Minsky and Kindleberger, that credit supply expansions driven by reduced perceptions of credit risk can shape business cycles. Important theoretical arguments that expand on this basic credit view theme include Diamond and Rajan (2012), Drechsler et al. (2018), Acharya and Naqvi (2019), and Dell'Ariccia and Marquez (2006).

This loan-level "high frequency" evidence also complements the more aggregate correlations linking credit and business cycles (Schularick and Taylor, 2012; López-Salido et al., 2017; Mian et al., 2020; Granja et al., 2022; Rajan and Ramcharan, 2015). Our loan-level approach builds on important contributions that also use regulatory data to measure the link between monetary policy and bank risk-taking (Jiménez et al., 2014; Dell'Ariccia et al., 2017). A key difference with the existing literature is the use of option prices to measure directly the "Fed put" or the role of "tail risk" in the monetary transmission mechanism, helping to triangulate on the mechanism through which perceived monetary policy insurance at the bank level might affect a bank's credit policy. The use of a "high frequency" research design along with loan-level data is also new to this literature, helping to more easily visualize key identification assumptions and complementing the two stage model used in Jiménez et al. (2014) to address similar identification problems. That Spanish data and US data across very different time periods and identification strategies yield qualitatively similar results suggests that the risk-taking channel might be salient.

Our options-based approach builds on work by Kelly et al. (2016a) and Kelly et al. (2016b), and more recently Haddad et al. (2025), which makes a related point that large scale asset purchases and other central bank promises of support in bad states can affect risk perceptions and asset prices. Also, that options prices appear to inform banks' lending decisions, which can cascade through the real economy, adds to the broader literature on the role of asset prices in shaping real economic decisions (Dow et al., 2017; Edmans et al., 2015; Goldstein, 2023). Our loan-level research design helps to address the standard common information problem that can affect inference when studying how information embedded in asset prices affects real decisions.

Our paper is organized as follows. Section 1 discusses our research design, identification challenges, and the data. Section 2 presents evidence for the risk-taking channel in credit policy as a result of bank tail risk variation on FOMC announcement days. Section 3 conducts mechanism tests using compensation and concentration data. Section 4 concludes.

1 Research Design and Data

1.1 Research Design

According to the risk-taking channel of monetary policy, changes in the policy rate, forward guidance, and other central bank tools can affect economic conditions by altering how economic agents perceive and price risk (Borio and Zhu, 2012). The theoretical mechanisms underlying this channel vary depending on the institutional context (Bauer et al., 2023; Kashyap and Stein, 2023). In the case of banks, a key prediction is that expansionary monetary policy can lead to greater risk-taking, for example by loosening credit standards in order to lend to riskier borrowers.

For instance, the belief that the central bank is both willing and able to censor the left tail of the distribution of future outcomes can reduce the downside risks to bank equity– the "central bank put option" or the "Fed put." Notable examples of such state-contingent policies include central bank promises to do "whatever it takes" or to keep interest rates "low for long" in part through quantitative easing (Haddad et al., 2025).[5] But communications or

[5] A large literature has shown that QE in both the US and EU increased prices of assets held by banks, greatly improving their net worth – see Luck and Zimmermann (2020), Orame et al. (2025), and Darmouni and Rodnyansky (2017).

forward guidance at regularly scheduled FOMC meetings that increase transparency about a central bank's reaction function and signal a commitment to accommodative state-contingent policies, as well as unexpectedly large reductions in the policy rate, can all reduce extreme downside risks to a bank's future equity values, inducing some banks to make riskier loans.

While such increased risk-taking can be optimal (Bernanke, 2022), moral hazard on the part of creditors may reduce their motivation to control banks' risk-taking when downside risks are attenuated, especially when bank supervision and regulations are weak or incomplete (Dewatripont and Tirole, 1994; Diamond and Rajan, 2012). Moral hazard between management and long-term shareholders can further exacerbate risk-taking in the loan book when monetary policy reduces a bank's tail risk. Because shareholders observe profitability and aggregate loan volumes, but not the actual risk of the loans, managers and loan officers compensated based on short-term performance may have strong incentives to exploit the reduction in near-term tail risk. In doing so, they can take on more hidden risk in the loan book to meet bonus and performance targets (Hanson and Stein, 2015; Rajan, 1994; Stein, 1989). In addition, a commitment to keep interest rates low for an extended period, along with other expansionary policies, can reduce banks' tail risk by lowering the cost of liquidity. This, in turn, allows banks to operate with greater leverage or to make riskier loans (Drechsler et al., 2018).

Empirically identifying the risk-taking channel is difficult. Central banks do not quantify the magnitude of the implicit put option they extend to banks, nor do banks reveal how they perceive this option or its influence on their behavior. This opacity makes it difficult to isolate the risk-taking channel from the many other ways in which monetary policy influences bank lending (Kashyap and Stein, 2000; Drechsler et al., 2016). Moreover, because monetary policy responds to the same underlying economic conditions that shape banks' credit decisions, empirical estimates may be biased downward.

However, this bias can also be upward if both credit demand and bank loan supply respond simultaneously to monetary policy surprises. As a result, a standard approach of using monetary policy surprises to address anticipatory bias, as in Romer and Romer (2004), does not resolve the identification problem in this context. For example, an expansionary monetary policy shock may disproportionately increase credit demand among riskier firms. These firms might also endogenously seek credit from banks that experience the largest reduction in tail risk following the shock. Observing such banks originate riskier loans after an expansionary shock is therefore consistent with both the risk-taking channel and endogenous shifts in the composition of credit demand.

To address these challenges, our research design first extracts market beliefs about individual banks' tail risk using bank equity options prices. It then uses regulatory loan-level data in a "high-frequency" setup to hold constant the composition of borrowers and to absorb latent time-varying factors. We describe these steps next.

1.1.1 Extracting Tail Risk Beliefs from Options Prices

In the first step, we use data on bank equity put option prices to measure the impact of scheduled FOMC announcements on the distribution of banks' future equity values. A put option is a financial contract that gives the holder the right to sell the underlying asset at a future maturity date and at a fixed price, known as the strike price. An out-of-the-money (OTM) put option has a strike price below the current market price of the underlying asset, whereas an at-the-money (ATM) put option has a strike price close to the market price.

Variation in bank equity option returns with respect to moneyness (the ratio of the strike price to the current price of the underlying asset) helps reveal investors' beliefs about changes in the entire distribution of the asset's future value (Breeden and Litzenberger, 1978).[6] Therefore, they are informative about the impact of the central bank announcements on future asset value distributions when measured in a tight window around the policy announcement. For example, an increase in the price of an OTM put option with lower moneyness relative to an ATM put option suggests a higher perceived probability that the bank's equity will fall far below its current value, relative to the probability of a modest decline. This reflects the fact that put options pay off when the equity value falls below the strike price.

More specifically, put options increase in value, *ceteris paribus*, when the price of the underlying asset falls. In other words, put options have negative deltas, where delta refers to the sensitivity of the option price with respect to the underlying equity price. In the canonical Black-Scholes model of option pricing, the absolute value of delta corresponds to the probability of a positive payoff. Accordingly, ATM put options have deltas near -0.5 and are more likely to pay off, while OTM options have deltas ranging from -0.5 to 0, reflecting lower probabilities of a positive payoff. A larger increase in the price of OTM options (those with deltas closer to zero), relative to ATM options (those with deltas closer to -0.5), implies that the perceived probability of extremely low equity values has risen more than the probability of moderately low values. In other words, investors assign greater probability mass to the left tail of the underlying stock's distribution. We use this variation to measure the impact of FOMC announcements on the tail risk of banks' publicly traded equity.

The method of extracting investor beliefs from option prices is widely used in the literature, and we adapt this approach to examine how FOMC announcements affect the tail risk

[6]Specifically, option prices reveal the risk-neutral distribution of future asset values, which reflects both investor beliefs and a risk adjustment. For instance, a positive return on an OTM bank equity option indicates an increase in the perceived probability of lower future equity values and/or an increase in investors' risk aversion toward states in which bank equity values are low. Therefore, throughout the text, references to option-implied beliefs and expectations refer to those implied by the risk-neutral distribution.

of bank equity values.[7] To make the intuition behind our research design concrete, suppose the FOMC announcement takes place on day t, and let e_i denote bank i's equity value on day $t + \tau$, for example, one month after the announcement. For ease of exposition, assume that e_i can take on n discrete values: $e_i \in \{x_{i1}, \ldots, x_{in}\}$, where $x_{i1} < x_{i2} < \ldots < x_{in}$. Just before the announcement on day t, the probability distribution over these outcomes is given by $\lambda_{i1}, \lambda_{i2}, \ldots, \lambda_{in}$, where $\lambda_{i1} + \lambda_{i2} + \cdots + \lambda_{in} = 1$.

Banks operate under minimum regulatory capital requirements, so the cost of declining equity values is non-convex: a realization in the left tail of the equity distribution can lead to failure. To simplify the exposition, consider the extreme case in which the bank fails if $e_i = x_{i1}$ on day $t+\tau$. We assume that monetary policy affects bank equity values by altering the left tail of the probability distribution. A positive or contractionary monetary policy shock m on day t increases the probability of the lowest equity outcome: $\lambda'_{i1} = \lambda_{i1} + \beta_i m$, where $\beta_i > 0$ captures bank i's tail risk exposure to monetary policy. This increase in the probability of x_{i1} is offset by an equal reduction in the probability of the highest equity outcome: $\lambda'_{in} = \lambda_{in} - \beta_i m$.

To measure the impact $\beta_i m$ of a monetary policy shock on a bank's tail risk, consider a deep out-of-the-money (OTM) put option with a strike price k_j such that $x_{i1} < k_j < x_{i2}$. The return on such an option is especially sensitive to monetary policy announcements that affect beliefs about tail risk, specifically the probability of x_{i1}. An option with strike price k_j pays off only if x_{i1} is realized at expiration and its price equals the expected payoff: $p_{ij} = \lambda_{i1}(k_j - x_{i1})$. The return (or change in price) of the option on the FOMC announcement

[7] For example, Kelly et al. (2016b) use options with maturities spanning political events to measure political uncertainty. In the context of state-contingent effects of policy, Kelly et al. (2016a) compare put options on individual banks and bank indices during the Great Recession to identify expectations of a sector-wide bailout. Similarly, Haddad et al. (2025) develop a framework to extract the impact of policy announcements on the entire distribution of asset values. They show that quantitative easing announcements influence not only immediate market outcomes but also expectations about future, state-contingent outcomes — for example, in the corporate bond market.

day is given by:

$$R'_{ij} = \frac{\lambda'_{i1}(k_j - x_{i1})}{\lambda_{i1}(k_j - x_{i1})} = 1 + \frac{\beta_i m}{\lambda_{i1}}. \tag{1}$$

Directly estimating (1), however, is not practical, as liquid deep OTM equity options are scarce, and the available range of moneyness (i.e., the set of strike prices) varies across bank stocks and over time. Therefore, as we show in Appendix Section B, the relationship between an option's returns and its delta can be used to detect the effect of monetary policy on tail risk.

To implement the empirical strategy, we use put option quote data from OptionMetrics from January 2013 through August 2023, which matches the period covered by the Y-14Q regulatory data and includes 84 scheduled FOMC announcements. We apply a series of liquidity filters to the options data; see Appendix Section A for details. We restrict the sample to out-of-the-money (OTM) put options with deltas between -0.5 (near at-the-money) and 0 (deeply OTM) on the FOMC announcement day. For each option j on bank i at date t, we compute the return as:

$$Option\,return_{ijt} = \frac{Price_{ijt}}{Price_{ijt-1}} - 1, \tag{2}$$

where $Price_{ijt}$ is the mid-quote at market close on the FOMC day, and $Price_{ijt-1}$ is the mid-quote on the last trading day before the announcement. The forward-looking nature of option prices ensures that these returns capture the effect of unexpected monetary policy shocks on the conditional distribution of bank equity values. Even if a bank's exposure to potentially multidimensional monetary policy shocks—such as changes in interest rate expectations or term premia—is known beforehand, the realization of the shock occurs on the announcement day.

We proxy for bank-level tail risk shocks on FOMC days, $\beta_i m$, by estimating the following regression of option returns on deltas:

$$Option\,return_{ijt} = \alpha_{it} + \gamma_{it} Delta_{ijt} + \epsilon_{ijt} \tag{3}$$

separately for each bank i and FOMC announcement date t, using all available options j observed on that day. This procedure yields a panel of bank-by-FOMC day tail risk measures, γ_{it}. A negative γ_{it} indicates that returns on put options with larger deltas (OTM) declined more on the announcement day, consistent with a reduction in tail risk. A positive γ_{it} suggests an increase in tail risk.

Figure 1 illustrates the interpretation of γ_{it} using an example with two groups of four banks with the most positive and negative γ_{it} on January 27, 2016 – group A and group B.[8] On that day, the FOMC announcement generated a -0.52 standard deviation monetary policy shock, as measured by the high-frequency identification approach of Bauer and Swanson (2023b). Consistent with the standard view that expansionary policy reduces risks to the financial system, average ATM put option returns were negative for both sets of banks, indicating a decline in the overall perceived probability of equity losses. However, average returns on deeper OTM puts with deltas between -0.2 and -0.1 were significantly negative for banks in group B while they were close to zero for group A. This pattern suggests that the announcement more sharply reduced the perceived likelihood of very low equity values for banks in group B, implying a large decline in their downside tail risk. In contrast, the tail risk of banks in group A has not changed significantly.

We next provide systematic evidence on the relationship between monetary policy and the tail risk shocks γ_{it}. Specifically, we regress γ_{it} on various high-frequency measures of monetary policy shocks from the literature, each measured using a 30-minute window around

[8] Note that we aggregate the individual banks into groups when presenting graphical results to ensure the anonymity of the banks in the sample.

the FOMC announcement. To construct a comprehensive panel of bank tail risk shocks, we use the full sample of option price data from January 1996 to August 2023. Table 1 reports coefficients from simple univariate pooled cross-sectional regressions of γ_{it} on different monetary policy shock measures. These include the policy rate shock based on federal funds futures (FF), high-frequency changes in Eurodollar futures two and three quarters ahead (ED3 and ED4), the combined shocks from Nakamura and Steinsson (2018) (NS), the path component as in Gürkaynak et al. (2005), and both total (MPS) and orthogonalized ($\text{MPS}^{\perp}$) monetary policy shocks from Bauer and Swanson (2023b).[9]

Consistent with empirical evidence on realized equity prices in Bernanke and Kuttner (2005), across all monetary policy shock measures, positive shocks are associated with an average increase in tail risk—that is, a higher likelihood of a large decline in bank equity prices over the next 30 days relative to the probability of a smaller change. The largest effects are concentrated at the short end of the yield curve: a one standard deviation shock to the policy rate increases γ_{it} by 0.034, or approximately 0.09 standard deviations. In comparison, the path shock extracted from longer-term rates increases γ_{it} by 0.0169, or approximately 0.04 standard deviations.

In Appendix C, we build on the literature examining the interest rate sensitivity of bank equity to document the bank-level factors that shape the transmission of monetary policy shocks to a bank's tail risk (English et al., 2018; Gomez et al., 2021). We find that bank leverage and the maturity gap—the difference between assets and liabilities that reprice within one year—are key determinants of a bank's tail risk sensitivity to monetary policy. The effects of these factors are also intuitive. Leverage mechanically amplifies the volatility of equity returns. In addition, if a bank's assets are priced using flexible contracts while deposits reprice more slowly, then a large maturity gap means higher interest rates can

[9]The monetary policy shock measures are obtained from the San Francisco Fed's website and Acosta et al. (2024).

increase asset income without raising funding costs. This improves the bank's net interest margin and reduces downside tail risk.

1.1.2 Absorbing Latent Factors

We use information from put option returns to examine whether monetary policy–induced changes in a bank's tail risk affect its risk-taking incentives in lending. However, as discussed in Section 1.1, inference can be confounded by latent factors that jointly influence credit demand and loan supply, as well as by the endogenous matching of borrowers and lenders following monetary policy announcements. To test the bank risk-taking channel more cleanly, it is therefore ideal to hold credit demand fixed and isolate variation in loan supply. We address this challenge using regulatory Y-14Q data, described in detail in Section 1.2, which provide loan origination dates and enable a "high-frequency" research design that better facilitates causal inference.

Our baseline specification estimates the effect of γ_{it} on the riskiness of loans originated within 25 business days following each FOMC announcement for all Y-14Q reporting banks.[10] Since underwriting and originating a corporate loan—averaging just under $30 million in our sample—takes several weeks, loans made during this window primarily reflect loan demand shaped by economic conditions preceding the announcement. This design helps hold the bank's borrower pool fixed and limits the potential for endogenous borrower-lender matching.

By construction, γ_{it}, computed for each FOMC day, captures the effect of new information about monetary policy on the tail risk of each bank. If the risk-taking channel is operative, banks with larger γ_{it} should systematically originate safer loans from the pool of applications already under review. Because we fix the post-FOMC window to 25 business days, the decision to originate a loan (particularly the likelihood of safer versus riskier loans) primarily

[10]FOMC announcements typically occur every six weeks, and a 25-day window approximates the midpoint between announcements. Restricting the sample to this window also reduces potential influence from the subsequent meeting. Moreover, most options contracts in our sample have maturities around 30 days.

reflects the bank's loan supply response rather than shifts in borrower composition or latent demand in response to the FOMC announcement.

The research design permits parametric "event study" tests that help assess the plausibility of the assumption that the borrower pool and banks' credit policy do not change in anticipation of the FOMC meeting. These tests examine whether credit policy in the ten days leading up to the FOMC announcement anticipates a bank's realized tail risk following the announcement. For example, if riskier borrowers endogenously match with riskier banks before the meeting, then banks' credit policy could shift even in the pre-announcement window. The event study tests are designed to detect such pre-FOMC adjustments.

We also develop event study tests to rule out latent option return dynamics and to credibly identify the FOMC announcement as the source of bank risk-taking. If the γ_{it} computed on the FOMC announcement day reflects pre-existing trends in tail risk that also influence loan book risk, then γ_{it} values computed on other days during the same FOMC week might similarly predict risk-taking. However, if the research design successfully identifies the causal impact of monetary policy on risk-taking, then only the γ_{it} from the announcement day should predict subsequent credit risk decisions.

Finally, the research design allows the inclusion of bank-by-year-quarter fixed effects and firm-by-year-quarter fixed effects to absorb, respectively, bank-specific time trends and time-varying firm borrowing demand that could contaminate inference. In the former case, we compare the same bank's lending behavior across different FOMC announcements within the same quarter. This approach rules out the possibility that banks with persistently poor loan screening technologies, or those specializing in lending to distressed sectors, are both more likely to lend to riskier firms and to experience larger increases in tail risk following monetary policy shocks. In the latter case, firm-by-year-quarter fixed effects non-parametrically absorb borrowing demand at the firm level within the quarter, helping to isolate the effect of the bank's realized γ_{it} on its credit policy.

1.2 Data Description and Summary Statistics

To measure the impact of an FOMC meeting on day t on bank i's tail risk, we run the regression in equation (3) using OTM put options indexed by j for which we have the price available after applying data filters detailed in Appendix A. Panel A of Figure 2 shows a binscatter of option returns as a function of delta for the bank-FOMC day combination in our sample. Consistent with the literature, OTM puts that insure against tail risks are more expensive and have lower average returns than ATM puts (Coval and Shumway, 2001). Panel B shows the distribution of the option return slope γ_{it}. The average slope γ_{it} at the bank-FOMC day panel is -0.132 with a median of -0.140 and standard deviation of 0.383. While γ_{it} is negative on average, bank-year-quarter FE explain only 52% of the variation, suggesting a high level of variation within bank-year-quarter across FOMC days that we exploit in our empirical tests.

To measure bank risk-taking in commercial and industrial (C&I) lending, we use regulatory Y-14Q data, which cover the 24 largest U.S. banks from January 2013 through August 2023. These data include the loan origination date, the identity of the borrowing firm, key accounting variables at origination, and critically, the internal risk rating assigned by the bank to each loan. While banks use their own internal rating systems to assess borrower credit risk, the Y-14Q data standardize these ratings to ensure consistency across institutions and over time. Importantly, throughout our sample period, all corporate loans were assigned a uniform 100 percent capital weight regardless of risk rating, reducing banks' incentives to manipulate loan risk assessments for regulatory arbitrage.

Our research design uses a 25-day window following each of the 84 scheduled FOMC announcement days during the sample period. This yields a baseline sample of 159,443 newly originated term loans and lines of credit (LOC). Table 2 provides summary statistics for these loans and their borrowers. Panel A shows that the average loan size is $29.8 million, with a standard deviation of $125.1 million. Credit risk ratings, reported on a standardized 1–10 scale where higher values indicate safer loans, are summarized in Panel B. Due to sparsity in some rating bins, we aggregate the original scale into a four-category integer scale for our regressions.[11]

Panel C of Table 2 presents summary statistics of loan and bank characteristics in our data. The average interest rate on loans is 2.6%, 29% of loans are collateralized, and the average log maturity in days is 7.4, which corresponds to 4.5 years. The median borrower firm has a 17.7% cash and reserves fraction in assets, a return on assets of 15.8%, and spends 2.6% of assets for debt service.

Table 3 shows that the loan risk rating has intuitive correlations with other loan characteristics (Column 1). In particular, safer loans tend to be larger, have significantly lower interest rates, and are less likely to be collateralized. We add borrower characteristics in Columns 2 to 4, where Column 2 presents OLS results, and Columns 3 and 4 report results from ordered logit using the 4-point and 10-point scales, respectively. These results show that borrower firms with higher profitability have safer loan ratings. While higher interest rate expenses as a share of assets (DSCR) predict riskier ratings, safer firms tend to have higher leverage. Furthermore, higher liquid reserves are intuitively associated with safer loan ratings.

[11] Specifically, ratings of 1–5 are grouped into category 1, 6 into category 2, 7 into category 3, and 8–10 into category 4.

2 Results

2.1 Main Results

We examine the impact of FOMC-related bank tail risk shocks on risk-taking in the bank's loan book. The dependent variable in Table 4 is the risk score of all new loans and credit lines originated by a bank within the 25-day window following each FOMC meeting. The baseline risk score ranges from 1 to 4, with higher values indicating safer loans—that is, loans with a lower probability of default. The independent variable of interest is γ_{it}, which measures the impact of the FOMC announcement on the bank's tail risk. Column 1 of Table 4 includes bank fixed effects and year-by-quarter fixed effects, with standard errors clustered at the bank level. The bank fixed effects control for persistent, bank-level characteristics that may influence both exposure to tail risk shocks and the composition of the bank's loan portfolio. The year-by-quarter fixed effects absorb time-varying aggregate factors.

The OLS estimate in Column 1 is positive and statistically significant (p-value<0.01), suggesting that a decrease in a bank's tail risk following an FOMC announcement is associated with a decrease in loan risk rating, in other words, increased risk-taking in its loan book over the subsequent 25 days. A one standard deviation decrease in γ_{it} corresponds to a 0.02 to 0.022 standard deviation decline in the average risk score on new loans.[12] To better interpret these magnitudes, column 2 reports results from an ordinal logit (ologit) model, as the risk score is an ordinal ranking. The ologit estimates similarly indicate a shift in credit policy toward riskier borrowers following a decline in tail risk.

Figure 3 plots the effect of a unit, or 2.6 standard deviation, change in tail risk on the probability of each risk rating based on the ologit estimates. Equivalently, a one percentage point (or three standard deviation) decrease in tail risk implies a 1.6 percentage point increase

[12] We show the robustness of our results to two alternative constructions of the tail risk shock in Appendix Table A.1. Furthermore, we confirm that regressing loan risk ratings on the most OTM and ATM option returns results in a significant positive coefficient on the former, and a negative coefficient on the latter.

in the relative odds of observing a loan with a rating of "1"—the riskiest category—and a corresponding 1.5 percentage point decrease in the odds of observing loans rated "4," the safest category. The unconditional probabilities of observing loans rated "1" and "4" in the sample are 15.2 percent and 13.8 percent, respectively. Before putting these magnitudes into further context, we first run tests to evaluate whether the observed correlations reflect bank risk-taking in response to tail risk shocks.

An immediate question is whether the results in Columns 1 and 2 are driven by overall downside risk, including moderate declines, or are specific to tail risk in bank equity. To address this, Column 3 of Table 4 includes a control for the FOMC announcement day return of the option closest to a delta of -0.5 (i.e., an ATM option) in the construction of the tail risk shock γ_{it}, using the same ologit specification. The coefficient on γ_{it} remains largely unchanged, while the coefficient on the ATM option return is not statistically significant. This indicates that the observed shift in bank credit policy in the 25 days following the FOMC announcement is not driven by changes in the perceived likelihood of moderate declines in bank equity value. Instead, it specifically reflects the relative change in the value of OTM options, which are sensitive to tail risk.

Relatedly, our results may be driven by the effect of the FOMC announcement on the level of bank equity values, rather than on the tails of the conditional distribution. In this case, the findings could reflect standard cash flow or discount rate effects of monetary policy shocks (Bernanke and Kuttner, 2005). To address this, Column 4 of Table 4 includes the daily bank equity return as a control. One important driver of bank stock returns on FOMC days is the effect of interest rate shocks on the value of the deposit franchise (English et al., 2018; Drechsler et al., 2021). Banks with larger maturity gaps between repricing assets and liabilities benefit more from rising rates, experience higher stock returns, and have less incentive to "reach for yield" through riskier lending. What we find from this additional test is that the coefficient on γ_{it} remains largely unchanged, while the coefficient on the bank stock return is positive. This implies that banks experiencing positive equity returns on the FOMC day tend to originate safer loans, while crucially, this mechanism is distinct from the effect of tail risk shocks on lending behavior.

Finally, Column 5 controls for the aggregate monetary policy shock observed on the FOMC announcement day using the measure from Bauer and Swanson (2023b), and the results remain unchanged. This highlights that it is not sufficient to focus on the aggregate monetary policy shock alone. Instead, the tail risk shock γ_{it}—which captures market perceptions of the interaction between a bank's tail risk exposure and the aggregate shock—is necessary to identify how the risk-taking channel of monetary policy affects bank credit policy.

Anticipatory bias may still contaminate these estimates. Our research design uses a fixed 25-day window following each scheduled FOMC meeting to hold constant the stock of borrower applications and to limit endogenous credit demand and loan supply, as discussed in Section 1.1. However, both borrowers and banks may adjust their behavior in anticipation of FOMC actions. To address this concern, we test whether tail risk shocks on FOMC days are associated with variation in loan ratings only after, and not before, the announcement. This also helps mitigate concerns related to the structure of the Y-14Q data, which records only the origination date, not the approval date. Any shift in approval behavior before the FOMC meeting could otherwise affect the composition of loans observed in the post-FOMC window and contaminate the research design.

Figure 4 presents an event study using a 41-day window that begins 11 days before the FOMC announcement and extends to 30 days after. This figure plots OLS coefficients of loan risk ratings from 11 days before to 30 days after the FOMC day regressed on tail risk shocks on the FOMC day. In particular, the tail risk shock is interacted with dummy variables for loans grouped into eight time bins defined relative to the FOMC day. The coefficients shown correspond to these interaction terms, with loans made 28 to 30 days after the meeting serving as the omitted category. The estimated effects of the tail risk shock on loan risk ratings are statistically insignificant in the first three bins, covering from 11 days before to 5 days after the announcement. This suggests that loan risk ratings approved before the FOMC day are not systematically related to the subsequent tail risk shock, providing evidence against anticipatory bias.

Instead, the coefficient on the tail risk shock measure γ_{it} becomes significant only 6 to 9 days after the FOMC meeting. It peaks around 10 to 14 days afterward, as banks incorporate the realized tail risk movement on the FOMC day into their lending decisions, and begins to decline between days 15 and 20, as newer information becomes more relevant for credit decisions. By days 21 to 27, the coefficient on γ_{it} is no longer statistically significant. The evidence in Figure 4 therefore weighs against the concern that pre-FOMC anticipation by either banks or borrowers biases the estimates reported in Table 4. Instead, it suggests that FOMC-related innovations to banks' tail risk might have a causal impact on bank credit policy.

We next examine if tail risk shocks specifically on FOMC days predict loan risk ratings, which is a necessary condition to link the results to monetary policy and bank risk-taking. For example, option returns exhibit strong momentum, which implies that tail risk shocks inferred from option prices even before the FOMC day may predict loan ratings (Heston et al., 2023). In addition, banks that are riskier for reasons unrelated to monetary policy exposure may experience larger option price movements on FOMC days, and variation in their tail risk on other days could predict loan ratings just as well as tail risk shocks measured on FOMC days. To assess this concern, we next implement an event study framework.

In our sample period, 81 out of 84 FOMC announcements occur on a Wednesday. To test whether the results are driven by latent option price dynamics or reflect the FOMC announcement itself, we regress loan risk ratings within the 25-day post-FOMC window on daily bank tail risk shocks, γ_{it}, measured separately for each day from the Friday before to the Monday after each FOMC Wednesday. Figure 5 shows that the OLS coefficients for the three days before and after the announcement are economically and statistically insignificant. The only significant relationship between tail risk shocks and subsequent credit policy occurs exactly on the FOMC day. This accretion of evidence strongly suggests that monetary policy, rather than latent dynamics in bank option returns or anticipatory behavior, drives the observed post-FOMC changes in credit policy.

2.2 Robustness

While the main results suggest that the perceived insurance provided by monetary policy influences bank risk-taking, several alternative explanations remain possible. We now conduct a series of further robustness checks, including variations in the fixed effects structure. For simplicity, these tests use the linear OLS specification from Column 1 of Table 4. Relying on the OLS model also helps avoid the incidental parameters problem that can bias the ordinal logit estimator when the number of fixed effects is large.

We first address the concern that latent, time-varying, bank-specific shocks may bias the estimates. Such shocks could include changes in a bank's loan screening technology, regulatory capital position, or internal expectations about future loan demand and borrower credit risk. These factors could simultaneously affect both a bank's tail risk and its credit policy. For example, if market participants believe that a bank's screening or risk management practices have improved, its perceived tail risk may decline, while the bank becomes more willing to lend to observationally riskier borrowers. Similarly, if latent economic conditions improve — such as the health of the local economy in which the bank primarily operates —

tail risk may decline and lending to riskier firms may increase.

Column 1 of Table 5 addresses this concern non-parametrically by including bank-by-year-quarter fixed effects to absorb quarterly, bank-specific shocks. Bank-by-year-quarter fixed effects are particularly demanding in this setting, as there are usually only two meetings a quarter, and this specification exclusively uses the variation in the tail risk shocks for the same bank within the same quarter across two FOMC meetings. The estimated effect is about 50 percent smaller than in Column 1 of Table 4, but remains statistically significant (p-value $= 0.02$).

A related concern involves aggregate shocks that vary across FOMC meeting dates. While we have shown that the results are robust to controlling for monetary policy shocks at each meeting (Column 5 of Table 4), latent high-frequency sentiment or economic shocks adjacent to FOMC dates may simultaneously influence both bank credit policy and monetary policy decisions (Bauer and Swanson, 2023a). Column 2 of Table 5 addresses this concern by including both bank and FOMC meeting fixed effects. The estimates remain essentially unchanged relative to the baseline in Column 1 of Table 4. This suggests that our results are not driven by common aggregate shocks that jointly affect bank tail risk and credit policy.

These results might also reflect changes in the available supply of loanable funds, which could be related to bank tail risk and cause a bias toward originating smaller or larger loans—particularly if loan size is correlated with risk ratings. Column 3 of Table 5 partially addresses this concern by including a control for the log of the loan amount. The OLS estimate of the γ_{it} coefficient remains largely unchanged. Although the coefficient on the loan amount is not statistically significant, its average value is consistent with theoretical expectations: larger loans are associated with safer borrowers.

We return to concerns about latent firm credit demand and endogenous matching between firms and banks — classic threats to identification in this literature — using a non-parametric approach. Specifically, borrower firms may endogenously match to certain banks within each year-quarter period, for example, because riskier firms are more likely to seek credit from banks more exposed to monetary policy or other shocks. In addition, because bank–firm lending relationships are often persistent, firm-level demand shocks may correlate with bank tail risk.

To address this concern, Column 4 of Table 5 includes firm-by-year-quarter fixed effects in addition to bank fixed effects. The firm-by-year-quarter fixed effects hold constant firm credit demand and credit quality within each year-quarter cluster. As a result, for firms that apply for credit from two different banks within the same quarter, or from the same bank before two different FOMC days, the specification in Column 4 estimates the likelihood of receiving credit based on variation in the banks' tail risk driven by monetary policy. Only 23,500 or so firm–year–quarter observations meet this criterion, resulting in a loss of over 60 percent of the sample. This makes it a particularly demanding test. Nevertheless, the effect of γ_{it} on loan risk scores remains both economically and statistically significant. Note that when we extend the estimation window to 30 days to gain more observations, the coefficient on γ_{it} remains unchanged, but is now significant at the 5 percent level.

A more subtle source of bias arises from the monetary policy shock itself. Because monetary policy affects not only banks but also borrowing firms, an expansionary shock that reduces a bank's tail risk may also simultaneously lower the tail risk of the bank's borrowers. As a result, riskier borrowers that also have high exposure to the monetary policy shock may apply for loans prior to the FOMC announcement gambling on an expansionary shock. If these applications primarily go to banks that will experience larger tail risk reductions in case of an expansionary shock, then the credit demand channel may still bias the results. A related but distinct concern arises if expansionary shocks not only reduce a borrower's perceived tail risk but also lower their de facto probability of default, especially for riskier borrowers. In that case, the loan risk rating may overstate the bank's actual risk-taking, as the borrower may no longer be as risky as their rating implies.

To address these concerns, we use option price data for publicly traded borrower firms in our sample to estimate an analogous firm-level tail risk shock, γ_{it}, on each FOMC day. After applying basic liquidity filters to the firm-level put options, we are left with a subsample of 15,777 loans. Column 5 of Table 5 includes both the bank-level tail risk shock and the corresponding firm-level tail risk shock, each measured on the FOMC announcement day. Despite the smaller sample—limited to public firms with sufficiently liquid option markets—the coefficient on the bank tail risk shock is slightly larger than in the baseline specification in Column 1 of Table 4, and remains statistically significant (p-value = 0.04). Reassuringly, the coefficient on the firm tail risk shock is also highly significant (p-value $<$ 0.01) and negative: firms that experience a decline in their equity tail risk on the FOMC day receive higher (safer) credit risk scores.

Finally, Column 6 of Table 5 assesses whether the relationship between tail risk and credit policy is non-linear using a simple spline model. Mechanically, because financial regulation requires banks to maintain minimum levels of book equity, a large increase in a bank's market equity tail risk may signal future loan losses and a decline in book equity. This elevated risk of insolvency can, in turn, prompt the bank to sharply adjust its credit policy. However, smaller or moderate changes in tail risk may elicit little response, given the small consequence relative to high adjustment costs associated with altering lending standards and disrupting customer relationships.

In Column 6 of Table 5, the model uses three indicator variables to decompose γ_{it} into quartiles, allowing the effect of γ_{it} on credit policy to vary depending on whether it falls in the 4th, 3rd, or 2nd quartile of the distribution; the 1st quartile serves as the omitted category. The OLS estimates in Column 6 suggest that when γ_{it} falls in the 3rd or 4th quartile, the average credit score on new loans over the subsequent 25 days is about 0.056 points higher. In contrast, realizations in the 2nd quartile are not significantly different from the baseline.

The ordered logit estimates in Column 7 of Table 5 provide a clearer interpretation of the magnitudes. Relative to the base case of low (first-quartile) tail risk on the FOMC day, a top-quartile realization of γ_{it} is associated with a 1.2 percent decrease in the odds of originating category 1 loans (riskiest) and a corresponding 1.1 percent increase in the odds of category 4 loans (safest) over the subsequent 25-day window – see Figure 6.

To put these estimates in context, note that each bank originates an average of 83 loans in the 25-day window following each FOMC meeting, with roughly 15% classified as category 1 (riskiest) loans. The ordered logit estimates in Column 7 thus imply that a bank experiencing a top-quartile tail risk shock would reduce its share of category 1 loans by about 1.2 percent—roughly one fewer risky loan per bank. Given that the average size of a category 1 loan is approximately \$3.04 million, if all 24 banks in the sample experienced such a shock—say, in response to quantitative tightening or a large unexpected policy rate hike—and there were no substitution toward other lenders, the total decline in lending to the riskiest firms would amount to about \$70 million over the subsequent 25 days.

2.3 Loan Terms Results

We have shown that when banks experience a decrease in tail risk following an FOMC meeting, they increase the likelihood of originating riskier loans. To rule out the possibility that loan risk ratings are stale or proxy for other latent factors, we examine alternative dimensions of the bank's risk-taking response in Table 6. Specifically, we build on arguments from the literature suggesting that, for a given probability of default, banks can adjust their risk exposure by varying loan maturity, the interest rate, or the use of collateral (Diamond and Verrecchia, 1991; Hart and Moore, 1998; Benmelech and Bergman, 2009). For example, following an increase in tail risk, a bank might reduce its exposure by disproportionately shortening the maturity of loans rated as the riskiest.

In Table 6 we examine how tail risk shocks differentially affect other characteristics of loans depending on their risk rating. To do this, we regress loan characteristics (log maturity, interest rate spread, collateral) on a dummy variable indicating whether the loan is rated 1 or 2—the riskiest categories—and interact it with dummy variables for the quartiles of the tail risk shock γ_{it}. Column 1 shows significant evidence that higher tail risk shocks are associated with shorter loan maturities for riskier loans. Specifically, banks that experience a 4th quartile realization in tail risk following an FOMC meeting reduce the average maturity of loans to the riskiest borrowers by 2.1 percent more than for safer loans. Appendix Table A.3 uses the coefficients in Table 6 to tabulate the marginal effects over the distribution of tail risk realizations for safer and riskier loans and reports the corresponding p-values.

Similarly, Column 2 of Table 6 examines the loan interest rate relative to the 10-year Treasury yield observed on the loan origination date.[13] For banks in the 4th quartile of the FOMC tail risk shock, average loan spreads increase by approximately 11 basis points more for riskier loans over the 25 days following the meeting. Finally, Column 3 investigates whether banks respond to tail risk shocks by adjusting the use of collateral in loan contracts. In this specification, the dependent variable is a dummy indicating whether the loan is collateralized. The estimates are imprecise, which is unsurprising given that identifying and valuing suitable collateral takes time, making it difficult to detect changes in collateral usage over the relatively short 25-day window.

Taken together, these results show that after a decline in their own tail risk, banks not only shift their lending toward riskier borrowers but also adjust loan contract terms by

[13] We use the Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, quoted on an Investment Basis. Data are retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/DGS10

extending maturities and reducing spreads. This pattern of evidence is consistent with the risk-taking channel of monetary policy. Next, we examine the mechanisms that mediate the effect of bank tail risk shocks on FOMC days on credit policy.

3 Possible Mechanisms

In this section, we develop empirical tests to better understand the mechanisms of the risk-taking channel. In particular, we examine whether agency frictions between senior management and long-term shareholders, as well as competition in the loan market, amplify the effect of tail risk shocks on bank risk-taking.

3.1 Compensation

While shareholders can easily observe key aspects of a bank's bond portfolio and hedging strategy, the credit risk in a bank's loan book is largely hidden. As a result, lending decisions can more easily reflect agency frictions between a bank's long-term shareholders and its senior management. In our setting, consider executives with high-powered compensation contracts—contracts that reward loan revenue and market share targets with cash bonuses and salary increases, rather than with stock or options that vest over a longer horizon.

While options introduce convexity in executive payoffs and may incentivize risk-taking in other settings, it is important to note that bank lending risk differs from the standard intuition. Risk-taking in lending primarily increases left tail risk in the bank's portfolio, while the upside is truncated—the most a bank can earn is the loan fee and interest rate spread. As a result, option-based compensation does not necessarily increase incentives for risk-taking in the loan book. Increased risk from bank lending is not a mean-preserving spread as captured by volatility, e.g. in Chen et al. (2006), but rather an increase in downside tail risk with limited or no increase in upside, due to the capped returns on loan contracts. In this setting, option-based compensation primarily serves to lengthen the executive's decision-making horizon rather than to amplify risk-taking incentives.

As a result, if moral hazard is present, executives with short-term oriented compensation may have stronger incentives to respond to the perceived insurance from the current stance of monetary policy by making riskier, higher-yield loans that generate immediate fees and revenues. This behavior can help them meet short-term bonus targets and keep up appearances for shareholders (Rajan, 1992; Stein, 1989; Falato and Scharfstein, 2025).

Table 7 uses data on executive compensation at banks to examine whether the structure of compensation for senior executives mediates the impact of FOMC-related tail risk shocks on the bank's credit policy. To this end, we first compute the ratio of the fair value of options to salary and bonus. Because the data are not always available each quarter, and are highly persistent over time for each bank, we use the average of this ratio over the whole sample period to maximize the number of observations.[14] This average serves as a proxy for cross-sectional differences in compensation culture across banks. The weighted average vesting period of option-based compensation in the dataset is approximately 2.3 years, so a lower ratio of options to salary indicates a compensation structure that emphasizes short-term performance for senior management. If moral hazard is indeed a relevant concern, then risk-taking in response to tail risk shocks should be more pronounced among banks with lower option-to-salary ratios.

To streamline the presentation of results, Column 1 of Table 7 interacts an indicator variable equal to one if γ_{it} is in the bottom quartile of the tail risk distribution with the bank's option-to-salary-and-bonus ratio. The bottom quartile indicator enters linearly, while the option ratio is absorbed through bank fixed effects. This specification allows us to directly test whether compensation culture mediates the risk-taking channel for the banks that benefit most from a decline in tail risk—that is, those in the bottom quartile of γ_{it}. The bottom

[14] See Appendix D for the details of data construction.

panel of the table tabulates the marginal effects of the bottom quartile tail risk variable across the distribution of compensation.

Consistent with earlier results, the coefficient on the bottom quartile indicator in Column 1 of Table 7 is negative and highly significant (p-value < 0.01), indicating that large reductions in bank tail risk are associated with greater risk-taking in the loan book. The interaction term with the options ratio is positive and significant (p-value < 0.05), suggesting that this effect is amplified when compensation is more short-term oriented—favoring current salary and bonuses over long-duration options. Appendix Table A.4 tabulates the marginal effects for loans at the bottom quartile of tail risk across the distribution of compensation along with standard errors. For a bank at the 25th percentile of the options-to-salary-and-bonus ratio, a bottom quartile realization of tail risk implies an average 0.06-point decline in loan risk scores over the next 25 days (p-value < 0.01). For a bank at the 75th percentile of the ratio, the effect is three times smaller and statistically insignificant (p-value $= 0.25$). As a robustness check, Column 2 controls for the weighted average duration of options-based compensation, and Column 3 includes the weighted duration of all compensation. These alternative variables are not significant, reinforcing the interpretation that short-term compensation structures may amplify the risk-taking channel. That said, the limited cross-sectional variation in compensation data leaves open alternative explanations. We next consider the role of competition in the C&I loan market to further assess the mechanism.

3.2 Competition

A large theoretical literature argues that competition, by compressing loan margins, fee income, and a bank's franchise value, reduces the cost of failure and can increase managerial risk-taking incentives.[15] Competition also makes it easier to use relative performance

[15] Classic references include Keeley (1990), Hellmann et al. (2000), Boyd and De Nicolo (2005), and Martinez-Miera and Repullo (2010).

evaluation, allowing banks to incentivize loan officers to meet lending and market share targets. Moreover, highly competitive lending environments tend to be characterized by greater asymmetric information—both across banks and between banks and borrowers—leading to a riskier applicant pool from which to originate loans (Broecker, 1990; Dell'Ariccia and Marquez, 2006).

These arguments suggest that competition may exacerbate risk-taking and amplify the moral hazard created by compensation contracts that reward short-term performance. To test these predictions, we use the full universe of Y-14Q loans from 2013 to 2023 — including those outside the FOMC window — and compute the Herfindahl-Hirschman Index (HHI) of large banks' C&I lending for each city-by-year-quarter cluster. We then calculate each bank's market share in these clusters. Multiplying the HHI in each city-by-year-quarter by a bank's market share of loans in that cluster and summing across all clusters yields a bank's overall exposure to competition in each year-quarter.[16] Intuitively, banks that lend primarily in cities with high HHIs face less competition, while those lending predominantly in markets with low HHIs are more exposed to C&I competition overall. Of course, this measure omits regional banks, as well as private credit, and despite the detailed bank-level data, is best viewed as a proxy for spatial competition in the C&I loan market.

Using a similar specification to the preceding columns in Tables 7 and A.4, Column 4 interacts the bank–year-quarter-level HHI measure, lagged by two quarters, with a binary indicator for whether a bank's tail risk shock was in the bottom quartile on the FOMC announcement day. There is significant evidence that competition in the C&I lending market mediates banks' responses to FOMC-induced changes in tail risk. The OLS estimate implies that for a bank in the bottom quartile of tail risk and the top quartile of competition, credit risk scores on new loans over the subsequent 25 days decrease by about 0.04 points (p-value

[16] We focus on a bank's overall exposure to C&I competition because, unlike in consumer or small business lending, the size of most loans recorded in the Y-14Q data likely requires approval from senior management.

< 0.01). By contrast, for a bank with the same bottom quartile tail risk realization but operating in the top HHI quartile—facing less C&I competition—the change in credit risk scores is not statistically significant; the estimated effect is –0.02 with a p-value of 0.19.

To test whether competition exacerbates moral hazard between managers and shareholders due to short-term oriented compensation, Column 5 of Tables 7 and A.4 includes a triple interaction term: Tail risk, interacted with the ratio of options to bonus and salary and spatial competition, along with all sub components. The marginal effects suggest that the impact of a bottom quartile tail risk realization on subsequent risk-taking is strongest among banks operating in highly competitive markets and with compensation structures that emphasize short-term performance. For banks in both the bottom quartile of the HHI (most competitive) and the bottom quartile of the options-to-salary-and-bonus ratio, a bottom quartile tail risk shock leads to a 0.06 point decrease in the average loan risk rating (p-value < 0.01). In contrast, for banks in the top quartile of both HHI and the compensation ratio—those facing little competition and emphasizing long-term incentives—the same tail risk shock has no meaningful effect on loan risk-taking (–0.001 points with a p-value = 0.95).

4 Conclusion

This paper documents that the risk-taking channel of monetary policy influences bank lending to corporate borrowers. Consistent with the effects of a "Fed put," banks that experience larger reductions in the perceived risk of extreme downside equity outcomes on FOMC announcement days extend more credit to riskier borrowers and ease loan terms, such as maturity.

Daily option-implied measures of bank tail risk shocks allow us to exploit the heterogeneous impact of monetary policy across banks and examine the mechanisms that mediate the risk-taking channel. We find that banks with more short-term oriented executive compensation — an indicator of potential moral hazard between long-term shareholders and managers — exhibit greater risk-taking in the loan book when their tail risk declines. Moreover, the risk-taking channel is stronger among banks operating in more competitive corporate lending markets.

Our empirical approach addresses a range of identification challenges in estimating the risk-taking channel. First, bank equity option prices reveal market beliefs about the impact of the "Fed put" on each individual bank, helping to isolate the perceived strength of downside risk reduction resulting from policy announcements. Second, by focusing on loans originated within 25 days after each FOMC announcement — during which corporate loan applications are already in process — we hold credit demand effectively constant. The granularity of our data further allows us to control for time-varying bank and borrower fixed effects, as well as for the impact of monetary policy shocks on borrower tail risks. These features together suggest that observed lending behavior reflects the effect of monetary policy shocks on bank tail risk.

Taken together, our results show that downside equity tail risk — the dimension of risk most relevant for banks due to regulatory constraints—is precisely where the risk-taking channel drives loan supply decisions. This effect persists even after accounting for broader downside risk, including moderate equity declines, and the immediate impact of monetary policy on bank equity valuations. In particular, our findings highlight the importance of monetary policy's effect on the perceived likelihood of large future equity losses for banks, potentially contributing to boom-bust cycles resulting from monetary policy shocks.

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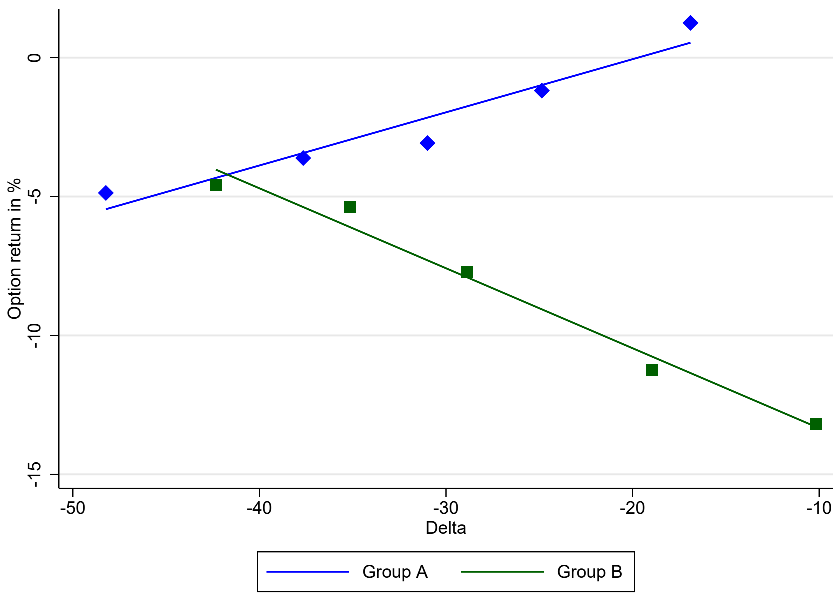
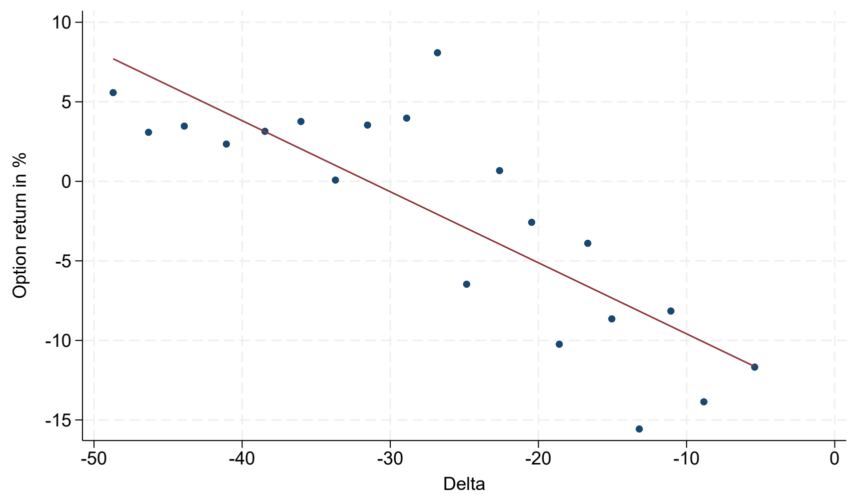
Figure 1. Option returns and deltas: The case of two groups of banks on January 27, 2016



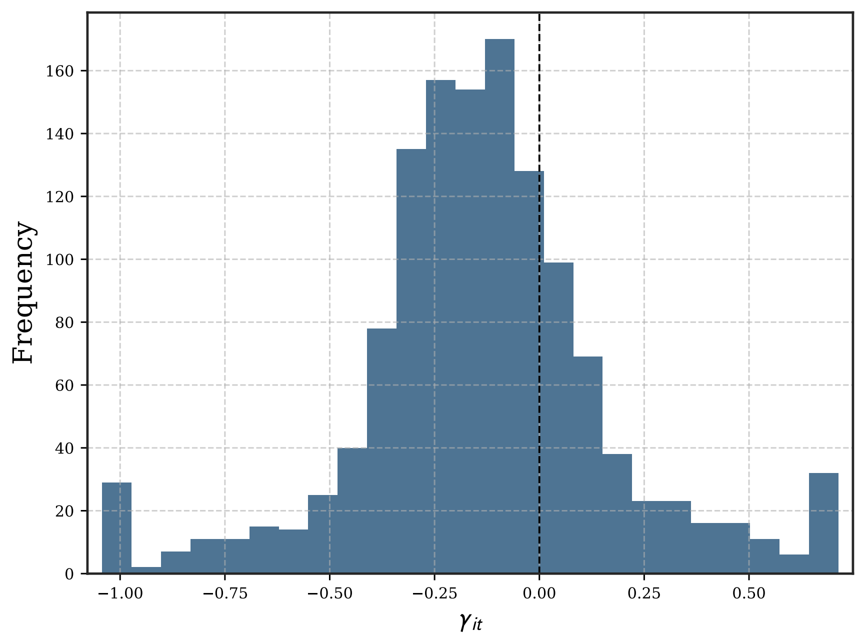
Notes. This figure shows out-of-the-money (OTM) put option returns in % plotted against their deltas (multiplied by 100) in a binscatter on the FOMC day January 27, 2016, for the four banks with the most positive (Group A) and negative (Group B) γ_{it} on that day. Data source: OptionMetrics.

Figure 2. Option returns and tail risk shocks

Panel A: Option returns

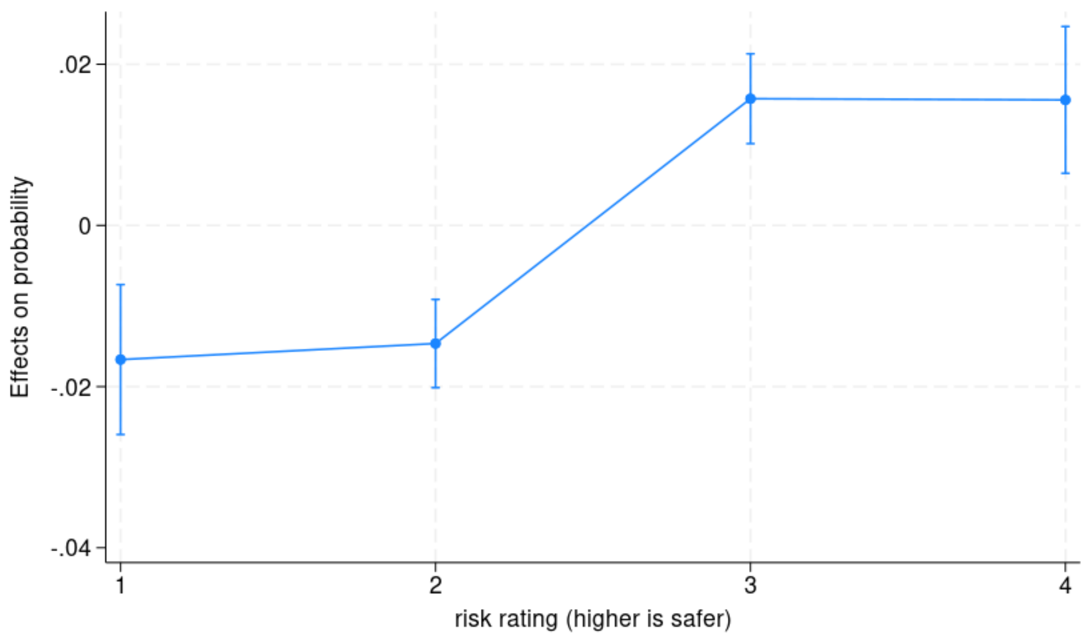


Panel B: Histogram of γ_{it}



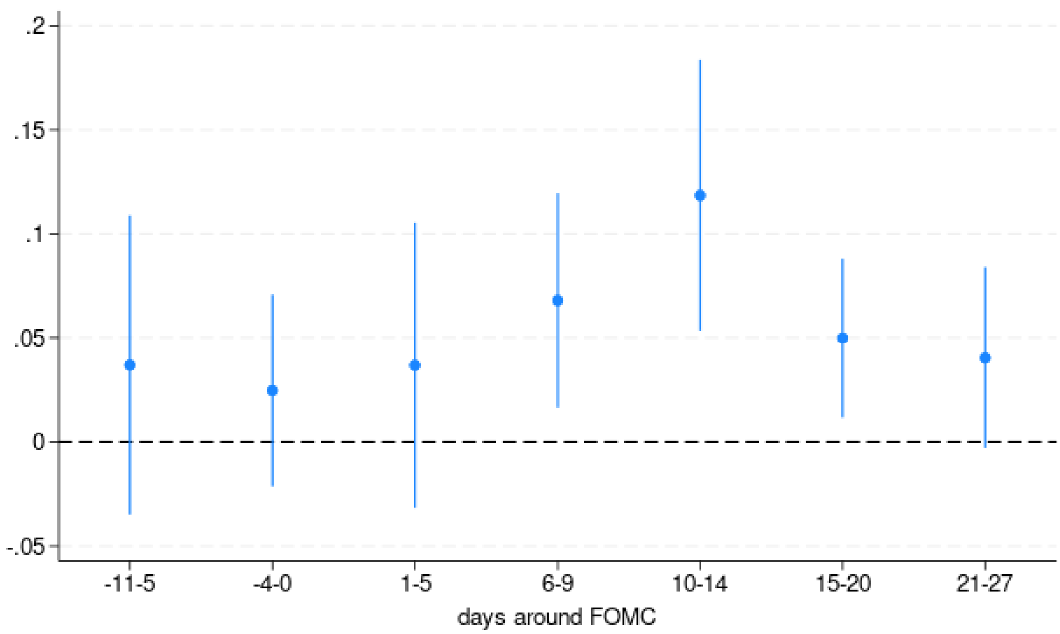
Notes. Panel A shows a binscatter of option returns in % plotted against option delta (multiplied by 100) for all FOMC day option returns of the banks in our sample. Panel B shows a histogram of the bank-level tail risk shocks on FOMC days γ_{it}, defined as the regression coefficient in equation (3) for each bank i and FOMC date t, across options j. A negative γ_{it} implies a tail risk reduction, while a positive one implies an increase. For visual clarity, γ_{it} is winsorized at the 2^{nd} and 98^{th} percentiles. Data source: OptionMetrics.

Figure 3. The impact of bank tail risk shocks on loan risk ratings



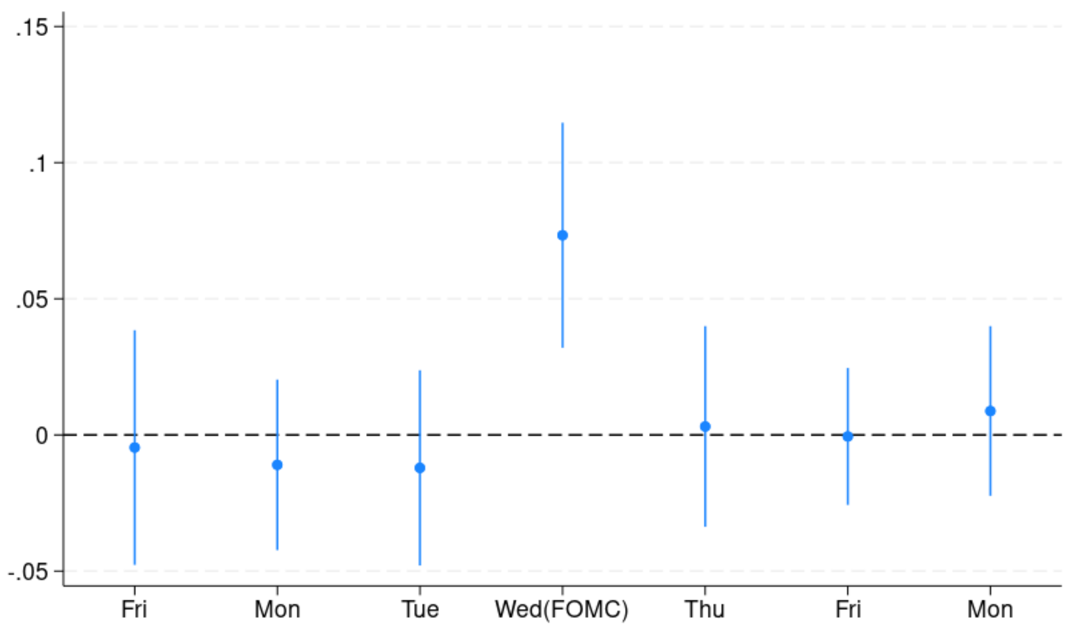
Notes. This figure plots the marginal effect of a unit increase in the tail risk shock γ_{it} on the probability of observing a loan across the loan risk distribution. Note that higher loan risk scores indicate a safer loan. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Figure 4. The impact of tail risk shocks on bank risk-taking before and after FOMC



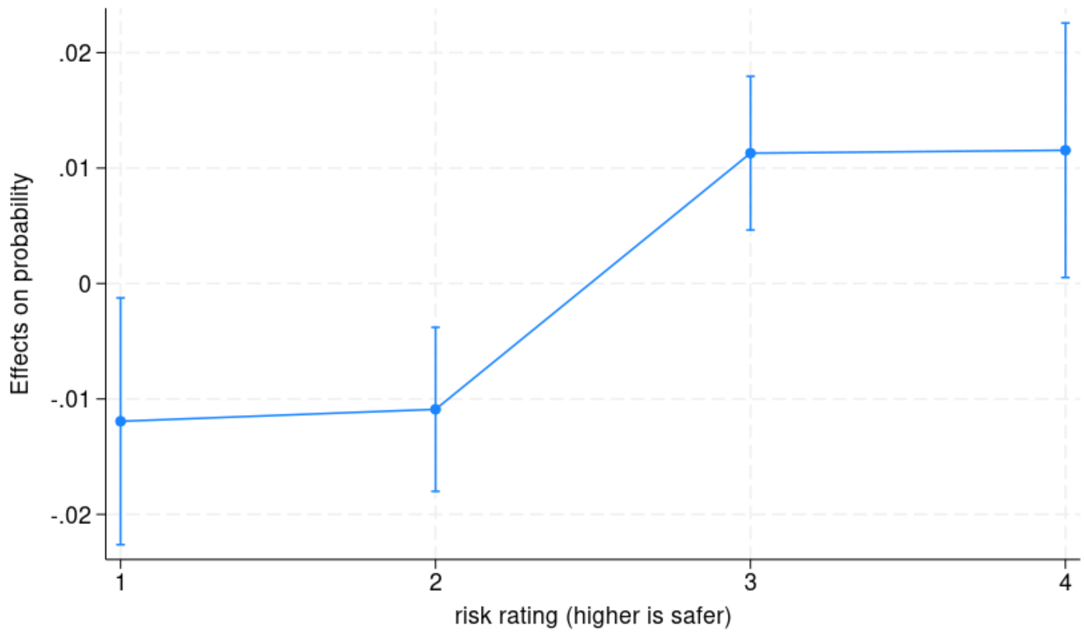
Notes. This figure plots OLS regression coefficients of loan risk ratings from 11 days before to 30 days after the FOMC day on FOMC day tail risk shocks, where the tail risk shock is interacted with dummies for loans grouped into eight bins based on their distance from the FOMC day. The plot presents the coefficient on the interaction terms where loans made from 28 to 30 days after the meeting is the omitted category. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Figure 5. The impact of daily tail risk shocks in the FOMC week on bank risk-taking



Notes. This figure plots coefficients from seven OLS regressions. The dependent variable in each regression is loan ratings in the 25-day window from the FOMC day, and the independent variable is the daily bank tail risk shocks. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Figure 6. The marginal impact of tail risk on bank risk-taking



Notes. This graph plots the marginal impact of top quartile tail risk exposure γ_{it} on the probability of observing a loan across the loan risk distribution using the estimates from column 7 of Table 5. Note that higher loan risk scores indicate a safer loan. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table 1
Tail risk shocks and monetary policy shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FF	0.0341***						
	(0.0107)						
ED3		0.0259***					
		(0.0069)					
ED4			0.0295***				
			(0.0079)				
NS				0.0329***			
				(0.0070)			
Path					0.0169**		
					(0.0080)		
MPS						0.0254***	
						(0.0068)	
$\text{MPS}^{\perp}$							0.0205***
							(0.0072)
R^2	0.0053	0.0035	0.0044	0.0055	0.0015	0.0034	0.0022
Obs.	2253	2385	2385	2385	2385	2385	2385

Notes. This table presents pooled regressions of banks' tail risk shocks, γ_{it}, on various measures of high-frequency monetary policy shocks on FOMC announcement days. FF is the federal funds rate shock. ED3 and ED4 are two- and three-quarter-ahead Eurodollar futures contracts. NS is the high-frequency change in the instrument set's first principal component scaled to be one-for-one with the daily change in zero-coupon 1-year Treasuries (Nakamura and Steinsson, 2018; Acosta et al., 2024). Path is from Bauer and Swanson (2023b) using the decomposition of Gürkaynak et al. (2005). MPS and $\text{MPS}^{\perp}$ are the total and orthogonalized monetary policy shocks from Bauer and Swanson (2023b). The sample period is from January 1996 to August 2013 and contains 214 FOMC meetings. For the FF column, the sample ends in December 2022 and contains 209 FOMC meetings. All independent variables are normalized to have zero mean and unit standard deviation. We cluster standard errors at the bank level. Data sources: OptionMetrics and various sources indicated above.

Table 2

Panel A: Loan-level summary statistics

	All
Committed Exposure	\$29,817,270
	(\$125,145,117)
Obs.	159,443

Panel B: Distribution of loans by risk rating

10 Point Rating	N	Percent	Cumulative Percent
1	313	0.2	0.2
2	60	0.04	0.23
3	820	0.51	0.75
4	2,308	1.45	2.2
5	20,905	13.11	15.31
6	64,707	40.58	55.89
7	48,129	30.19	86.08
8	18,753	11.76	97.84
9	2,962	1.86	99.7
10	486	0.3	100
Total	159,443	100	

Panel C: Loan and borrower characteristics

		(1)	
	Mean	Median	SD
Interest Rate	0.026	0.025	0.024
Collateral=1	0.289	0.000	0.453
Ln Maturity(Days)	7.357	7.507	2.062
Cash and reserves/assets	0.271	0.177	0.275
Debt service/assets	0.093	0.026	0.202
Return on assets	0.309	0.158	0.799
Obs.	159,443		

Notes. Panel A reports the mean and the standard deviation (in parentheses) of Y-14Q U.S. C&I Loans originated within 25 days of scheduled FOMC meetings and FR Y-9C from 2013 to 2023. Panel B reports the frequency distribution of loan risk ratings in our sample on a 10 point scale. Panel C reports the mean, median, and standard deviation (SD) of loan and borrower characteristics, which are winsorized at the 1% level. Data source: Federal Reserve Y-14Q.

Table 3

Loan risk ratings and loan-borrower characteristics

	(1)	(2)	(3)	(4)
	OLS	OLS	ologit	ologit
	4-point scale	4-point scale	4-point scale	10-point scale
Committed Exposure	0.0232	0.103***	0.268***	0.263***
	(0.0206)	(0.0120)	(0.0271)	(0.0259)
Interest Rate	-11.17***	-9.132***	-24.98***	-24.85***
	(0.898)	(0.522)	(1.799)	(1.722)
Maturity	0.0228**	0.0116	0.0321	0.0370*
	(0.0101)	(0.00750)	(0.0197)	(0.0203)
Collateral=1	-0.270***	-0.246***	-0.636***	-0.624***
	(0.0620)	(0.0313)	(0.0878)	(0.0868)
ROA		0.149***	0.425***	0.429***
		(0.0123)	(0.0375)	(0.0346)
Leverage		0.0166***	0.0529***	0.0531***
		(0.00330)	(0.0104)	(0.00973)
Liquidity		0.240***	0.595***	0.584***
		(0.0524)	(0.121)	(0.119)
Debt Service Coverage Ratio		-0.886***	-2.687***	-2.652***
		(0.0856)	(0.255)	(0.229)
R^2	0.122	0.208	0.101	0.090
Obs.	148187	84260	84260	84260

Notes. This table reports results from regressing risk ratings of C&I Loans in the Y-14Q dataset on loan (Column 1) and borrower (Columns 2 to 4) characteristics from 2013 to 2023. Columns 1 through 3 use the 4-point rating scale, Column 4 uses the 10-point rating scale. Columns 1 and 2 are OLS regressions, Columns 3 and 4 are ordered logit regressions. All specifications include bank and year-quarter fixed effects, and standard errors are clustered at the bank-level. Data source: Federal Reserve Y-14Q.

Table 4
The impact of tail risk shocks on bank risk-taking

	(1) OLS	(2) ologit	(3) ologit	(4) ologit	(5) ologit
Tail risk	0.0634***	0.134***	0.132***	0.128***	0.141***
	(0.0164)	(0.0300)	(0.0302)	(0.0305)	(0.0299)
Diffusive risk			-0.0309		
			(0.0353)		
Stock returns				1.133**	
				(0.470)	
Monetary policy shock					-0.0319
					(0.0292)
R^2	0.061	0.025	0.025	0.025	0.025
Obs.	159,443	159,443	159,443	159,443	159,443

Notes. This table reports our main results on the impact of FOMC day bank tail risk shocks on bank risk-taking. The dependent variable is the risk rating of new loans made over 25 days after each FOMC meeting, which takes on integer values from 1 to 4, with higher values indicating safer loans. The independent variables are the bank tail risk shock (γ_{it}), diffusive risk (FOMC day ATM option return), FOMC day stock return, and monetary policy shocks from Bauer and Swanson (2023b). Column 1 reports results from OLS while all other columns report ordered logit results. All specifications include bank and year-quarter fixed effects, and standard errors are clustered at the bank-level. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table 5

The impact of tail risk shocks on bank risk-taking: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	OLS	OLS	OLS	ologit
Bank tail risk	0.0333**	0.0721***	0.0668***	0.0296*	0.0738**		
	(0.0123)	(0.0194)	(0.0151)	(0.0167)	(0.0332)		
Loan amount, ln			0.0337				
			(0.0199)				
Firm tail risk					-0.0526***		
					(0.0135)		
4th quartile tail risk						0.0441**	0.0971**
						(0.0204)	(0.0381)
3rd quartile tail risk						0.0557**	0.118***
						(0.0198)	(0.0399)
2nd quartile tail risk						0.0118	0.0324
						(0.0247)	(0.0536)
R^2	0.096	0.063	0.064	0.891	0.084	0.061	0.025
Obs.	159,437	159,443	159,443	65,639	15,777	159,443	159,443

Notes. This table reports robustness results on the impact of FOMC day bank tail risk shocks on bank risk-rating. The dependent variable is the risk rating of new loans made over 25 days after each FOMC meeting which takes on integer values from 1 to 4, with higher values indicating safer loans. Column 1 uses bank-by-year-quarter fixed effects (FE). Column 2 uses bank FE and FOMC announcement day FE. Column 3 controls for log loan amount. Column 4 uses bank FE and borrower firm-by-year-quarter FE. Column 5 uses controls for the borrower firm's tail risk shocks on FOMC days. Column 6 uses indicators for quartiles of bank tail risk shocks. Column 7 uses an ordered logit model with the same independent variables as Column 6. Columns 3, 5, 6, and 7 use bank FE and year-quarter FE. Standard errors are clustered at the bank-level. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table 6

The impact of tail risk shocks on other dimensions of risk

	(1)	(2)	(3)
	Loan maturity, log	Int. rate spread	Collateral
Risky	0.0162	0.00633***	0.0641**
	(0.0160)	(0.000994)	(0.0290)
4th quartile tail risk	0.00815*	0.000888*	0.0121
	(0.00438)	(0.000443)	(0.0103)
4th quartile tail risk*Risky	-0.0220**	0.000328	-0.0164**
	(0.00834)	(0.000724)	(0.00731)
3rd quartile tail risk	0.00214	0.000221	0.00115
	(0.00655)	(0.000760)	(0.0113)
3rd quartile tail risk*Risky	-0.00234	0.000844	0.00974
	(0.00925)	(0.00122)	(0.00900)
2nd quartile tail risk	0.00795	0.00118	-0.0104
	(0.00537)	(0.000853)	(0.00757)
2nd quartile tail risk*Risky	-0.0117	-0.000487	0.0268
	(0.00832)	(0.00137)	(0.0163)
R^2	0.080	0.134	0.604
Obs	159,310	96,048	159,487

Notes. This table examines the impact of FOMC day bank tail risk shocks on other dimensions of the loan contract. The dependent variable in Column 1 is the maturity of the loan – the log number of years. Column 2 uses the spread between the interest rate on the loan and the 10-year Treasury rate observed at the close of business on the loan origination day. Column 3 uses an indicator variable that equals 1 if the loan is collateralized. We regress these characteristics on a dummy variable indicating whether the loan is rated 1 or 2—the riskiest categories—and interact it with dummy variables for the quartiles of the tail risk shock. All regressions are OLS and include bank and year-quarter fixed effects. Standard errors are clustered at the bank-level. Marginal effects are reported in Appendix Table A.3. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table 7

The role of executive compensation and lending market competition on bank risk-taking

	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	OLS
Bottom quartile tail risk	-0.0878***	-0.0229	-0.108	-0.158*	0.0351
	(0.0264)	(0.0538)	(0.0734)	(0.0773)	(0.311)
Bottom quartile*options/bonus and salary	0.00725**	0.00495**	0.00690**		-0.0256
	(0.00347)	(0.00231)	(0.00297)		(0.0422)
Bottom quartile*option duration		-0.0216			
		(0.0166)			
Bottom quartile*compensation duration			0.00997		
			(0.0264)		
C&I HHI				-0.783	1.976
				(0.681)	(2.783)
Bottom quartile*HHI				0.690	-0.660
				(0.435)	(1.937)
HHI*options/bonus and salary					-0.357
					(0.314)
Bottom quartile*HHI*options/bonus and salary					0.177
					(0.256)
R^2	0.061	0.057	0.061	0.062	0.063
Obs	157,830	189,942	157,830	150,444	148,985

Notes. This table examines the role of executive compensation and lending market competition in mediating the impact of bank tail risk shocks on FOMC days on risk-taking. The dependent variable is the risk rating of new loans made over 25 days after each FOMC meeting, which takes on integer values from 1 to 4, with higher values indicating safer loans. For independent variables, we use a dummy for the bottom quartile of tail risk shocks γ_{it} (largest reductions in tail risk). The independent variables include interactions with the ratio of granted option fair values to the sum of bonus and salaries, the duration of option grants, and the duration of the entire executive compensation including salaries, bonuses, restricted stocks, and options. See Appendix D for the details of compensation data. We also construct the Herfindahl-Hirschman index (HHI) at the bank-level where higher values indicate less competitive markets. See Section 3.2 for details. All regressions are OLS and include bank and year-quarter fixed effects. Standard errors are clustered at the bank-level. Marginal effects are reported in appendix table A.4. Data sources: OptionMetrics and Federal Reserve Y-14Q, Schedule H.1.

Appendix

A Options Data Filters

We apply the data filters on both FOMC days and the last pre-FOMC days used to compute option returns. Our sample is restricted to put options that have a delta between -0.5 and 0 on the FOMC day. In particular, we drop options that have zero open interest, zero trading volume, missing delta or implied volatility in OptionMetrics, best offer smaller than best bid, a mid quote that violates no-arbitrage bounds, mid quote below \$0.10, and bid-ask spread larger than half of the mid quote. We then restrict the sample to date x bank x time-to-maturity combinations that have at least two options. Among remaining maturities, we pick the one closest to 30 days conditional on being between 6 and 60 days. We then compute option returns on FOMC days if the option is still in our dataset on the FOMC day and the previous day after applying filters. We winsorize option returns at the 1^{st} and 99^{th} percentiles in the pooled panel data and then run the regression in equation 3 for each bank-FOMC day. As a result, the mean time to maturity of options within bank-FOMC day option observations is 30.16 days and the median is 30 days. The average delta of the most OTM put is -0.14 (median is -0.13) and that of the closest-to-ATM option is 0.41 (median is 0.43).

B Option Returns and Tail Risk on FOMC Days

Empirically, the availability of liquid deep OTM equity options data is limited, and the available moneyness range varies across stocks and time. Therefore, we argue that the slope of a wide range of OTM option returns with respect to an option's delta is informative about the impact of monetary policy on tail risk. To see this, consider a put option with strike k_j that is not necessarily below x_{i2}. Suppose that the monetary policy shock does not affect the probabilities of e_i outcomes below k_j, except x_{i1}. The option price right before the announcement can be written as

$$p_{ij} = \sum_{x_{iq} < k_j} \lambda_{iq}(k_j - x_{iq}), \tag{A.1}$$

and the option price upon the announcement is

$$p'_{ij} = \lambda'_{i1}(k_j - x_{1i}) + \sum_{x_{i1} < x_{iq} < k_j} \lambda_{iq}(k_j - x_{iq}). \tag{A.2}$$

The option return is then given by

$$R'_{ij} = \frac{p'_{ij}}{p_{ij}} = 1 + \frac{\beta_i m}{\lambda_{i1} + \sum_{x_{1i} < x_{iq} < k_j} \lambda_{iq} \frac{k_j - x_{iq}}{k_j - x_{i1}}}. \tag{A.3}$$

The denominator of the option return is increasing in the probability of a positive option payoff given by $\text{Prob}(e_i < k_j) = \sum_{x_{iq} < k_j} \lambda_{iq}$, i.e., the negative of a put option's delta. Deeper OTM option returns with lower k_j have higher sensitivity to the monetary policy impact $\beta_i m$ because most of their value comes from the probability of the lowest equity value. Therefore, for the same bank on the same announcement day, we use the coefficient of daily option return on option delta (γ_{it}) as our proxy for $\beta_i m$. This approach allows us to accommodate the heterogeneity in the range of available option moneyness across banks and over time. Thus, by using γ_{it}, we can compare banks' tail risk at any given point in time, despite variations in option availability.

C Drivers of Bank Equity Tail Risk

Table A.2 corroborates further the research design and uses the cross-sectional heterogeneity among banks to understand the bank-level factors that mediate the impact of monetary policy on bank equity tail risk. In the language of our conceptual framework in Section 1.1.1, we investigate the bank-level determinants of β_i, which governs the total change in tail risk, $\beta_i m$, where m denotes the monetary policy shock. In the interest of concision, we use the Bauer and Swanson (2023b) monetary policy shocks in these tests.

When considering the potential drivers of bank tail risk exposure to monetary policy shocks, we build on the literature focused on the interest rate sensitivity of bank equity (English et al., 2018; Gomez et al., 2021). Leverage, for example, mechanically affects the riskiness of equity, and after a positive monetary policy shock, equity tail risk may increase among banks closer to regulatory insolvency. The literature on the interest rate sensitivity to bank equity also notes that the impact of the monetary policy on bank equity depends on the maturity structure of the bank's assets. If assets are priced using flexible contracts, while deposits are sticky and reprice slowly, then rising interest rates can generate additional income from assets without inducing a concomitant increase in interest expenses, thereby improving a bank's net interest margin. For example, a bank with a large amount of assets that reprice in one year relative to liabilities that reprice over the same horizon might see its income increase if monetary policy steepens the yield curve. Bank size – the log of assets – is also a well-known factor that can proxy the impact of monetary policy on a bank's liquidity position (Kashyap and Stein, 2000).

The dependent variable in Column 1 of Table A.2 is the FOMC announcement day measure of the tail risk shock, γ_{it}. The specification interacts the monetary policy shock at each meeting with lagged bank balance sheet variables from the prior quarter. All regressions include bank fixed effects and year-by-quarter fixed effects. Column 1 indicates that the maturity gap significantly mediates the impact of monetary policy shocks on bank tail risk. For a bank at the 25th percentile of the maturity gap—measured as the difference between assets and deposits that reprice within one year—a one percentage point increase in interest rates leads to an estimated 1.1 percentage point increase in tail risk (p-value = 0.09). In contrast, for a bank at the 75th percentile, which is more likely to benefit from rising rates through improved net interest margins, the effect is approximately 0.3 percentage points smaller. This difference is statistically significant at the 1 percent level.

Column 1 also provides suggestive evidence that tail risk increases more among highly leveraged banks. For a bank at the 25th percentile of the Tier 1 risk-weighted assets ratio, a one percentage point increase in interest rates is associated with a 1.1 percentage point rise in tail risk (p-value = 0.07). For a bank at the 75th percentile, the effect is roughly 50 percent smaller and not statistically significant (p-value = 0.40). The difference in effects across the leverage distribution is statistically significant at the 1 percent level. In contrast, the mediating effects of bank size are not statistically significant.

Column 2 considers a number of closely related balance sheet factors that might also mediate the impact of monetary policy. Arguments focusing on liquidity suggest that higher interest rates can prompt depositors and creditors to move their money to higher-yielding assets, forcing the bank to liquidate assets to finance these outflows. If such liquidations result in fire sales, the shock can increase tail risk. Column 2 therefore allows the impact of the monetary policy shock to depend on both the deposits-to-assets ratio and the bank's reserves-to-assets ratio. It also controls for the share of securities with maturities longer than five years, return on assets, and the share of available-for-sale and hold-to-maturity assets (Orame et al., 2025). Most of these additional controls are statistically insignificant, including the Tier 1 equity to risk-weighted assets ratio. The only significant control is the share of hold-to-maturity assets, which are relatively illiquid because liquidating them requires marking them to market—an accounting treatment that can impair the balance sheet when interest rates rise. As a result, a higher share of hold-to-maturity assets predicts a greater increase in tail risk in response to an unexpected rise in interest rates. All in all, the maturity gap continues to significantly mediate the impact of monetary policy on tail risk, even after including this broad set of controls.

Column 3 shows that the balance sheet factors mediating the impact of monetary policy on tail risk differ from those that influence shocks to the middle of the equity return distribution—i.e., diffusive risk. The dependent variable is the return on "at-the-money" (ATM) put options on the FOMC announcement day. Higher returns on ATM options reflect increased probabilities of all equity price declines, including small declines that do not qualify as tail risk. In this case, the maturity gap is not statistically significant. Instead, classic solvency and liquidity channels appear to be more relevant: banks with higher Tier 1 equity ratios and greater reliance on retail deposits experience smaller increases in ATM put option prices following a positive monetary policy shock.

D Compensation Data

We construct three variables based on executive compensation, following the approaches of Falato and Scharfstein (2025), Gopalan et al. (2014), and Li and Peng (2021). First, we calculate the ratio of the stock option grants' fair value to total payroll (salary plus bonus). Second, we measure the duration of stock options. Third, we compute compensation duration, as described below.

For the construction of compensation variables, we use data from ISS Incentive Lab. The dataset provides detailed information on grants for top executives, covering both equity-based and non-equity-based awards. It includes data on the grant date, award type, plan size, vesting schedule, fair value, and vesting period. We measure compensation duration as the weighted average of vesting periods of the different components of executive pay. We follow Gopalan et al. (2014) and estimate compensation duration based on three components: salary, bonus, and equity-pay, which includes restricted stock units (rsu) and stock options. We measure the compensation duration as

$$\text{Duration} = \frac{(\text{Salary} + \text{Bonus}) \times 0 + \sum_{i=1}^{n_s} \text{rsu}_i \times t_i + \sum_{j=1}^{n_o} \text{Option}_j \times t_j}{\text{Salary} + \text{Bonus} + \sum_{i=1}^{n_s} \text{rsu}_i + \sum_{j=1}^{n_o} \text{Option}_j}, \tag{A.4}$$

where salary and bonus are annual salary dollar values, reported in the summary compensation table. We consider both to have zero duration at the grant date. A top executive might receive several grants within a year. Hence n_s denotes the number of restricted stock units and n_o the option-based plans which are granted in the fiscal year. For restricted stock and stock options, we consider the fair value that is reported in the Grants of plan-based awards table. For cliff vesting, where the entire award vests at once after a fixed period, we define t_j and t_i as the high date, which represents the full duration until vesting. For ratable vesting, where the award vests gradually over time (e.g., evenly over several years), we approximate t_j and t_i as the average vesting time, calculated as (low date + high date)/2.

Appendix Tables

Table A.1

The main result with alternative tail risk shock measures

	(1) OLS	(2) OLS	(3) OLS
Tail risk (baseline)	0.063***		
	(0.016)		
Tail risk (Alternative 1)		0.054***	
		(0.016)	
Tail risk (Alternative 2)			0.070***
			(0.014)
R^2	0.061	0.061	0.059
N	159,443	159,443	138,315

Notes. Column 1 repeats the analysis in Column 1 of Table 4. Column 2 uses an alternative tail risk shock construction with $\gamma_{it} = \frac{or_{it}^{otm} - or_{it}^{atm}}{\Delta^{otm} - \Delta^{atm}}$ where or and Δ respectively are the FOMC day return and delta of the most OTM and closest-to-ATM option in our sample at the bank-FOMC day level. Column 3 follows our baseline procedure in constructing the tail risk shock γ_{it} but uses only options with a delta smaller than -0.1 following Kelly et al. (2016b). All OLS specifications include bank and year-quarter fixed effects, and standard errors are clustered at the bank-level. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table A.2

Drivers of bank tail risk shocks on FOMC days

	(1) Slope	(2) Slope	(3) ATM
Shock*tier1ratio	−0.00137	−0.00149	−0.00365***
	(0.00168)	(0.00144)	(0.00114)
Shock*assets, ln	0.00103	0.00150	−0.00626
	(0.00527)	(0.00672)	(0.00890)
Shock*maturity gap/assets	−0.10658***	−0.11636***	−0.03505
	(0.03609)	(0.03438)	(0.02887)
Shock*5 year+ securities/assets		0.04704	0.03574
		(0.15213)	(0.06850)
Shock*ROA		1.02002	0.07910
		(1.23015)	(1.25616)
Shock*HTM/assets		0.00095*	0.00108*
		(0.00054)	(0.00061)
Shock*AFS/assets		−0.00078	−0.00011
		(0.00050)	(0.00031)
Shock*reserves/assets		−0.00007	0.00015
		(0.00018)	(0.00013)
Shock*core deposits/assets		0.01667	−0.12684**
		(0.03304)	(0.05992)
R^2	0.155	0.161	0.380
Obs	1,519	1,519	1,519

Notes. This table examines the drivers of banks' tail risk exposure to monetary policy shocks. The dependent variable is the baseline bank tail risk shock γ_{it} in Columns 1 and 2, and the FOMC day ATM bank equity option return in Column 3. The independent variables are monetary policy shocks (Shock) from Bauer and Swanson (2023b) interacted with lagged bank characteristics: Tier 1 capital ratio, log assets, the maturity gap relative to assets, the share of securities with longer than 5-year maturity, return on assets (ROA), share of assets classified as hold-to-maturity (HTM), share of assets classified as available-for-sale (AFS), ratio of reserves to assets, and the ratio of core deposits to assets. All OLS specifications include bank and year-quarter fixed effects, and standard errors are clustered at the bank-level. Data source: OptionMetrics, FR Y-9C, FR Y-14Q, Schedule H.1.

Table A.3

Marginal effects of tail risk shocks on other dimensions of risk

	(1) Loan maturity,log	(2) Int. rate spread	(3) Collateral
Q4 Non-Risky	0.0081	0.0009	0.0121
P-value	(0.0044)	(0.0004)	(0.0103)
Q4 Risky	-0.0139	0.0012	-0.0043
P-value	(0.0062)	(0.0007)	(0.0130)
Q3 Non-Risky	0.0021	0.0002	0.0011
P-value	(0.0066)	(0.0008)	(0.0113)
Q3 Risky	-0.0002	0.0011	0.0109
P-value	(0.0060)	(0.0009)	(0.0170)
Q2 Non-Risky	0.0080	0.0012	-0.0104
P-value	(0.0054)	(0.0009)	(0.0076)
Q2 Risky	-0.0038	0.0007	0.0163
P-value	(0.0053)	(0.0012)	(0.0177)
Obs	159,310	96,048	159,487

Notes. This table uses the coefficients from Table 6 to tabulate the marginal effect of various tail risk realizations across the credit risk distribution on other dimensions of loan outcomes. For example, "Q4-non risky" is the marginal impact of a Q4 realization on the loan outcome for a loan with a rating above 2—a safer loan. We also report the associated p-values for these marginal effects. All regressions are OLS and include bank and year-quarter fixed effects. Standard errors are clustered at the bank-level. Data sources: OptionMetrics and Federal Reserve Y-14Q.

Table A.4

Marginal effects of compensation & competition on bank risk-taking

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
25th pctile compensation	-0.063***	0.005	-0.084	-0.044***	
	(0.016)	(0.041)	(0.068)	(0.013)	
75th pctile compensation	-0.016	0.026	-0.040	-0.020	
	(0.014)	(0.032)	(0.061)	(0.016)	
25th pctile comp, 25th pctile HHI					-0.061***
					(0.017)
25th pctile comp, 75th pctile HHI					-0.063
					(0.048)
75th pctile comp, 25th pctile HHI					-0.039***
					(0.013)
75th pctile comp, 75th pctile HHI					-0.001
					(0.018)
Obs	157,830	189,942	157,830	150,444	148,985

Notes. This table uses the coefficients from Table 7 to tabulate the marginal effect of a bottom quartile tail risk across the ratio of options to salary and bonus compensation ratio (columns 1-4). Column 5 tabulates the marginal effect of a bottom quartile tail risk across both the bonus compensation ratio and the time-varying spatial HHI competition measure. For example, in column 1, we evaluate the marginal effect of bottom tail risk at the 25th and 75th percentile of the options to salary and bonus compensation ratio respectively. In column 5, "25th percentile options, 25th percentile HHI" denotes the marginal effect of bottom tail risk at those two points in the distribution. Data sources: OptionMetrics and Federal Reserve Y-14Q, Schedule H.1.