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Monetary Policy, Inflation, and Crises: Evidence from History and Administrative Data

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ABSTRACT

We show that a U-shaped monetary rate path increases banking crisis risk, via credit and asset price cycles, analyzing 17 countries over 150 years. Rate hikes (raw or instrumented) increase crisis risk, but only if preceded by prolonged cuts. These patterns are unique to banking crises, unlike noncrisis recessions. Regarding the mechanism, prolonged cuts raise the likelihood of large credit and asset price booms,

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consistent with higher credit supply and risk-taking. Subsequent hikes strongly reduce credit and asset prices, and increase banks' realized credit risk, rather than interest rate risk. We find consistent results in administrative loan-level data for Spain.

CENTRAL BANKS IN EUROPE AND the United States started raising monetary policy rates in 2022 to fulfill their price stability mandates. However, such actions involve trade-offs, not only between inflation control and recession risk (Blinder (2023)), but also between tighter monetary policy and financial stability (e.g., the risk of a banking crisis). Financial stability concerns in particular may be heightened after a long period of monetary easing, as discussed in recent policy debates (e.g., Rajan (2023)), and illustrated by the banking failures and broader financial distress in March 2023.[1]

While the trade-offs between monetary policy actions, inflation, and output growth have been well-studied, much less is known about how monetary policy affects financial stability, a first-order concern nowadays. Existing studies provide mostly indirect evidence and lack a clear consensus. On the one hand, several studies link lower monetary rates to higher lending, asset prices, and bank risk-taking (e.g., Kashyap and Stein, 2000; Borio and Lowe, 2002; Bernanke and Kuttner, 2005; Adrian and Shin, 2010; Jiménez et al., 2014; Becker and Ivashina, 2015; Hanson and Stein, 2015; Di Maggio and Kacperczyk, 2017)—factors that are linked to future financial crises (e.g., Greenwood et al., 2022). On the other hand, other research suggests that monetary rate hikes (as opposed to cuts) may increase crisis risk (Schularick, ter Steege, and Ward, 2021, see also Galí, 2014).

This lack of consensus may reflect the fact that the entire monetary rate path—not just recent rate changes—is what matters for crisis risk. Recent theoretical work suggests that periods of expansive monetary policy can create financial vulnerabilities (e.g., elevated credit and asset prices) that subsequent tightening may crystallize into a crisis (Diamond and Rajan, 2012; Acharya and Rajan, 2022; Boissay et al., 2023; Goldberg and López-Salido, 2023; Kashyap and Stein, 2023). However, to date, there is no empirical evidence on the importance of the monetary rate path for crises.

In this paper, we empirically study how monetary rate dynamics affect financial stability. In particular, we examine how the monetary rate path affects the likelihood of a subsequent banking crisis, as well as the associated mechanisms. Experience of past crises suggests that the full path of monetary rates may be important. Figure 1 shows the level of the monetary rate around important crises of the 1930s U.S. Great Depression, the 2007 U.S. Subprime Crisis, the 1990s Japanese crisis, the 2008 Spanish banking and real estate crisis, and the 1990s Swedish banking crisis, as well as the 1890 U.K. Baring crisis. In all of these episodes, monetary rates display a clear U-shaped pre-crisis path, consisting of sharp rate cuts approximately eight to three years before

[1] See *The Economist* (2022), *IMF* (2023), *Financial Times* (2023), *Wall Street Journal* (2023), and Speech by ECB Executive Board Member Isabel Schnabel (2023).

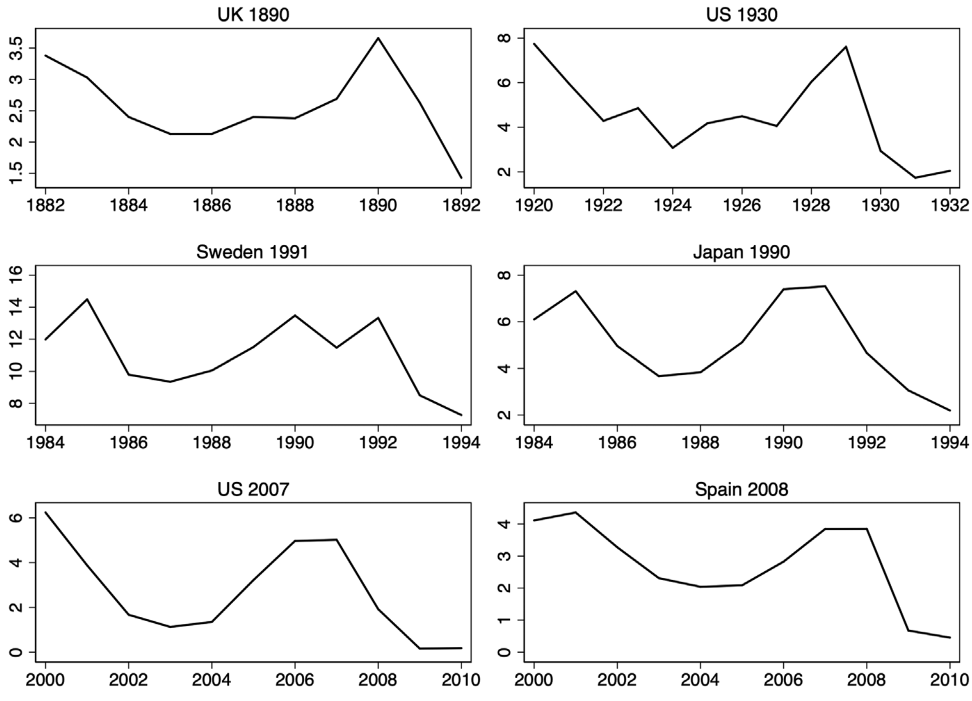


Figure 1. Monetary policy rates around select crisis events. This figure shows the level of the short-term nominal monetary policy rate for the indicated country around the year of the crisis. The crisis dates used here follow Baron, Verner, and Xiong (2021), while later we employ the Jordà, Schularick, and Taylor (2016a) chronology, which dates the U.S. banking crisis in the Great Depression to 1931 and the Japanese crisis to 1997.

the crisis that are followed by rate increases in the years running up to the onset of the crisis.

Using long-run data for 17 countries going back to 1870 (from Jordà, Schularick, and Taylor, 2016a), we begin by studying the path of monetary rates *before* historical banking crises. The U-shaped pattern seen in the six cases depicted in Figure 1 extends to the average crisis in the sample. On average, monetary rates are cut eight to three years before the crisis starts, and then raised during the three years leading up to the crisis. This pattern holds under different crisis definitions (baseline from Jordà, Schularick, and Taylor (2016a); robustness from Baron, Verner, and Xiong (2021)), and is even more pronounced for deep crises (those with the lowest GDP growth) and in the post-World War II period. When we categorize the eight-year interest rate paths into four types—U shape (cuts over five years followed by raises over three years), double cut, double raise, and raise-then-cut—we find that most historical crises, and all deep crises after World War II (WWII), were preceded by a U-shaped monetary rate path.[2] Importantly, these patterns differ for

[2] Note that unconditional frequencies of the four monetary rate paths are roughly equal across our sample, but the frequencies conditional on a crisis differ strongly.

recessions not accompanied by banking crises, even severe ones, where only the recent rate increases tend to matter. We also find that the inflation dynamics are not robustly related to banking crises.

We next assess whether rate hikes after previous long rate cuts increase *subsequent* crisis risk. We first show that the three-year crisis frequency after the U-shaped monetary rate path is 18%, which is roughly double the unconditional crisis frequency and much higher than the frequency for the other monetary rate paths. As before, these differences become more pronounced for deep crises and after WWII. Using regression analysis, we confirm that the U-shaped monetary rate path materially increases banking crisis risk, while other monetary rate paths do not.

To mitigate potential endogeneity concerns, we use an instrument exploiting the famous trilemma of international finance (Mundell, 1963). This instrumental variable (IV) approach uses variation in monetary policy changes in base countries and how they transmit through differences in exchange rate pegs and capital account openness, following Jordà, Schularick, and Taylor (2020).[3] The IV results confirm that higher monetary rates increase crisis risk if rates were previously cut over a long period. Specifically, a one percentage point (ppt) rate increase over three years, after rates had been cut over the previous five years, increases the three-year crisis probability by 12 ppts, more than doubling the unconditional crisis risk. Interestingly, the results differ for nonfinancial (even deep) recessions, with only the recent monetary rate increases—regardless of previous cuts—increasing recession risk.

We further show that these effects are stronger for monetary rate paths with a deeper U shape. Here, we separate monetary policy rate changes into (i) a proxy for the systematic component predicted by the main business-cycle variables (GDP growth, inflation, and other macro variables, including lags), and (ii) residual changes that go beyond the systematic component. We find that residual cuts and raises substantially increase crisis risk in the data. Systematic cuts followed by systematic raises are also linked to crises, but the effects are smaller and less robust.

In the second part of the paper, we explore the mechanisms behind our main finding, that is, we examine why the U-shaped monetary rate path increases banking crisis risk (while this is not the case for noncrisis recessions, even the deepest ones). Recent crisis narratives (e.g., Taylor, 2013) and theoretical work suggest that long periods of monetary loosening can create financial vulnerabilities, and subsequent rate hikes—when these vulnerabilities are elevated—can trigger crises (Boissay et al., 2023). To test this hypothesis, we examine how monetary rate paths relate to a measure of financial vulnerabilities from Greenwood et al. (2022), defined as the "red zone" of simultaneously high credit and asset price growth. We show that the red zone is the main underlying mechanism for our results.

[3] See also Maddaloni and Peydro (2011), and Jiménez et al. (2012, 2014) for similar applications. In both the OLS and IV specifications, we control for country-level and global GDP growth and inflation, and residualize the IV using macroeconomic data for the base country, so monetary policy rate effects are over and above main business-cycle variables.

We first show that monetary rate cuts over a long period (raw, instrumented, or above and beyond the systematic component) strongly increase the likelihood of a financial red zone. This credit expansion is consistent with a credit supply mechanism. The boom in credit volumes is accompanied by low credit spreads, and credit booms with ex ante low (vs. high) credit spreads are followed by ex post worse bank outcomes—lower bank stock prices, lower profits, and higher loan losses—consistent with high bank risk-taking and credit mispricing during the boom. Bank equity prices and book capital also rise sharply during the boom that defines the red zone—both in real terms and relative to nonfinancial firms—facilitating the credit supply boom. Measures of bank equity sentiment rise as well (over and above firms' equity). Consistent with this pattern, red zones are followed by predictably low bank stock returns, suggesting that bank stock prices are too high during the boom.

We next show that raising monetary rates while in the red zone sharply increases the risk of a banking crisis. Importantly, it is the combination of these two forces—monetary rate paths and red zones—that is key. Red zones are only materially associated with future crises if monetary rates were cut over a long period before entering the red zone, and once in the red zone, crisis risk increases substantially only if monetary rates are raised. Summarizing these patterns, we show that when both a U-shaped monetary rate path and a red zone occur, the three-year crisis probability is 36%. In contrast, when just the red zone or just a U-shaped monetary rate path occurs, the crisis probability is about 10%, close to the unconditional mean of three-year crisis likelihood. As before, these differences are starker for deep crises, deeper U shapes (relative to the systematic component), and in the post-WWII period.

To understand why the combination of U-shaped monetary rates and red zones is key for crisis risk (in addition to the above results on credit supply and bank risk-taking), we study the links between monetary rate hikes, financial vulnerabilities, and bank performance. We first find that while rate hikes generally reduce credit and asset prices, the drop is much larger when credit and asset prices are already elevated. That is, monetary rate hikes trigger a much larger decline in, for example, house prices when house prices previously expanded rapidly (above the red-zone threshold). We also find that raising rates after previous cuts puts significant stress on banks, in the form of higher loan losses, lower profits, lower bank stock returns, and a higher risk of a bank equity price crash. These results are consistent with a credit risk mechanism, but they offer little support for an interest rate risk mechanism (based on different measures of bank profits and stock returns). Overall, the results suggest that rate hikes unwind financial vulnerabilities that had built up during the long period of monetary rate cuts, with a crucial role for realized credit risks in the banking sector.

To validate our findings using more granular data, and to analyze differences across loans, borrowers, and banks, allowing a stronger identification of some mechanisms, we conduct an in-depth case study of the 2008 crisis in Spain. Spain's crisis is representative of many historical (especially post-WWII) crises, as it followed a major real estate–driven bank credit boom (see

Jordà, Schularick, and Taylor, 2016b; Müller and Verner, 2023). We use loan-level data on the universe of bank loans (and defaults) extended by Spanish banks from 1995 to 2008 Q3, via the supervisory credit register matched to firm and bank administrative data. Spain also provides relatively exogenous monetary policy conditions, as it has been part of a monetary union since 1989 (first the European Monetary Mechanism, then the euro), and euro-area monetary policy prior to the crisis was mainly shaped by core countries like Germany, whose macroeconomic dynamics differed sharply from those of Spain (see, e.g., Maddaloni and Peydro, 2011).

Using these data, we first show that long periods of monetary rate cuts are associated with higher credit growth, especially for loans granted by ex ante riskier banks (those with high ex ante nonperforming loan ratios) to ex ante riskier firms (those in the construction and real estate sector).[4] By controlling for borrowers' unobservables (e.g., time-varying firm-level credit demand) through firm-time and firm-bank fixed effects, the results point to a credit supply and bank risk-taking mechanism. Consistent with credit supply, we also find that firms (including ex ante riskier firms) associated with ex ante riskier banks not only receive more credit, but also have a lower cost of credit after prolonged rate cuts. Turning to the crystallization of credit vulnerabilities, we find that rate hikes significantly increase the likelihood of ex post loan defaults, especially after previous monetary cuts. Effects are again larger for loans from ex ante weaker banks to ex ante riskier firms.

Contribution to the Literature. Our paper makes two main contributions. First, we contribute to the literature on monetary policy and financial stability by documenting a novel empirical finding—a U-shaped monetary rate path significantly increases crisis risk—and by identifying the key mechanisms behind this result. These findings help reconcile some seemingly conflicting results in previous studies. In particular, while several studies show that monetary rate *cuts* increase credit and asset prices, two leading sources of financial instability (see, e.g., Bernanke and Kuttner, 2005; Maddaloni and Peydro, 2011; Brunnermeier and Sannikov, 2014; Gertler and Karadi, 2015; Hanson and Stein, 2015; Dell'Ariccia, Laeven, and Suarez, 2017; Adrian et al., 2020), Schularick, ter Steege, and Ward (2021) find that monetary rate *hikes* increase crisis risk. We show that it is the full *path of monetary rates* (the U shape) that matters for banking crises—neither rate cuts nor rate hikes alone are sufficient. With respect to the mechanisms, we show that prolonged rate cuts fuel credit and asset price booms, notably through credit supply (including risk-taking), while subsequent hikes trigger a materialization of the risks that built up during the

[4] In Spain, as in many countries, risky lending was mainly to real estate firms rather than households, as households receive full recourse loans (and hence have relatively low default rates). Müller and Verner (2023) show that real-estate-related corporate credit booms are important for real outcomes in a large historical panel of countries.

boom through strong reversals in credit and asset prices and banking sector stress, particularly credit risk and bank stock price crash risk.[5]

Our findings also relate closely to recent theoretical work on monetary policy and financial stability. While prior studies focus on the effects of low monetary rates on asset prices and credit (e.g., Stein, 2012), much less attention has been paid to how the full path of monetary policy affects crisis risk. As an exception, Boissay et al. (2023) outline a mechanism that is very much in line with our results: in their model, extended monetary easing leads to credit and investment booms (including high risk-taking), and subsequent monetary tightening triggers a crisis (a credit crunch driven by the fear of loan defaults). Related work by Acharya et al. (2022) and Goldberg and López-Salido (2023) also links cycles of monetary loosening and tightening to financial fragility.[6]

Second, we contribute to the empirical literature on the determinants of financial crises. Most studies on banking crises highlight credit booms as the main source of precrisis vulnerabilities (Schularick and Taylor, 2012; Jordà, Schularick, and Taylor, 2013), with asset price booms playing a strong amplifying role (Borio and Lowe, 2002; Jordà, Schularick, and Taylor, 2015; Baron, Verner, and Xiong, 2021; Jordà et al., 2021; Greenwood et al., 2022).[7] We show that credit and asset price booms (red zones) are *not* strongly associated with future banking crises unless monetary policy follows a U-shaped path. Moreover, we show that red zones without a U-shaped monetary rate path, and U-shaped monetary rates without a red zone, do not strongly increase crisis risk. Our results help explain why: monetary rate cuts over a long period (the first half of the U) not only increase the likelihood of credit and asset price booms (red zones) but also the risk of vulnerabilities (e.g., credit supply and risk-taking) that can crystallize into crises following subsequent rate hikes (especially through credit rather than interest rate risk). Overall, our findings suggest that U-shaped monetary rate paths give rise to fragile financial booms and drive the transition of these booms into crises—placing monetary policy dynamics at the heart of financial stability concerns.

[5] Our results also contribute to the literature on monetary policy, credit, and risk-taking. Previous studies show that lower monetary rates increase bank lending (e.g., Kashyap and Stein, 2000; Jiménez et al., 2012; Acharya et al., 2020), bank risk-taking (e.g., Adrian and Shin, 2010; Jiménez et al., 2014; Martinez-Miera and Repullo, 2017), and nonbank reach for yield (e.g., Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017). Krishnamurthy and Muir (2025) show that credit spread compression often precedes crises, signaling high risk appetite. We contribute to this literature by showing that the full path of monetary policy rates is key to the dynamics of credit booms and crisis risk, and that these mechanisms, seen in recent micro-level studies, also hold across history at the systemic level.

[6] Several studies highlight important state dependencies in monetary policy (e.g., Tenreyro and Thwaites, 2016; Jordà, Schularick, and Taylor, 2020; Berger et al., 2021; Eichenbaum, Rebelo, and Wong, 2022). While these studies mostly focus on how past policy affects the ability to stimulate the economy through rate cuts, our results suggest a similar state dependence for the impact of rate hikes on financial stability.

[7] Other studies have shown that crises are costly for GDP (Cerra and Saxena, 2008; Reinhart and Rogoff, 2009), and that big data can help predict such crises (Ward, 2017; Fouliard et al., 2020; Bluwstein et al., 2023).

Having established our two main contributions, we highlight the main differences with respect to the contemporaneous paper by Grimm et al. (2023), who find that when the real monetary rate is below an estimated natural rate over an extended period, crisis risk increases, with credit and asset prices key channels. First, we show that it is not only loose policy, but also the subsequent tightening that drives crises. Notably, U-shaped rate dynamics are crucial for banking crises but not for noncrisis (even deep) recessions, which suggests that financial mechanisms are at play. Second, while red zones unconditionally raise crisis risk, we find that red zones need to be accompanied by a U-shaped monetary rate path to materially matter. This result is important not only for the monetary policy literature, but also for the literature on the determinants of financial crises. Third, we provide a detailed analysis of the mechanisms behind these results: long rate cuts lead to red zones with elevated credit supply, bank risk-taking, and mispricing, while subsequent rate hikes trigger crises through sharp reversals in credit and asset prices, credit losses, and bank equity crashes.[8] Overall, the two papers are complementary in showing that monetary policy dynamics are central to financial stability.

The remainder of the paper is organized as follows. Using long-run data, Section I analyzes the relationship between the path of monetary policy rates and crisis risk, while Section II studies the underlying mechanisms. Section III exploits the Spanish administrative data to analyze monetary policy rate dynamics and loan-level outcomes. Section IV concludes with some policy implications.

I. The Path of Monetary Policy Rates and Crisis Risk

A. *The Path of Monetary Policy Rates around Crises*

The cases depicted in Figure 1 display a pronounced U shape in monetary policy rates prior to banking crises. Is this pattern specific to these particular cases, or more general? To answer this question, we examine how monetary policy rates evolve around an average historical crisis event.

We use data from the Jordà, Schularick, and Taylor (2016a) macrohistory database, which, in addition to hundreds of noncrisis recessions, covers 87 systemic banking crisis events in 17 advanced economies (Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States) between 1870 and 2020. In our baseline analysis, we rely on the (updated) narrative crisis definition of Schularick and Taylor (2012), who define systemic banking crises as "events during which a country's banking

[8] We use monetary policy rates—raw, instrumented, or above a proxy for the systematic component predicted by the main business-cycle variables—while Grimm et al. (2023) use real rates relative to an estimated natural rate, which is a key measure in theory but is difficult to measure in practice, especially in real time. In addition, different from Grimm et al. (2023), we also use administrative credit register data, alongside long-run data, to offer complementary evidence and stronger identification of credit-related mechanisms.

sector experiences bank runs, sharp increases in default rates accompanied by large losses of capital that result in public intervention, bankruptcy, or forced merger of financial institutions." We additionally show robustness to the crisis definition of Baron, Verner, and Xiong (2021), which is based on both narrative chronology and data on bank stock returns (with sharp declines in bank stock returns used as an additional crisis indicator).

The monetary rate is the short-term nominal interest rate set by the central bank as the main lending or penalty rate or, when these data are not available (e.g., when there was no central bank as in the United States before 1913), the rate for short-term interbank lending or the rate on short-term government securities (equivalent to today's Treasury bills). We note that while our sample encompasses several different monetary policy regimes, short-term rates have generally been directly set or indirectly influenced by policymakers through financial market activities to achieve their targets, and hence they provide a useful summary measure for the conduct of policy (Romer and Romer, 2004; Friedman and Kuttner, 2010).[9]

Crisis Window Averages: We start by plotting the average levels of monetary policy rates around past crises using simple event windows. To do so, we take the level of each of these variables at $t-7$ to $t+7$ around each crisis date t, and average these levels across the 77 crises in our sample.[10] Figure 2 presents the results. The solid black lines show the average level of the (short-term nominal) monetary rate for the window from seven years before to seven years after the onset of the average crisis. The dashed green lines show the sample mean short-term rate for noncrisis observations.

The left-hand panel of Figure 2 shows the monetary policy rate averages around banking crises dated using the Jordà, Schularick, and Taylor (2016a) chronology, which uses a narrative panic definition. The middle panel compares these results to (i) the alternative chronology of Baron, Verner, and Xiong (2021) (BVX crises) and (ii) a "deep crisis" definition that considers only those crises that are accompanied by the lowest GDP growth (-3% or less in one year, or -1% or less on average in the $t-1$ to $t+2$ window around the crisis start date). The right-hand panel shows the averages for each of these types of crises during the post-1945 period. The left panel shows that the average crisis is preceded by U-shaped monetary policy, with a series of cuts in monetary rates seven to four years before the crisis followed by increases during the three years in the run-up to the crisis. The middle and right panels show that the U shape also holds for the Baron, Verner, and Xiong (2021) crisis definition, and is more pronounced for deep crises, especially after WWII. Overall, the

[9] For example, Romer and Romer (2004) argue that "*Even in periods when the FOMC was not explicitly targeting the federal funds rate, it was concerned about this key interest rate and discussed the likely implications of policy actions for its behavior. Therefore, as a practical matter, the change in the intended funds rate is the easiest indicator of Federal Reserve intentions to deduce accurately over a long period of time and over a variety of monetary regimes*."

[10] We require at least 13 nonmissing monetary rate observations in the $t-7$ to $t+7$ window around a crisis, which leaves us with a total of 77 crisis observations.

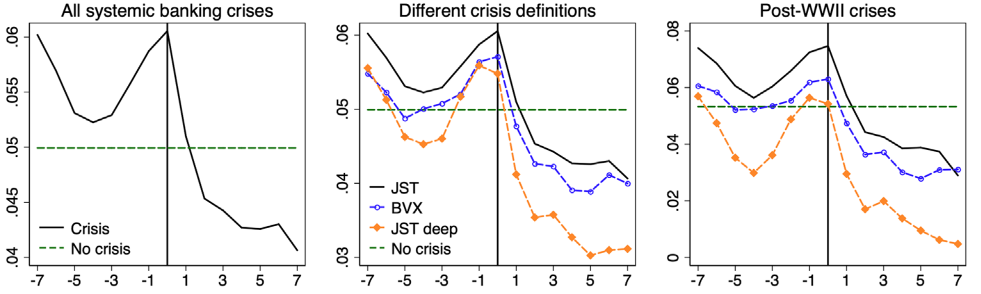


Figure 2. The average level of monetary policy rates around past crises. This figure plots unweighted averages of the level of the monetary rate in year t (start of the crisis at $t = 0$) for 77 crises (24 post-WWII). The left panel uses the narrative crisis definition of Jordà, Schularick, and Taylor (2016a). The middle panel additionally considers the Baron, Verner, and Xiong (2021) crisis chronology (BVX crises), and deep crises (JST deep crises), defined as Jordà, Schularick, and Taylor (2016a) banking crises with -3% or less real GDP growth in one year, or average -1% or less real GDP growth over the $t-1$ to $t+2$ crisis window. Green dashed lines show the sample mean of the respective variable for noncrisis observations. (Color figure can be viewed at wileyonlinelibrary.com)

swings in monetary rates are substantial, around 1 ppt down and up over the full sample, and as large as 3 ppts on average for deep crises after WWII.[11] For completeness, Figures IA.14 to IA.16 at the end of the Internet Appendix show the level of the monetary policy rate around each crisis in our sample.[12]

Crisis-Window Regressions: To test whether these precrisis patterns are statistically significant, we run the regression

$$y_{i,t+h} - y_{i,t} = \alpha_{i,h} + \alpha_{d,h} + \beta_h \mathbb{1}_{Crisis_{i,t}=1} + \epsilon_{i,t+h}. \tag{1}$$

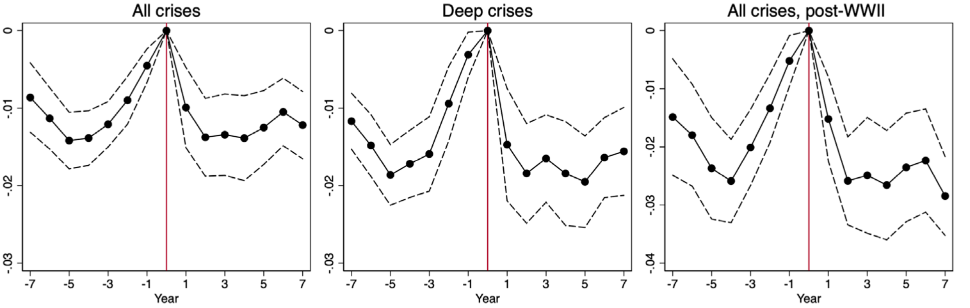
Above, y are monetary policy rates, $h = -7, \ldots, 0, \ldots, 7$ are horizons with $y_{i,t+h} - y_{i,t}$ corresponding to changes between year $t+h$ and year t (from seven years before to seven years after year t). $\mathbb{1}_{Crisis_{i,t}=1}$ is an indicator for the start of a systemic banking crisis in country i and year t, and α_i and α_d are country and decade fixed effects.

Figure 3 shows the estimated β_h coefficients for different horizons h alongside the 90% confidence intervals, for different crisis definitions and samples. Panel A shows the raw monetary policy rates (as in Figure 2), and Panel B shows monetary rates residualized to (above and beyond) the main business-cycle dynamics. To calculate the residualized rate, we regress the changes in monetary rates on contemporaneous and lagged GDP growth and inflation (country-level and global), contemporaneous investment, consumption, current account, lagged changes in long- and short-term rates, and decade fixed effects.

[11] As shown in Figure 2, in all crises, short-term rates decrease substantially after the start of a banking crisis. In this paper, we analyze the determinants of crises and connect them with rates *before* a crisis.

[12] The Internet Appendix may be found in the online version of this article.

Panel A**:** Raw monetary policy rates.



Panel B**:** Monetary policy rates residualized to macroeconomic variables.

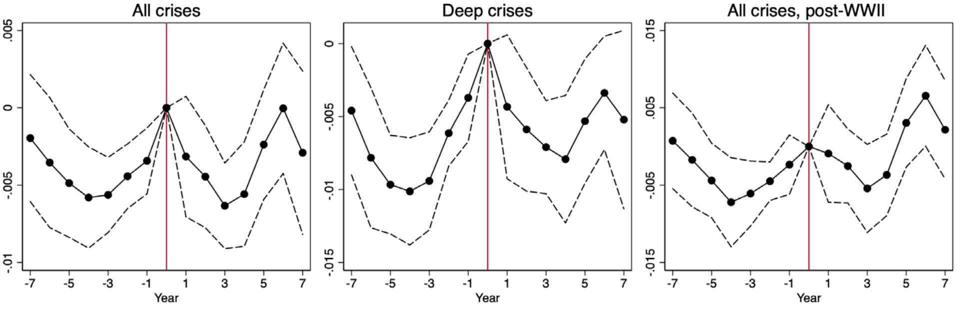


Figure 3. Monetary policy rates—Crisis window regressions. This figure shows regression coefficients and 90% confidence intervals from regressing changes in monetary policy rates between $t+h$ and t on the crisis dummy for horizons $h = -7, \ldots, 0, \ldots, 7$, with 0 corresponding to the beginning of a crisis according to the Jordà, Schularick, and Taylor (2016a) chronology. Deep crises are those with the lowest GDP growth. Panel A uses raw monetary policy rates as the dependent variable. Panel B uses monetary rates residualized to the systematic component of monetary policy proxied by macroeconomic dynamics (see text). (Color figure can be viewed at wileyonlinelibrary.com)

We allow the coefficients to vary by country, and for GDP growth and inflation, also by monetary regime (gold standard before 1914, augmented gold standard 1919 to 1938, Bretton-Woods 1946 to 1973, and floating post-1973).

Under all three crisis definitions, both raw and residualized monetary rates follow a pronounced U-shaped pattern before the crisis, similar to the patterns of the simple crisis-window averages in Figure 2. The crisis-window regressions additionally show that this U-shaped pattern is precisely estimated, with statistically significant and economically meaningful declines in monetary rates between years $t-7$ and $t-4$ before the crisis.[13] Monetary

[13] The (residualized) monetary rate decline in the first half of the U can occur for a variety of reasons. For example, monetary policy could be imported due to an exchange rate peg as, for example, in Spain before the 2008 crisis. Alternatively, the central bank could be keeping rates low to mitigate deflation concerns, as argued by Taylor (2007) for the case of the United States prior to the 2007 crisis (driven by concerns about repeating the Japanese experience in the 1990s in the aftermath of the 2000 stock market crash). Low rates in Japan in the late 1980s were in turn

rates then remain relatively low during years $t-4$ to $t-3$ before a crisis, before displaying sharp and statistically significant increases in the run-up to the crisis during years $t-3$ to t.

Internet Appendix Figure IA.2 shows the average paths of (CPI) inflation, real interest rates, and long-term rates around historical banking crisis episodes using the same methodology as equation (1). For these variables, there is less of a clear precrisis path. Real rates over the full sample and inflation post-WWII do show a precrisis U shape, but the paths are estimated with large standard errors and are not robust across subperiods (e.g., there is no clear U shape in the real rate after WWII, and no clear U shape in inflation over the full sample). Long-term safe interest rates, proxied by the 10-year government bond yield, show relatively little variation before crises, and as a result the term premium follows a "lambda" shape (Figure IA.3).[14]

Overall, the short-term nominal monetary policy rate displays a much more pronounced and robust precrisis path than real rates, inflation, or long-term rates. That being said, the U shape in monetary rates likely captures both the financial vulnerabilities that arise from a U shape in the real cost of borrowing and the financial vulnerabilities that arise from nominal inflation dynamics. But depending on the crisis (and time period), either one of these vulnerabilities might be more important, making the nominal monetary rate (the sum of real rates and inflation) a more informative summary statistic of interest-rate-related crisis vulnerabilities. Furthermore, both real rates and inflation are measured with substantial error in our historical sample (different from nominal monetary rates), since we do not have data on inflation expectations, which helps explain the wide standard errors around the precrisis path of these variables.

Recessions: Figure IA.1 shows the average level of the monetary policy rate around nonfinancial recessions, that is, business-cycle peaks that were not accompanied by a systemic banking crisis event (in a window of ± 2 years), using the same scale as for the crisis-window regressions in Figure 3, Panel A. We find little evidence of a U-shaped monetary rate path before a recession, although, consistent with existing literature (e.g., Romer and Romer, 2004), recessions are on average preceded by increases in interest rates, especially in the post-WWII period when monetary policy was used more actively to manage the economic cycle. Moreover, we find no U-shaped dynamics for deep noncrisis recessions, defined as business-cycle peaks associated with large GDP declines that are not accompanied by a systemic banking crisis event. The results suggest that the U-shaped path of monetary policy rates is unique to banking crises as opposed to nonfinancial business-cycle fluctuations, even deep noncrisis recessions.

motivated by intended adjustments of external imbalances (Okina, Shirakawa, and Shiratsuka, 2001; Itoh, Koike, and Shizume, 2015).

[14] For some of the earlier time periods, we use bonds of longer maturity than 10 years because of data availability. For the CPI and other variables used, see Jordà, Schularick, and Taylor (2016a) for underlying data sources and definitions.

Table I

Frequency of Monetary Rate Paths before Crises and Recessions

This table reports the frequency of monetary rate paths between years $t-8$ and t conditional on a crisis (Panel A) or a nonfinancial recession (Panel B) in year $t+1$ (columns (1) to (4)), and unconditionally (column (5)). Path frequencies are the ratio of the number of observations with a given path to total observations (conditionally or unconditionally). Nonfinancial recession is a business-cycle peak not accompanied by a crisis (following Jordà, Schularick, and Taylor, 2016a). Deep crises (recessions) are crises (recessions) with the lowest GDP growth. In rows, the four bins are defined by the sign of the change (cut or raise) in the monetary rate between $t-8$ and $t-3$, and the sign of the change between $t-3$ and t. For example, U shape (cut, raise) is given by a cumulative cut in rates between $t-8$ and $t-3$, followed by a cumulative raise between $t-3$ and t. *, **, and *** indicate significance of whether the path frequency conditional on a crisis or recession is higher than that conditional on no crisis or recession at the 0.1, 0.05, and 0.01 level, respectively (with standard errors double-clustered by country and year).

	(1) All	(2) Deep	(3) Post-WWII	(4) Post-WWII Deep	(5) Unconditional
			Panel A: Banking Crises		
U shape (cut, raise)	0.55***	0.68***	0.71***	1.00***	0.27
Raise, raise	0.19	0.14	0.12	0.00	0.24
Raise, cut	0.16	0.11	0.08	0.00	0.26
Cut, cut	0.10	0.08	0.08	0.00	0.23
			Panel B: Nonfinancial Recessions		
U shape (cut, raise)	0.34***	0.29	0.33*	0.27	0.27
Raise, raise	0.21	0.21	0.29	0.40	0.24
Raise, cut	0.24	0.24	0.24	0.20	0.26
Cut, cut	0.20	0.26	0.14	0.13	0.23

Frequencies of Monetary Rate Paths before Crises and Recessions: To summarize the results above, we study the relative frequencies of different rate paths in the eight-year window before a banking crisis or recession. To do so, we classify monetary policy dynamics over an eight-year window into four paths (shapes): a U shape (cut and raise), double raise, "lambda" shape (raise and cut), and double cut. For all these cases, we use the initial five years to define the first cut or raise, and the subsequent three years to define the precrisis or prerecession raise or cut (so, e.g., the U shape is defined as a cut in $t-8$ to $t-3$ followed by a raise between $t-3$ and t).

Table I shows the frequencies of each of these four paths over the eight years before a crisis (Panel A) or recession (Panel B) alongside the unconditional path frequency in column (5). Column (1) considers all banking crises (using the Jordà, Schularick, and Taylor, 2016a definition) in Panel A and all nonfinancial recessions in Panel B, column (2) considers deep (lowest GDP growth) crises and recessions, and column (3) ((4)) includes all (deep) crises and recessions in the post-WWII period, respectively. Panel A shows that the U-shaped monetary rate path is much more frequent before a crisis than other rate paths, especially for deep crises and after WWII: 55% of all crises, and 100% of deep crises after WWII were preceded by a U-shaped monetary rate path.

Table II

Frequencies of Crises after Different Monetary Rate Paths

This table reports the crisis frequency between year t and $t+2$ for different crisis definitions and monetary policy rate paths. The crisis frequency is the ratio of crisis to total observations for different rate paths. Deep crises are those with the lowest GDP growth. In rows, the four bins are defined by the sign of the change (cut or raise) in the monetary rate between $t-8$ and $t-3$, and the sign of the change between $t-3$ and t. The number of observations is roughly equal across the four policy shape categories (see Internet Appendix Table IA.I). *, **, and *** indicate significance of whether the crisis frequency conditional on a specific rate path is higher than the average of the other three paths at the 0.1, 0.05, and 0.01 level, respectively (with standard errors double-clustered by country and year).

	(1) Crisis	(2) Deep Crisis	(3) Post-WWII Crisis	(4) Post-WWII Deep Crisis
U shape (cut, raise)	0.18***	0.12***	0.16***	0.14***
Raise, raise	0.09	0.04	0.04	0.01
Raise, cut	0.06	0.02	0.02	0.00
Cut, cut	0.06	0.03	0.03	0.01
Unconditional	0.10	0.05	0.06	0.04

These frequencies are much higher than the unconditional U-shape frequency of 27%, and statistically higher than the frequencies conditional on no crisis.

For nonfinancial recessions shown in Table I, Panel B, the prevalence of the U shape is much lower: 34% of recessions in the full sample were preceded by U-shaped monetary rates, which is slightly above the unconditional frequency of 27%. After WWII, 40% of deep recessions were preceded by a double raise (second row), while only 27% were preceded by a U shape. Figure IA.4 plots the precrisis and prerecession frequencies together for each of the four monetary rate paths, and shows that the precrisis U-shape frequencies are not only significantly higher than those for other shapes or the unconditional mean, but also significantly higher than the prerecession U-shape frequencies.

B. The Path of Monetary Policy and Crisis Frequencies

Conditional on a crisis, we frequently observe a U-shaped rate path, but does this mean that conditional on a U-shaped rate path, crisis risk is also substantially higher? We address this question in two steps. First, we compare crisis frequencies after different monetary rate paths to analyze which type of rate path is associated with a higher risk of crises. Second, we use a regression framework to analyze the likelihood of crises based on the path of previous changes in monetary policy rates.

Table II shows the frequency of crises between years t and $t+2$ conditional on different monetary rate paths in years $t-8$ to t, classified as in Table I above.[15] As before, we consider all crises and deep crises, for the full sample

[15] Since the exact timing (year) of the onset of a crisis is difficult to predict, as our baseline definition we consider all crises in the three-year window from t to $t+2$ after the end of the monetary rate shape at t.

and after WWII. We calculate the crisis frequency as the ratio of crisis to total observations (with nonmissing data) in the three-year window after the specified monetary rate path. The number of crisis and total observations is shown in Internet Appendix Table IA.I. The total number of observations is similar across the four rate paths, so the differences in frequencies in Table II are driven by differences in the numbers of crises across rate paths.

A U-shaped path of monetary policy rates is associated with a substantially higher risk of systemic banking crises. If monetary rate hikes unambiguously increased crisis risk, we would expect the double raise in the second row of Table II to be associated with the highest crisis frequency, but this is not the case. In the data, crises are more than twice as likely after the U shape compared to a double raise (18% vs. 9% crisis frequency in column (1)), and roughly twice as likely compared to the unconditional crisis probability during these three years (10%).[16] Similarly, if long monetary rate cuts were the only thing that mattered for crises, we would observe similarly high crisis risk after a "Cut, cut" path, but this is not the case. The relative differences in crisis frequencies between the U shape and other paths become even larger for deep crises and after WWII (columns (3) and (4)). The crisis frequency after a U-shaped rate path is also significantly larger than the average of the other paths.

Table IA.II shows that these results continue to hold in a narrower one-year crisis window, and Table IA.III shows that they hold for a symmetric six-year policy shape window (e.g., a U shape is given by a cut from $t-6$ to $t-3$ followed by a raise from $t-3$ to t). Differently, Table IA.IV shows that rate increases (as opposed to a U shape) are crucial for noncrisis recessions. Nonfinancial recession frequencies are higher both after a U shape and a double raise, and the post-U-shape recession frequency is generally not statistically higher than that after a double raise. For example, the likelihood of a deep (normal) recession after WWII is 4% (28%) after a U-shaped monetary rate path, while it is 6% (26%) after a double raise.

C. U-Shaped Monetary Policy and Banking Crisis Risk

We next evaluate whether the U shape in monetary policy rates is associated with subsequent crises by regressing a crisis dummy on the change in the monetary policy rate, and allowing the effects of changes in rates on crisis risk to vary depending on the past monetary policy path. Specifically, we estimate linear probability models for a crisis occurring between t and $t+2$ as follows:

$$Crisis_{i,t \text{ to } t+2} = \alpha_i + \beta_1 \Delta_3 Rate_{i,t} + \beta_2 Cut_{i,t-8,t-3} + \beta_3 \Delta_3 Rate_{i,t} \times Cut_{i,t-8,t-3} + \gamma X_{i,t} + u_{i,t}, \quad (2)$$

[16] Given an annual crisis probability of around 3.2%, the probability of at least one crisis observation in a three-year window is 10%.

where i and t are country and year indices, $\Delta_3 Rate$ denotes three-year changes in monetary policy rates, Cut takes a value of one if rates were cut (cumulative change < 0) between years $t-8$ and $t-3$, and X is a vector of controls. We control for contemporaneous values and eight lags of local (country i) and global (yearly cross-country average) inflation and GDP growth, as well as eight lags of the crisis dummy in all of our regression specifications. Consistent with the analysis in previous sections, we use the $t-8$ to $t-3$ window to define a dummy for a cut in monetary policy rates, the $t-3$ to t window for the rate increase, and the t to $t+2$ window to define a dummy indicating the start of the systemic banking crisis.[17] A positive β_3 coefficient would indicate that monetary rate hikes have an especially strong effect on crisis risk if monetary rates were previously cut, in line with the previously documented U-shape effects.

We run the above regression for raw changes in rates $\Delta_3 Rate$, and for changes in rates instrumented using the trilemma of international finance following Jordà, Schularick, and Taylor (2020). This IV strategy helps alleviate concerns that the monetary rate changes might be a response to changes in banking crisis risk. The intuition behind the instrument is that countries in fixed-exchange-rate regimes with open capital accounts are forced to track monetary policy in the base country (Mundell, 1963). This means that base-country interest rate changes can be used as instruments for changes in interest rates in the peg country. To implement this methodology in the long-run data sample, we follow previous work (Jordà, Schularick, and Taylor, 2020; Schularick, ter Steege, and Ward, 2021) and instrument the change in interest rates in a country with a fixed-exchange-rate regime with the change in rates in the base country residualized conditional on economic conditions in the base country:

$$Trilemma\ IV_{i,t} = \Delta Rate^{Residual}_{b(i),t} * PEG_{i,t} * PEG_{i,t-1} * KOPEN_{i,t}, \tag{3}$$

where $\Delta Rate^{Residual}_{b}$ is the residual monetary policy rate change for the base country (e.g., Germany for countries in the European Exchange Rate Mechanism), calculated as the difference between the raw monetary rate change and the value predicted by lagged economic conditions in the base country (inflation, GDP, consumption, investment, short-term and long-term interest rates), PEG variables are dummies for fixed-exchange-rate regimes, and $KOPEN$ measures the degree of capital account openness.[18] To mirror the setup of equation (2), we instrument the three-year changes in rates and their interaction with the cut dummy with, respectively, the three-year change in the residualized trilemma instrument and its interaction with the cut dummy. In all

[17] Note that here we allow for a contemporaneous relationship between increases in interest rates and banking crises as indicated by our case studies. In robustness exercises in the Internet Appendix, we confirm that these relationships continue to hold when we estimate pure forecasting regressions, replacing $Crisis_{i,t\ to\ t+2}$ with $Crisis_{i,t+1}$.

[18] The variable $KOPEN$ takes values between zero and one based on the rescaled Quinn, Schindler, and Toyoda (2011) indicator.

Table III

The Path of Monetary Policy Rates and Banking Crisis Risk

This table shows linear probability models for a systemic banking crisis occurring between years t and $t+2$. All specifications control for contemporaneous values and eight lags of country and global GDP growth and inflation, as well as eight lags of the crisis dummy. $\Delta_3 Rate$ is the three-year change in the monetary policy rate. *Cut* is a dummy which equals one if monetary rates were cut between $t-8$ and $t-3$. IV specifications instrument $\Delta_3 Rate$ with the residualized trilemma variable (see text). IV interaction specifications include the residualized trilemma variable and its interaction with the cut dummy as instruments. In this case, the Kleibergen-Paap Weak ID is the joint test for both instruments. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Dependent Variable: $\text{Crisis}_{t\ to\ t+2}$							
	Full Sample				Post-WWII			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_3 Rate_t$	0.02**	0.01	0.03	0.01	0.01	0.01	0.03	0.01
	(0.01)	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)
$Cut\ Rate_{t-8,t-3}$		0.05		0.04		0.04		0.01
		(0.03)		(0.03)		(0.03)		(0.03)
$\Delta_3 Rate_t \times Cut\ Rate_{t-8,t-3}$		0.03**		0.07**		0.02**		0.08***
		(0.01)		(0.03)		(0.01)		(0.03)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID			46.69	27.48			55.68	25.91
Observations	1,627	1,627	1,627	1,627	951	951	951	951

specifications, we compute Driscoll and Kraay (1998) standard errors with five lags to capture the fact that shocks to monetary rates may be correlated across countries and time.

The results of these regressions are reported in Table III. Column (1) shows that on their own, increases in monetary policy rates are associated with elevated crisis risk over the following years, consistent with Schularick, ter Steege, and Ward (2021). Column (2) adds the cut dummy and the interaction of cuts in $t-8$ to $t-3$ with subsequent rate changes, which captures U-shaped monetary rate effects. Monetary rate cuts over a long period (*Cut Rate* dummy) on their own are only weakly associated with a higher risk of crises. What really matters is whether these monetary rate cuts are followed by monetary raises, as indicated by the economically large and statistically significant interaction coefficient $\Delta_3 Rate \times Cut$. A monetary rate cut over five years followed by a 1 ppt increase in rates over the next three years is associated with a 9 ppt higher probability of a crisis (the sum of the coefficients in the first three rows of column (2)).[19]

[19] Note that the standard deviation of three-year changes in monetary rates is around 2 ppt, and hence a monetary rate cut over five years followed by a one-standard-deviation increase in

In Table III, column (3), we instrument three-year changes in monetary rates ($\Delta_3 Rate$) with the residualized trilemma shocks coded according to equation (3). In column (4), we additionally include the cut dummy and the interaction of rate changes with previous cuts, instrumenting the rate change with the trilemma IV, and the interaction with the trilemma IV interacted with the cut dummy. The first-stage relationship between the trilemma instrument and monetary policy rates is strong, as indicated by a Kleibergen-Paap Weak ID statistic well above the critical threshold (the weak ID test in column (4) is the joint test for both IVs). The results confirm that the association between rate hikes and crises is driven by those rate hikes that happen after a long period of cuts as indicated by the large and highly significant interaction term. Compared to OLS, the IV coefficients are somewhat larger, consistent with (local) central banks not raising monetary rates as much when financial stability concerns become more important (which would reduce the size of the OLS but not the IV coefficient).

Looking at Table III, column (4), a 1 ppt monetary rate hike after cuts over a long period is associated with an additional 7 ppt higher probability of banking crises, whereas raising monetary rates without previous cuts is not strongly linked to crises. Columns (5) to (8) show that results are similar in the post-WWII sample. In both the IV specifications in columns (4) and (8), a monetary rate U shape of cutting rates over five years and then raising them by 1 ppt over the next three years is associated with about 10 to 12 ppt higher subsequent crisis risk (summing the coefficients in the first three rows, with these effects driven by the interaction of cuts and future raises). In Table IA.V, we show that these effects are much stronger (and significant) for *long* periods of monetary rate cuts (three years or more), consistent with the view that banking crises happen when monetary rates are hiked after a long period of monetary loosening (as in, e.g., Boissay et al., 2023).

Robustness: In the Internet Appendix, we show further robustness tests. In Table IA.VI, we show that the relationship in Table III holds for one-year-ahead crisis prediction, using two-way (country and year) clustered standard errors, and controlling for global credit growth. Table IA.VII shows that the results hold when including decade fixed effects as control variables, excluding the post-2000 period containing the Global Financial Crisis, and excluding observations without a central bank in place. Results also remain strong when we restrict attention to the post-Bretton-Woods subsample, which most closely reflects the current monetary regime (Table IA.VII, columns (3) and (4)).

Table IA.VIII shows that the results also hold for an alternative chronology of crisis dates based on Baron, Verner, and Xiong (2021). The patterns that we document are reflected in real GDP growth, which is significantly lower following a U-shaped monetary rate path as indicated by the interaction term

rates over the next three years is associated with a 13 ppt higher probability of a crisis (using Table III, column (2)). Also note that in both the OLS and the IV specifications in columns (2), (4), (6), and (8) of Table III, the sum of the coefficients on $\Delta_3 Rate$, *Cut Rate*, and the interaction term is significantly different from zero.

in Table IA.IX. Table IA.X additionally shows that the results hold if we use probit rather than linear probability models of crisis risk. Finally, Table IA.XI shows that the U-shaped monetary rate interaction is associated with higher (cumulative) crisis risk at horizons beyond three years. This result suggests that raising monetary rates after a long period of cuts increases overall crisis risk, as opposed to simply affecting the timing of the crisis (which was going to happen anyway).

We next explore whether crisis risk is also higher after a U shape in inflation or real rates. Table IA.XII shows the baseline OLS regression in equation (2), but with the change in inflation (columns (1) and (2)), real rates (columns (3) and (4)), and the level of the real rate relative to an estimated natural rate r^* (columns (5) and (6)) on the right-hand side in place of the (nominal) monetary rate.[20] A U shape in inflation or real rates (directly or relative to natural rates) is not robustly associated with crisis risk, with most of the coefficients economically small and statistically insignificant. In addition, Table IA.XIII shows that our baseline results in Table III remain unchanged when controlling for rich dynamics of $r - r^*$ deviations.[21]

Recessions: Next, we ask whether these patterns apply to the business cycle more generally and study the occurrence of business-cycle peaks that are not associated with banking crises (in a ±2-year window, following the classification in Jordà, Schularick, and Taylor, 2016a). Here, we replace the dependent variable in equation (2) with an indicator for such nonfinancial recessions using the same three-year window from t to $t + 2$. Table IV shows that increases in monetary rates are associated with a higher likelihood of nonfinancial recession (including deep recessions). However, this relationship does not depend on the previous path of monetary rates as shown by the insignificant interaction terms. This means that raising rates increases the likelihood of a recession, consistent with previous literature (e.g., Blinder, 2023). Differently, when it comes to banking crisis risk, raising monetary rates after previous monetary cuts for a long period (the U-shaped path) is what really matters.

Depth of the U: We next ask whether the relationship between a U shape in monetary rates and crises becomes stronger for a more pronounced (i.e., deeper) U. To do so, we look at cuts and raises above and beyond the systematic component of monetary policy proxied by the main business-cycle dynamics (see Section III.A and Figure 3, Panel B). Table V shows the crisis frequencies after different monetary policy shapes similar to Table II, but now splitting the U shape into a "moderate U," where rate cuts and/or subsequent raises follow the normal monetary policy reaction to the main macro dynamics (systematic

[20] The natural rate is estimated as in Del Negro et al. (2019), using the sample-relevant filtering adjustments of Grimm et al. (2023).

[21] Note that the level of the natural rate is difficult to measure precisely, especially in real time, see, for example, the wide range of estimates in Bauer and Rudebusch (2020) and Davis et al. (2024). We also note that our monetary rate changes are correlated with changes in the real short-term rate minus the natural rate, not surprisingly as the natural rate tends to be constant over short periods of time.

Table IV

The Path of Monetary Policy Rates and Nonfinancial Recessions

This table shows linear probability models for nonfinancial recessions (business-cycle peaks not associated with a banking crisis) occurring between years t and $t+2$. Deep nonfinancial recessions are those with the lowest GDP growth. All specifications control for eight lags of country and global GDP growth and inflation, and (deep) recessions. $\Delta_3 Rate$ is the three-year change in the monetary policy rate. *Cut* is a dummy that equals one if monetary rates were cut between $t-8$ and $t-3$. IV specifications instrument $\Delta_3 Rate$ with the residualized trilemma variable. IV interaction specifications include the residualized trilemma variable and its interaction with the cut dummy as instruments. In this case, the Kleibergen-Paap Weak ID is the joint test for both instruments. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Normal Recession$_{t\ to\ t+2}$				Deep Recession$_{t\ to\ t+2}$	
	OLS		IV		OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 Rate_t$	0.03***	0.02***	0.06**	0.06**	0.01***	0.04*
	(0.01)	(0.01)	(0.03)	(0.03)	(0.00)	(0.02)
$Cut\ Rate_{t-8,t-3}$		−0.05		−0.08*	−0.05*	−0.06**
		(0.04)		(0.04)	(0.02)	(0.03)
$\Delta_3 Rate_t \times Cut\ Rate_{t-8,t-3}$		0.02		−0.00	−0.01	−0.02
		(0.01)		(0.04)	(0.01)	(0.02)
Country fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID			59.12	31.64		29.80
Observations	1,616	1,616	1,616	1,616	1,616	1,616

cuts or raises), and a "strong U," where both the cut and raise are above and beyond the normal reaction (residual cuts and raises).[22] Table IA.XIV shows the number of crises alongside the total number of observations for each monetary rate path.

The frequencies show that the combination of monetary rate cuts and subsequent raises above and beyond the systematic component is most strongly associated with future crises. The crisis frequency over the three years after a strong U (residual cut and raise) is 26%, three to nine times the frequency of crises in the no-U-shape bins and roughly three times the unconditional mean. As before, these differences hold for deep crises and are larger after WWII. A moderate U shape (featuring either a systematic cut or systematic raise) is also associated with higher crisis frequencies than the non-U-shape bins, but the differences are smaller than for the strong U shape. Table IA.XV repeats the exercise for one-year-ahead crisis frequencies, and obtains similar results.

Table IA.XVI shows that this result holds in a regression framework (using instrumented changes in rates, and including controls). We follow a similar

[22] A residual cut followed by a systematic raise, and a systematic cut followed by a residual raise, are both classified as a "moderate U." Note that a residual U means both a raw cut and a residual cut followed by both a raw raise and a residual raise.

Table V

Crisis Frequencies and Systematic versus Residual Monetary Rate Changes

This table reports the crisis frequency between year t and $t+2$ for different crisis definitions and monetary policy rate paths. Crises are dated using the Jordà, Schularick, and Taylor (2016a) chronology. In rows, the four bins are defined by the sign of the change (cut or raise) in the raw and residual monetary rate between $t-8$ and $t-3$, and between $t-3$ and t. Strong U is a raw and a residual rate cut (over and above the systematic component of monetary policy; see text) between $t-8$ and $t-3$ followed by a raw and residual raise between $t-3$ and t. Moderate U is a raw cut followed by a raw raise, but with the cut and/or raise being in line with or smaller than the change in the systematic monetary rate component. *, **, and *** indicate significance of whether the crisis frequency conditional on a specific rate path is higher than the average of the other paths at the 0.1, 0.05, and 0.01 level, respectively (using standard errors double-clustered by country and year).

	(1) Crisis	(2) Deep Crisis	(3) Post-WWII Crisis	(4) Post-WWII Deep Crisis
Strong U (residual cut & raise)	0.26***	0.19***	0.27***	0.22***
Moderate U (systematic cut or raise)	0.13	0.08*	0.08	0.07
Raise, raise	0.08	0.02	0.05	0.01
Raise, cut	0.03	0.01	0.02	0.00
Cut, cut	0.06	0.03	0.03	0.01
Unconditional	0.10	0.06	0.07	0.04

methodology to equation (2), but now interact the three-year rate changes with a dummy for residual or systematic cuts (Table IA.XVI, columns (2), (3), and (6)), and interact residual and systematic rate changes over $t-3$ to t with the cut dummy (Table IA.XVI, columns (4), (5), and (6)). Across these IV specifications, residual cuts and residual raises are strongly associated with crisis risk. Tables IA.XVII and IA.XVIII show robustness of this result in the post-WWII sample and in the OLS setting, respectively.

II. Understanding the Mechanisms

In this section, we provide evidence on the mechanisms explaining the main finding of this paper, that is, why the U shape in monetary policy rates increases banking crisis risk. In the previous section, another key finding is that for nonfinancial recessions—even deep ones—what matters are (recent) higher monetary rates, but not the U shape (interaction of higher monetary rates with previous cuts over a long period). Hence, the potential mechanisms for the impact of U-shaped monetary rates on banking crises point to financial channels. Previous studies show that banking crises are accompanied by a boom-bust pattern in credit and asset prices: before a crisis, credit and asset prices grow rapidly, while the onset of the crisis sees this financial boom reverse alongside a broader decline in economic activity (Schularick and Taylor, 2012; Mian, Sufi, and Verner, 2017; Greenwood et al., 2022).

Does the U shape in monetary policy rates play a role in driving these dynamics? Recent theoretical work suggests that this may be the case. Boissay et al. (2023) develop a New Keynesian model in which a long period of monetary loosening followed by unexpected tightening (a U shape) increases the risk of an endogenously created financial crisis. The reason for this is that the initial monetary loosening triggers an investment and credit boom (and search for yield/risk-taking behavior), and the subsequent tightening during this boom triggers a collapse in credit markets (due to the fear of loan defaults), and with it a financial crisis. In particular, Boissay et al. (2023) write that "*keeping the policy rate low for a long time stimulates the accumulation of capital and gradually erodes capital returns over time, eventually prompting investors to search for yield. The upshot is that a crisis is more likely when the central bank discretionarily hikes its policy rate after having kept it low–for–long, i.e. when it implements a so–called 'U–shaped' monetary policy*."[23]

Guided by these theories and previous empirical evidence showing that monetary policy affects credit and asset prices (Kashyap and Stein, 2000; Bernanke and Kuttner, 2005; Jiménez et al., 2012; Gertler and Karadi, 2015; Jordà, Schularick, and Taylor, 2020), we first analyze potential mechanisms by studying whether cutting monetary rates over a long period gives rise to financial vulnerabilities in the form of rapidly growing credit and asset prices (the financial red zone of Greenwood et al., 2022). We then explore two competing explanations for why this may happen (following Bernanke and Gertler, 1995): credit supply (including bank-risk-taking/search for yield, and loan mispricing) and credit demand. In light of several recent studies (Baron and Xiong, 2017; Krishnamurthy and Li, 2025; Krishnamurthy and Muir, 2025), we also investigate the role of sentiment or overoptimistic expectations in contributing to these credit supply and demand pressures.

Next we study whether raising monetary rates in a state of elevated financial vulnerability translates into a banking crisis, especially for those financial vulnerabilities associated with (previous) monetary rate cuts over a long period. We again start with the overall patterns and then drill down into the underlying channels at play, focusing on the reversal in existing financial vulnerabilities (through reductions in credit and asset prices), as well as stress in the banking sector in terms of lower bank profits, higher bank loan losses, and (large) bank stock price declines, notably through the materialization of credit risk and interest rate risk (including deposit withdrawals). We also study whether, and how, financial booms and U-shaped monetary rate dynamics interact, that is, whether—and why—the *combination* of these two forces is important.

[23] In another relevant paper, Goldberg and López-Salido (2023) show that raising monetary rates in a financial boom exacerbates the subsequent macroeconomic downturn through a negative impact on leveraged investors. Akinci et al. (2023) develop a model linking long periods of loose monetary policy to the build-up of financial vulnerabilities, but do not focus on subsequent rate hikes as the crisis trigger.

A. Monetary Rate Cuts and the Financial Red Zone

For our analysis, we first need to define what constitutes a financial boom. To do so, we rely on a simple proxy recently established by Greenwood et al. (2022), namely, the financial red zone (R-zone), defined as periods when credit and asset prices are jointly elevated. Specifically, following Greenwood et al. (2022), we define the R-zone indicator as the joint occurrence of high credit and asset price growth over the preceding three years, with high credit growth defined as being above the 80$^{\text{th}}$ percentile of the distribution of three-year changes in the respective credit-to-GDP ratio, and high asset price growth defined as being above the 66.7$^{\text{th}}$ percentile of the distribution of three-year changes in real asset prices (the same thresholds as in Greenwood et al., 2022). We compute the R-zone separately for business lending and stock prices (business R-zone) and for household lending and house prices (household R-zone), and focus on an indicator for being either in the household or business R-zone.[24]

We first ask whether long periods of monetary rate cuts increase the risk of the economy ending up in the financial red zone. Table VI uses different measures of monetary rate cuts over five years, $t-5$ to t, to predict the dummy variable of being in either a household or business R-zone in any of the following three years, $t+1$ to $t+3$. All specifications control for contemporaneous values and five lags of real GDP growth and inflation (country and global), as well as the R-zone indicator. IV estimates additionally instrument the monetary rate variable with the cumulative Jordà, Schularick, and Taylor (2020) trilemma shocks during years $t-5$ to t.

Table VI, columns (1) and (2) show that lowering monetary rates over a five-year period increases the probability of being in the red zone over the next three years, with larger cuts (more negative $\Delta Rate$) associated with higher red-zone frequencies. Columns (3) and (4) show that conditional on a cut in monetary rates (*Cut Rate* dummy equals one), the red zone becomes significantly more likely. Columns (5) and (6) show that cutting rates over and above the systematic monetary policy component (proxied by the main business-cycle dynamics, as described in the previous section) makes the red zone more likely, and columns (7) and (8) show that a large rate cut over and above the systematic component (large residual cut dummy equals one if the five-year raw and residual monetary rate change is in the lowest 25$^{\text{th}}$ percentile) is associated with a significantly higher probability of future crises. Table IA.XIX further shows that the relationship between (residual) monetary rate cuts and the red zone is much stronger for long periods of rate cuts of at least three years or more.

Why do long periods of monetary loosening increase the likelihood of red zones? The literature offers two potential explanations: higher credit demand (including better borrower fundamentals), and higher credit supply (including

[24] If no decomposition into household and business credit is available, we use an indicator for high growth of total private credit and combine it with sectoral (equity or housing) asset prices to define business and household R-zones.

Table VI

Monetary Rate Cuts and the Financial Red Zone

This table presents linear probability models for being in a financial red zone (*R-Zone*), defined as joint high growth in credit and asset prices, for business credit and stock prices or for household credit and house prices, using the same thresholds as in Greenwood et al. (2022). We use high total credit growth as a proxy when the business/household credit split is not available. $\Delta Rate$ is the change in monetary rates. *Cut Rate* is a dummy that takes the value of one if the change in monetary rates is negative. $\Delta Residual\ Rate$ is the change in monetary rates over and above the systematic component. *Large Resid. Cut* takes the value of one if both raw and residual rate changes are in the bottom quartile of the respective distributions. IV specifications instrument the change in (residualized) rates or the (large residualized) cut dummy with the residualized trilemma variable cumulated over the corresponding five years. All regressions control for contemporaneous values and five lags of country and global real GDP growth and inflation, as well as for the R-zone dummy. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Dependent Variable: R-Zone$_{t+1\ to\ t+3}$							
	$\Delta Rate_{t-5,t}$		$Cut\ Rate_{t-5,t}$		$\Delta Residual\ Rate_{t-5,t}$		$Large\ Resid.\ Cut_{t-5,t}$	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
See header	-0.02^{***}	-0.05^{***}	0.08^{**}	0.35^{**}	-0.02^{***}	-0.07^{**}	0.12^{***}	0.49^{***}
	(0.01)	(0.02)	(0.04)	(0.14)	(0.01)	(0.03)	(0.03)	(0.17)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Kleibergen-Paap		45.13		54.88		61.84		17.05
Observations	1,335	1,335	1,335	1,335	1,252	1,252	1,252	1,252

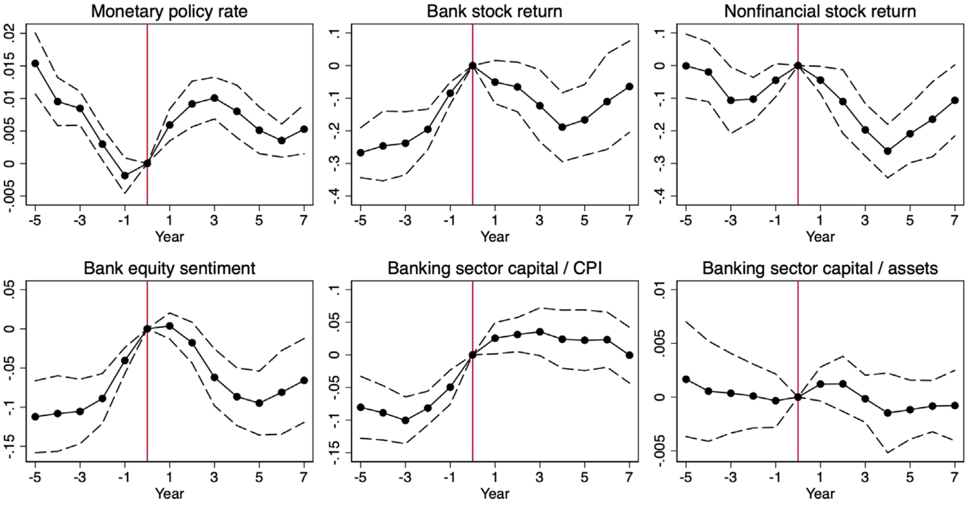


Figure 4. Macrofinancial developments around R-zones preceded by monetary rate cuts. This figure shows regression coefficients and 90% confidence intervals from regressing the change in the respective variable between $t + h$ and t on the dummy equal to one when the economy enters a business or household red zone that was preceded by a monetary policy rate cut, for horizons $h = -5, \ldots, 0, \ldots, 7$, with 0 corresponding to the first year in the pre-cut red zone (i.e., credit and asset price growth were high between $t = -3$ and $t = 0$, and monetary policy rates were cut between $t = -6$ and $t = -1$). Returns are calculated as the sum of capital gain and dividend minus inflation, in logs. Bank sentiment at time t is calculated as the predictable component of the bank stock return between years $t + 1$ and $t + 3$ (building on Baron and Xiong (2017) and López-Salido, Stein, and Zakrajšek (2017)), using past bank equity dividend-price ratios and the change in credit to GDP as predictors. High sentiment means that bank stock returns will be predictably low in the future. (Color figure can be viewed at wileyonlinelibrary.com)

bank risk-taking and loan mispricing).[25] As argued by Greenwood et al. (2022), the composite red zone measure captures both higher quantities (credit) and higher prices (lower cost of capital) in a given sector of the economy, and is therefore more consistent with supply pressures. In this paper, we investigate these roles further by first analyzing the behavior of bank and nonfinancial equity prices, as well as bank capital, during the boom that defines the red zone, and then analyzing the links between long monetary rate cuts and not only credit volumes but also credit spreads during the boom.

The top graphs of Figure 4 plot the path of monetary policy rates as well as bank and nonfinancial equity returns around red zones that are preceded by monetary rate cuts (i.e., a dummy for entering the red zone equals one at $t = 0$, meaning that credit and asset price growth is high from $t = -3$ to 0, and hence there is strong boom as the economy approaches the red zone).[26] To construct

[25] We also analyze measures of overoptimism, differentiating between the firm side versus the bank side, and hence between credit demand versus the supply side.

[26] Year 0 corresponds to the start of a red zone episode. That is, by definition, there is a strong credit and asset price boom (in the household sector, the business sector, or both) from year $t = -3$

these graphs, we use the same methodology as the crisis-window regressions in equation (1), but instead of the crisis dummy on the right-hand side we use a dummy that takes a value of one whenever the economy enters a red zone and rates were cut in the preceding five years. The bottom graphs additionally plot the level of bank equity sentiment, estimated as the predictable component of bank stock returns (see Baron and Xiong, 2017; López-Salido, Stein, and Zakrajšek, 2017), the level of banking sector capital relative to CPI, and the bank capital-to-asset ratio (bank equity over total assets, from Jordà et al., 2021). To compute bank sentiment, we build on Baron and Xiong (2017) and López-Salido, Stein, and Zakrajšek (2017) and predict future bank stock returns using information on past credit growth and bank equity price-dividend ratios, then use minus the predicted bank stock return between years $t+1$ and $t+3$ as the proxy for bank equity sentiment at t (see Internet Appendix Section II.A for more details). High bank equity sentiment at t means that bank stock returns over $t+1$ to $t+3$ are predictably low.

The top-left panel of Figure 4 confirms that monetary rates decline for several years before entering the pre-cut red zone.[27] During the strong boom period while the economy approaches the red zone (years $t=-3$ to $t=0$ in the graph), we also observe a boom in bank stock returns, both overall and over and above the returns of nonfinancial firms. While aggregate book bank capital (including retained earnings) is increasing in real terms, bank capital ratios are stable, consistent with a contemporaneous increase in credit (as well as other bank assets). These patterns are consistent with the credit supply mechanism, where banks increase credit as the market and book values of their equity go up, keeping constant the bank capital to total assets ratio.[28] Moreover, the empirical proxy for bank equity sentiment is also elevated—over and above nonfinancial firm sentiment (see Figure IA.7)– contributing to the increases in the market values of bank equity and to credit supply. Consistently, Table IA.XX shows that red zones, especially those preceded by monetary rate cuts, are followed by predictably low future bank stock returns, consistent with bank stock prices being too high during the strong boom that defines the red zone. These effects are also stronger and more robust than for the predictably low future nonfinancial stock returns, as shown in Table IA.XXI.

To further distinguish between credit supply and demand pressures, Table IA.XXII studies the links between monetary rate cuts and credit volume expansions with high or low credit spreads. To do so, we divide the credit

to $t=0$ in Figure 4. After year 0, the economy may (or may not) continue to be in the red zone (note that there is considerable heterogeneity in the length of these spells, with countries being in a red zone from just one year up to 10 years).

[27] Figure IA.6 further shows that rates are cut over and above the systematic monetary policy rate component, not only for red zones preceded by cuts, but also for all red zone starts.

[28] Figure IA.8 shows that the same patterns hold if we focus on pre-cut R-zones after WWII. Figure IA.9 considers all R-zones (not just those preceded by monetary rate cuts), with similar results but a less stark difference between bank and nonfinancial returns. This suggests that the banking-sector-specific aspects of the red-zone boom are especially salient if the boom was preceded by monetary rate cuts over a long period.

volume booms (episodes with credit growth above the R-zone threshold) in our sample into those accompanied by ex ante low versus high credit spreads.[29] As argued in previous studies (Mian, Sufi, and Verner, 2017), a credit boom accompanied by decreasing credit spreads, ceteris paribus, is indicative of an outward shift in the supply curve. Table IA.XXII shows that monetary rate cuts, raw or above the systematic monetary rate component, are associated with credit booms that start with a decrease in spreads (Panel A), but not with those credit booms that start with increases in spreads (Panel B), consistent with monetary rate cuts increasing credit supply. Furthermore, Table IA.XXIII shows that ex ante low-spread credit booms are not justified by more favorable ex post outcomes: in fact, ex ante low-spread booms are associated with ex post worse future bank profits and bank stock returns, higher bank loan losses, and higher risk of a banking crisis—both on their own and compared to the ex ante high-spread booms.[30] These results are not only more consistent with credit supply than demand, but also with some credit mispricing during the boom.[31]

In sum, the results in this subsection all point to credit supply expansions (including bank risk-taking, credit mispricing, and bank-specific overoptimism) as important channels linking long periods of monetary cuts to the build-up of financial risks.

B. Raising Monetary Rates, Red Zones, and Banking Crises

In the previous subsection, we show that monetary rate cuts over a long period increase the likelihood of a financial red zone. As shown by Greenwood et al. (2022), being in the red zone increases the risk of a future crisis. We now explore whether this link between red zones and crises depends on the conduct of monetary policy. To do so, first we add a dummy for being in the R-zone over the last three years to linear probability models of a banking crisis, and interact it with an indicator for monetary rates being raised. The results of these regressions are shown in Table VII. We then study the combined impact of red zones and/or U-shaped monetary rates on the probability of banking crises in Table VIII, analyzing whether financial booms and U-shaped monetary rate dynamics interact and amplify each other in important ways.

[29] We define a low-spread credit boom as a credit boom episode where either (i) business credit growth is above the R-zone threshold, and the corporate bond spread (from Kuvshinov, 2025) is decreasing when the economy enters the boom, or (ii) household credit growth is above the R-zone threshold and the mortgage credit spread (from Mian, Sufi, and Verner, 2017) is decreasing when entering the boom.

[30] Note that credit booms in the data typically last several years, and the level of the spread changes during the boom. Table IA.XXII on long rate cuts and entering the boom therefore looks at changes in spreads at the start of the boom. We then use all boom observations and the current level of the spread when looking at credit booms and future outcomes in Table IA.XXIII.

[31] It is important to highlight that even if the evidence did not support any mispriced credit, (private) credit in principle does not price negative externalities associated with social costs of strong financial distress such as fire sales, credit crunches, or bank failures with the associated costs to the whole economy and taxpayers (see, e.g., Freixas and Rochet, 2008 and Lorenzoni, 2008).

Table VII

Raising Monetary Rates in the Financial Red Zone and Crisis Risk

This table presents linear probability models for a systemic banking crisis occurring between years t and $t+2$. The *R-zone* is defined as joint high growth in credit and asset prices, for business credit and stock prices or for household credit and house prices, using the same thresholds as in Greenwood et al. (2022). $R\text{-}zone_{t-3\ to\ t-1}$ takes the value of one if a business and/or household red zone is detected in any of the last three years. $I(\Delta_3 Rate_t \geq 0)$ is a dummy for monetary rate hikes over a three-year window, for all monetary rate increases (columns (1) to (3)), residual rate increases (columns (4) and (5)), and systematic rate increases (column (6)). IV specifications include a dummy for the cumulative trilemma shocks over the three-year window being positive, and its interaction with the R-zone indicator as instruments. The Kleibergen-Paap Weak ID is the joint test for both instruments. All regressions control for contemporaneous values and three lags of country and global real GDP growth and inflation, as well as three lags of the crisis dummy. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Dependent Variable: $Crisis_{t\ to\ t+2}$					
	All Raises			Residual Raises		Systematic Raises
	OLS (1)	OLS (2)	IV (3)	OLS (4)	IV (5)	OLS (6)
$R\text{-}Zone_{t-3\ to\ t-1}$	0.13***	0.03	−0.07	0.07**	−0.03	0.12***
	(0.04)	(0.02)	(0.07)	(0.03)	(0.06)	(0.04)
$I(\Delta_3 Rate_t \geq 0)$		0.05*	−0.01	0.02	−0.03	0.05*
		(0.03)	(0.10)	(0.03)	(0.12)	(0.03)
$R\text{-}Zone \times I(\Delta_3 Rate \geq 0)$		0.18***	0.38***	0.16**	0.44***	0.05
		(0.05)	(0.15)	(0.07)	(0.16)	(0.06)
Country fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID			12.04		11.04	
Observations	1,362	1,362	1,362	1,362	1,362	1,362

In Table VII, we find that the link between R-zones and crises documented in previous studies (Greenwood et al., 2022) hinges crucially on the conduct of monetary policy. Table VII, column (1) shows that, as in Greenwood et al. (2022), R-zones are associated with a higher likelihood of a crisis. The risk of a crisis increases significantly if monetary rates increase while the economy is in the R-zone, as shown by the significant and strongly positive interaction coefficient between the two in column (2) (bottom row). Column (3) shows that this effect becomes stronger when using the trilemma IV. In contrast, if the economy is in the R-zone and monetary rates are not raised, crisis risk does not increase materially.[32] Columns (4) to (6) show that the links between raising monetary rates in the R-zone and future crises are particularly strong for residual raises over and above the systematic monetary rate component. In addition, Table IA.XXIV shows that the combination of rate hikes and R-zones

[32] Figure IA.10 shows that similar state dependencies hold when we look at the link between monetary policy actions in the R-zone and real activity more generally, with rate hikes in the R-zone associated with lower real GDP growth over the following years.

Table VIII

U-Shaped Monetary Rate Path, Red Zones, and Crisis Frequencies

This table reports the crisis frequency (ratio of crisis to total observations, shown in brackets) between years t and $t+2$ for different crisis definitions, depending on the path of monetary policy and financial red zone occurrence in years $t-8$ to t. In Panel A, U-shaped MP indicates monetary rates were cut between years $t-8$ and $t-3$ and raised between $t-3$ and t. No U-shaped MP includes all other monetary rate paths. R-zone means that the economy was in a household or business R-zone in at least one of the years between $t-2$ and t, whereas no R-zone means it was not in either a business or household R-zone in any of those years. In Panel B, residual U-MP indicates monetary rates were cut between years $t-8$ and $t-3$ and raised between $t-3$ and t, both by more than the systematic component. Systematic U-MP means that monetary rates were cut and then raised, but by no more than the systematic component (in either the cut or raise, or both). Crises are dated using the Jordà, Schularick, and Taylor (2016a) chronology, deep crises are those with the lowest GDP growth. *, **, and *** indicate significance of whether the crisis frequency in a specific U shape & R-zone bin is higher than the average of other bins, at the 0.1, 0.05, and 0.01 level, respectively (using standard errors double-clustered by country and year).

	(1)	(2)	(3)	(4)
	Crisis	Deep Crisis	Post-WWII Crisis	Post-WWII Deep Crisis
Panel A: All U Shapes				
U-shaped MP & R-zone	0.36*** (18/50)	0.23*** (12/50)	0.36*** (12/34)	0.30*** (10/34)
U-shaped MP & no R-zone	0.10 (11/117)	0.07 (9/117)	0.06 (3/57)	0.05 (3/57)
No U-shaped MP & R-zone	0.11 (11/99)	0.04 (4/99)	0.06 (4/71)	0.01 (1/71)
No U-shaped MP & no R-zone	0.05 (18/364)	0.03 (10/364)	0.02 (4/220)	0.00 (0/220)
Unconditional	0.09 (58/630)	0.05 (34/630)	0.06 (24/382)	0.04 (14/382)
Panel B: Systematic vs. Residual U Shapes				
Residual U-MP & R-zone	0.45*** (14/30)	0.33*** (10/30)	0.48*** (11/22)	0.40*** (9/22)
Systematic U-MP & R-zone	0.22** (3/15)	0.09 (1/15)	0.12 (1/11)	0.09 (1/11)

is not important for nonfinancial (even deep) recessions—as in Section I, it is only monetary rate increases that are key, as opposed to the interaction (in this case with the financial red zone).

In the rest of this subsection, we analyze the combination of U-shaped monetary rates and red zones. Above, we show that cutting monetary rates over a long period makes the economy more likely to end up in a financial red zone. We further show that raising monetary rates in the red zone increases crisis risk (also, red zones without raising monetary rates are not strongly associated with crises). This evidence together suggests that rather than acting as separate forces, it is the combination of red zones and U-shaped monetary policy rates that could be crucial for banking crises. To examine whether this is the case, we study crisis risk after U-shaped monetary policy rates, red zones, and their combination.

Table VIII reports the crisis frequencies for different monetary rate paths and red zones, alongside the number of crisis and noncrisis observations for each bin in brackets, and a significance test of whether the crisis frequency is higher than (the average of) that in the other bins. The top row of Panel A shows the frequency of crisis observations over the next three years if, over the previous eight-year period, monetary rates followed a U shape and the economy was in a household or business R-zone in any of the years between $t-2$ and t (the years following the long monetary rate cut). The second row shows the crisis frequencies for U-shaped monetary rate paths that were not accompanied by a R-zone, and the next two rows show the frequencies for all non-U-shaped paths of monetary rates with and without R-zones, respectively.

Table VIII shows that it is the combination of U-shaped monetary rates *and* red zones that is crucial for banking crises. If monetary rates follow a U shape and the economy is in the R-zone during the latter years of the U (top row of the table), the frequency of crises over the next three years is around 36% (and 23% to 30% for deep crises). In contrast, for U-shaped monetary policy without an R-zone (second row), the crisis frequency (10% for all crises) is close to the unconditional mean, although it is still higher than the crisis frequency in the case of no red zone and no U-shaped monetary policy (5% for all crises). Similarly, crisis risk for R-zones without U-shaped monetary policy (third row) is close to the unconditional mean. Notably, after WWII there were 71 red zones without U-shaped monetary policy rates, but only one of them ended up in a deep banking crisis, while 10 out of only 34 red zone observations with a U-shaped monetary policy ended up in a deep banking crisis. Panel B shows that these results are especially strong for the combination of the residual U shape (cuts and raises over and above the systematic monetary policy component) and the red zone, although crisis probabilities for the systematic U shape and red zone combination are also above average. Table IA.XXV shows that similar results hold when we consider a broader R-zone window (R-zones starting during any of the last five years of the U shape).

The implications of these findings are different from previous studies that largely focus on booms in credit and asset prices as the drivers of crisis risk (Schularick and Taylor, 2012; Baron, Verner, and Xiong, 2021; Greenwood et al., 2022). Our results show that on its own, a financial boom is not sufficient for a strong increase in crisis risk. That is, for the boom to translate into a high likelihood of a banking crisis, a U-shaped monetary policy rate path is also necessary. To analyze whether both cutting monetary rates before the red zone and raising them in the red zone matter, Table IX tests whether raising monetary rates in the R-zone is associated with higher crisis risk, distinguishing between R-zones preceded by monetary rate cuts (columns (4) to (6)) and monetary rate increases (columns (7) to (9)). We find that raising monetary rates while in an R-zone preceded by monetary rate cuts is strongly associated with banking crisis risk, both for raw (column (5)) and instrumented (column (6)) rate changes. R-zones preceded by monetary rate hikes, however, are not associated with subsequent crises, even if monetary rates are raised while in the red zone (columns (7) to (9)). In sum, the last two tables show that financial booms and U-shaped monetary rate dynamics amplify each other, and the

Table IX
Raising Monetary Rates in the Financial Red Zone, Previous Cuts, and Crisis Risk

This table presents linear probability models for a systemic banking crisis occurring between years t and $t+2$. The red zone (R-zone) is defined as joint high growth in credit and asset prices, using the same thresholds as in Greenwood et al. (2022). We use business credit and equity prices for the business R-zone, and household credit and house prices for the household R-zone. We use high total credit growth as proxy when the business/household split is not available. $R\text{-}zone_{t-3\ to\ t-1}$ takes a value of one if a business and/or household red zone is detected in any of the last three years. R-zone, pre-cut (R-zone, pre-raise) corresponds to R-zone spells with the first R-zone observation preceded by interest rate cuts (raises) over a five-year window. $I(\Delta_3 Rate_t \geq 0)$ is a dummy for monetary rate hikes over a three-year window. IV specifications include a dummy for the cumulative trilemma shocks over the three-year window being positive, and its interaction with the R-zone indicator as instruments. The Kleibergen-Paap Weak ID is the joint test for both instruments. All regressions control for contemporaneous values and three lags of country and global real GDP growth and inflation, as well as three lags of the crisis dummy. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Dependent Variable: $Crisis_{t\ to\ t+2}$								
	R-Zone			R-Zone, pre-cut			R-Zone, pre-raise		
	OLS		IV	OLS		IV	OLS		IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$R\text{-}Zone_{t-3\ \text{to}\ t-1}$	0.11***	0.03	−0.09	0.16***	0.04	−0.04	0.02	0.01	−0.06
	(0.04)	(0.03)	(0.07)	(0.05)	(0.04)	(0.11)	(0.03)	(0.03)	(0.12)
$I(\Delta_3 Rate_t \geq 0)$		0.05	−0.04		0.05**	−0.02		0.10**	0.10
		(0.03)	(0.10)		(0.02)	(0.11)		(0.05)	(0.15)
$R\text{-}Zone_{t-3\ \text{to}\ t-1} \times I(\Delta_3 Rate_t \geq 0)$		0.18***	0.42***		0.22***	0.39*		0.03	0.17
		(0.06)	(0.16)		(0.08)	(0.24)		(0.07)	(0.28)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID			12.99			11.09			3.36
Observations	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1470

combination of these two forces substantially worsens financial stability risks (as compared to either of them taken separately).

C. Monetary Raises and Reversal in Pre-existing Vulnerabilities

The combination of U-shaped monetary policy rates and red zones is crucial for crises. But why is this the case? In the previous sections, we document that long periods of cuts in monetary rates are associated with a build-up of financial vulnerabilities in the form of higher credit and asset prices, with credit supply (including bank risk-taking and mispricing) being an important mechanism. This is consistent with previous studies showing a link between lower monetary rates and search for yield, excessive risk-taking, maturity mismatch,

Figure 5. Interaction of monetary rate changes and previous financial red zone vulnerability. This figure plots coefficients $\beta_{3,h}$ in equation (4) for the interaction of yearly changes in monetary rates and a dummy variable for the dependent variable growing above the R-zone threshold in the previous three years. Specifications control for five lags of all three variables on the right-hand side of equation (4), as well as contemporaneous values and five lags of country and global real GDP growth and inflation, and the crisis dummy. Country fixed effects are included. Driscoll-Kraay standard errors are computed with 1.5 × h lags and 10% confidence intervals are shown.

and higher leverage (Rajan, 2006; Adrian and Shin, 2010; Jiménez et al., 2014; Becker and Ivashina, 2015; Acharya et al., 2020). In the following two subsections, we focus on how raising monetary rates crystallizes the vulnerabilities built up during the long monetary rate cuts and triggers the transition to a banking crisis.

We start by testing whether raising monetary rates when credit or asset prices are strongly elevated (e.g., when house prices are high) triggers an especially large reversal in that variable (in this case, an especially large house price decline). To do so, we run the following local projections:

$$\Delta_h y_{i,t+h} = \alpha_{i,h} + \beta_{1,h}\Delta Rate_{i,t} + \beta_{2,h} I(\Delta_3 y_{i,t} \geq \text{Rz}) + \beta_{3,h}\Delta Rate_{i,t} \times I(\Delta_3 y_{i,t} \geq \text{Rz}) + \gamma X + \epsilon_{i,t+h}, \quad h \in \{1, \ldots, 10\}. \tag{4}$$

Above, y is the level of household credit, house prices, business credit, or stock prices (the four components of the R-zone indicator), $\Delta Rate$ is the raw or instrumented (using the trilemma IV) change in the monetary policy rate, $I(\Delta_3 y_{i,t} \geq \text{Rz})$ is an indicator for existing vulnerabilities that takes a value of one if the three-year growth in y is above the R-zone threshold (as defined above), and zero otherwise, and X is a control vector (contemporaneous values and five lags of country and global real GDP growth and inflation, crisis dummy, and five lags of rate changes, R-zone-indicators, and their interactions). The coefficient, $\beta_{1,h}$, tells us how the variable y responds to changes in monetary rates, and the main coefficient of interest, $\beta_{3,h}$, tells us whether these responses to changes in monetary rates are stronger if the financial variable is elevated, indicating existing financial vulnerabilities.

Figure 5 plots the interaction coefficient $\beta_{3,h}$ for each of the four financial variables y that define the red zone. The coefficients are negative and economically large, implying that if a financial variable displays a pre-existing vulnerability in the sense of previous very strong growth (above the red zone threshold), the reversal in that variable triggered by raising monetary rates is much stronger. For example, for every 1 ppt increase in monetary rates, house prices drop by an extra 3% if past house price growth was high. Figure IA.11 shows the responses for all variables $\beta_{1,h}$—$\beta_{3,h}$, and shows that while hiking monetary rates is generally associated with future declines in credit and asset prices ($\beta_{1,h} < 0$), these declines become much larger (more than double) if there was pre-existing very strong growth, that is, a vulnerability ($\beta_{3,h} < 0$). Figure IA.12 shows robustness to additional controls.

D. The Path of Monetary Rates and Banking Sector Performance

We now analyze how banking sector outcomes depend on the dynamic path of monetary policy rates. To do so, we run the same regression as our baseline specification for crises in equation (2) (Section I.C), but here we use various indicators of bank performance instead of the crisis dummy on the left-hand side. These variables are the three-year change in bank profitability (measured as the accounting return on bank equity), the three-year change in bank loan losses/write-offs due to nonperforming loans (NPLs) (relative to bank book equity), three-year changes in the other components of net income (related to net interest income and other expenses) relative to book equity, the market return on bank equity, and a dummy for a bank equity crash,[33] all taken over the years t to $t+2$. We control for contemporaneous values and eight lags of country and global GDP growth and inflation, as well as eight lags of the crisis dummy and the dependent variable, again mirroring the setup in equation (2). The resulting coefficients of interest are again β_1, which measures the impact of changes in monetary rates on different measures of banking performance, β_2, which captures the impact of long monetary rate cuts, and β_3, which measures the interaction of the two.

Table X presents the estimated regression coefficients for the four measures of banking sector outcomes, in both OLS and IV specifications. Monetary rate hikes lead to somewhat worse bank performance over the next three years (not robust across performance measures), but this worsening is especially strong (economically and statistically) if monetary rates were previously cut over a long period of time. In columns (1) and (2), if monetary rates were cut over a period of five years and then increased by 1 ppt over the following three years, banks' accounting return on equity falls by 1 to 3 ppt (with basically all of this effect driven by the interaction term). Moreover, looking at columns (3) and (4), the decline in bank profitability after U-shaped monetary rates is driven by higher loan losses as opposed to components related to lower net interest income or other expenses (see the insignificant coefficients in columns (5) and

[33] We define it using the chronology in Baron, Verner, and Xiong (2021), which combines bank equity crashes with a −30% or lower annual market return on bank equity and evidence of widespread bank failures.

Table X

The Path of Monetary Policy Rates and Banking Outcomes

This table presents regressions for different banking outcomes depending on the path of monetary policy rates. Dependent variables, in columns, are the change in banking sector profits relative to (book) equity (columns (1) and (2)), change in bank loan losses relative to book equity (columns (3) and (4)), change in other net income components relative to book equity (columns (5) and (6)), cumulative real bank stock returns (columns (7) and (8)), and a dummy that equals one if there is a bank equity crash (defined as in Baron, Verner, and Xiong, 2021, using an indicator for –30% or lower bank stock returns and evidence of bank failures; columns (9) and (10)). Data on banking sector return on equity (*RoE*), loan losses, and other net income (the difference between *RoE* and loan losses) are from Richter and Zimmermann (2020); data on bank stock returns and crashes are from Baron, Verner, and Xiong (2021). All specifications control for contemporaneous values and eight lags of country and global real GDP growth and inflation, as well as eight lags of the dependent variable and the crisis dummy. $\Delta_3 Rate$ is the three-year change in the nominal monetary policy rate. *Cut Rate* is a dummy that equals one if monetary rates were cut between $t-8$ and $t-3$. IV specifications include the residualized trilemma variable and its interaction with the cut dummy as instruments. The Kleibergen-Paap Weak ID is the joint test for both instruments. Driscoll-Kraay standard errors (five lags) are in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	$\Delta RoE_{t\ to\ t+2}$		$\Delta Loan\ loss_{t\ to\ t+2}$		$\Delta Other\ inc_{t\ to\ t+2}$		$r^{Bank\ equity}_{t\ to\ t+2}$		$Crash^{Bank\ equity}_{t\ to\ t+2}$	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_3 Rate_t$	−0.13	−0.02	0.65*	1.13***	0.42***	1.14	−0.02	0.02	−0.00	−0.00
	(0.16)	(0.32)	(0.34)	(0.39)	(0.13)	(0.74)	(0.01)	(0.02)	(0.00)	(0.01)
$Cut\ Rate_{t-8,t-3}$	−0.07	0.42	−1.13	−1.57**	−1.44***	−2.17**	−0.04	−0.06	0.04	0.03
	(0.74)	(0.65)	(1.25)	(0.74)	(0.55)	(0.89)	(0.05)	(0.05)	(0.03)	(0.03)
$\Delta_3 Rate_t \times Cut\ Rate_{t-8,t-3}$	−0.83***	−3.14***	1.18***	3.17**	0.14	−0.94	−0.03*	−0.07*	0.02**	0.07**
	(0.26)	(1.02)	(0.32)	(1.45)	(0.18)	(0.78)	(0.02)	(0.04)	(0.01)	(0.03)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID		32.18		17.46		13.19		18.27		27.94
Observations	1,350	1,350	770	770	758	758	1,298	1,298	1,627	1,627

(6)), with loan losses over equity increasing by 1 to 3 ppt after the interaction of a 1 ppt rate hike with previous cuts. Table IA.XXVI reproduces these results for a consistent sample.

In addition, columns (7) to (10) of Table X show that the previous results of U-shaped monetary rates on the accounting measures of profits and losses are mirrored in the market returns on bank equity, with 3 to 7 ppt lower three-year bank stock returns, and a 2 to 7 ppt higher probability of a bank equity price crash (after the interaction of higher monetary rates with previous cuts over a long period). Table IA.XXVII shows that the increases in the two key downside risk measures of Table X—loan losses and the risk of a bank equity crash—are very strong for a deeper U, with the interaction coefficient on $\Delta Rate \times Cut$ especially large for cuts and raises in monetary rates that are over and above the systematic component.

These results show that raising monetary rates after a prolonged period of monetary cuts crystallizes banking sector risks that build up over a long period of monetary cuts. The results on loan losses and other components of bank income suggest that these lower profits and returns are driven primarily by higher realized credit risks, as opposed to realized interest rate risks (including deposit outflows). We provide several additional results in the Internet Appendix that further support the importance of the credit risk channel. Table IA.XXVIII conducts a similar exercise for market (as opposed to accounting) returns on bank equity, which reflect not only current but also expected future credit and interest rate risk realizations. We first separate bank stock returns into components correlated with loan losses and changes in credit spreads over long-term government bond yields (which act as a proxy for credit risk), and those correlated with changes in term spreads and deposit outflows (which to some extent proxy for interest rate risk, including deposit fragility). The results in Table IA.XXVIII show that after U-shaped monetary rates, the credit risk component of bank stock returns falls sharply, with little changes in the interest rate risk (including the deposit fragility) component of returns. Finally, Table IA.XXIX shows that U-shaped monetary rates are not strongly associated with future deposit outflows at the aggregate banking system level.

In sum, the different sets of results suggest that—after the U shape of monetary rates—there is strong stress in the banking sector in terms of worse profits and losses and stock market prices (including higher bank stock crash risk), notably through the materialization of credit risk, rather than interest rate risk (including deposit outflows).

Policy Implications: Taken together, the findings in this section point toward a nuanced view on the use of monetary policy to reduce financial vulnerabilities. Several prior studies suggest that to deflate booms in credit and asset prices, policymakers could lean against the wind by raising monetary policy rates (Adrian and Liang, 2018; Gourio, Kashyap, and Sim, 2018; Greenwood et al., 2022). Based on our results, however, once in an R-zone that follows cuts in monetary policy rates, such policy action is much more likely to trigger a crisis by crystallizing the financial vulnerabilities that build up during the period of monetary loosening.

While our paper provides reduced-form evidence within a positive analysis, and we do not analyze the optimal conduct of monetary policy (nor any normative or welfare analysis), our results point toward several policy options. First, if policymakers need to raise rates to maintain price stability or rein in a nascent financial boom, doing so preemptively (i.e., before the economy enters the financial red zone) can substantially attenuate the risks to financial stability. Second, if policymakers have to raise rates while in the red zone, especially if they previously cut rates over a long period, moderating the increases and keeping their magnitude in line with the systematic policy reaction to GDP and inflation will help attenuate crisis risk. Third, if policymakers need to tighten policy when the economy is already in the red zone, they can rely on other tools, for example, banking supervision. These recommendations are in line with insights from recent theoretical work. In the model of Boissay et al. (2023), optimal monetary policy in the presence of endogenous financial crises involves a preemptive response to impending financial booms and a moderation of rate hikes when financial vulnerabilities are elevated. Goldberg and López-Salido (2023) show that when in a financial boom, the optimal policy response moderates the pace of rate hikes, for example, by committing to hiking rates in the future instead of immediately, and uses macroprudential tools (e.g., tightening supervision) to rein in financial sector excesses. Such moderation in the pace of rate hikes is also in line with recommendations from the literature on monetary policy gradualism (Stein and Sunderam, 2018).

III. Loan-Level Evidence from Spain's Boom and Crisis

To validate our findings in a more granular data set, and study loan, borrower, and bank heterogeneity in a context that strengthens identification of credit supply and bank risk-taking, we now turn to Spanish Credit Register (CIR) data to analyze the effect of U-shaped monetary policy on financial vulnerabilities at the loan level. Specifically, we conduct a detailed case study of Spain's boom that preceded the 2008 crisis, which is representative of many historical crises, especially after WWII, as it was preceded by a large bank credit boom related to real estate (Jordà, Schularick, and Taylor, 2016b; Müller and Verner, 2023). Moreover, macroeconomic developments in Spain (see Figure IA.13) during the pre-crisis period mirror general patterns documented for historical crises—monetary rates were cut for several years in the early 2000s, with credit and asset prices (notably, house prices) growing rapidly, and when monetary rates were later raised over the 2006 to 2007 period, this hike was swiftly followed by a banking crisis in 2008 to 2009.

Our case study has the advantage that monetary rate changes were fairly exogenous to Spain's macroeconomic conditions, mirroring our identification strategy in Section I.C. Spain was part of the ERM in the 1990s and joined the euro in 1999, with monetary policy set at the euro-area level. In particular, decisions by the European Central Bank (ECB) to cut interest rates in the early 2000s mainly corresponded to the need to boost GDP, employment, and price growth in core euro-area countries (notably Germany), and did not reflect the economic situation in Spain, which had experienced high growth in GDP, credit, and CPI (similar to other peripheral euro-area countries such as Ireland; see Maddaloni and Peydro, 2011). Thus, especially during this precrisis period, monetary policy rates in Spain can be viewed as exogenous, while policy in the 2010s was more aligned with economic developments in the euro-area periphery.

Spain has two further qualities that make it an excellent candidate for our case study. First, its financial system is dominated by banks, which means that studying bank loan conditions and performance in detail can give us a good overview of overall financial developments in the country. Second, Spain has a supervisory credit register matched with administrative lender and borrower risk characteristics that covers a long period of time. These features allow us to study at the loan level how risks build up during a long period of declining monetary rates, and how they then crystallize into a crisis when monetary rates are raised.

We start by focusing on the boom period, analyzing the impact of monetary rate cuts on lending volumes and rates, focusing on the role of risky lenders and borrowers, to better isolate the credit supply and bank risk-taking channels. We then study the transition into a crisis, analyzing the impact of U-shaped monetary policy (interaction of cuts with subsequent hikes in rates) on defaults at the individual loan level, to get a more detailed picture of the realized credit risks.

Sources of Administrative Data. Banco de España, in its role as bank supervisor of the Spanish financial system, is the owner of the CIR, a confidential supervisory register that collects detailed monthly information on new and outstanding loans to firms, with amounts exceeding 6,000 euros (a very low level for corporate loans), granted by all credit institutions operating in Spain since 1984, and defaults of these loans. This data set contains not only information about the loan (e.g., size, maturity), but also information on the identity of the bank that grants the loan and on the identity of the firm that receives it, which allows us to expand the original data set with bank balance sheet information (also compiled by Banco de España at a monthly frequency) and firm economic and financial information from Spain's Mercantile Register (including a measure at the firm level of loan interest payments), collected annually since 1995.

For the purposes of our analysis, we work with quarterly data after 1995 containing all loans to nonfinancial companies by commercial banks, savings banks, and credit cooperatives. These financial institutions account for more than 95% of bank debt in the Spanish financial system. We analyze these data at the firm-bank level. To this end, we aggregate all new loans granted by a bank to a given firm in the same quarter. Moreover, to keep the data manageable, we take a 10% random sample of the entire population of Spanish firms.[34] Based on the sample of all loans granted to these firms, we study the links between monetary policy rates and credit volumes, credit prices, and loan defaults. We define default, or delinquency, as loan payments more than 90 days overdue, following the main definition used by supervisors and regulators. To analyze how monetary policy affects bank loan supply, we define the change in credit between a firm and a bank as the annual log of the change of loan commitments. Since there is no information on interest rates on loans between firms and banks, we study the cost of debt at the firm level using financial expenses over liabilities (current and noncurrent) as a proxy, taken from firms' profit and loss accounts reported to the Spanish Mercantile Register.[35] Table IA.XXX provides summary statistics (mean, standard deviation, and quartiles) of the variables used in the analysis.

For our main analysis, we limit our sample to loans granted before 2008 Q3, for three reasons. First, monetary policy rates after the onset of the Global Financial Crisis were not exogenous to the economic situation in Spain, as the ECB reacted to developments in the periphery countries during the Global Financial Crisis and the euro-area sovereign debt crisis. Second, changes in monetary policy rates during the post-2008 period were largely limited by the zero lower bound. Third, linking defaults to individual bank characteristics becomes more difficult after 2008, since many weaker banks were taken over by stronger banks during the crisis, weakening or changing the link between bank characteristics at loan origination and during the life of the loan.

Monetary Rate Cuts, Bank Credit Supply, and Bank Risk-Taking. We start by analyzing the link between monetary rate cuts and lending volumes by running OLS regressions of the form

$$\Delta y_{i,j,t} = \beta_1 Cut_{t-5,t} + \beta_2 Cut_{t-5,t} \times Bank\ risk_{i,t-1} + \beta_3 Cut_{t-5,t} \times Bank\ risk_{i,t-1} \times Firm\ risk_{j,t-1} + \gamma_1 F_{j,t-1} + \gamma_2 B_{i,t-1} + \gamma_3 M_t + u_{i,j,t}, \tag{5}$$

where Δy is the yearly change in credit granted by bank i to firm j, Cut is a dummy variable equal to one if the change in overnight interest rates between years $t-5$ and t is below its average value, F is a vector of control variables and fixed effects at the firm level that, depending on the specification, includes industry (NACE at three digits) and location (zip code level) fixed effects, firm fixed effects, and firm $\times$ bank fixed effects, B is a vector of control variables and fixed effects at the bank level that includes bank fixed effects and/or observable bank characteristics (in the previous quarter) such as the log of total assets, capital and liquidity ratios, return on assets (ROA), and NPL ratios, and M_t is a vector of macro controls and fixed effects that includes interactions of lagged

[34] We use the entire population of firms for the study of the cost of bank debt, as this analysis is done at the firm-year level, not at the firm-bank-quarter level.

[35] The log changes in credit are winsorized to be between −100 and 200, to prevent the results from being affected by extreme values. Similarly, the variable cost of debt is winsorized at the 5% and 95% levels.

values of GDP and CPI, and—in some specifications—time fixed effects (lower-degree terms of any interaction are included in the regression).[36]

We are interested in the β_1 coefficient on the *Cut* dummy, which indicates how credit volumes change after monetary rates are cut over a long time period. We then gradually saturate the equation with additional controls and add terms for the interaction between monetary cuts and proxies for firm and bank-level risk. As a measure of bank risk, we employ the banks's NPL ratio, and the β_2 coefficient indicates whether banks with high past NPLs lend more when monetary rates are cut. The firm risk proxy takes a value of one if a firm is in the real estate and construction sector (zero otherwise), and the β_3 coefficient indicates whether such firms receive relatively more credit by weaker banks when monetary rates are cut.

The results of these regressions are reported in Table XI. The top row of Panel A shows that long periods of monetary rate cuts are associated with higher growth in lending volumes, conditional on bank, firm, geographic, and macro controls and fixed effects (column (1)). This result continues to hold when controlling for bank-firm fixed effects in column (2). In terms of the economic impact, when interest rates have been cut in previous years (*Cut* equals one), credit increases by up to 4.8 ppt (see column (2)). Moving on to columns (3) and (4), the increase in lending after long monetary rate cuts is stronger for loans given out by ex ante weaker banks. Moving from the 25^{th} to 75^{th} quartile of banks sorted by their NPL ratio additionally increases the effect of a monetary cut on credit by 2.8 ppt (based on column (4)). Finally, the increase in lending is stronger for loans given by ex ante weaker banks to ex ante riskier firms—those in the construction and real estate sector, as indicated by the positive triple interaction coefficient in the third row of column (5). Moreover, column (6) shows that these effects are over and above overall time-varying credit supply to all firms, borrower-lender sticky relationships, and firm-level time-varying credit demand, which we control for using bank-time, firm-bank, and firm-time fixed effects, respectively. In terms of magnitude, in column (6) the effect of a monetary cut over a long period increases credit growth by an additional 7.9 ppt if the borrowing company belongs to the construction and real state sector and borrows from a weak bank, for an interquartile range change in bank NPL.

We next proxy the cost of credit using firm-level data on debt service payments and estimate variants of equation (5) with firm-level changes in the cost of debt as the dependent variable.[37] Panel B of Table XI shows that monetary rate cuts are associated with reductions in the cost of debt at the firm level (of 20 basis points (bps) in column (1)), which are especially strong for firms reliant

[36] Since monetary policy rates were on average decreasing in our sample (see Table IA.XXX), the *Cut* dummy variable effectively corresponds to large cuts in monetary rates.

[37] Here, we control for firm observables (log of assets, log of age, own funds over total assets, liquid assets over total assets, and ROA) given that this regression is at the firm-time level. Bank characteristics are for the average bank at the firm level, using as weights the credit exposition of the firm with the bank prior to monetary policy changes.

Table XI

Monetary Rate Cuts, Lending Volumes, and Cost of Firm Debt in Spain

This table reports OLS regression results of credit growth and changes in the cost of debt on long periods of monetary rate cuts. New loans are included until 2008 Q3. *Cut* is a dummy variable indicating whether the change in (overnight) rates between years $t-5$ and t is below its average value. All variables are demeaned by subtracting their sample mean. Coefficients are listed in the first row, and standard errors corrected for clustering at the time and bank level (Panel A) and at the bank and firm levels (Panel B) are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" indicates that it is not included, and "-" indicates that it is absorbed by the included set of fixed effects. All specifications in Panel B include firm fixed effects, firm controls, and main bank controls. For observations, m corresponds to millions. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

Panel A. Dependent Variable: $\Delta log(Credit)_{i,j,t}$, loan level

	(1)	(2)	(3)	(4)	(5)	(6)
$Cut_{t-5,t}$	2.54*	4.80**	3.59**			
	(1.33)	(2.18)	(1.55)			
$Cut_{t-5,t} \times$ *Bank NPL ratio*			2.62**	1.32**	1.19**	
			(1.02)	(0.54)	(0.57)	
$Cut_{t-5,t} \times$ *Bank NPL ratio* $\times$ *Real estate firm*					2.12***	2.42*
					(0.58)	(1.44)
Firm FE	Yes	-	-	-	-	-
Macro controls	Yes	Yes	Yes	-	-	-
Bank controls	Yes	Yes	Yes	Yes	Yes	-
Bank FE	Yes	-	-	-	-	-
Time FE	No	No	No	Yes	Yes	-
Firm × Bank FE	No	Yes	Yes	Yes	Yes	Yes
Bank × Time FE	No	No	No	No	No	Yes
Firm × Time FE	No	No	No	No	No	Yes
Lower-level interactions	-	-	-	-	Yes	Yes
Observations	1.9m	1.9m	1.9m	1.9m	1.9m	1.9m
R^2	0.078	0.187	0.187	0.188	0.188	0.518

Panel B. Dependent Variable: $\Delta Cost\ of\ Debt_{j,t}$, Firm Level

	(1)	(2)	(3)	(4)	(5)	(6)
$Cut_{t-5,t}$	−0.20***	−0.18***				
	(0.07)	(0.06)				
$Cut_{t-5,t} \times$ *Bank NPL ratio*		−0.13***	−0.21***	−0.29***	−0.32***	−0.30***
		(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
$Cut_{t-5,t} \times$ *Bank NPL ratio* $\times$ *Real estate firm*						−0.00
						(0.03)
Macro controls	Yes	Yes	-	-	-	-
Main bank FE	Yes	Yes	Yes	-	-	-
Time FE	No	No	Yes	-	-	-
Main bank × Time FE	No	No	No	Yes	Yes	Yes
Industry × Location × Time FE	No	No	No	No	Yes	Yes
Lower-level interactions	-	-	-	-	-	Yes
Observations	1.2m	1.2m	1.2m	1.2m	1.2m	1.2m
R^2	0.163	0.163	0.169	0.171	0.325	0.327

on weaker banks for their borrowing (columns (2) to (5)) with an additional reduction of 63 bps for firms borrowing from high (top quartile) as opposed to low (bottom quartile) NPL ratio banks (based on column (5)). Interestingly, we find similar effects for the cost of debt of firms in the real estate and other sectors (column (6)). Taken together, these results provide more detailed evidence supporting our findings in the macroeconomic data: cutting rates over a long period triggers credit supply expansions tilted towards riskier lending (by weaker banks).

U-Shaped Monetary Rate Path and Loan Defaults. We next analyze the interactions between monetary rate hikes, previous monetary cuts, and future defaults at the individual loan level. To do so, we use OLS to estimate the linear probability model

$$Loan\ Default_{i,j,t,t+3} = \beta_1 \Delta_3 Rate_{t,t+3} + \beta_2 Cut_{t-5,t} + \beta_3 \Delta_3 Rate_{t,t+3} \times Cut_{t-5,t} + \gamma_1 F_{i,t-1} + \gamma_2 B_{j,t-1} + \gamma_3 M_t + u_{i,j,t,t+3}, \quad (6)$$

where $Loan\ Default$ is a dummy variable that takes the value of one if the loan granted by bank j at time t to firm i becomes delinquent in the subsequent three years, and zero otherwise, $\Delta_3 Rate$ is the change in the monetary rate between years t and $t+3$, in ppt, and the other variables are as defined before. F, B, and M are firm, bank, and macro controls as before, and we additionally control for loan size. The β_1 coefficient reflects the relationship between loan defaults and changes in monetary policy rates after loan origination. A positive β_2 coefficient would mean that the probability of loan default is higher when the loan is granted in periods of declining monetary rates. A positive β_3 coefficient would mean that the relationship between loan defaults and higher monetary rates becomes stronger if the monetary rate increases were preceded by a period of declining policy rates. As in equation (5), we also analyze the heterogeneous effect of β_3 for weaker banks lending to ex ante riskier firms.

Table XII reports results of the regressions specified in equation (6). We start with a model free of any firm- and bank-level controls, and progressively saturate the specification with observable and unobservable bank and firm characteristics. In column (1), there are no bank or firm controls, and both the coefficients on both *Cut* and $\Delta_3 Rate$ are positive and statistically significant. This tells us that three-year-ahead loan defaults increase when monetary interest rates decreased in the five years before the loan was granted, and when there is an increase in monetary policy rates after loan origination. From column (2) onward, we test for the role of the U shape with the introduction of the interaction term between *Cut* and $\Delta_3 Rate$. In column (2), the estimated coefficient on this variable is positive and statistically significant, implying that the effect of recent increases in monetary interest rates on loan default is stronger when monetary rates decreased before loan origination, consistent with our hypothesis. Column (3) includes observable bank controls and firm × bank fixed effects. Even though, the R^2 increases from 3.2% to 55.1%, we obtain very similar results, suggesting that the estimated effects do not suffer from biases due to

Table XII

The Path of Monetary Rates and Loan-Level Defaults in Spain

This table reports OLS regression results of the probability that a loan granted at time t becomes delinquent in the next three years ($t+1$ to $t+3$) for different monetary policy rate paths. Loans are included until 2008 Q3 and we follow loan defaults for three years, and hence the sample is until 2011. *Cut* is a dummy variable indicating whether the change in monetary rates between years $t-5$ and t is below its average value, and $\Delta_3 Rate$ is the percentage point change in the monetary policy rate between years t and $t+3$. All variables are demeaned by subtracting their sample mean. Coefficients are listed in the first row, and standard errors corrected for clustering at the time and bank level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" indicates that it is not included, and "-" indicates that it is absorbed by the included set of fixed effects. For observations, m corresponds to millions. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 level, respectively.

	Dependent Variable: $Loan\ default_{t+1\ to\ t+3}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 Rate_{t,t+3}$	0.001***	0.002***	0.002***	0.000		
	(0.000)	(0.000)	(0.001)	(0.001)		
$Cut\ Rate_{t-5,t}$	0.010***	0.011***	0.011***	0.016***		
	(0.002)	(0.001)	(0.003)	(0.004)		
$\Delta_3 Rate_{t,t+3} \times Cut\ Rate_{t-5,t}$		0.003***	0.005***	0.007***		
		(0.000)	(0.001)	(0.001)		
$\Delta_3 Rate \times Cut \times Bank\ NPL\ ratio$					0.003***	0.003***
					(0.001)	(0.001)
$\Delta_3 Rate \times Cut \times Bank\ NPL \times Real\ estate$						0.005***
						(0.001)
Industry × Location FE	No	No	—	—	—	—
Bank controls	No	No	Yes	Yes	Yes	Yes
Bank FE	No	No	—	—	—	—
Macro controls	Yes	Yes	Yes	Yes	—	—
Time FE	No	No	No	No	Yes	Yes
Firm FE	No	No	—	—	—	—
Firm × Bank FE	No	No	Yes	Yes	Yes	Yes
Firm controls	No	No	No	Yes	Yes	Yes
Lower-level interactions	—	—	—	—	Yes	Yes
Observations	1.1m	1.1m	1.1m	0.7m	0.7m	0.7m
R^2	0.032	0.032	0.551	0.584	0.585	0.585

(further) unobservable omitted variables (following Altonji, Elder, and Taber, 2005; Oster, 2019). In column (4), we restrict the sample to those observations with observable firm financial characteristics and obtain similar results.

In terms of economic effects, a 1 ppt increase in the monetary interest rate after loan origination increases the three-year probability of loan delinquency by 4.4% in relative terms (following Table XII, column (3), given that the average default probability equals 4.5 ppt).[38] The probability of loan delinquency

[38] The 4.4% relative increase is calculated as the ratio of 0.002 (coefficient on $\Delta_3 Rate$ in column (3) of Table XII) to 0.045 (the sample mean of loan defaults from Table IA.XXX) in percentage points.

increases by 24.6% if monetary rates were cut around loan origination (from the coefficient on the *Cut* dummy in column (3)). In addition, a 1 ppt increase in the monetary policy rate after periods of declining monetary policy rates raises the probability of loan default by 11.2% (again, based on column (3)). Summing the coefficients, the probability of delinquency increases by 40.2% if, at origination, the *Cut* dummy is equal to one, and monetary rates increase by 1 ppt over the following three years.

Columns (5) and (6) of Table XII show that the increases in default rates are stronger for loans given out by weaker banks to ex ante riskier firms (those in the construction and real estate sector). Going from the 25^{th} to 75^{th} percentile of the NPL ratio distribution additionally increases the likelihood of default after U-shaped monetary policy by 14.1% (using the estimates in column (5)). Column (6) shows that the probability of default increases by an additional 23.5% if the firm operates in the construction and real estate sector and for an interquartile range change of bank NPL ratio. Banks with higher ex ante NPLs not only have higher ex post loan defaults after a U shape in monetary rates, but especially higher defaults on loans to riskier firms. Table IA.XXXI shows that the effects of U-shaped monetary rates on ex ante riskier loans are very strong when we consider loans of longer maturity, which had a long exposure to the low-interest-rate period. For example, the triple and quadruple interaction coefficients in column (6) of Table XII (coefficients of 0.003 to 0.005) become larger if we consider firms that have long-maturity loans, especially for those firms with the largest portion of long-term debt (coefficients of 0.004 to 0.012 in Table IA.XXXI).

IV. Conclusion

In this paper, we analyze the link between monetary policy dynamics and financial stability using long-run data for 17 countries going back to 1870, and detailed administrative data covering the post-1995 period in Spain. We find that, on average, before a (deep) banking crisis, monetary rates follow a U shape, with a long period of monetary rate cuts followed by rate increases. Moreover, we show that a U-shaped monetary rate path substantially increases banking crisis risk. These patterns are unique to banking crises as opposed to (even deep) noncrisis recessions, and are stronger for a deeper U-shaped pattern of cuts and raises beyond the systematic monetary rate component.

The mechanisms are related to the interaction of U-shaped monetary rates and financial red zones of high credit and asset price growth, which is crucial not only for monetary policy, but also for financial booms and crises. Long periods of monetary loosening increase the probability of being in a financial red zone, with evidence consistent with higher credit supply (including bank risk-taking and some mispricing). Subsequent monetary rate increases then crystallize the red zone financial vulnerabilities, strongly decreasing credit and asset prices, and substantially increasing stress in the banking sector with an especially important role for realized credit risks. Crucially, red zones without U shapes (or monetary rate U shapes without red zones) are not strongly linked to subsequent banking crises. We provide consistent evidence on the importance of credit supply expansions, bank risk-taking, and subsequent realized credit risks through a detailed study of the 2008 to 2009 real estate boom and banking crisis in Spain using administrative loan-level data.

Overall, our analysis shows that the dynamic path of monetary policy rates is crucial for financial stability. Our paper does not offer a normative implication, but it suggests important trade-offs, pointing toward a subtle and nuanced view on the use of monetary policy to mitigate financial stability risks. For example, previous studies suggest that to reduce crisis risk, policymakers can raise monetary policy rates to lean against the wind and lower credit and asset price growth. Our findings show that if monetary rates are cut over a long period of time, allowing financial vulnerabilities to build-up, (strong) subsequent monetary rate hikes are likely to crystallize these vulnerabilities and dramatically increase crisis risk.

Our results therefore suggest that if policymakers wish to reduce crisis risk, they should (i) avoid large discretionary cuts in monetary rates, especially if these monetary cuts over a long period generate a red zone of very high credit and asset price growth, (ii) act preemptively before the red zone if monetary rate increases are needed, (iii) moderate the magnitude of rate hikes if tightening policy in the red zone, and (iv) use other tools such as tighter bank supervision to address financial stability risks if strong monetary rate hikes are needed in the red zone. These mechanisms and policy recommendations are in line with recent the theoretical work of Boissay et al. (2023) and Goldberg and López-Salido (2023). Important avenues for future research include understanding why policymakers cut monetary rates over extended periods—potentially creating financial vulnerabilities—and examining how the interaction between monetary policy dynamics and other policies, such as banking supervision and macroprudential regulation, influences crisis risk.

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Supporting Information

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Appendix S1: Internet Appendix.
Replication Code.