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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. Monetary rate hikes (raw or instrumented using the international finance's trilemma) materially increase crisis risk, but only if rates were previously cut (or low) for long. Differently, non-crisis recessions are associated with rate hikes but no U. Regarding the mechanism, rate cuts in the first half of the U increase the likelihood of vulnerable

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"red zones" of high credit and asset prices, while subsequent rate hikes within "red zones" tend to trigger crises. U-shaped monetary rates are also associated with boom-bust dynamics in bank stock returns and profits (in long-run data), and with higher loan defaults, especially for ex-ante riskier borrowers and banks (in post-1995 administrative data for Spain). Overall, results suggest that monetary policy dynamics are crucial for financial stability.

Keywords: banking crises, monetary policy, financial stability, credit, asset prices, banks, macro-finance

JEL classification codes: E51; E52; E44; G01, G21; G12.

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1. INTRODUCTION

With annual inflation rates reaching 10% in 2022, central banks in Europe and the U.S. started raising monetary policy rates to fulfill their price stability mandates. These policy actions, however, carry non-trivial trade-offs, not only between monetary tightening and the risk of a recession (Blinder, 2023), but also between tighter monetary policy and financial stability, e.g., the risk of a banking crisis (IMF Global Financial Stability Report, April 2023; Speech by Isabel Schnabel, 19 May 2023). These financial stability concerns may be particularly pertinent after a period when monetary rates were cut and kept low for long, as discussed extensively in recent policy and media debates (e.g., The Economist, 8th December 2022; Acharya and Rajan, 2022b; Rajan, 2023), and illustrated by the failures of the Silicon Valley Bank and Credit Suisse, and broader banking distress, in March 2023 (FT, 14 March 2023; WSJ, 20 March 2023; Jiang, Matvos, Piskorski, and Seru, 2023).

The trade-offs between monetary policy actions, taming inflation, and reducing GDP growth are extensively researched and well understood. But much less is known about the effects of monetary policy actions on financial stability, a first-order concern today. Existing studies provide mostly indirect evidence, and do not offer a clear consensus. On the one hand, there is evidence that low monetary policy rates increase lending and asset prices, as well as bank risk taking (e.g., Kashyap and Stein, 2000; Borio and Lowe, 2002; Bernanke and Kuttner, 2005; Adrian and Shin, 2010; Jiménez, Ongena, Peydró, and Saurina, 2014; Becker and Ivashina, 2015; Hanson and Stein, 2015; Di Maggio and Kacperczyk, 2017), factors shown to be strongly associated with future crises (e.g., Greenwood, Hanson, Shleifer, and Sørensen, 2022). On the other hand, when studying the crisis link directly, Schularick, ter Steege, and Ward (2021) find that it is monetary policy rate hikes, rather than cuts, that increase crisis risk (see also Galí, 2014).

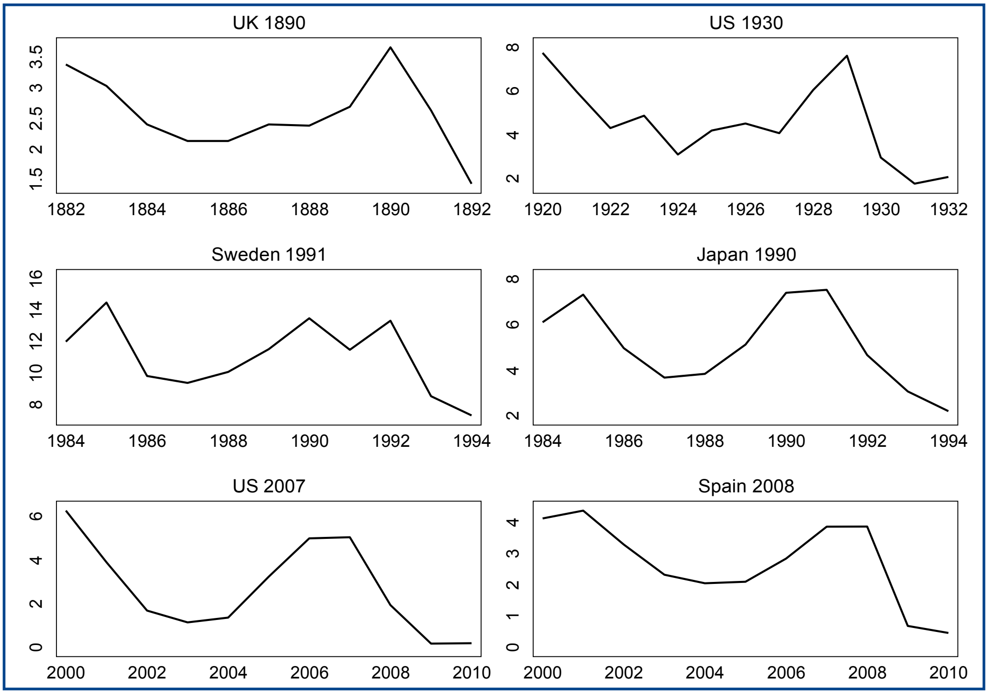
One reason why consensus is hard to reach may be that, when it comes to crisis risk, the whole path of past and current monetary policy rates matters. Recent theoretical work suggests that periods of loose monetary policy may create financial vulnerabilities, for example, through high growth in asset prices and credit, and a subsequent policy tightening may crystallize these vulnerabilities and trigger a crisis (Diamond and Rajan, 2012; Acharya and Rajan, 2022a; Boissay, Collard, Galí, and Manea, 2021; Kashyap and Stein, 2023). However, there is a lack of empirical evidence on the relationship between the full dynamic path of monetary policy rates and financial stability.

In this paper, we study the link between monetary policy rate dynamics and financial stability. In particular, we analyze the impact of the full path of monetary rates on the likelihood of subsequent banking crises, as well as the associated mechanisms. Experience of past crises suggests that the full dynamics of monetary policy rates may indeed matter. Figure 1 shows the level of the short-term monetary policy rate around important past crisis events: the 1930s U.S. Great Depression, the 2007-08 Global Financial Crisis, the Japanese crisis of the 1990s, and the 1990s Swedish banking crisis; as well as the U.K. Baring crisis of 1890. In all these episodes, monetary policy rates display one salient feature: the U-shaped pre-crisis rate path, consisting of sharp monetary policy rate cuts 8 to 3 years before the crisis followed by rate increases in the years running up to the crisis onset.

We show that banking crises in general (not just the case studies in Figure 1) are preceded by U-shaped monetary policy rates, by analyzing many crises and monetary cycles in 17 countries over 150 years. Moreover, raising monetary rates (either raw or instrumented using the international finance trilemma, as in Jordá, Schularick, and Taylor, 2020) materially increases crisis risk, but only if monetary rates were previously cut (or were low) over a long period. These patterns are strong and robust for nominal monetary rates, but much weaker for inflation, real rates, long-term rates, and are different for non-crisis recessions. Regarding the mechanism, (strong) monetary rate cuts increase the likelihood of vulnerable financial "red zones" of high credit and asset price growth (Greenwood et al., 2022), and subsequent monetary tightening within red zones substantially increases crisis risk (and substantially reduces real activity). Differently, red zones without previous rate cuts and red zones without subsequent monetary hikes are not strongly associated with banking crises; similarly, U-shaped monetary rates without red zones are not associated with higher (above-average) crisis risk. U-shaped monetary rates are also associated with boom-bust dynamics in bank stock returns and profits. Finally, in post-1995 administrative data for Spain, a U-shaped monetary rate path increases ex-post loan defaults, especially for ex-ante riskier borrowers and banks.

To study the link between monetary policy cycles and financial stability, we exploit long-run data for 17 countries going back to 1870 (from Jordá, Schularick, and Taylor, 2016), as well as detailed administrative data covering the post-1995 period in Spain (from the credit register matched to firm and bank administrative datasets). This allows us to both cover many banking crises and monetary policy cycles in the long-run cross-country analysis, and cover the universe of bank loans and defaults in administrative data for one important banking crisis. We use the long-run data to i). Characterize the full path of monetary rates around past crises, ii). Study the path-dependence in the links between monetary rates and crisis risk, and iii). Study the mechanisms linking the path of monetary rates, financial booms, and crises. We then turn to administrative data to zoom in on one of the episodes shown in Figure 1, Spain in the early 2000s, and analyze the heterogeneous effects of the path of monetary policy rates on individual loan defaults by type of bank and borrower.

Figure 1: Monetary policy rates around selected past crisis events.



Notes: Level of the short-term nominal monetary policy rate for selected country and year. The crisis dates we use here follow Baron et al. (2021), while we will later employ the Jordá et al. (2016) chronology, which dates the banking crisis in the Great Depression to 1931 and the Japanese crisis to 1997.

We first document the full path of monetary policy rates, inflation, and real rates around historical banking crisis episodes. We find that the patterns documented for the six case studies in Figure 1 extend to the average crisis in the long-run sample. Short-term nominal interest rates decrease from about 7 years prior to a crisis, before they start rising in the 3 years running up to the crisis. This pattern holds across crisis definitions (a narrative crisis definition from Jordá et al., 2016 and the Baron, Verner, and Xiong, 2021 definition based on bank stock returns), and becomes stronger for the subset of deep crises (in terms of GDP growth) and in the post-1945 sample. The patterns for the pre-crisis paths of inflation, real interest rates, and long-term rates are, on the contrary, weak and non-robust. Moreover, monetary policy rates somewhat increase before economic recessions not associated with a banking crisis (including deep non-crisis recessions), but they do not follow a U shape. This suggests that the observed path dependency is specific to short-term nominal monetary policy rates, and to banking crises as opposed to non-crisis recessions.

We then explore the link between monetary rate dynamics and crises more formally by looking at crisis frequencies after different paths of monetary rates. To do this, we bin the data into four (two by two) different policy rate shapes (paths) based on monetary rate dynamics over an 8-year period, with the U shape corresponding to monetary policy rate cuts over 5 years followed by rate increases over the subsequent 3 years. We then compare crisis frequencies over the 3-year window after the end of each policy shape, and find that crises are much more frequent after U-shaped monetary policy. For example, the frequency of systemic banking crises after a monetary rate U shape is 20%, which is more than twice the frequency after other monetary rate paths (double raises, double cuts, or a raise and cut Λ-shape), despite the fact that the frequencies of these four monetary cycles are very similar in the data. These differences become even more pronounced when we look at the subsets of deep crises and post-WW2 crises. Most banking crises in the full sample, and all deep crises in the post World War 2 sample, were preceded by a U-shaped path of monetary policy rates. Another way to think about this U shape before crises is that monetary rate hikes entail different financial stability risks depending on the previous path of monetary policy rates. When we put this logic into a regression framework, we find that monetary policy rate increases are associated with a higher likelihood of a subsequent crisis (as in Schularick et al., 2021), but that this relationship is almost entirely due to episodes when monetary rates were previously cut over a long period. To mitigate potential endogeneity concerns in such regressions, we use an instrument exploiting the famous trilemma of international finance (Mundell, 1963). The IV approach is based on variation in base country monetary policy rate changes, and their transmission through exchange rate pegs and the openness of capital accounts, following Jordá et al. (2020) (see also Maddaloni and Peydro, 2011; Jiménez, Ongena, Peydró, and Saurina, 2012, 2014, for similar applications).[1]

The results confirm our hypothesis that the effect of monetary policy on crisis risk is highly path dependent. Three-year increases in monetary rates only materially increase crisis risk if rates had been cut over the five-year window before, or relatedly, if monetary policy rates have been low for long. The effects that we find are both economically and statistically significant: a cut in monetary rates during years $t - 8$ to $t - 3$ followed by a 1 percentage point increase in rates during years $t - 3$ to t increases the probability of a crisis between years t and $t + 2$ by 12 percentage points (in the IV specification). These effects are also much larger than the 3 percentage point increase in crisis probability after an unconditional 1 percentage point increase in monetary policy rates (i.e., not conditioning on the previous rate change). Again, we do not find the same path-dependent effects for inflation, real rates, or when analyzing non-financial recessions rather than banking crises.

We then proceed to analyze the mechanisms behind our main result. As the narrative accounts for our case studies in Figure 1 suggest (see, e.g., Taylor, 2013), the reason for this strong state- dependency may lie in the boom in financial markets potentially triggered by the previous cut in monetary rates. When we study the behavior of asset prices and credit after monetary policy rate changes, we find evidence consistent with this channel. As a combined measure of financial vulnerabilities, we follow Greenwood et al. (2022) and define an economy to be in the financial red zone if credit and asset prices are jointly elevated. It turns out that a cut in monetary rates makes the economy more likely to end up in the red zone. Moreover, we show that only red zones preceded by monetary rate cuts (and not those preceded by monetary rate hikes) are significantly associated with a higher risk of future banking crises.

We next tie crisis risk directly to monetary policy actions in the red zone. We find that the likelihood of a banking crisis when the economy is in a red zone only increases if monetary rates are increased. Differently, there is no association between red zones and banking crises if rates are reduced while in the red zone.

[1] In both the IV and OLS specifications, we control for past GDP growth, inflation, and crises, and we residualize the IV using macroeconomic data for the base country, as in Jordá et al. (2020), so monetary policy rate effects are over and above main business cycle variables.

These results hold both using raw changes in monetary rates, and changes due to the trilemma IV, and they remain in place when we look at real effects of monetary policy directly, with monetary rate increases in the red zone associated with comparatively larger declines in future real GDP growth. We further show that these effects only hold for those red zones which were preceded by cuts in monetary policy rates. Taken together, we find that the frequency of banking crises is highest for the combination of a U in monetary policy rates and a build up of financial vulnerabilities as measured by the red zone. If monetary policy rates were cut between years $t-8$ and $t-3$ and raised between years $t-3$ and t, and the economy was in the red zone in at least one year during $t-3$ to t, the three-year-ahead crisis frequency is close to 40%, roughly four times the unconditional mean. Moreover, U-shaped monetary rates without red zones are not associated with above-average crisis risk.

To further understand the results and the associated mechanisms, we analyze banks' performance depending on the path of monetary policy rates and red zones. We find that the market returns on bank equity are lower when monetary policy rates increase following a period of declining monetary rates. Consistently, accounting profitability (return on book equity) declines over the three years following a monetary policy U. Moreover, not only do bank stock returns decline, but there is also a material increase in the frequency of bank equity crises (with bank returns lower than -30% following Baron et al., 2021) after a U shape in monetary policy rates. We also find that bank stock returns strongly increase prior to the start of a red zone (different from stock returns of non-financial firms), and bank (and non-financial firm) stock returns decline after the start of the red zone. When looking at these episodes in more detail, we find that measures of bank equity sentiment display the same boom-bust pattern as stock returns around red zones, while the capital ratio (a commonly used measure of shareholders' skin in the game) is stable. Together, these findings provide a link between the full monetary policy U shape and financial instability: as monetary policy is first loosened, financial booms and banking sector vulnerabilities build up. When policy is tightened, these vulnerabilities crystallize, potentially triggering a banking crisis.

To analyze heterogeneous effects of U-shaped monetary policy on banks, and hence dig deeper into the mechanisms, we turn to the Spanish credit register data to examine the effect of monetary policy rate dynamics on (ex-post) individual loan defaults. In addition to having the universe of bank loans and defaults via a credit register matched to firm and bank administrative datasets, the advantage of using the Spanish data in this context is that the behavior of monetary rates closely mirrors our instrumental variable strategy in the aggregate data. With Spain joining the European Monetary Mechanism in 1989 and being part of the Eurosystem after 1999, monetary policy rates were decided in Frankfurt, not in Madrid. Before the Global Financial Crisis (GFC) and the euro area sovereign debt crisis, Spanish monetary policy therefore followed the developments in euro area core countries (e.g., Germany) with substantially different economic dynamics from Spain. This allows us to study the implications of monetary policy rate dynamics for loan defaults, including heterogeneities across firms and banks. To focus on the pre-crisis monetary rate U shown for Spain in Figure 1, we limit our baseline analysis to loans granted before the GFC only, but we also provide results for all available data until 2020, before the COVID shock.

We find that a monetary policy rate cut over the previous 5 years before a loan is granted is associated with a significantly higher likelihood of default over the next 3 years. At the same time, 3-year increases in monetary policy rates after a loan was granted are also associated with a higher likelihood of loan default. Importantly, monetary policy rate hikes following a cut are associated with a significantly higher additional likelihood of default. A rate cut over a 5-year period followed by a 1 percentage point raise in rates over the next 3 years increases loan default probability by 32.6% in relative terms (given that the average default probability equals 4.5 percentage points). These results hold across a wide range of specifications, from no controls to including several granular layers of fixed effects to control for unobserved variation. Moreover, we also find that these patterns are more pronounced for ex ante riskier firms (including real estate firms), for loans extended by ex ante riskier banks, and are even stronger for loans extended by riskier banks to riskier firms.

Our paper cuts across several strands of the literature, linking the seemingly ambiguous results on the relationship between monetary policy rates and financial risk, as well as combining evidence from aggregate long-run and granular loan-level data. The closest strand of the literature is the macroeconomic evidence on the link between monetary policy rates and financial stability, which provides some seemingly conflicting results. On the one hand, cuts or low monetary policy interest rates increase credit growth and asset prices, two leading sources of financial instability pointed out in the literature (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, Duarte, Liang, and Zabczyk, 2020; Grimm, Jordá, Schularick, and Taylor, 2023). On the other hand, when studying the link between monetary policy rate changes and crises directly, Schularick et al. (2021) show that it is monetary rate increases, not cuts, that increase crisis risk (see also Galí, 2014). Existing theoretical models also point to potential links between low interest rates, asset prices, and credit (e.g., Stein, 2012) but there is little research on the theoretical links between the full path of monetary policy and crisis risk. As an exception, recent papers by Boissay, Collard, Galí, and Manea (2021) and Acharya, Chauhan, Rajan, and Steffen (2022) argue that a sequence of low interest rates (or loose monetary policy more generally) followed by a policy tightening leads to a higher crisis risk. We contribute to this literature by showing that, empirically, the path of monetary policy rates (raises after long cuts or low rates) is what matters for banking crises.

We also contribute to the literature on monetary policy, credit provision, and risk taking. This literature tends to find that monetary policy easing increases lending (e.g., Kashyap and Stein, 2000; Jiménez, Ongena, Peydró, and Saurina, 2012; Drechsler, Savov, and Schnabl, 2017; Acharya, Imbierowicz, Steffen, and Teichmann, 2020) and encourages bank risk-taking (e.g., Adrian and Shin, 2010; Jiménez et al., 2014; Martinez-Miera and Repullo, 2017). Similarly, there is evidence of reach for yield in non-bank financial intermediaries (e.g., Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017). We contribute to this literature by showing that the full path of monetary policy rates (in particular, the U-shaped rate path) affects financial stability, and by going beyond the micro-level analysis of loan defaults and reach for yield to also study the probability of financial crises, as well as credit and asset price dynamics at the financial system level.

A large literature has studied the link between monetary policy and the macroeconomy (see Ramey, 2016 for an overview), and several papers have argued in favor of important state depen- dencies (e.g., Tenreyro and Thwaites, 2016; Jordá et al., 2020). Berger, Milbradt, Tourre, and Vavra (2021) show that one such state dependency may actually lie in the past path of monetary policy itself, arguing that monetary policy decisions in the US after 2008 may have affected the sensitivity of real activity to future rate changes through mortgage prepayment and, in effect, might have limited future policy space. A similar channel is explored in Eichenbaum, Rebelo, and Wong (2022). While these papers think about this path dependence mostly in terms of the ability to stimulate the economy through interest rate cuts, our results suggest that a similar state-dependency might apply for the sensitivity of financial stability to future rate hikes.

Finally, our results contribute to the large literature on financial crises. This literature has shown that financial crises entail high macroeconomic costs (e.g., Cerra and Saxena, 2008; Reinhart and Rogoff, 2009). At the same time, both crises and their severity are somewhat predictable using "early warning indicators"—such as credit expansions and asset price growth (e.g., Schularick and Taylor, 2012, Borio and Lowe, 2002, Bluwstein, Buckmann, Joseph, Kang, Kapadia, and Simsek, 2021, Greenwood et al., 2022)—and measures of financial vulnerabilities—such as elevated asset prices, leverage, and bank equity losses (e.g., Jordá, Schularick, and Taylor, 2013; Jordá, Schularick, and Taylor, 2015; Jordá, Richter, Schularick, and Taylor, 2021; Baron, Verner, and Xiong, 2021). Our paper contributes to this literature in identifying the path of monetary policy as crucial for crises, in particular long periods of cuts or low rates as one of the sources for the build-up of credit and asset price vulnerabilities, and the reversal in policy interest rates as a trigger for the subsequent loan defaults and crisis dynamics.

The remainder of the paper is organized as follows. We document the full path of monetary policy rates and inflation around crises in Section 2. We analyze the relationship between the dynamic shape of monetary policy and crisis risk in Section 3. We study the underlying mechanisms in long-run data in Section 4, and drill into the heterogeneities across firms and banks using Spanish administrative data in Section 5. Section 6 concludes with some policy implications.

2. MONETARY POLICY AND INFLATION AROUND CRISES

2.1. The path of monetary policy rates around crises

The case studies presented in Figure 1 in the introduction display a very pronounced U shape for monetary policy prior to banking crises. Without further analysis it is, however, difficult to tell whether this pattern of monetary policy is systematic, i.e., indicative of monetary policy rates around crises in general. To study this question, we explore how monetary policy interest rates evolve around an average crisis in long-run cross-country data.

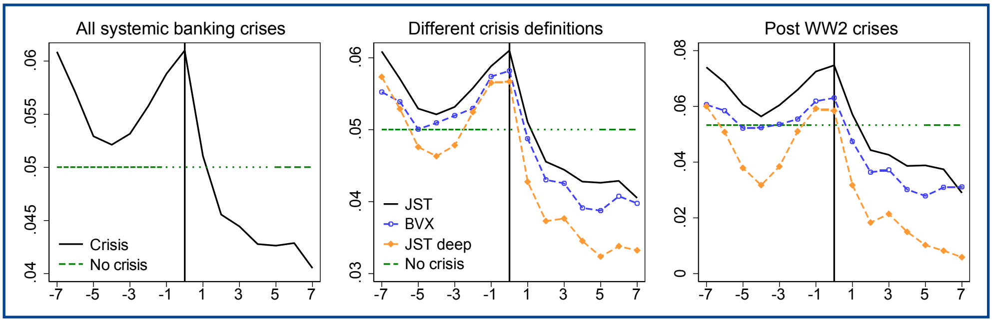
We use the data from the Jordá et al. (2016) macro-history database, which cover 87 systemic banking crisis events (around 70 of which include data on the full path of monetary policy rates around an extended crisis window) across 17 advanced economies (Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States) between 1870 and 2020. For 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 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 et al. (2021), which is based on a mix of narrative chronology and data on bank stock returns (with sharp declines in bank stock returns used as an additional crisis indicator). The monetary policy rate is the nominal short-term interest rate, set by the central bank as the main lending or penalty rate or, when these data are not available, the rate for short-term interbank lending, or the rate on short-term government securities (equivalent to today's Treasury Bills).

Crisis-window averages. We start by plotting the average levels of monetary policy rates around past crises using simple event windows. To do this, 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.[2] The results are shown in Figure 2. The solid black lines show the average level of the short-term interest rate

[2] This sample of 77 crises means that we have at least 13 non-missing monetary policy rate observations in the t 7 to t + 7 crisis window. For the analysis later in the paper (Sections 3 and 4),

(monetary policy rate) for the window from 7 years before to 7 years after the onset of the average crisis. The dashed green lines show the average level of short-term rates across all observations that do not coincide with the crisis start date.

Figure 2: The average level of monetary policy rates around past crises.



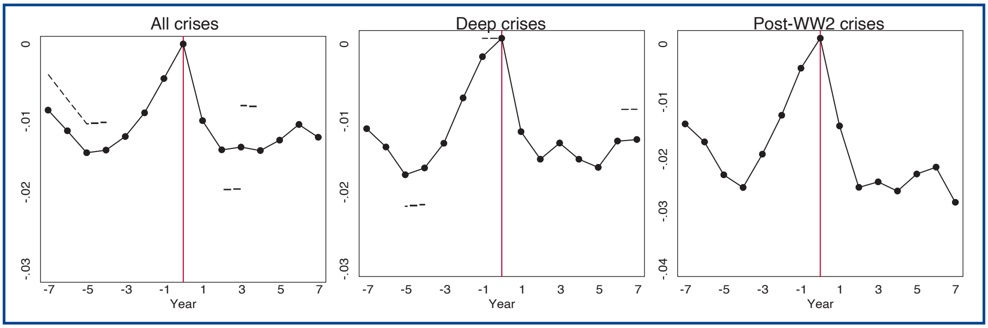
Notes: Unweighted averages of the level of the short-term interest rate (monetary rate) in year t (start of the crisis at t = 0). Total of 77 crises (24 post-WW2). The left panel uses the narrative crisis definition from Jordá et al. (2016). The middle panel additionally considers the Baron et al. (2021) crisis chronology (BVX crises), and deep crises (JST deep crises) defined as Jordá et al. (2016) banking crises with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the t 1 to t + 3 crisis window. The right panel limits the sample to crises that started after 1945. Green dashed lines show the mean of the respective variable for non-crisis observations.

The left-hand panel of Figure 2 shows the monetary policy rate averages around banking crises dated using the Jordá et al. (2016) chronology, which uses a narrative panic definition. The middle panel compares these results to (i) the alternative chronology of Baron et al. (2021) (BVX crises), and to (ii) a "deep crisis" definition which considers only those crises that are accompanied by low GDP growth (-3% in one year, or -1% on average over 3 years, in the $t-1$ to $t+3$ window around the crisis start date). The right-hand panel shows the averages for each of these types of crises during the post-1945 time period. The left panel of Figure 2 shows that the average crisis is preceded by U-shaped monetary policy, with a series of cuts in monetary rates 7 to 4 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 et al. (2021) crisis definition, and is more pronounced for deep crises, especially after World War 2. Overall, the swings in

we further limit the sample to having 8 consecutive monetary rate observations in the run-up to the crisis, which reduces the number of crises in the sample to 68.

policy rates are substantial, around 1 ppt down and up over the full sample, and as large as 3 ppts on average for deep crises starting after World War 2.

Figure 3: Monetary policy rates – crisis window regressions.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing monetary policy rates on the crisis dummy for horizons h = 7, ..., 0, ..., 7, with 0 corresponding to the beginning of the crisis according to the Jordá et al. (2016) chronology. Deep crises are those with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the t 1 to t + 3 crisis window. Post-WW2 crises are those that started after 1945.

Crisis window regressions. To test whether these pre-crisis patterns are statistically significant, we run the following regression:

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

Above, y are monetary policy rates, h = −7, ..., 0, ..., 7 are horizons with yi,t+h − yi,t corresponding to changes between 7 years before year t (h = −7) and year t, 7 years after year t (h = 7) and year t, and so on. 1Crisisi,t =1 is an indicator for the start of a systemic banking crisis in country i in year t, and αi and αd are country and decade fixed effects.[3]

Figure 3 shows the estimated β_h coefficients for different horizons h alongside the 90% confidence intervals, for different crisis definitions and samples. Under all three different crisis definitions,

[3] We add decade fixed effects to control for common cross-country trends in the observed variables, such as the decline in interest rates after 1980 (Holston, Laubach, and Williams, 2017) and the "great moderation" of the 1990s (Stock and Watson, 2002).

monetary policy rates follow a pronounced U shape before the crisis, similar to the patterns for the simple crisis-window averages in Figure 2. The crisis window regressions additionally show that this U shape is precisely estimated, with statistically significant and economically meaningful declines in monetary policy rates between years t − 7 and t − 4 before the crisis, interest rates remaining low in the middle of the window during years t − 4 to t − 3, and sharp statistically significant increases in rates in the run-up to the crisis during years t − 3 to t. The swings in monetary rates are substantial, around 1–2 ppts down and up, on average, over the full sample, and as large as 3 ppts for crises starting after World War 2. Appendix Figure A.1 shows the path of monetary policy rates residualized to changes in other macroeconomic variables such as GDP, investment, and inflation, with similar results.

2.2. The paths of other macro-financial variables

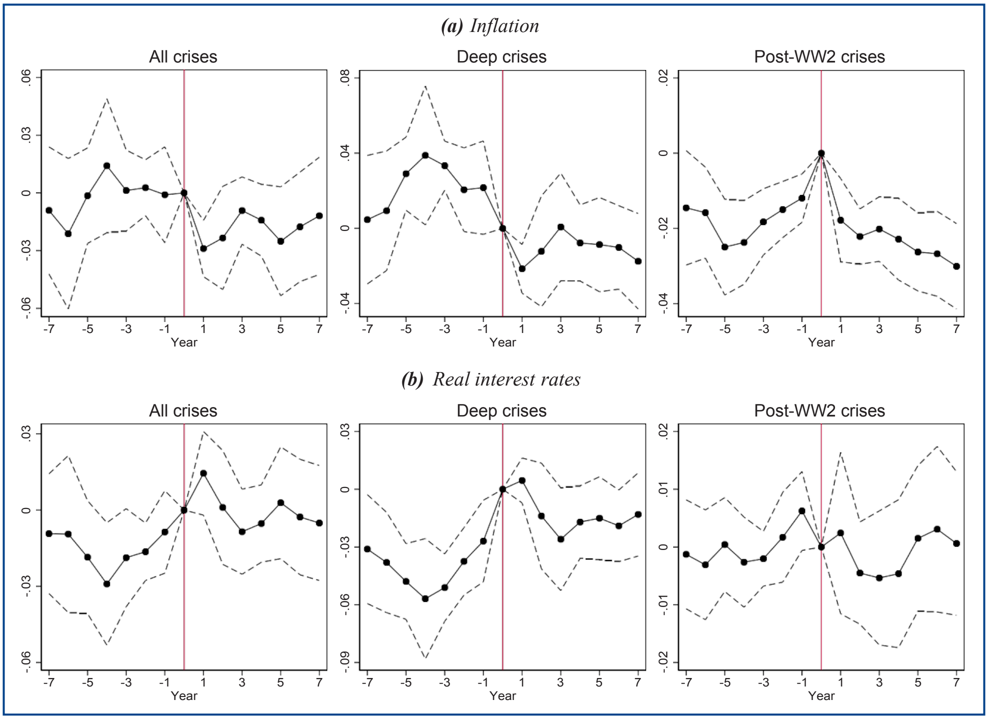
Is the U-shaped path something specific to monetary policy rates, and to banking crises? Or do similar patterns appear for other macro-financial variables that could in turn drive the response of monetary policy (e.g., inflation), for other measures of interest rates (e.g., long-term rates), and for non-financial recessions as opposed to banking crises? We investigate this question next, and find that the U-shaped path is indeed something specific to crises, and to (nominal short-term) monetary policy rates.

Inflation, real rates, and long-term rates. Figure 4a shows the average path of inflation before and after the start of a systemic banking crisis, obtained by using inflation (change in the CPI index) as the y variable in regression (1).[4] Over the full sample, inflation before crises follows no clear pattern and is close to the average (left panel). For deep crises, inflation displays a rough Λ shape, with increases between years t − 7 and t − 4 and drops thereafter. This changes for post-1945 crises, with falls in inflation between t − 7 and t − 5 and increases between t − 5 and t. Many of these patterns are not statistically different from zero. All these results make us conclude that there is little evidence of a specific pre-crisis path of inflation, unlike for monetary policy rates, and there are marked differences in the inflation behavior around crises between the pre- and post-1945 subsamples.

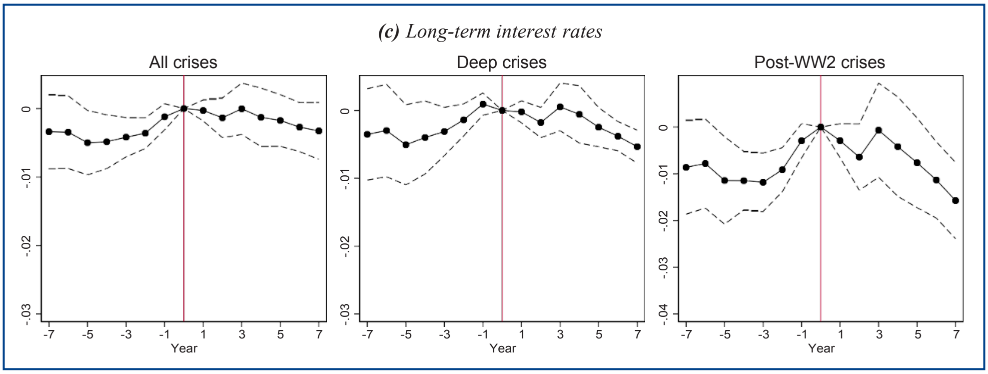
[4] For the CPI and other variables used, see Jordá et al. (2016) for the underlying data sources and definitions.

We obtain similar results for the real interest rate shown in Figure 4b.[5] We observe a U shape in real rates on average before the crisis in the full sample (left and middle panels), even though these estimates are rather noisy given the large observed volatility of real (as opposed to nominal) interest rates. For post World War 2 crises (right panel), there is little change in the real interest rate before or after the crisis. Therefore, as with inflation, we conclude that there is relatively little robust evidence of a specific real interest rate path before the crisis.

Figure 4: Inflation, real rates, and long-term rates – crisis window regressions.

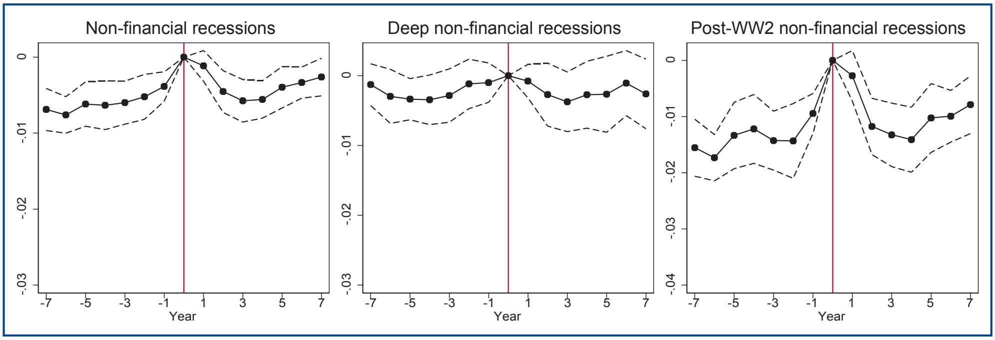


[5] We compute the real interest rate as the difference between nominal rates and realized inflation in a given year, as inflation expectations data are not available for our sample.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing inflation (panel a), real rates (panel b), and long-term interest rates (panel c) on the crisis dummy for horizons h = 7, ..., 0, ..., 7, with 0 corresponding to the beginning of the crisis according to the Jordá et al. (2016) chronology. Deep crises are those with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the t 1 to t + 3 crisis window. Post-WW2 crises are those that started after 1945. Inflation is the change in the log CPI index. Real rate is the difference between the nominal rate and inflation in the same year. Long-term rate is the yield on government bonds of (approximately) 10-year maturity, and the scale in panel (c) is the same as the one used for short-term monetary policy rates in Figure 3.

Figure 5: Monetary policy rates – recession window regressions.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing monetary policy rates on the non-crisis recession dummy for horizons h = 7, ..., 0, ..., 7, with 0 corresponding to the business cycle peak (identified using the Bry and Boschan, 1971 algorithm) that does not overlap with a systemic banking crisis dated according to the Jordá et al. (2016) chronology. Deep recessions are those with a -3% GDP or less growth in one year or average -1% or less growth over 3 years, in the 3-year window after the business cycle peak. Post-WW2 recessions are those that started after 1945.

Similarly, we find no strong evidence for a specific pre-crisis path of long-term interest rates.[6]6 Figure 4c shows the average levels of the (nominal) long-term rate before and after the crisis using the window regression set-up in 1, and the same scale as for the short-term monetary policy rate in Figure 3. There is little change in the long-term rate before and after crises, and any observed changes are much less pronounced than those for short-term monetary policy rates. Note that the robust U shape of short-term interest rates and little variation of long-term interest rates imply that we observe a Λ shape (the opposite of the U shape for short-term rates) in the term premium, the difference between the long- and short-term interest rates (see Appendix Figure A.2).

Recessions. Are these patterns specific to banking crises, as opposed to non-financial recessions? To check for this, Figure 5 shows the average level of the short-term monetary policy rate around non-financial recessions: i.e., those economic recessions (negative GDP growth in one year or more) that were not accompanied by a systemic banking crisis. Again, we use the same scale as for the crisis window regressions in Figure 3. There is little evidence of U-shaped monetary policy 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 World War 2 period when monetary policy was used more actively to manage the economic cycle (Figure 3 right panel). Moreover, we again find no U shape dynamics for deep non-crisis recessions (Figure 5 middle panel), where deep recessions follow an identical definition as deep crises (in terms of GDP growth declines), but in this case without a systemic banking crisis happening around the recession.

[6] "Long" means 10-year, but longer-maturity bonds are used for some of the earlier sample period.

3. THE PATH OF MONETARY POLICY RATES AND CRISIS RISK

What is the link between the dynamic path of monetary rates and crisis risk? We study 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.

3.1. Monetary rate paths and crisis frequencies

We start with a simple analysis of crisis frequencies after different paths of monetary policy rates. Figure 2 showed that on average, crises are preceded by U-shaped monetary policy rates, with several years of cuts in rates followed by several years of increases. But it could still be the case that some other policy paths result in similarly high crisis frequencies compared to the U shape. To check if this is the case, we ask whether crises are more frequent after a U-shaped monetary policy rate path than after other policy rate paths. To do this, we classify pre-crisis monetary policy into four paths (shapes) based on the monetary policy rate changes in the 8 years before the crisis. We divide these 8 years into an initial 5-year period that allows us to capture an extended period of decreasing monetary rates, and a subsequent 3-year period that allows us to capture the subsequent reversal in interest rates before the crisis.[7] First, we classify as the U shape any policy actions that resulted in a cumulative rate cut between years $t-8$ and $t-3$, followed by a raise from $t-3$ to t. Second, we consider double raise episodes of subsequent increases from $t-8$ to $t-3$, and from $t-3$ to t. Finally, we have the Λ shape of raises from $t-8$ to $t-3$ followed by cuts from $t-3$ to t, and double cuts from $t-8$ to $t-3$ and from $t-3$ to t. The number of observations across these four monetary policy shape paths is roughly similar (see Appendix Table A.1).

We then compute the post-path crisis frequency by taking the ratio of crisis observations to all observations with non-missing data after the end of each specific monetary policy rate path. Since the exact timing (year) of the onset of a crisis is difficult to predict, as our baseline definition we consider all crises in

[7] Constant rates are classified as increases, but results do not change if we classify them as cuts.

the three-year window from t to t + 2 after the end of the policy shape at t.[8] The corresponding crisis frequencies, for different crisis definitions, are shown in Table 1. We consider the baseline Jordá et al. (2016) crisis definition in columns 1 (full sample) and 3 (post-WW2), and the deep crises which are accompanied by low GDP growth in columns 2 and 4. Importantly, the number of observations is roughly equal across the four different policy shapes, both in the full sample and after World War 2 (see Appendix Table A.1). This means that the differences in crisis frequencies are driven by different numbers of crises rather than different numbers of observations for each monetary policy rate path.

Table 1: The path of monetary policy rates and crisis frequencies.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U shape (cut, raise)	0.20	0.13	0.18	0.14
Raise, raise	0.08	0.04	0.03	0.00
Raise, cut	0.05	0.02	0.01	0.00
Cut, cut	0.04	0.02	0.02	0.00
Unconditional	0.10	0.05	0.06	0.03

Notes: This table reports the crisis frequency between year t and t + 2 for different crisis definitions and paths of nominal monetary policy rates. Crisis frequency is the ratio of crisis to total observations for different rate paths. Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least 3% GDP growth in 1 year, or 1% average growth over 3 years in the window t 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945. In rows, the 4 bins are defined by the sign of the change (cut or raise) in the nominal monetary rate between t 8 and t 3 and the sign of the change (cut or raise) between t 3 and t. For example, U-shape (cut, raise) refers to a cumulative cut in rates between t 8 and t 3 and a subsequent cumulative raise between t 3 and t. The number of observations is roughly equal across the four policy shape baskets, with the corresponding numbers of crisis and total observations for each monetary rate shape shown in the Appendix Table A.1.

[8] A few of the crises can be associated with different policy shapes depending on where we are in the 3-year crisis window. In these cases, we assign the crisis to the most frequent of these policy shapes within the window. For example, if the crisis is associated with a U in the 8 years preceding time t and t + 1, and a double raise in the 8 years preceding t + 2, we classify it as being preceded by a U.

A U-shaped path of monetary policy rates is associated with a substantially higher risk of systemic banking crises. If monetary rate increases unambiguously increased crisis risk, we would expect the double raise in row 2 of Table 1 to be associated with the highest risk of crises, 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 (20% versus 8% crisis frequency in column 1), and twice as likely compared to the unconditional probability of experiencing a banking crisis during these 3 years (10%).[9] These differences become even larger when we consider deep crises in column 2, and post World War 2 crises in column 3. When it comes to deep systemic banking crises which started after World War 2 (column 4), every single one of these was preceded by a U shape in nominal monetary policy rates, and none by other monetary rate shapes.

Appendix Table A.1 shows the actual numbers of crisis and total observations alongside each frequency. The total observations are roughly equally split across the four different monetary rate paths, but the raw number of crises is much higher for the U shape. In fact, for each time period and crisis definition, most crises were preceded by U-shaped monetary policy. For example, out of 68 crises in our full sample, 39 were preceded by a U in monetary rates and 29 by other monetary rate paths. Appendix Table A.2 shows that these results hold if we consider a narrower 1-year crisis window instead of the 3-year window shown in Table 1, and Appendix Table A.3 shows that they hold for a symmetric 6-year policy shape window (e.g., U is a cut from $t-6$ to $t-3$ followed by a raise from $t-3$ to t).

Differently, Appendix Table A.4 shows that increases in monetary policy rates are crucial for the frequency of non-crisis recessions (as opposed to the U shape being crucial for frequency of banking crises). For example, after World War 2 a deep non-financial recession is more likely after a double raise than after a U shape in monetary policy rates. Across all panels of Table A.4, higher rates (independently of whether previously rates were cut or raised) are what matters.

3.2. The path of monetary rates and future banking crises

Nominal monetary policy rates. We next evaluate whether the U shape in

[9] Given an annual crisis probability of around 3.5%, we have a probability of 10% for at least one crisis observation in a three-year window.

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 path of monetary policy by additionally including a dummy for whether rates were cut in the past, and the interaction of the change in rates with this dummy. To be consistent with the results on pre-crisis window averages in Section 2 and the crisis frequencies in Section 3.1, we use the window of t − 8 to t − 3 to define a dummy for the cut in monetary policy rates, the window of t − 3 to t for the rate increase, and the window of t to t + 2 for the dummy indicating the start of the systemic banking crisis. Specifically, we estimate linear probability models for a crisis occurring between t and t + 2 as follows:[10]

$$\text{Crisis}_{i,t \text{ to } t+2} = \alpha_i + \beta_1 \Delta_3 \text{Rate}_{i,t} + \beta_2 \text{Cut}_{i,t-8,t-3} + \beta_3 \Delta_3 \text{Rate}_{i,t} \times \text{Cut}_{i,t-8,t-3} + \gamma X_{i,t} + u_{i,t \text{ to } t+2}. \quad (2)$$

Above, i and t are country and year indices, Δ_3Rate refers to three-year changes in monetary policy rates, and Cut takes the value of 1 if rates were cut (cumulative change < 0) between years t – 8 and t – 3. $X_{i,t}$ is a control vector that includes eight lags of real GDP growth, inflation, and the crisis dummy.

We run the above regressions both for raw changes in rates Δ_3Rate, and for changes in rates instrumented using the trilemma of international finance following Jordá et al. (2020) (see Maddaloni and Peydro, 2011; Jiménez et al., 2012, 2014, for previous applications). 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 Jordá et al. (2020) and instrument the change in interest rates in a country in a fixed exchange rate regime with the change in rates in the base country residualized conditional on economic conditions in the base country, as follows:

$$\text{Trilemma IV}_{i,t} = \Delta\text{Rate}^{Residual}_{b(i),t} * PEG_{i,t} * PEG_{i,t-1} * KOPEN_{i,t}. \quad (3)$$

[10] Note that we allow here for a contemporaneous relationship between raises in interest rates and banking crises as indicated by our case studies. In robustness exercises in the appendix we confirm that these relationships also hold when we estimate pure forecasting regressions, replacing Crisisi,t to t+2 with Crisisi,t+1.

Table 2: The path of monetary policy rates and crisis risk.

	Dependent variable: $\text{Crisis}_{t \text{ to } t+2}$					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3\text{Rate}_t$	0.02***	0.02***	0.01*	0.03**	0.02*	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
$\text{Cut Rate}_{t\ 8,t\ 3}$		0.07**	0.07**		0.06***	0.06***
		(0.02)	(0.02)		(0.02)	(0.02)
$\Delta_3\text{Rate}_t\ \ \text{Cut Rate}_{t\ 8,t\ 3}$			0.03***			0.06**
			(0.01)			(0.03)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID				82.26	82.72	36.08
Observations	1624	1624	1624	1624	1624	1624

Notes: This table shows linear probability models for a systemic banking crisis occurring between years t and t + 2. All specifications control for 8 lags of GDP growth, inflation, and the crisis dummy. Δ3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV specifications instrument Δ_3Rate with the residualized Jordá et al. (2020) trilemma variable. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Above, $\Delta\text{Rate}^{\text{Residual}}$ is the residual monetary policy rate change for the base country (e.g., Germany for countries in the ERM 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, again following Jordá et al., 2020). PEG variables are dummies for fixed exchange rate regimes, and KOPEN measures the degree of capital account openness.[11] To mirror the set-up of

[11] KOPEN takes values between 0 and 1 based on the rescaled Quinn, Schindler, and Toyoda (2011) indicator.

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.

The results of these regressions are shown in Table 2. Column 1 shows the results of regressing the crisis dummy on three-year changes in monetary policy rates in a simple OLS regression with country fixed effects and lags of GDP growth, inflation and crises as controls. Similar to the results in Schularick et al. (2021), we find that an increase in monetary rates is associated with elevated crisis risk over the following years. A 1 percentage point cumulative increase in interest rates between years t − 3 and t is associated with a 2 percentage point higher probability of a systemic banking crisis between years t and t + 2. Column 2 shows that a cut in rates between t − 8 and t − 3 is associated with higher crisis risk, consistent with other studies finding a link between loose monetary policy and the build-up of financial vulnerabilities (Bernanke and Kuttner, 2005; Maddaloni and Peydro, 2011; Dell'Ariccia et al., 2017; Grimm et al., 2023). The probability of a crisis between years t and t + 2 is 7 percentage points higher if rates were cut between t − 8 and t − 3. In column 3, we additionally include the interaction between the two monetary policy variables, corresponding to equation (2). The interaction coefficient is significant, suggesting that increases in monetary rates are associated with crisis risk particularly when there has been a cut in monetary rates previously. A 1 percentage point cumulative increase in rates during years t − 3 to t is associated with 4 percentage points higher crisis probability during years t to t + 2 if rates were previously cut (the sum of Δ_3Rate and Δ_3Rate × Cut coefficients in column 6), and only 1 percentage point higher crisis probability if they were not (the Δ_3Rate coefficient).

In Table 2 columns 4 to 6 we instrument three-year changes in monetary rates (Δ3Rate) with the residualized trilemma shocks coded according to equation (3), following Jordá et al. (2020). Instrumented three-year changes in monetary rates in column 4 are associated with a higher likelihood of crises. The first-stage relationship between the trilemma instrument and monetary policy rates is strong, as indicated at the bottom of the table by the Kleibergen-Paap Weak ID statistic (well above the critical threshold). In column 6 we additionally include the interaction of the three-year changes in monetary rates and the dummy variable for a previous cut from t − 8 to t − 3, instrumenting the rate change with the trilemma IV, and the interaction with the trilemma IV interacted with the cut dummy. The Kleibergen-Paap weak ID test reported below is the joint test for both instrumental variables.

The results confirm that the association between rate hikes and crises is driven by those rate hikes which happen after a period of rate cuts as indicated by the significant interaction term. Compared to OLS, the IV coefficients are larger (and marginally statistically different from OLS, at 10% level, in some specifications), 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 2 column 6, a monetary rate increase between years $t-3$ and t is not associated with higher crisis risk if rates were not previously cut (Cut dummy equals zero): the coefficient on Δ_3Rate is zero and statistically insignificant. A monetary rate increase after a series of cuts, on the contrary, is associated with a subsequent 6 percentage point higher crisis probability for every 1 percentage point cumulative 3-year increase in monetary policy rates. Summing together the Cut and Δ_3Rate × Cut coefficients in column 6, a sequence of reducing rates and then increasing them by 1 percentage point over three years is associated with a 12 percentage points increase in crisis risk, more than doubling the crisis probability compared to the sample mean of 10%.

Robustness. In Appendix Table A.5, we show that the relationship in Table 2 holds for 1-year ahead crisis prediction, in post-1945 data, using Driscoll-Kraay standard errors and including decade fixed effects and a large set of control variables. Table A.6 shows that these results also hold for crises using as an alternative chronology of crisis dates in Baron et al. (2021). These state-dependent patterns are also reflected in real GDP growth, which is significantly lower following a monetary rate U as indicated by the interaction term in Appendix Table A.8. Appendix Table A.7 additionally shows that results hold if we use probit rather than linear probability models of crisis risk. While we do not argue that policymakers should use their own actions as a signal of impending crisis risk, the table also shows that adding the three variables which characterize the path of monetary policy to the crisis prediction framework significantly improves the AUC (area under the curve), a commonly-used measure of forecast accuracy.

Duration and depth of the U. U-shaped monetary policy is associated with a higher risk of systemic banking crises, but does this relationship become stronger if the U shape lasts for a longer period of time, or is more pronounced (i.e., the U is deeper)? Table 3 evaluates whether crises become more likely the longer a period of low interest rates lasts before rates are raised. To do this, we first define monetary rates at time t as low if rates are below their moving average over the preceding 10-year window. We then combine consecutive observations of low monetary rates into a spell of low interest rates to measure how long a low spell has lasted as of year t – 2. Using this information, we test whether raising monetary policy rates between years t – 2 and t – 1 is associated with a higher likelihood of a crisis between years t and t + 2, and whether this effect becomes stronger the longer the preceding low rate spell. Table 3 column 2 shows that the likelihood of a crisis is increasing in the interaction between rate changes and the length of the preceding low interest rate spell. The longer a low interest rate environment has lasted, the higher the risk of triggering a crisis by increasing rates. This result is confirmed when we instrument the yearly change in monetary rates with the trilemma IV in column (4). Another way to think about this increase in rates in a low interest rate environment is to focus on the end of a low monetary rate spell (the first year the condition that current monetary rates are below the 10-year moving average is not met anymore). In line with the previous results, column (5) shows that the end of a low interest rate environment is associated with a higher likelihood of a banking crisis, and this likelihood increases the longer the previous spell was going on (column 6).[12]

Table 3: Low-for-long monetary policy rates and crisis risk.

	Dependent variable: $Crisis_{t\ to\ t+2}$					
	OLS		IV		OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Rate_{t\ 1}$	0.04***	0.01	0.04	-0.05		
	(0.01)	(0.01)	(0.03)	(0.04)		
log(No. years (low rate)$_{t\ 2}$)	0.01	0.01	0.02	0.01		0.00
	(0.02)	(0.02)	(0.02)	(0.02)		(0.02)
$\Delta Rate_{t\ 1}$ log(No. years (low rate)$_{t\ 2}$)		0.03**		0.07***		
		(0.01)		(0.03)		
End of low rate spell$_{t\ 1}$					0.06***	-0.01
					(0.01)	(0.03)

[12] The results in Table 3 also hold if we define the low-rate dummy based on residualized interest rates taking into account business cycle dynamics, results available upon request.

$End_{t\ 1}$ log(No. years (low rate)$_{t\ 2}$)						0.06***
						(0.02)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID			47.20	14.95		
Observations	976	976	836	836	976	976

Notes: ΔRatet is the yearly change in monetary policy rates. No. years (low rate) measures the number of years monetary rates have been lower than their average over a preceding 10-year window. IV specifications instrument ΔRatet with the Jordá et al. (2020) trilemma instrument. IV interaction specifications additionally include the interaction of the log number of years in a low spell with the trilemma IV. In this case the Kleibergen-Paap Weak ID is the joint test for both instruments. End is an indicator that is one if monetary rates are above the 10-year moving average for the first time after a spell of low monetary rates. All specifications control for 8 lags of GDP growth, inflation and past crises. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 4: Real interest rates, inflation, and crisis risk.

	Dependent variable: $Crisis_{t\ to\ t+2}$					
		Real rates			Inflation	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 Var_t$	0.002	0.002	0.001	0.000	0.001	-0.000
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$1(\Delta Var_{t-8,t-3} < 0)$		0.009	0.009		-0.006	-0.006
		(0.024)	(0.024)		(0.024)	(0.024)
$\Delta_3 Var_t\ 1(\Delta Var_{t\ 8,t\ 3} < 0)$			0.002			0.002
			(0.003)			(0.002)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Observations	1624	1622	1622	1622	1622	1622

Notes: This table shows linear probability models for a systemic banking crisis occurring between years t and t + 2. Var refers to the real interest rate in columns 1–3, and inflation in columns 4–6. Inflation is the change in the Consumer Price Index. Real interest rate is the difference between the nominal rate and inflation in the same year. OLS regressions with country fixed effects. All specifications control for 8 lags of GDP growth and the crisis dummy. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

As an alternative way to gauge the effect of U depth on crisis risk, we rely on an additional measure of the U-shaped policy path, which allows us to construct a more direct measure of its depth. We construct this measure as the deviation in year $t - 3$ from the linear trend line connecting the level of monetary rates in $t - 8$ and t. If realized monetary policy rates in $t - 3$ are below this line, a dummy variable for the U-shape takes unity. If monetary rates in $t - 3$ are more than 1 percentage point below this line, we additionally define a dummy variable for a deep U. The results of including these two variables in the crisis regressions are shown in Appendix Table A.9. We find that a U-shaped monetary rate path is associated with significantly higher likelihood of crises, and this effect is driven particularly by deep U shapes.

Table 5: The path of monetary policy rates and non-financial recessions.

	Dependent variable: Recession$_{t\ to\ t+2}$				Deep recession$_{t\ to\ t+2}$	
	OLS		IV		OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Δ_3Rate$_t$	0.02***	0.02**	0.06***	0.06***	0.01*	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Cut Rate$_{t\ 8,t\ 3}$		-0.02		-0.05	-0.00	-0.02
		(0.03)		(0.03)	(0.02)	(0.02)
Δ_3Rate$_t$ × Cut Rate$_{t-8,t-3}$		0.02		-0.00	-0.00	-0.01
		(0.01)		(0.02)	(0.01)	(0.02)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID			88.99	41.98		39.21
Observations	1624	1624	1624	1624	1624	1624

Notes: This table shows linear probability models for non-financial recessions (business cycle peaks not associated with a banking crisis) occurring between years t and $t + 2$. Deep non-financial recessions are those associated with a -3% GDP or less growth in one year or average -1% or less growth over 3 years, in the 3-year window after the business cycle peak. All specifications control for 8 lags of GDP growth, inflation and (deep) recessions. IV specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Inflation and real rates. We next compare the results on the path-dependence of crisis risk with nominal short-term rates to those of real rates and inflation. Here, we report the OLS results for both of these variables in Table 4. Different to nominal monetary rates, higher real rates are not robustly associated with higher crisis risk, and there are no clear state-dependencies concerning the real interest rate path and risk of future crises in the data. A similar result holds for inflation, shown in columns 4 to 6, with increases in inflation not associated with a higher risk of crises, and no path-dependencies between the sequence of high and low inflation episodes on the one hand, and crisis risk on the other.

Non-financial recessions Finally, we ask whether these patterns apply to the business cycle more generally. Here, instead of focusing on banking crises, we replace the dependent variable in equation (2) with the occurrence of a non-crisis business cycle peak in the same three-year window from t to t+2. Table 5 shows that increases in monetary policy rates are associated with a higher likelihood of a (deep) non-financial recession. However, this relationship does not depend on the previous path on monetary rates as shown by the insignificant interaction terms. This means that raising rates increases the likelihood of a recession, consistent with previous literature (Blinder, 2023). But when it comes to banking crises, raising rates after previous cuts, and the U-shaped path, are what really matters. We next investigate why this is the case, i.e. which mechanisms connect the U-shaped monetary rate path to financial instability.

4. UNDERSTANDING THE MECHANISMS IN THE LONG-RUN DATA

Why is the U shape in monetary policy rates associated with higher crisis risk? Previous studies have shown that banking crises are accompanied by a boom-bust pattern in credit and asset prices: before the crisis, credit and asset prices boom, while the crisis onset sees these financial booms reverse alongside a slowdown in economic activity (Schularick and Taylor, 2012; Greenwood, Hanson, Shleifer, and Sørensen, 2022; Mian, Sufi, and Verner, 2017). In Appendix Figure A.3, we confirm that these patterns also hold in our sample: the 7 years before the onset of the crisis are associated with above-average growth in credit, asset prices, and real activity, while the crisis aftermath is associated with deleveraging and an economic slowdown.

Does monetary policy play a role in driving these financial cycles? We know from previous research that monetary loosening brings about a higher growth in asset prices and credit, and monetary tightening leads to declines in these variables (Kashyap and Stein, 2000; Bernanke and Kuttner, 2005; Jiménez et al., 2012; Gertler and Karadi, 2015; Drechsler et al., 2017; Jordá et al., 2020). In Appendix Figure A.4, we confirm that monetary rate cuts (both raw and instrumented) are associated with higher credit and asset price growth in our sample. But we know little about the link between the path of monetary policy rates and the financial cycle. To study this, we first test whether monetary policy rate cuts during the initial stage of the U are conducive to a joint credit and asset price boom defined as the financial "red zone" (R-zone) following Greenwood et al. (2022). We then test whether the subsequent rate increases can trigger a banking crisis, and whether there are important interaction effects and state-dependencies.

4.1. The path of monetary rates, financial red zones, and crises

Rate cuts and entering the R-zone. Decreases in monetary policy rates are associated with increases in asset prices and credit growth over the next few years (Appendix Figure A.4). We now ask whether we can link monetary rate cuts to a joint measure of financial vulnerabilities which captures large increases in both credit and asset prices, shown to be especially conducive to crises. To do this, we rely on a simple proxy recently established by Greenwood et al. (2022), the financial red zone (R-zone), defined as periods when asset prices and credit are jointly elevated. We follow them and define the R-zone indicator variable as the joint occurrence of high credit and asset price growth over the preceding 3 years, with high credit growth defined as being above the 80th 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 66.7th percentile of the distribution of three-year changes in real asset prices (the same thresholds as in Greenwood et al., 2022). We compute this indicator separately for business lending & stock prices (business R-zone), for household lending & house prices (household R-zone), and jointly based on being either in the household or business R-zone.[13]

Table 6: Monetary policy rate cuts and the financial red zone.

Dependent variable:	R-Zone $BUS_{t+1 \text{ to } t+3}$		R-Zone $HH_{t+1 \text{ to } t+3}$		R-Zone $Either_{t+1 \text{ to } t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Cut $Rate_{t\,5,t}$	0.06**	0.01	0.12***	0.07**	0.11***	0.04
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Large Cut $Rate_{t\,5,t}$		0.08***		0.08**		0.13***
		(0.03)		(0.03)		(0.03)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Observations	1693	1693	1521	1521	1750	1750

Notes: 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. Cut (large cut) is a dummy that takes unity if the cumulative change in monetary rates between t-5 and t is negative (in the lowest quartile of the distribution). All regressions control for five lags of real GDP growth, inflation and crises. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Based on this chronology, we then ask whether long periods of monetary policy rate cuts are predictive of the economy ending up in the R-zone. To do this, we rely on the simple rate cut indicator variable Cutt−5,t introduced in Section 3.2 and equation (2), and ask whether cuts in monetary rates over the past 5 years

[13] If no decomposition into household and business credit is available, we use an indicator for high growth of total private credit.

are associated with the probability of being in the R-zone over the following three years. The dependent variable is hence an indicator for at least one of the following years t + 1 to t + 3 being associated with an R-zone. Columns 1, 3, and 5 of Table 6 show that cuts in monetary policy rates are associated with a higher likelihood of ending up in the business or household R-zone, and columns 2, 4, and 6 show that this relationship is in large part driven by large cuts in monetary rates (the bottom quartile of the rate change distribution). A large cut in monetary policy rates over a 5-year period increases the probability of being in the R-zone over the next 3 years by 13 percentage points (Table 6 column 6).

Raising rates in the R-zone and crises. Monetary rate cuts, especially if these cuts are large, make the economy more likely to end up in the financial red zone. Greenwood et al. (2022) show that these episodes are associated with a higher likelihood of subsequent crises. But what is driving the transition from R-zones to crises? One potential candidate is, again, monetary policy, and in particular, increases in rates. Put differently, is raising monetary rates while in the red zone associated with a particularly strong increase in crisis risk? To check for this, we add a dummy for being in the R-zone over the last three years to linear probability models for a banking crisis, and interact it with an indicator for monetary rates being raised. The results of these regressions are shown in Table 7.

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 7 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. Differently, if the economy is in the R-zone and rates are not raised, crisis risk does not increase materially. Appendix Table A.10 shows that these patterns also hold when we consider household and business R-zones separately. Appendix Figure A.5 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. Note that looking at GDP rather than a 0/1 dummy gives us more time variation in the outcome variable, and the specifications in Figure A.5 also hold when including year fixed effects to control for unobserved cross-country confounding factors.

Table 7: Raising rates in the financial red zone and crisis risk.

	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)
$\text{R-Zone}_{t\ 3\ \text{to}\ t\ 1}$	0.12***	0.04*	-0.08	0.17***	0.06*	-0.03	0.01	-0.01	-0.08
	(0.02)	(0.02)	(0.08)	(0.04)	(0.03)	(0.10)	(0.04)	(0.02)	(0.12)
$I(\Delta_3 Rate_t \geq 0)$		0.05**	-0.10		0.06**	-0.07		0.10***	0.04
		(0.02)	(0.07)		(0.02)	(0.08)		(0.02)	(0.08)
$\text{R-Zone}_{t\ 3\ \text{to}\ t\ 1}$ $I(\Delta_3 Rate_t \geq 0)$		0.16***	0.41**		0.20***	0.41**		0.04	0.19
		(0.05)	(0.17)		(0.07)	(0.20)		(0.08)	(0.27)
Country fixed effects	√	√	√	√	√	√	√	√	√
Controls	√	√	√	√	√	√	√	√	√
Kleibergen-Paap Weak ID			21.14			17.36			2.71
Observations	1474	1474	1474	1474	1474	1474	1474	1474	1474

Notes: Financial 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. $\text{R-zone}_{t\ 3\ \text{to}\ t\ 1}$ takes unity 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 cumulated trilemma shocks over the three-year window being positive, and its interaction with the R-zone indicator as instruments. In this case the Kleibergen-Paap Weak ID is the joint test for both instruments. All regressions control for three lags of real GDP growth, inflation, and crisis. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

We next ask whether the effects of raising rates on crisis risk are stronger especially for those R-zones which were preceded by cuts in monetary policy rates. To do this, columns 4–9 of Table 7 distinguish between those R-zones which were preceded by rate cuts (columns 4 to 6), and those R-zones preceded by rate increases (columns 7 to 9). We find that the strong relationship between R-zones and crisis risk only holds for those R-zones which were preceded by rate cuts (column 4).

Moreover, columns 5 and 6 show that raising rates while in an R-zone preceded by monetary rate cuts is strongly associated with crisis risk, both for raw (column 5) and instrumented (column 6) rate changes. If the R-zone was preceded by monetary rate hikes, however, R-zones are not associated with subsequent crises (column 7), and raising rates once in the pre-raise R-zone does not lead to a significant additional increase in the risk of a systemic banking crisis (columns 8 and 9).[14]

Monetary policy U, R-zones, and crises. The results above point to a strong link between U-shaped monetary policy, R-zones, and crises. To summarize these linkages, Table 8 shows the crisis frequencies for different monetary policy rate paths and red zones. The top row shows the frequency of crisis observations over the next years if, over the previous 8-year period monetary policy followed a U shape, and the economy was in an (either household or business) R-zone in any of the years between $t - 3$ and t (the years following the monetary rate cuts). The second row shows the crisis frequencies for U-shaped monetary rate paths that were not accompanied by the R-zone, and the bottom two rows show the frequencies for non-U-shaped paths of monetary rates with or without R-zones, respectively.

Among all these observations, it is the combination of a U-shaped monetary rate path and R-zones that really stands out in terms of crisis risk. If monetary policy rates follow a U shape and the economy is in the R-zone during the latter years of the U, crisis frequency over the next 3 years is around 40% for all crises, and 26–32% for deep crisis (Table 8 top row). Differently, for U-shaped monetary policy without an R-zone (second row), the crisis frequency is close to the unconditional mean. For R-zones without U-shaped monetary policy in the third row of Table 8, the crisis frequencies are below the unconditional mean, at 6% or lower. Appendix Table A.11 shows the corresponding numbers of crisis and total observations for each of the policy shape and R-zone bins in Table 8. For most of the observations in our sample, the economy is not in the R-zone and monetary policy does not follow the U shape (bottom row of Table A.11). But if there is no R-zone or U-shaped policy, the crisis frequency is also very low: e.g., out of the 13 post World War 2 deep crises, 11 were preceded by an R-zone and U-shaped policy (i.e., 85% of all crises), even though this combination of policy rate paths and R-zones only accounts for 17% of total observations in this part of the sample.

[14] In our sample, relatively few R-zones are not preceded by rate cuts, consistent with the much higher probability of ending up in the R-zone reported in Table 6.

Table 8: U-shaped monetary rate path, red zones, and crisis frequencies.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U-shaped MP & R-zone	0.38	0.26	0.40	0.32
U-shaped MP & no R-zone	0.09	0.08	0.04	0.04
No U-shaped MP & R-zone	0.09	0.05	0.04	0.00
No U-shaped MP & no R-zone	0.05	0.02	0.02	0.00
Unconditional	0.09	0.06	0.06	0.03

Notes: This table reports the crisis frequency between year 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. U-shaped MP means monetary rates were cut between year 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 either a household or business R-zone in at least one of the years between t 3 and t; whereas no R-zone means it was not in either business nor household R-zone in any of those three years. Crisis frequency is the ratio of crisis to total observations in those years. Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least −3% GDP growth in 1 year, or −1% average growth over 3 years in the window t − 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945.

Taken together, our findings in this section bring a much more nuanced view on the use of monetary policy to reduce financial vulnerabilities. Several prior studies have suggested that in order to reduce the booms in credit and asset prices, the policymakers could lean against the wind by raising monetary policy interest rates (Adrian and Liang, 2018; Gourio, Kashyap, and Sim, 2018; Greenwood et al., 2022). Based on the results presented in our paper so far, however, once in the R-zone, such a policy action is much more likely to trigger the crisis by crystallizing the financial vulnerabilities that built up during the period of low interest rates. Therefore, our findings suggest that it is important to address these asset price and credit booms before the economy enters the financial red zone.

4.2. The path of monetary rates and banking sector performance

Banks are important providers of credit to the macroeconomy, and there is also extensive evidence that monetary policy affects bank lending, including risk taking. Moreover, our evidence points to bank lending (red zones) and monetary policy as both being crucial for crisis risk. Therefore, in this section we analyze the performance of banks (similarly to what we did before for crisis risk) depending on the full dynamic path of monetary policy.

To study this, we run the same regression as our baseline specification for crises in equation (2) (Section 3.2), but use cumulative bank stock returns over the years t to t + 2 instead of the crisis dummy as the dependent variable. We control for 8 lags of bank stock returns, GDP growth, inflation, and the crisis dummy, again mirroring the set-up in equation (2). The resulting coefficients of interest are, again, β_1 which measures the impact of changes in monetary policy rates on bank stock returns, β_2 which captures the impact of prolonged cuts in interest rates, and β_3 which measures the interaction of the two.

Table 9: The path of monetary policy rates and bank stock returns.

	Dependent variable: real bank stock return, t to t +					
		2 OLS			IV	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ_3Rate$_t$	-4.03***	-3.99***	-2.95***	-3.89**	-3.80**	-1.45
	(0.49)	(0.51)	(0.63)	(1.66)	(1.73)	(1.77)
Cut Rate$_{t\ 8,t\ 3}$		-1.34	-1.62		-1.49	-1.99
		(2.77)	(2.72)		(2.98)	(2.48)
Δ_3Rate$_t$ Cut Rate$_{t\ 8,t\ 3}$			-2.74**			-6.92*
			(1.26)			(4.12)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID			69.51	66.68		26.88
Observations	1296	1296	1296	1296	1296	1296

Notes: The dependent variable are cumulative bank stock returns over the years t to t + 2. All specifications control for 8 lags of GDP growth, inflation, bank stock returns, and the crisis dummy. Δ_3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV specifications instrument Δ_3Rate with the residualized Jordá et al. (2020) trilemma variable. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 9 shows the estimated regression coefficients. As with crises, we report both the OLS results for raw changes in monetary policy rates in columns 1–3, and the changes in rates instrumented using the trilemma IV in columns 4–6. Columns 1 and 4 show that monetary policy rate hikes lead to declines in bank stock returns, with a 1 percentage point increase in rates over 3 years associated with 4 percentage points lower bank stock returns over the subsequent 3-year period. Similarly to crises, we observe important state dependencies in this relationship. Turning to the IV specification including the interaction term in column 6, a 1 percentage point increase in monetary policy rates over a period of 3 years is associated with 7 percentage points lower bank stock returns over the next 3 years if rates were previously cut, but not significantly associated with lower bank stock returns if rates were previously raised.

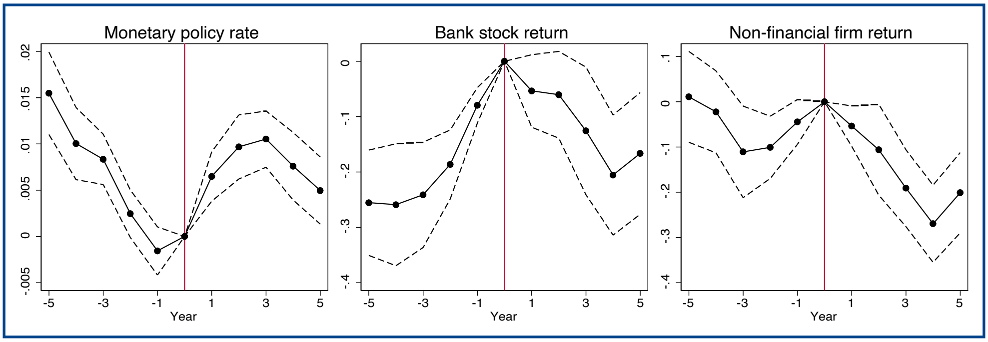
These results show that U-shaped monetary rate dynamics are detrimental to banking sector performance. While Table 9 considers the effects of changes in monetary rates on both positive and negative bank stock returns, in Appendix Table A.13 we focus on the risk of bank equity crises, defined following Baron et al. (2021) as crises with a -30% or lower annual market return on bank equity. We find similar state dependencies: rate hikes materially increase the risk of a bank equity crisis, but only if monetary rates were previously cut over a long time period. In Appendix Table A.14, we show that the response of bank profitability (the change in the accounting return on bank equity, RoE, which includes realized loan losses) to monetary policy exhibits state-dependencies similar to those displayed by stock returns. Monetary policy rate hikes (raw and instrumented) reduce bank profits, but only if monetary rates were previously cut.

In a final step, we plot the path of monetary policy rates, bank stock returns, and the returns on stocks of non-financial firms, around the time that the economy enters the financial red zone. To construct these paths, as before, we rely on window regressions, but now we run these regressions around the time t = 0 when the economy enters the R-zone, rather than the first year of the crisis:

$$y_{i,t+h} - y_{i,t} = \alpha_{i,h} + \alpha_{d,h} + \beta_h \mathbb{1}_{\text{Enter R-zone}_{i,t}=1} + \epsilon_{i,t+h}. \qquad (4)$$

Above, h = −5, ..., 0, ..., 5 are regression horizons, and the dummy 1Enter R-zone is set equal to 1 in the first year that the economy enters either the household or business red zone (indicating high asset price and credit growth between years t − 3 and t). Based on our findings above, we focus on red zones preceded by monetary rate cuts for our baseline specification, since these are much more likely to culminate in a banking crisis, and show the results for all red zones in the Appendix. yi,t+h − yi,t are the changes in the variable between year t + h and t, with the y variables corresponding to, respectively, the nominal monetary policy rate, and the real market returns on bank and non-financial firm equity.

Figure 6: Monetary rates, bank and non-financial equity returns around red zones preceded by rate cuts.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing monetary policy rates, cumulative real bank stock returns, and cumulative real market returns on non-financial equity, on the dummy which equals to 1 when the economy enters a business or financial red zone that was preceded by a monetary policy rate cut, for horizons h = 5, ..., 0, ..., 5, with 0 corresponding to the first year of being in the pre-cut red zone (meaning that credit and asset price growth were high between t 3 and t, and monetary policy rates were cut between t 5 and t). Returns are measured as the sum of capital gain and dividend minus inflation, in logs.

The left panel of Figure 6 confirms that R-zones preceded by a series of monetary rate cuts are strongly associated with U-shaped monetary policy rate dynamics, with rates cut before entering the red zone (by definition) and raised once in the red zone which, as shown in Section 4.1, materially increases crisis risk. The left panels of Appendix Figure A.6 show that this U shape in monetary rates holds even when we average across all R-zones, including those that were preceded by increases in monetary policy rates.

The middle and right panels of Figure 6 show that R-zones are also preceded by a boom in bank stock returns, but we do not see a similarly strong boom in market returns on non-financial firm equity. Panels (b) and (c) of Appendix Figure A.6 show that this pattern depends on the type of red zone that we are considering.

Business R-zones are preceded by both high bank and non-financial firm stock returns. Household sector R-zones, which are defined over the house price index, are associated with high bank returns, but not with high non-financial firm returns. After entering the R-zone, however, both bank and non-financial firm returns decline significantly over the following four years before recovering somewhat.

These results suggest that the financial boom during the R-zone has some elements which are specific to the banking sector, but once this financial boom unwinds, the effects are felt by both banks and non-financial firms. Two common channels used to explain banking sector dynamics during financial booms and busts are changes in the bank capital-to-asset ratio (a proxy for shareholders' skin in the game), and risk appetite or sentiment. The left and middle panels of the Appendix Figure

A.7 plot the banking-system-wide capital ratio (bank equity over total assets, from Jordá et al., 2021), and the total amount of bank capital (normalized by CPI) around R-zones preceded by monetary policy rate cuts. There is little change in the bank capital ratio, and the total amount of bank capital in the economy increases before entering the R-zone.[15] The right panel of Appendix Figure A.7 plots the evolution of bank equity sentiment around R-zones, with high levels of sentiment corresponding to predictably low future bank stock returns (see Baron and Xiong, 2017; López-Salido et al., 2017).[16] There is evidence of a boom-bust in bank equity market sentiment mirroring that in bank stock returns, consistent with previous studies showing that monetary policy can affect investor sentiment and risk aversion (Pflueger and Rinaldi, 2022; Kashyap and Stein, 2023).

Together, these findings provide a link between the monetary policy rate U shape and banking instability: as monetary policy rates are cut over a long time period, credit and asset price booms and banking sector vulnerabilities build up. When monetary rates are subsequently raised, these financial vulnerabilities crystallize, with bank stock returns and profits decreasing, potentially triggering a banking crisis.

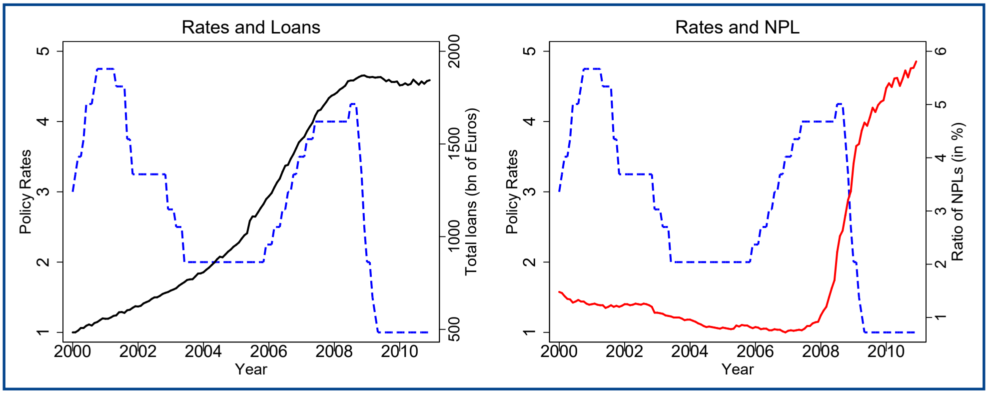
[15] This is largely because bank profits increase during the R-zone boom, meaning that banks are able to retain earnings and keep their capital growing in line with assets.

[16] More precisely, we 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 bank equity sentiment at t; see Appendix C for more detail.

5. LOAN-LEVEL EVIDENCE FROM THE SPANISH CREDIT REGISTER

To understand the heterogeneous effects of U-shaped monetary policy rates on banks (and their borrowers), and hence dig deeper into the mechanisms, we turn to the Spanish credit register data to examine the effect of monetary policy rate dynamics on (ex-post) individual loan defaults.

Figure 7: Monetary policy rates, private credit, and loan defaults in Spain around the 2007–08 crisis.



Notes: The left panel shows the interest rate for main refinancing operations (in percent, dashed blue line), and total loans to the private domestic sector (ebillions, solid black line) in Spain for years 2000 to 2010. The right panel shows the interest rate (dashed blue line) alongside the ratio of non-performing loans to total loans (solid red line). Data are monthly (interest rates are annualized).

We analyze Spain's 2008 crisis, as Spain has three qualities that make it an excellent candidate for our empirical strategy. First, it has a financial system dominated by banks, which means that studying bank performance (defaults) in detail gives us a good overview of the overall financial developments in the country. Second, it has a fairly exogenous monetary policy over the time period that we are interested in. Spain was part of the European Exchange Rate Mechanism (ERM) in the 1990s, and joined the euro in 1999. This means that monetary policy during the time period of our post-1995 sample closely mirrors our identification strategy in the aggregate, with Spanish monetary policy rates decided in Frankfurt with a focus on the core countries of the euro. Third, 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 understand how credit risk is associated with monetary policy rates at the level of an individual loan, and to explore the heterogeneous responses at bank and firm level.

To provide some background, Figure 7 shows that the aggregate developments in Spain during the pre-crisis boom of the early 2000s mirrored the average patterns for historical crises shown in Figures 2 and A.2, that is a U in monetary policy rates (with a credit boom, especially for real estate firms) followed by a banking crisis with a very large increase in bank loan defaults. The left panel shows that monetary policy rates (dashed blue line) first decreased, hitting their lowest point of 2% in years 2004–05. The decisions by the European Central Bank to cut interest rates mainly corresponded to the need to boost GDP, employment and price growth in core European countries (notably Germany), and did not reflect the economic situation in Spain which, on the contrary, experienced high GDP and credit growth and inflation during this time period (similar to other peripheral countries such as Ireland, see Maddaloni and Peydro, 2011). Especially for this period, monetary policy rates in Spain can be viewed as exogenous, while policy in the 2010s was more aligned to economic developments in the euro-area peripheral countries.

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

For the purposes of the paper we, therefore, work with quarterly data after 1995 containing newly granted loans to non-financial companies by commercial banks, savings banks, and credit cooperatives. These financial institutions account for more than 95 percent 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 given 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. Based on the sample of all newly granted loans to these firms, we study the determinants of loan defaults at three year ahead horizon. We define default, or delinquency, as the loan payments being more than 90 days overdue, following the main definition used by supervisors and regulators. Appendix Table A.15 provides the 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. We do this 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 and Euro-area sovereign debt crises. Second, the changes in short-term 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 lifetime of the loan. That being said, our main results also hold for the full 1995–2020 sample (where we include all loans granted up to 2016, and all defaults up to before the COVID pandemic), except unsurprisingly for the bank heterogeneity variable related to weak balance sheets (we show the results for the full sample in the Appendix Table A.18, see also Table A.17).[17]

Empirical specifications. We analyze the link between ex-post loan defaults and the path of monetary policy rates. We start by analyzing average effects to confirm that the findings on bank performance from the previous section hold in the credit register data. We then turn to study firm and bank level heterogeneities to gain additional insights. Specifically, we estimate by OLS the following linear probability model:

$$\text{Loan Default}_{i,j,t,t+3} = \beta_1 \Delta_3 \text{Rate}_{t,t+3} + \beta_2 \text{Cut}_{t-5,t} + \beta_3 \Delta_3 \text{Rate}_{t,t+3} \times \text{Cut}_{t-5,t} + \gamma_1 F_{i,t-1} + \gamma_2 B_{j,t-1} + \gamma_3 M_t + u_{i,j,t,t+1} \qquad (5)$$

[17] During 2010–2016, bank NPL ratios (which we use as proxy for weak banks) lose their significance as an indicator of bank weakness because many weaker banks were bought by stronger banks.

where i refers to the firm, j to the bank that grants the loan and t to time. 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 0 otherwise.[18] Δ_3Rate is the change in the overnight interest rate between years t and t + 3, in percentage points. Cut is a dummy variable indicating whether the change in overnight interest rates between years t − 5 and t is below its average value.[19] The specification closely mirrors our approach in the long-run data, focusing on loans that were granted during a period of decreasing monetary policy rates, and studying their default risk when monetary rates start increasing.

We show the results without controls and progressively saturate these specifications with a large set of control variables and fixed effects. F is a vector of control variables and fixed effects at firm level that includes, depending on the specification, industry (NACE at 3 digits) and location (zip code level) fixed effects, firm fixed effects, firm×bank fixed effects, and a set of observable firm characteristics (in the previous year) such as the log of assets, log of age, own funds over total assets, liquid assets over total assets, ROA, bad credit history (a dummy that takes value of 1 if the firm has defaulted before time t, and 0 otherwise) and the firm's average cost of credit (for those firms with audited financial information available from the Spain's Mercantile Register). B is a vector of control variables and fixed effects at 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, ROA and NPL ratios. Finally, Mt is a vector of macro controls and fixed effects that includes GDP and CPI in the same way as monetary interest rates, and—when heterogeneous effects are tested—it also includes time fixed effects (lower-degree terms of any interaction are included in the regression but not always shown in the tables).

The β_1 coefficient reflects the relationship between loan defaults and changes in monetary policy rates after loan origination. A positive β_2 coefficient means that the probability of loan default is higher when the loan is granted in periods of declining monetary policy rates. The coefficient on the interaction term, β_3, is testing for the role of U-shaped monetary policy: a positive β3 coefficient means that the relationship between loan defaults and higher monetary policy rates

[18] We obtain similar results when we analyze one-year probability of loan default.

[19] Since monetary policy rates were on average decreasing in our sample (see Appendix Table A.15), the Cut dummy variable effectively corresponds to large cuts in monetary rates.

becomes stronger if the monetary rate increases were preceded by a period of declining policy rates.

Table 10: The path of monetary rates and loan-level defaults in Spain.

	Dependent variable: Loan default$_{t+1\ to\ t+3}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta_3Rate_{t,t+3}$	0.001*	0.001**	0.002***	0.003***	0.003***	0.003***	0.003***	0.003***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cut $Rate_{t-5,t}$	0.012***	0.010***	0.011***	0.007***	0.007***	0.007**	0.008***	0.008***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta_3Rate_{t,t+3}$ × Cut $Rate_{t-5,t}$		0.003**	0.004***	0.003**	0.003***	0.002**	0.003***	0.004***	0.007***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry×Location FE	No	No	Yes	Yes	–	Yes	–	–	–
Bank Controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	–	–
Firm FE	No	No	No	No	Yes	No	Yes	–	–
Firm Bank FE	No	No	No	No	No	No	No	Yes	Yes
Firm Controls	No	No	No	No	No	No	No	No	Yes
Observations	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	0.7m
R^2	0.031	0.031	0.220	0.220	0.353	0.221	0.354	0.551	0.584

Notes: This table reports the 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 paths of monetary policy rates. New 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 (overnight) rates between years t-5 and t is below its average value, and Δ_3Rate 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 firm, bank and time level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that it is not included and "-" that is comprised 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 levels, respectively.

Results. Table 10 reports results of the regressions specified in equation (5). We show the estimates for the sample of loans granted prior to 2008 Q3 due to the more plausible exogeneity of monetary policy and other reasons discussed above, and show results for the full sample in Appendix Table A.17. We start with a model free of any controls, and progressively saturate the specification with observable and unobservable bank and firm characteristics. In column 1 there are no controls, and both the coefficients on Cut and Δ_3Rate are positive and statistically significant. This tells us that 3-year ahead loan defaults increase when monetary interest rates decreased in the 5 years before the loan was granted, and when there is an increase in monetary policy rates after loan origination.

From column 2 onwards we test for the role of the U shape in monetary policy rates with the introduction of the interaction term between Cut and Δ_3Rate. 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 interest rates decreased before loan origination, consistent with our hypothesis. Column 3 includes industry×location fixed effects, in column 4 we add observable bank controls, in column 5 firm fixed effects, column 6 is as column 4 but with bank fixed effects, in column 7 firm and bank fixed effects are included at the same time, and column 8 controls for firm×bank unobservables. In all these specifications we obtain very similar results (column (2) 0.003 and column (8) 0.004 for the interaction term), although the R2 increases from 3.1% to 55.1%, suggesting that the estimated effects do not suffer from biases due to (further) unobservable omitted variables (following Altonji, Elder, and Taber, 2005; Oster, 2019). In column 9 we restrict the sample to those observations with observable firm financial characteristics with similar results.[20]

In terms of economic effects, a 1 percentage point change in the monetary interest rate after loan origination increases the 3-year probability of loan delinquency by 7.4% in relative terms (following Table 10 column 8, and given that the average default probability equals 4.5 percentage points).[21] The probability of loan delinquency increases by 17.1% if monetary rates were cut around loan

[20] We demean all variables (subtracting their sample mean) to allow the lower level terms of an interaction to have the same interpretation as the one without the interaction when all variables are at their mean. Appendix Table A.16 shows the results without demeaning the variables in this way.

[21] The 7.4% relative increase is calculated as the ratio of 0.003 (coefficient on Δ_3Rate in column

origination (from the coefficient on the Cut dummy in column 8). Additionally, a 1 percentage point increase in the monetary policy rate after periods of declining policy rates raises the probability of loan default by 8.1% (again, based on column 8). Summing together the coefficients, the probability of delinquency increases by 32.6% if at origination, the Cut dummy is one, and monetary rates increase by 1 percentage point over the following three years. Appendix Table A.17 shows the results of running the same regression on the full 1995–2020 sample. Results are similar, though the size of the coefficients on the interaction term is, as expected, somewhat smaller.

In Table 11 we explore the existence of heterogeneous effects of the U shape of monetary policy by interacting the term Cut×Δ_3Rate with firm and bank characteristics. Columns 1 and 2 show that the effect of the U monetary shape is more relevant for risky firms, e.g., for construction and real estate firms or those firms that did not report to the Mercantile Register in the previous year (which means that the firm was not audited and, hence, had no administrative data for that year). The probability of default increases by an additional 25.9% if monetary rates are raised by 1 percentage point after a period of monetary rate cuts and the loan was granted to a firm in the real estate and construction sector (column 1), and for the non-audited firms this figure is 5.5% (column 2). From the bank side, the observed U-shaped effect is stronger for ex ante riskier banks (those with higher non-performing loan ratios). For instance, going from the 25th to 75th percentile of the NPL ratio distribution additionally increases the likelihood of default after U-shaped monetary policy by 30.6% (using the estimates in column 3).

Table 11 column 4 tests the robustness of all previous results by including all the interaction terms contemporaneously in the same regression. This leaves the results unchanged. Moreover, column 5 controls for time fixed effects, which absorbs all linear monetary policy effects and other non-observable time-varying macroeconomic variables. After controlling for these observable and unobservable variables, the heterogeneous effects are very similar (which also suggests that unobserved time-varying common shocks affecting loan defaults are uncorrelated to the monetary policy shape variables interacted with firm and bank risk characteristics). Column 6 replicates column 5 for the sample merged with the Mercantile Register database. For this sample we have another proxy for the risk

8 of Table 10) to 0.045 (the sample mean of loan defaults from the Appendix Table A.15) in percentage points.

Table 11: The path of monetary policy rates and loan-level defaults in Spain: heterogeneous effects.

	Dependent variable: Loan default$_{t+1 \text{ to } t+3}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ_3Rate$_{t,t+3}$	0.003***	0.003***	0.001*	0.002**			
	(0.001)	(0.001)	(0.001)	(0.001)			
Cut Rate$_{t-5,t}$	0.008***	0.007***	0.007***	0.007***			
	(0.003)	(0.003)	(0.003)	(0.003)			
Δ_3Rate$_{t,t+3}$ × Cut Rate$_{t-5,t}$	0.004***	0.004***	0.005***	0.005***			
	(0.001)	(0.001)	(0.001)	(0.001)			
Δ_3Rate × Cut × Real estate firm	0.012***			0.012***	0.012***	0.010***	0.011***
	(0.002)			(0.002)	(0.002)	(0.001)	(0.001)
Δ_3Rate × Cut × Firm not audited		0.002*		0.002*	0.002*		
		(0.001)		(0.001)	(0.001)		
Δ_3Rate × Cut × Firm cost of credit						0.002***	0.001***
						(0.000)	(0.000)
Δ_3Rate × Cut × Bank NPL ratio			0.003***	0.003***	0.002***	0.002***	0.002***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δ_3Rate × Cut × Bank NPL × Real estate							0.003*
							(0.002)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	Yes	Yes	Yes
Firm Controls	No	No	No	No	No	Yes	Yes
Observations	1.1m	1.1m	1.1m	1.1m	1.1m	0.7m	0.7m
R^2	0.552	0.551	0.551	0.552	0.552	0.586	0.586

Notes: This table reports the 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 paths of monetary policy rates. New 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 (overnight) rates between years t-5 and t is below its average value, and Δ_3Rate is the percentage point change in the monetary policy rate between years t and t+3. Coefficients are listed in the first row, standard errors corrected for clustering at the firm, bank and time level are reported in the row below. Firm cost of credit means measures the average cost of bank credit for the specific firm. Real estate firm includes both construction and real estate firms. Firm not audited means that the firm did not report to the Mercantile Register, and hence was not audited, in the previous year. Bank NPL is the non-performing loans ratio of the bank. All variables are demeaned by subtracting their sample mean. Lower-degree terms of the interaction are included in the regression but not shown in the table. For observations, m corresponds to millions. "Yes" indicates that the set of characteristics or fixed effects is included, and "No" that it is not included. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

of a firm: its average cost of bank credit, with a higher cost of credit corresponding to, on average, riskier firms. Column 6 shows that the U shape in monetary policy rates affects these riskier firms more. Going from the 25th to 75th percentile of the distribution of the average cost of credit additionally raises the default probability for loans granted during a U shape of monetary policy by 14.7%. Column 7 tests whether the effect observed for construction and real estate firms is stronger for ex ante riskier banks. In fact, 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 their loans to riskier firms as measured by firms active in the real estate sector.

Taken together, the results in this section provide an important link not detectable at the more aggregate level. We find that a loan is more likely to default ex-post when originated at a time when monetary policy rates had decreased over a five-year window, and that this effect is stronger when monetary interest rates start increasing. This effect is even stronger for ex-ante riskier firms, e.g., those in the real estate sector, and for ex-ante weaker banks, pointing towards a strong role of risky banks and firms in driving the build-up of financial vulnerabilities during times of monetary U.

6. CONCLUSION

We analyze the link between monetary policy cycles 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. In the long-run data, we find that pre-crisis monetary policy follows a U shape. We show that rates are, generally, cut 7 to 3 years before the crisis, and then increased in the run-up to the crisis. This U shape holds across different crisis definitions, and becomes more pronounced over time: we find that every single deep crisis after World War 2 was preceded by a U-shape in monetary policy rates. Further to this, using an instrumental variable based on the trilemma of international finance, we show that only those monetary policy rate hikes that were preceded by a series of cuts (or a long period of low rates) materially increase crisis risk. These path dependencies and pre-crisis patterns are much more prominent for nominal short-term rates than for inflation, real rates, or long-term rates (these ones are weak and non-robust). They are also different for systemic banking crises than for non-crisis (including deep) recessions, with the latter preceded by monetary rate increases but not by a U shape of monetary policy rates.

To understand why U-shaped monetary policy is linked to crises, we first show that the initial reduction of monetary rates is followed by high growth in credit and asset prices, putting the economy into a vulnerable financial "red zone" of Greenwood et al. (2022). After the subsequent monetary tightening, these red-zone vulnerabilities materialize, leading to higher crisis risk and larger than usual declines in real activity. Differently, red zones without previous rate cuts and red zones without subsequent monetary rate hikes are not associated with banking crises. Relatedly, U- shaped monetary rates without red zones are not associated with above-average crisis risk. Moreover, U-shaped monetary rates are also associated with boom-bust dynamics in bank stock returns and profits. To dig further into the underlying mechanisms, we use administrative data on the universe of bank loans and defaults during the 1990s and 2000s boom-bust cycles in Spain. Consistently, we find that U-shaped monetary policy increases the probability of ex-post loan defaults, but effects are much stronger for ex-ante riskier firms (including real estate firms) and for banks with weaker balance sheets, especially if lending to ex-ante riskier firms.

Overall, our analysis shows that the dynamic path of monetary policy has important implications for financial stability. Our paper does not offer a normative implication, but it suggests some important trade-offs, pointing towards a subtle and nuanced view on the use of monetary policy

to mitigate financial stability risks. For example, previous studies have suggested that in order 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 policy rates have been low for some time, allowing financial risks to build up, increasing monetary rates would actually crystallize these vulnerabilities and dramatically increase crisis risk. Therefore, our results suggest that it is important to address the asset price and credit booms before the economy enters the financial red zone, for example by leaning against the wind, or by using macroprudential policy. We leave the more detailed investigation of these policy trade-offs for future research.

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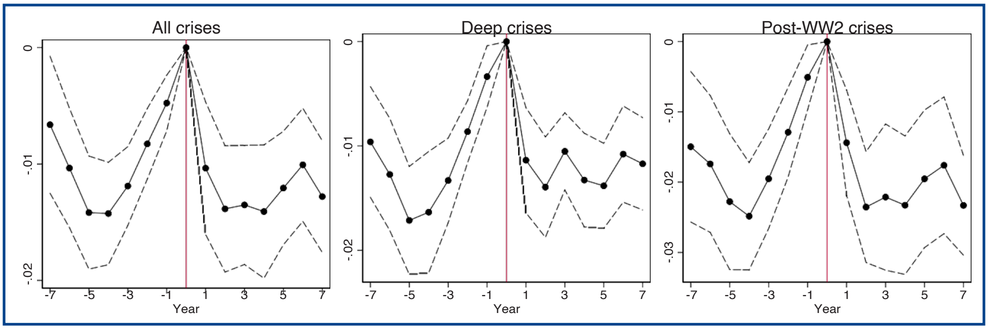
ONLINE APPENDIX

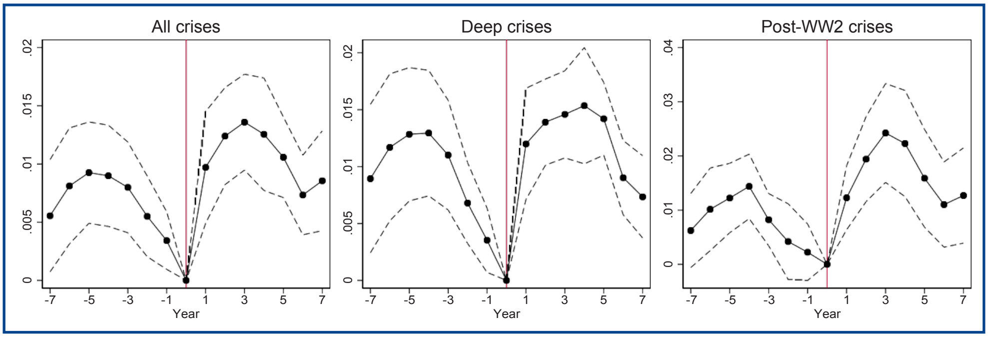
A. Monetary policy and inflation around crises: Additional results

Figure A.1: Residual monetary policy rates – crisis window regressions



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing residual monetary policy rates on the crisis dummy for horizons h = 7, ..., 0, ..., 7, with 0 corresponding to the beginning of the crisis according to the Jordá et al. (2016) chronology. Residual rates are measured as the residual from regressing the change in monetary rates on lagged inflation; GDP, consumption, and investment growth, current account, and changes in long- and short-term rates, then cumulating these residual changes in rates over time to construct the (level) residual rate path. Deep crises are those with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the t 1 to t + 3 crisis window. Post-WW2 crises are those that started after 1945.

Figure A.2: Term premium (long minus short rate) – crisis window regressions.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing the term premium on the crisis dummy for horizons h = 7, ..., 0, ..., 7, with 0 corresponding to the beginning of the crisis according to the Jordá et al. (2016) chronology. The term premium is the difference between long (approximately 10-year) and short-term interest rates. Deep crises are those with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the t 1 to t + 3 crisis window. Post-WW2 crises are those that started after 1945.

B. The path of monetary policy rates and crisis risk: Additional results

Table A.1: The path of monetary policy rates and crisis frequencies, including numbers of observations.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U shape (cut, raise)	0.20 (39/199)	0.13 (25/199)	0.18 (17/95)	0.14 (13/95)
Raise, raise	0.08 (14/169)	0.04 (6/169)	0.03 (3/107)	0.00 (0/107)
Raise, cut	0.05 (9/184)	0.02 (4/184)	0.01 (1/92)	0.00 (0/92)
Cut, cut	0.04 (6/160)	0.02 (4/160)	0.02 (2/93)	0.00 (0/93)
Unconditional	0.10 (68/713)	0.05 (39/713)	0.06 (23/387)	0.03 (13/387)

Notes: This table reports the crisis frequency between year t and t + 2 for different crisis definitions and paths of nominal monetary policy rates. Crisis frequency is the ratio of crisis to total observations in the respective shape bin, shown in brackets for each policy shape and crisis definition (both the crisis number of observations, and the total number of observations, refer to the number of 3-year windows for the particular crisis and policy shape). Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least −3% GDP growth in 1 year, or −1% average growth over 3 years in the window t − 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945. In rows, the 4 bins are defined by the sign of the change (cut or raise) in the nominal monetary policy rate between t − 8 and t − 3 and the sign of the change (cut or raise) between t − 3 and t. For example, U-shape (cut, raise) refers to a cut in rates between t − 8 and t − 3 and a subsequent raise between t − 3 and t.

Table A.2: The path of monetary policy rates and 1-year ahead crisis frequencies.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U shape (cut, raise)	0.07 (39/596)	0.04 (25/596)	0.06 (17/283)	0.05 (13/283)
Raise, raise	0.03 (14/506)	0.01 (6/506)	0.01 (3/322)	0.00 (0/322)
Raise, cut	0.02 (9/552)	0.01 (4/552)	0.00 (1/275)	0.00 (0/275)
Cut, cut	0.01 (6/467)	0.01 (4/467)	0.01 (2/265)	0.00 (0/265)
Unconditional	0.03 (68/2121)	0.02 (39/2121)	0.02 (23/1145)	0.01 (13/1145)

Notes: This table reports the crisis probability in year t + 1 for different crisis definitions. In rows, the 4 bins are defined by the sign of the change (cut or raise) in the nominal monetary policy rate between t 8 and t 3 and sign of the change (cut or raise) between t 3 and t. For example, U-shape (cut, raise) refers to a cut in rates between t 8 and t 3 and a subsequent raise in rates between t 3 and t. Crisis frequency is the ratio of crisis to total observations in those years, shown in brackets for each policy shape and crisis definition. Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least 3% GDP growth in 1 year, or 1% average growth over 3 years in the window t 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945.

Table A.3: The path of monetary policy rates and crisis frequencies - symmetric policy shape window.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U shape (cut, raise)	0.19	0.11	0.16	0.12
Raise, raise	0.07	0.05	0.03	0.01
Raise, cut	0.05	0.02	0.01	0.00
Cut, cut	0.05	0.03	0.02	0.00
Unconditional	0.10	0.05	0.06	0.03

Notes: This table reports the crisis frequency between year t and t + 2 for different crisis definitions and paths of nominal monetary policy rates between t 6 and t. Crisis frequency is the ratio of crisis to total observations in the respective shape bin. Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least −3% GDP growth in 1 year, or −1% average growth over 3 years in the window t − 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945. In rows, the 4 bins are defined by the sign of the change (cut or raise) in the nominal monetary policy rate between t − 6 and t − 3 and the sign of the change (cut or raise) between t − 3 and t. For example, U-shape (cut, raise) refers to a cut in rates between t − 6 and t − 3 and a subsequent raise between t − 3 and t.

Table A.4: The path of monetary policy rates and non-crisis recession frequencies.

	(1) Non-crisis recession	(2) Deep non-crisis recession	(3) Post-WW2 non-crisis recession	(4) Post-WW2 deep non-crisis recession
U shape (cut, raise)	0.37	0.15	0.25	0.04
Raise, raise	0.30	0.12	0.27	0.05
Raise, cut	0.28	0.11	0.21	0.02
Cut, cut	0.26	0.15	0.09	0.00
Unconditional	0.31	0.13	0.21	0.03

Notes: This table reports the probability of a non-crisis recession (Bry and Boschan, 1971 business cycle peak that is not accompanied by a crisis) between year t and t + 2 for different recession definitions and paths of nominal monetary policy rates. Recession frequency is the ratio of recession to total observations in the respective shape bin. Deep recession is accompanied by at least 3% GDP growth in 1 year, or 1% average growth over 3 years in the window t 1 to t + 3 around the business cycle peak. Post-WW2 recessions are those which started after 1945. In rows, the 4 bins are defined by the sign of the change (cut or raise) in the nominal monetary policy rate between t − 8 and t − 3 and sign of the change (cut or raise) between t − 3 and t. For example, U-shape (cut, raise) refers to a cut in rates between t − 8 and t − 3 and a subsequent raise in rates between t − 3 and t.

Table A.5: The path of monetary policy rates and crisis risk: Robustness (IV).

	Dependent variable: $Crisis_{t\ to\ t+2}$							
	1-year ahead		Post-WW2		Driscoll-Kraay		Decade FE + Controls	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_3 Rate_t$	0.01	0.00	0.02**	-0.00	0.02	0.00	0.02	0.00
	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Cut $Rate_{t-8,t-3}$	0.02**	0.02**	0.08***	0.07***	0.06*	0.06*	0.04	0.04*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)
$\Delta_3 Rate_t$ × Cut $Rate_{t-8,t-3}$		0.02**		0.09***		0.06*		0.04**
		(0.01)		(0.03)		(0.03)		(0.02)
Country fixed effects	√	√	√	√	√	√	√	√
Kleibergen-Paap Weak ID	82.72	36.08	78.55	38.13	42.91	23.61	47.48	16.60
Observations	1624	1624	949	949	1624	1624	1198	1198

Notes: This table shows linear probability models for a systemic banking crisis occurring in year t + 1 (columns 1 and 2), or years t to t + 2 (columns 3–8). Post-WW2 specifications restrict the sample to after 1945. Driscoll-Kraay specifications correct standard errors for serical autocorrelation of up to 5 lags, cross-correlation between countries, and residual cross-autocorrelation. Decade FE + Controls specifications include both country & decade fixed effects, and control for eight lags of real credit, house price, and stock price growth, as well as inflation and real GDP growth. Specifications in columns 1–6 control for 8 lags of GDP growth, inflation, and crises. All specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Interactions are between monetary rate changes and a dummy for a cut between t 8 and t 3. IV interaction specifications include the residualized JST 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. Standard errors in columns 1–4 and 7–8 are clustered by country and year. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.6: The path of monetary policy rates and crisis risk – Baron et al. (2021) crisis chronology.

	Dependent variable: Crisis (BVX definition)$_{t\ to\ t+2}$					
		OLS			IV	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ_3Ratet	0.02***	0.02***	0.01*	0.06***	0.06***	0.03***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Cut Rate$_{t\ 8,t\ 3}$		0.04*	0.04*		0.02	0.02
		(0.02)	(0.02)		(0.02)	(0.02)
Δ_3Rate$_t$ x Cut Rate$_{t\ 8,t\ 3}$			0.03***			0.06*
			(0.01)			(0.03)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID				77.77	79.56	37.45
Observations	1624	1624	1624	1624	1624	1624

Notes: This table shows linear probability models for a systemic banking crisis defined according to the chronology of Baron et al. (2021) occurring between years t and t + 2. All specifications control for 8 lags of GDP growth, inflation, and crises. IV specifications instrument monetary policy rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ_3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.7: The path of monetary policy rate and crisis risk: comparison of linear and probit models.

	Dependent variable: $\text{Crisis}_{t \text{ to } t+2}$					
	Linear			Probit		
	Baseline		IV	Baseline		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Δ_3Ratet		0.01**	0.00		0.01**	0.00
		(0.00)	(0.01)		(0.00)	(0.02)
Cut $\text{Rate}_{t\ 8,t\ 3}$		0.07**	0.07**		0.06**	0.07**
		(0.03)	(0.03)		(0.03)	(0.03)
Δ_3Ratet x Cut $\text{Rate}_{t\ 8,t\ 3}$		0.03***	0.07**		0.02***	0.06**
		(0.01)	(0.03)		(0.00)	(0.03)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
AUC	0.61	0.70	0.66	0.67	0.74	0.72
s.e.(AUC)	0.02	0.02	0.02	0.02	0.02	0.02
p-value vs AUC in (1)		0.00	0.03			
p-value vs AUC in (4)					0.00	0.00
Observations	1563	1563	1563	1563	1563	1563

Notes: This table shows linear probability (columns 1–3) and probit (columns 4–6) models for a systemic banking crisis occurring between years t and t + 2. All specifications control for 8 lags of GDP growth, inflation, and crises. IV specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy equal to 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST trilemma IV and its interaction with the cut dummy as instruments. In this case the Kleibergen-Paap Weak ID is the joint test for both instruments. Columns (1) & (4) only contain control variables for comparison of AUCs. p-values test for equality of AUCs across different models. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.8: The path of monetary policy rates and real GDP growth.

	Dependent variable: real GDP growth, t + 1 to t + 3					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ_3Ratet	-0.47***	-0.44***	-0.24**	-1.47***	-1.44***	-0.99***
	(0.09)	(0.10)	(0.09)	(0.38)	(0.40)	(0.27)
Cut Rate$_{t\ 8,t\ 3}$		-1.18**	-1.19**		-0.53	-0.55
		(0.56)	(0.55)		(0.65)	(0.65)
Δ_3Ratet x Cut Rate$_{t\ 8,t\ 3}$			-0.56***			-1.24**
			(0.15)			(0.58)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID				82.80	83.22	36.07
Observations	1608	1608	1608	1608	1608	1608

Notes: The dependent variable is cumulative growth of log real GDP per capita over the years t to t + 2. All specifications control for 8 lags of GDP growth, inflation, bank stock returns and non-financial stock returns. IV specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ_3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

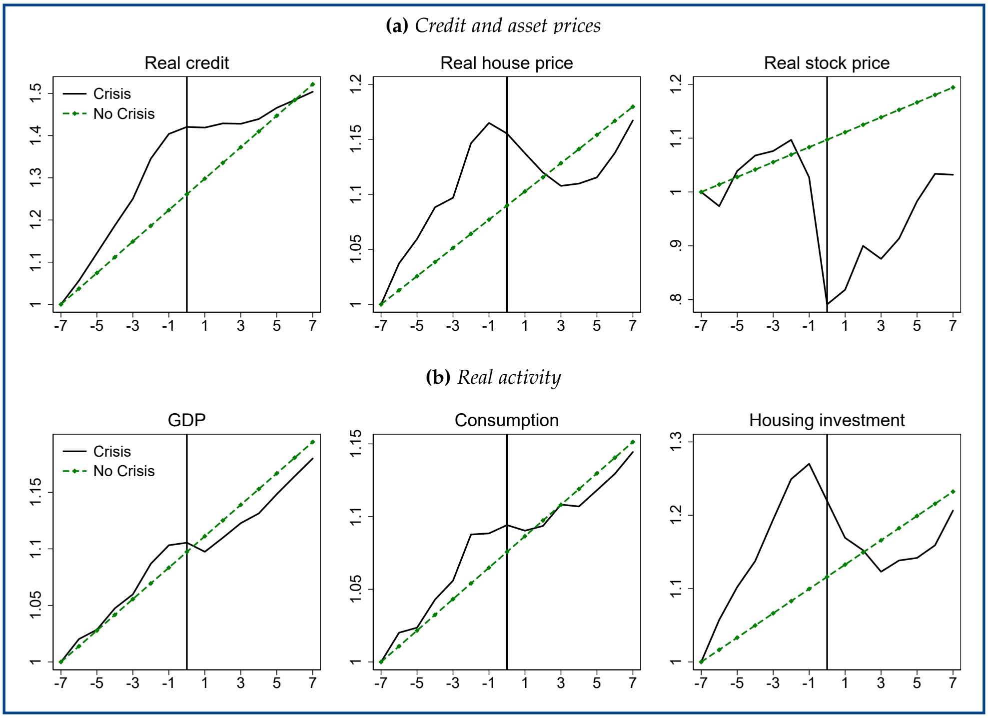
Table A.9: Indicator variables for a monetary rate U-shape and crisis risk.

	Dependent variable: $Crisis_{t\ to\ t+2}$			
	(1)	(2)	(3)	(4)
$\Delta Rate_{t-8,t}$	0.01**	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
$U_{t-8,t-3,t}$	0.07***	0.03*	0.07***	0.04*
	(0.02)	(0.02)	(0.02)	(0.02)
Deep $U_{t\ 8,t\ 3,t}$		0.09***		0.07***
		(0.02)		(0.02)
Country fixed effects	√	√	√	√
Controls	√	√	√	√
Observations	1903	1903	1835	1835

Notes: ΔRatet−8,t is the 8-year change in monetary policy rates. Ut−8,t−3,t is an indicator whether Ratet 3 is below the linear trend line from Ratet 8 to Ratet. Deep Ut 8,t 3,t is an indicator for monetary rates to be below this trend line by more than 1 percentage point. All specifications control for 8 lags of GDP growth, inflation, and crises. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

C. Understanding the mechanisms in long-run data: Additional results

Figure A.3: Credit, asset prices, and real activity around crises.



Notes: Unweighted averages of 77 systemic banking crises defined as in Jordá et al. (2016). To construct the figures, we calculate average log growth rates of each variable in a given pre- or post-crisis year, and cumulate them starting at 1, from 7 years before to 7 years after the crisis start date.

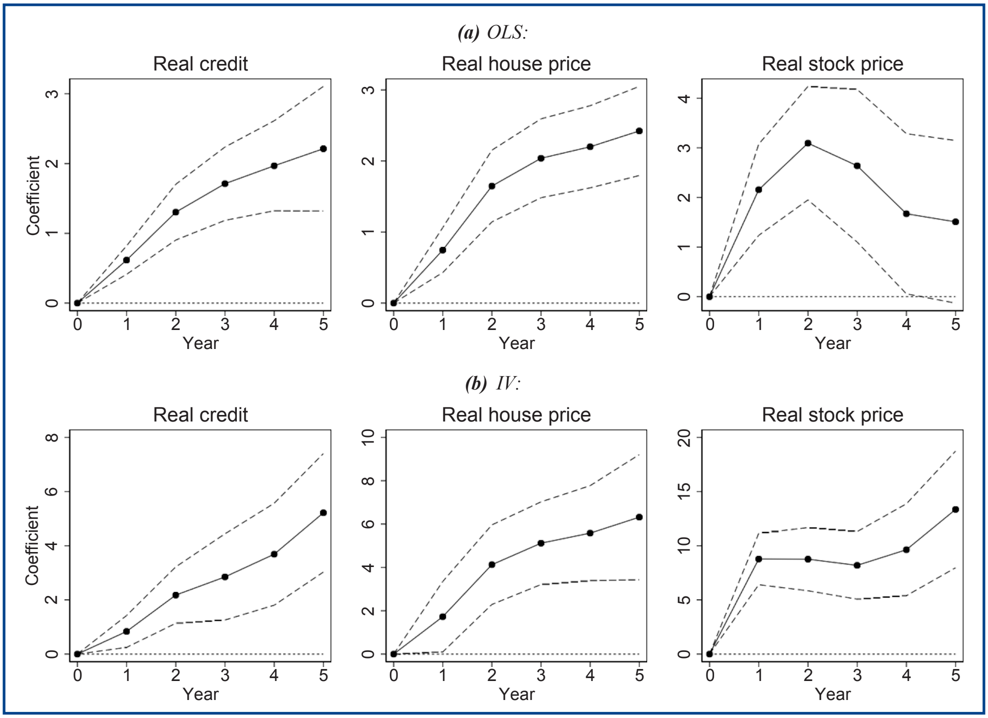
Rate cuts, credit, and asset prices. To study the impact of changes in monetary policy rates on credit and asset prices, we run the following local projection (Jordá, 2005):

$$\Delta_h y_{i,t,t+h} = \alpha_{i,h} + \beta_h \Delta \text{Rate}_{i,t} + \sum_{L=0}^{L=4} \gamma_l X_{i,t-L} + \epsilon_{i,t+h}, \quad h \in \{1, ..., 5\}. \tag{6}$$

Above, y is the log growth in real credit, real house price, or real stock price, between years t and t + h, for horizons h 1 to 5 years ahead. ΔRate is the change in the monetary rate, raw or instrumented using the Jordá et al. (2020) trilemma instrument. X are control variables (four lags and contemporaneous) consisting of contemporaneous and lagged GDP, inflation, real credit, house, and stock price growth, and lagged short- and long-term rate changes, and α_i are country fixed effects. Standard errors are clustered by country. Because we are interested in responses to policy during the boom, we exclude the 3 years immediately after the start of a crisis from our sample.

Figure A.4 shows the responses of credit, house prices, and stock prices to monetary policy rate innovations, measured as the coefficients β_h in equation (6). The coefficients are standardized to a 1ppt reduction in rates. Figure A.4a shows these responses for raw cuts in monetary rates, and Figure A.4b shows the results for rate changes instrumented using the Jordá et al. (2020) trilemma IV. In line with previous studies, we find that cuts in monetary policy rates lead to faster than usual growth in asset prices and credit.

Figure A.4: Response of credit and asset prices to monetary policy rate cuts.



Notes: Local projection estimates of future real credit, house price, and stock price growth, for horizons t + 1 to t + h on the change in monetary rates at t, raw (panel a) and instrumented using the Jordá et al. (2020) trilemma IV (panel b). All regressions include country fixed effects, and control for contemporaneous levels and four lags of GDP growth, inflation, real credit, house price, and stock price growth, and four lags of changes in short- and long-term rates. Dashed lines show 90% confidence intervals.

Table A.10: Raising rates in different types of red zones and crisis risk.

	Dependent variable: Crisis t to t+2								
	R-Zone Business			R-Zone Households			R-Zone Either		
	OLS		IV	OLS		IV	OLS		IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\text{R-Zone}_{t\,3\text{ to }t\,1}$	0.10***	0.04	-0.09	0.19***	0.07*	0.01	0.12***	0.04*	-0.08
	(0.04)	(0.03)	(0.10)	(0.04)	(0.04)	(0.08)	(0.02)	(0.02)	(0.08)
$I(\Delta_3 \text{Rate}_t \geq 0)$		0.07***	-0.04		0.03	-0.02		0.05**	-0.10
		(0.02)	(0.08)		(0.02)	(0.06)		(0.02)	(0.07)
$\text{R-Zone}_{t\,3\text{ to }t\,1} \geq$ $I(\Delta_3 \text{Rate}_t\ \ 0)$		0.12	0.38**		0.24***	0.35*		0.16***	0.41**
		(0.08)	(0.19)		(0.07)	(0.18)		(0.05)	(0.17)
Country fixed effects	√	√	√	√	√	√	√	√	√
Controls	√	√	√	√	√	√	√	√	√
Kleibergen-Paap Weak ID			23.66			25.03			21.14
Observations	1412	1412	1412	1279	1279	1279	1474	1474	1474

Notes: Financial red zone ("R-zone") is defined as joint high growth in credit and asset prices, us- ing 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. All regressions control for three lags of real GDP growth, inflation, and crisis. $I(\Delta_3\text{Ratet } 0)$ is a dummy for monetary rate hikes over a three-year window. IV specifications instrument this variable with a dummy for cumulated trilemma shocks over the three-year window being positive. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Raising rates in the R-zone and real activity. To study the relationship between changes in monetary rates, R-zones, and real activity directly (i.e., without conditioning on a banking crisis), we run local projections of future GDP growth on measures of the R-zone and monetary policy:

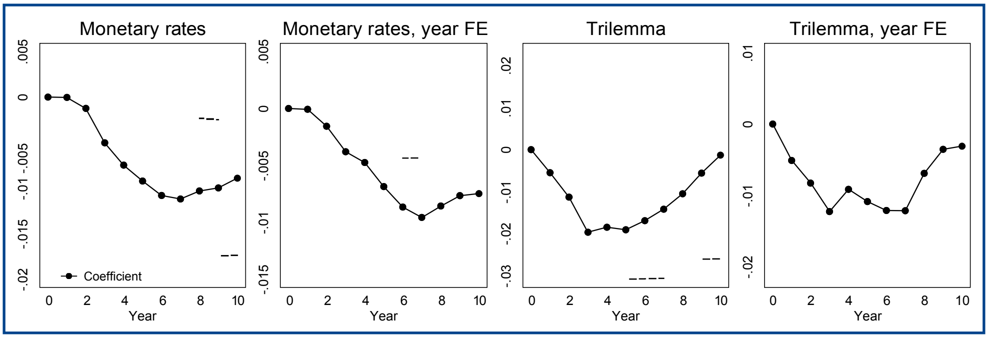
$$\Delta_h y_{i,t+h} = \sum_{j=0}^{5} \beta_{h,j}^{R} \text{R-zone}_{i,t-j-1} + \sum_{j=0}^{5} \beta_{h,j}^{MP} \Delta Rate_{i,t-j} + \sum_{j=0}^{5} \beta_{h,j}^{R\times MP} \Delta Rate_{i,t-j} \times \text{R-zone}_{i,t-j-1}$$

$$+ \alpha_{i,h} + \sum_{j=0}^{5} \gamma_{h,j}^{x} X_{i,t-j} + \epsilon_{i,t+h}\,. \qquad (7)$$

Above, Δhyi,t+h = yi,t+h yi,t is the growth of log real GDP for h = 1, ..., 10, and R-zone is a dummy equal to 1 when the economy is either in the business or household red zone. We lag this variable by one year, with the idea of allowing policymakers to observe that the economy is in the R-zone. ΔMP are raw monetary rate changes or the residualized trilemma IV shocks. X contains CPI inflation and GDP growth, their interaction with R-zone, and crisis dummies. The coefficients of interest are βR×MP. A negative sign of this coefficient means that monetary policy rate hikes have a stronger negative effect on real activity if the economy is currently in the financial red zone.

The two left panels in Figure A.5 show the βR×MP coefficients estimated based on equation (7) for raw monetary rate changes, including year fixed effects in the middle left panel, for different horizons h = 1, ..., 10. In both specifications, the negative effects of monetary policy on output become stronger if the economy is currently in a financial red zone. In the two right panels, Rate refers to the residualized monetary policy rate changes in the base country for countries with a peg in place, scaled by capital mobility. The response of output to these shocks while in the R-zone remains similar.

Figure A.5: Local projections for GDP response to monetary policy rate changes in the R-zone.



Notes: Estimations based on equation (7), where we regress h-year ahead real GDP growth on changes in rates, being in the red zone, the interaction of rate changes and being in the red zone, and control variables (lags of GDP growth, inflation, crisis dummies, and interactions of GDP growth and inflation with the R-zone indicator). Coefficients are for the interaction of monetary rate changes (trilemma instrument) and the lagged R-zone indicator. The two left panels are for raw monetary rate changes (middle left including year fixed effects). Middle right and right panels use the trilemma instrument directly. R-zone is an indicator for either household or business R-zone. Dashed lines are 90% confidence bands around coefficient estimates, based on standard errors dually clustered on country and year.

Table A.11: U-shaped monetary policy, red zones, and crisis frequencies – with numbers of observations.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U-shaped MP & R-zone	0.38 (19/50)	0.26 (13/50)	0.40 (14/35)	0.32 (11/35)
U-shaped MP & no R-zone	0.09 (10/116)	0.08 (9/116)	0.04 (2/57)	0.04 (2/57)
No U-shaped MP & R-zone	0.09 (9/97)	0.05 (5/97)	0.04 (3/70)	0.00 (0/70)
No U-shaped MP & no R-zone	0.05 (17/362)	0.02 (9/362)	0.02 (4/220)	0.00 (0/220)
Unconditional	0.09 (55/625)	0.06 (36/625)	0.06 (23/381)	0.03 (13/381)

Notes: This table reports the crisis frequency between year t and t + 2 for different crisis defini- tions, depending on the path of monetary policy and financial red zone occurrence in years t 8 to t. U-shaped MP means monetary rates were cut between year t 8 and t 3 and raised between t 3 and t. No U-shaped MP includes all other monetary policy rate paths. R-zone means that the economy was in either a household or business R-zone in at least one of the years between t 3 and t; whereas no R-zone means it was not in either business nor household R-zone in any of those three years. Crisis frequency is the ratio of crisis to total observations in the respective bin, numbers shown in brackets for each group (both the crisis number of observations, and the total number of observations, refer to the number of 3-year windows for the particular crisis and group). Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least −3% GDP growth in 1 year, or −1% average growth over 3 years in the window t − 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945.

Table A.12: U-shaped monetary rate path, red zones, and crisis frequencies – red zones between t − 5 and t.

	(1) Crisis	(2) Deep crisis	(3) Post-WW2 crisis	(4) Post-WW2 deep crisis
U-shaped MP & R-zone	0.34 (21/61)	0.21 (13/61)	0.35 (15/42)	0.26 (11/42)
U-shaped MP & no R-zone	0.08 (9/106)	0.08 (8/106)	0.04 (2/50)	0.04 (2/50)
No U-shaped MP & R-zone	0.09 (13/147)	0.05 (8/147)	0.03 (3/101)	0.00 (0/101)
No U-shaped MP & no R-zone	0.04 (14/318)	0.02 (7/318)	0.02 (4/189)	0.00 (0/189)
Unconditional	0.09 (57/632)	0.06 (36/632)	0.06 (24/382)	0.03 (13/382)

Notes: This table reports the crisis frequency between year t and t + 2 for different crisis defini- tions, depending on the path of monetary policy and financial red zone occurrence in years t 8 to t. U-shaped MP means monetary rates were cut between year t 8 and t 3 and raised between t 3 and t. No U-shaped MP includes all other monetary policy rate paths. R-zone means that the economy was in either a household or business R-zone in at least one of the years between t 5 and t; whereas no R-zone means it was not in either business nor household R-zone in any of those three years. Crisis frequency is the ratio of crisis to total observations in the respective bin, numbers shown in brackets for each group (both the crisis number of observations, and the total number of observations, refer to the number of 3-year windows for the particular crisis and group). Crises are dated using the Jordá et al. (2016) chronology. Deep crisis is crisis accompanied by at least −3% GDP growth in 1 year, or −1% average growth over 3 years in the window t − 1 to t + 3 around the crisis. Post-WW2 crises are those which started after 1945.

Table A.13: The path of monetary policy rates and bank equity crises.

	Dependent variable: Bank equity crisist to t+2					
		OLS			IV	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 Rate_t$	0.01***	0.01***	0.00	0.02**	0.02**	-0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Cut $Rate_{t\ 8,t\ 3}$		0.04**	0.04**		0.03**	0.04**
		(0.02)	(0.02)		(0.02)	(0.02)
$\Delta_3 Rate_t$ x Cut $Rate_{t\ 8,t\ 3}$			0.02***			0.06**
			(0.01)			(0.03)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID				81.57	83.26	36.60
Observations	1624	1624	1624	1624	1624	1624

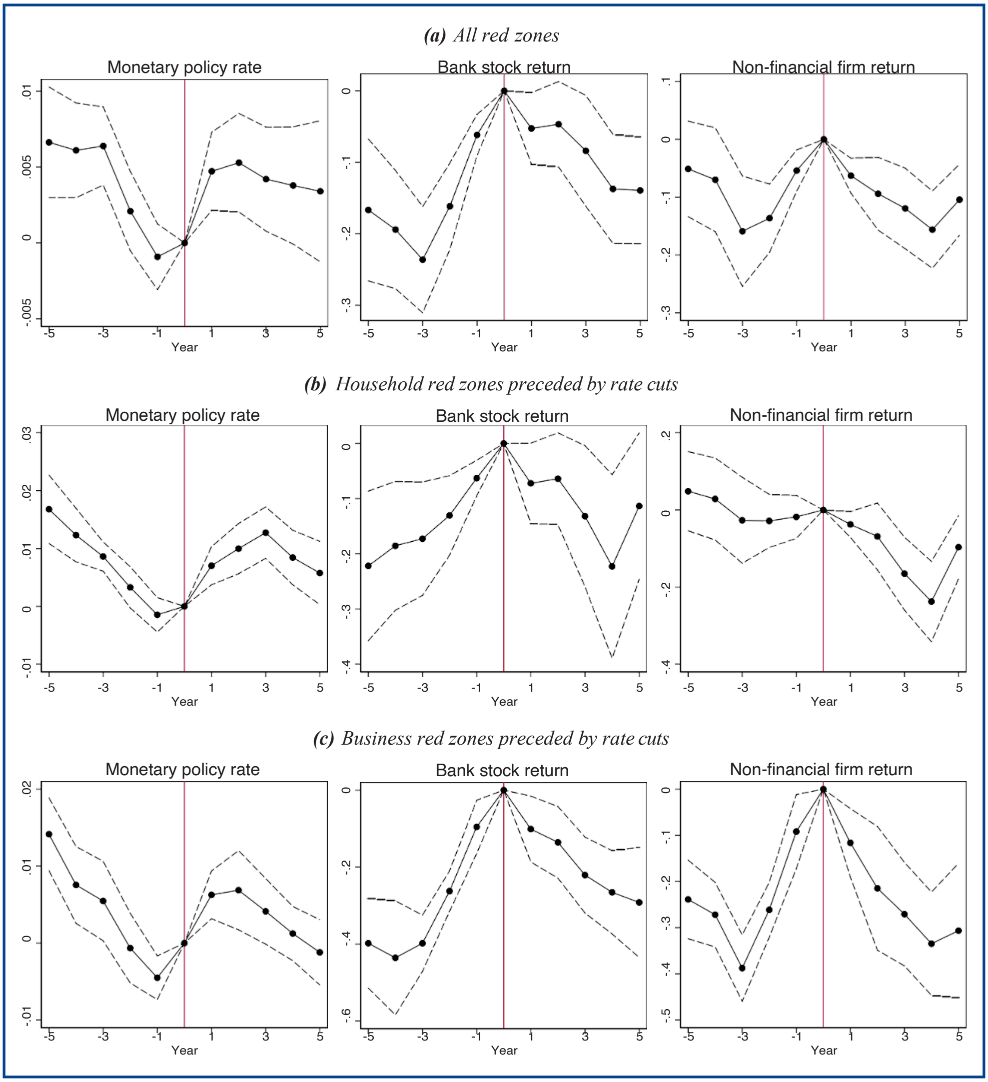
Notes: The dependent variable is the bank equity crisis dummy from Baron et al. (2021), set equal to 1 whenever a crisis episode is characterized by a bank stock return of -30% or less. All specifications control for 8 lags of GDP growth, inflation, and the crash dummy. IV specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.14: The path of monetary policy rates and the accounting return on bank equity.

	Dependent variable: Change in RoEt to t+2					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 Rate_t$	-0.30***	-0.29***	-0.06	-0.80**	-0.80**	0.09
	(0.09)	(0.08)	(0.11)	(0.37)	(0.38)	(0.20)
Cut Rate$_{t\ 8,t\ 3}$		-0.26	-0.26		0.08	0.15
		(0.55)	(0.55)		(0.53)	(0.52)
$\Delta_3 Rate_t$ x Cut Rate$_{t\ 8,t\ 3}$			-0.67***			-2.78***
			(0.23)			(1.04)
Country fixed effects	√	√	√	√	√	√
Controls	√	√	√	√	√	√
Kleibergen-Paap Weak ID			56.05	55.07	22.43	
Observations	1368	1368	1368	1368	1368	1368

Notes: The dependent variable is the cumulative (3-year) change in banking sector RoE over years t to t + 2, data from Richter and Zimmermann (2020). All specifications control for 8 lags of GDP growth, inflation, crisis dummy, and changes in banking sector RoE. IV specifications instrument monetary rate changes with the residualized Jordá et al. (2020) trilemma variable. Δ3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between t 8 and t 3. IV interaction specifications include residualized JST 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. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Figure A.6: Monetary policy rates, bank and non-financial equity returns around different types of red zones.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing monetary policy rates, cumulative real bank stock returns, and cumulative real market returns on non-financial equity, on the dummy which equals to 1 when the economy enters either a business or household red zone (panel a), a business red zone preceded by a rate cut (panel b), or a household red zone preceded by a rate cut (panel c), for horizons h = 5, ..., 0, ..., 5, with 0 corresponding to the first year of being in the red zone (meaning that credit and asset price growth were high between years t 3 and t). Returns are measured as the sum of capital gain and dividend minus inflation, in logs.

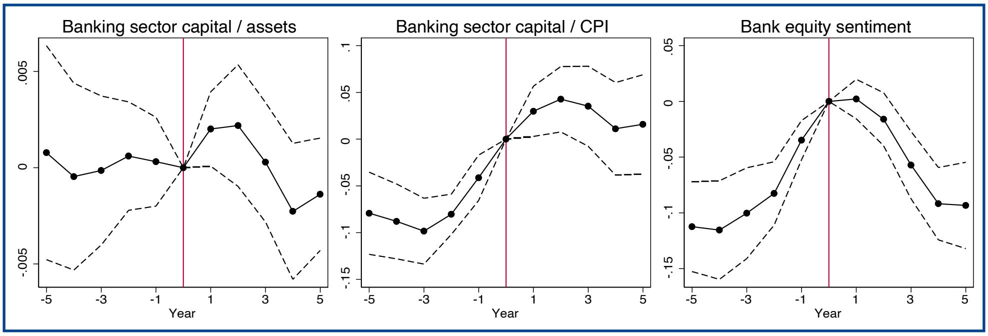
Constructing the bank equity sentiment variable. López-Salido et al. (2017) argue that predictably low returns on financial assets are associated with high levels of sentiment. The idea is that investors could have anticipated these low returns ex ante, but market prices did not adjust, hence returns remained predictably low, indicating either high levels of market sentiment or low levels of risk aversion (i.e., investors rationally demanding low risk compensation). We apply the same logic to construct a sentiment-based measure for bank stock returns. We first predict three-year-ahead bank stock returns using three lags of the bank equity price-dividend ratio (a common predictor of stock returns in the literature, see, e.g. Cochrane, 2008 and López-Salido et al., 2017) and three-year credit-to-GDP growth, shown to strongly predict future bank stock returns by Baron and Xiong (2017). Our sentiment measure is then just the negative of the 3-year ahead bank stock return forecast, indicating the fact that high sentiment means predictably low future returns:

$$r^{bank}_{i,t+1,t+3} = \alpha_i + \sum_{s=0}^{3} \beta^{pd}_s pd_{i,t-s} + \beta^{credit} \Delta_3 \left(\text{Credit/GDP}\right)_{i,t} + u_{i,t+1,t+3} \qquad (8)$$

$$\text{Bank equity sentiment}_{i,t} = -\hat{r}^{bank}_{i,t+1,t+3} \text{ (bank return forecast from (8)).} \qquad (9)$$

Above, i and t are country and year indices, r are real bank stock returns, pd is the log bank equity price-dividend ratio, and Credit/GDP the 3-year change in the ratio of total bank credit to GDP. The regression in (8) yields significant coefficients $\beta^{pd} < 0$ and $\beta^{credit} < 0$, in line with previous studies. The average level of the bank equity sentiment variable around R-zones preceded by monetary rate cuts is shown in the right-hand panel of Figure A.7.

Figure A.7: Bank capital and bank equity market sentiment around red zones preceded by rate cuts.



Notes: These graphs show the regression coefficients and 90% confidence intervals from regressing bank capital ratios, total real banking system capital, and bank equity sentiment, on the dummy which equals to 1 when the economy enters a business or financial red zone that was preceded by a monetary policy rate cut, for horizons h = 5, ..., 0, ..., 5, with 0 corresponding to the first year of being in the pre-cut red zone (meaning that credit and asset price growth were high, and monetary policy rates were cut, between years t 5 and t with t indicating the start of a R-zone episode). 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 López-Salido et al., 2017), using past information bank equity dividend-price ratios, and change in credit to GDP as predictors (high sentiment means that bank stock returns will be predictably low in the future).

D. Loan-level evidence from Spain: Additional results

Table A.15: Spanish administrative data: summary statistics.

		Mean (1)	S.D. (2)	P25 (3)	Median (4)	P75 (5)
Loan default$_{t,t+3}$ before 2008 Q3	0/1	0.045	0.207	0.000	0.000	0.000
Loan default$_{t,t+3}$ full sample	0/1	0.055	0.229	0.000	0.000	0.000
ΔRate$_{t,t+3}$	%	0.028	1.402	-0.662	0.011	0.967
Cut Rate$_{t\ 5,t}$	0/1	0.464	0.499	0.000	0.000	1.000
Firm average cost of credit	%	3.684	3.201	1.239	2.956	5.317
Construction & real estate firm	0/1	0.221	0.415	0.000	0.000	0.000
Firm not in Mercantile Register the previous year	0/1	0.257	0.437	0.000	0.000	1.000
Bank NPL Ratio	%	3.871	5.029	0.749	1.369	5.068

Notes: This table reports means, standard deviations and first/second/third quartiles of the main variables used in the loan-level regressions using Spanish administrative data.

Table A.16: The path of monetary policy rates and loan-level defaults in Spain: without demeaning.

	Dependent variable: Loan default$_{t+1 \text{ to } t+3}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta_3 Rate_{t,t+3}$	0.001*	0.000	0.000	0.002**	0.001	0.002**	0.001	0.002*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cut $Rate_{t-5,t}$	0.012***	0.010***	0.010***	0.006***	0.007***	0.007**	0.007***	0.007***	0.012***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta_3 Rate_{t,t+3}$ × Cut $Rate_{t-5,t}$		0.003**	0.004***	0.003***	0.003***	0.002**	0.003***	0.004***	0.007***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry×Location FE	No	No	Yes	Yes	–	Yes	–	–	–
Bank Controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	–	–
Firm FE	No	No	No	No	Yes	No	Yes	–	–
Firm Bank FE	No	No	No	No	No	No	No	Yes	Yes
Firm Controls	No	No	No	No	No	No	No	No	Yes
Observations	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	1.1m	0.7m
R^2	0.031	0.031	0.220	0.220	0.353	0.221	0.354	0.551	0.584

Notes: This table reports the 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 paths of monetary policy rates. New 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 (overnight) rates between years t-5 and t is below its average value, and Δ3Rate is the percentage point change in the monetary policy rate between years t and t+3. Coefficients are listed in the first row, and standard errors corrected for clustering at the firm, bank and time level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that it is not included and "-" that is comprised 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 levels, respectively.

Table A.17: The path of monetary policy rates and loan-level defaults in Spain, 1995–2020.

	Dependent variable: Loan default$_{t+1\text{ to }t+3}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ_3Rate$_{t,t+3}$	0.005***	0.005***	0.005***	0.006***	0.005***	0.006***	0.006***	0.006***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cut Rate$_{t-5,t}$	0.007***	0.006***	0.009***	0.006***	0.009***	0.005**	0.008***	0.008***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Δ_3Rate$_{t,t+3}$ × Cut Rate$_{t-5,t}$		0.000	0.002	0.002*	0.004**	0.002**	0.003**	0.004**	0.003**
		(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Industry×Location FE	No	No	Yes	Yes	–	Yes	–	–	–
Bank Controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	-	-
Firm FE	No	No	No	No	Yes	No	Yes	-	-
Firm Bank FE	No	No	No	No	No	No	No	Yes	Yes
Firm Controls	No	No	No	No	No	No	No	No	Yes
Observations	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.1m
R^2	0.038	0.038	0.220	0.220	0.353	0.221	0.354	0.551	0.526

Notes: This table reports the 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 paths of monetary policy rates. Cut is a dummy variable indicating whether the change in (overnight) rates between years t-5 and t is below its average value, and Δ_3Rate 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 firm, bank and time level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that it is not included and "-" that is comprised 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 levels, respectively.

Table A.18: The path of monetary rates and loan-level defaults in Spain, 1995–2020, heterogeneous effects.

	Dependent variable: Loan default$_{t+1 \text{ to } t+3}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta_3 Rate_{t,t+3}$	0.006***	0.007***	0.007***	0.007***			
	(0.001)	(0.001)	(0.001)	(0.001)			
Cut $Rate_{t-5,t}$	0.008***	0.008***	0.008***	0.009***			
	(0.003)	(0.003)	(0.003)	(0.003)			
$\Delta_3 Rate_{t,t+3}$ × Cut $Rate_{t-5,t}$	0.003**	0.005**	0.004**	0.005**			
	(0.001)	(0.002)	(0.001)	(0.002)			
Δ_3Rate × Cut × Real estate firm	0.007**			0.007**	0.007**	0.004	0.001
	(0.003)			(0.003)	(0.003)	(0.003)	(0.009)
Δ_3Rate × Cut × Firm not audited			0.003**	0.001	0.001		
			(0.001)	(0.001)	(0.001)		
Δ_3Rate × Cut × Firm cost of credit						0.002***	0.002***
						(0.000)	(0.000)
Δ_3Rate × Cut × Bank NPL ratio		0.001		0.001*	0.001	0.001	0.001
		(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
Δ_3Rate × Cut × Bank NPL × Real estate							-0.002
							(0.003)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm×Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	Yes	Yes	Yes
Firm Controls	No	No	No	No	No	Yes	Yes
Observations	1.6m	1.6m	1.6m	1.6m	1.6m	1.1m	1.1m
R-squared	0.497	0.496	0.497	0.500	0.500	0.528	0.530

Notes: This table reports the 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 paths of monetary policy rates. Cut is a dummy variable indicating whether the change in (overnight) rates between years t-5 and t is below its average value, and Δ_3Rate is the percentage point change in the monetary policy rate between years t and t+3. Coefficients are listed in the first row, robust standard errors are reported in the row below. Standard errors are corrected for clustering at the firm, bank and time level. Firm cost of credit measures the average cost of bank credit for the specific firm. Real estate firm includes both construction and real estate firms. Firm not audited means that the firm did not report to the Mercantile Register, and hence was not audited, in the previous year. Bank NPL is the non-performing loans ratio of the bank. All variables are demeaned by subtracting their sample mean. Lower-degree terms of the interaction are included in the regression but not shown in the table. For observations, m corresponds to millions. “Yes” indicates that the set of characteristics or fixed effects is included, and “No” that it is not included. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

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