LIÈGE université Library

https://lib.uliege.be

https://matheo.uliege.be

Research-Thesis: How Long-Term Monetary Policy Expectations Influence the Accumulation of Credit-Driven Financial Vulnerabilities

Auteur : Belfakiri, Wiâme
Promoteur(s) : Clerc, Pierrick
Faculté : HEC-Ecole de gestion de l'Université de Liège
Diplôme : Master en sciences économiques, orientation générale, à finalité spécialisée en macroeconomics and finance
Année académique : 2025-2026
URI/URL : http://hdl.handle.net/2268.2/27414

Avertissement à l'attention des usagers :

Tous les documents placés en accès ouvert sur le site le site MatheO sont protégés par le droit d'auteur. Conformément aux principes énoncés par la "Budapest Open Access Initiative"(BOAI, 2002), l'utilisateur du site peut lire, télécharger, copier, transmettre, imprimer, chercher ou faire un lien vers le texte intégral de ces documents, les disséquer pour les indexer, s'en servir de données pour un logiciel, ou s'en servir à toute autre fin légale (ou prévue par la réglementation relative au droit d'auteur). Toute utilisation du document à des fins commerciales est strictement interdite.

Par ailleurs, l'utilisateur s'engage à respecter les droits moraux de l'auteur, principalement le droit à l'intégrité de l'oeuvre et le droit de paternité et ce dans toute utilisation que l'utilisateur entreprend. Ainsi, à titre d'exemple, lorsqu'il reproduira un document par extrait ou dans son intégralité, l'utilisateur citera de manière complète les sources telles que mentionnées ci-dessus. Toute utilisation non explicitement autorisée ci-avant (telle que par exemple, la modification du document ou son résumé) nécessite l'autorisation préalable et expresse des auteurs ou de leurs ayants droit.



How Long-Term Monetary Policy Expectations Influence the Accumulation of Credit-Driven Financial Vulnerabilities

Master thesis presented by
Wiâme Belfakiri

Jury:

Supervisor:
Prof. Pierrick CLERC

Reader(s) Bruno DeBacker

To obtain the degree of Master of Science in Economics with a specialization in Macroeconomics and Finance

Academic year 2025/2026



Acknowledgements

I would like to express my sincere gratitude to my supervisor, Professor Clerc, for his continuous support, availability, and encouragement throughout this project. His guidance helped me stay on track at every stage of the research process, and his constructive feedback pushed me to think more carefully about the economic implications of my results.

I am especially grateful to Professor Bruno De Backer, whose expertise in empirical macroeconomics and generous guidance on the econometric aspects of this thesis were invaluable. I am also deeply grateful for his support in securing my internship at the National Bank of Belgium. That experience gave me direct exposure to central banking and macroprudential policy and first sparked my interest in the questions explored in this thesis. This work would not have been the same without his guidance and support.

I would also like to thank the faculty and staff of HEC Liège for the quality of the Master's programme in Macroeconomics and Finance. I am grateful to have studied in an environment that encouraged rigorous thinking and intellectual curiosity.

Abstract

This thesis examines whether conventional and unconventional monetary policy shocks contribute to the accumulation of financial vulnerabilities that precede systemic banking crises. Using annual data for 18 advanced economies over 1949–2020, we identify two structural monetary shocks within a sign-restricted VAR and estimate their dynamic effects through local projections.

The two shocks operate through different channels and at different speeds. The unconventional shock produces a relatively rapid and simultaneous increase in household debt and real house prices, creating the conditions associated with household financial overheating. The conventional shock acts more gradually on household balance sheets but is followed by a clear medium-term increase in banking-crisis probability.

A central finding of the thesis is that the transmission of monetary policy to financial vulnerability depends on the initial level of public debt. In low-debt economies, the response of household red-zone probability to an expansionary unconventional shock is concentrated at shorter horizons and weakens thereafter. In high-debt economies, the response becomes larger and more persistent at medium horizons, reaching almost 12 percentage points around six years after the shock.

Overall, the results suggest that monetary easing is not uniformly destabilising. Conventional and unconventional policy shocks affect financial stability through different channels, and their effects depend on the macro-financial environment in which they occur. In particular, elevated public debt appears to strengthen the transmission of unconventional monetary easing to household financial vulnerability.

Table of Contents

1 List of Abbreviations . . . 3
2 Introduction . . . 4
3 Contributions of the Thesis . . . 7
4 Theoretical Framework & Literature Review . . . 9
4.1 The Short-Term Indicator: The Policy Rate and the Risk-Taking Channel . . . 9
4.2 The Medium/Long-Term Indicator: The Term Spread as a Mirror of Expectations . . . 10
4.3 The "Red Zone" Theory: Non-Linear Financial Overheating . . . 11
4.4 The Gap: Monetary Expectations and the Build-up of Vulnerability 13
4.5 Empirical Hypotheses . . . 14
4.6 Empirical Transmission Framework . . . 15
5 Data, Econometric Methodology & Structural Identification . . . 16
5.1 Sample Description and Descriptive Statistics . . . 16
5.2 Structural Identification through Sign Restrictions (VAR4) . . . 19
5.3 From Shock Identification to Impulse Responses . . . 22
5.4 Are the Identified Shocks Predictable? . . . 24
5.4.1 Conventional shock . . . 25
5.4.2 Unconventional shock (UMP) . . . 26
6 Do Monetary Shocks Predict Banking Crises? . . . 27
6.1 From Monetary Shocks to Financial Vulnerabilities . . . 31
6.1.1 Local Projection Framework . . . 32
6.1.2 The Unconventional Monetary Policy Channel . . . 33
6.1.3 The Conventional Monetary Policy . . . 36
6.1.4 Comparison and Discussion . . . 39
7 Does the Initial Level of Public Debt Matter? . . . 40
7.1 Local Projection Framework . . . 41
7.2 From Monetary Shocks to Red Zones . . . 42
7.2.1 Household Red Zones . . . 42
7.2.2 Business Red Zones . . . 43
7.3 Effect of Monetary Shocks on Banking Crisis Probability . . . 44
7.4 Does Public Debt Amplify the Red-Zone to Crisis Link? . . . 46
7.5 Why Does Initial Public Debt Matter? . . . 48
8 Validation of the Identified Monetary Shocks . . . 50
8.0.1 Cross-Country Consistency . . . 50
8.0.2 Historical Consistency of the Identified Shocks . . . 51
8.0.3 Comparison with Grimm's Monetary Stance . . . 53
8.0.4 Summary of the Validation Exercises . . . 56
9 Robustness . . . 57

10 Limitations and Avenues for Future Research 61
11 Conclusion 62
Appendices 63
List of Resource Persons 80
Bibliography 81
Executive Summary 83

1 List of Abbreviations

CB Central Bank

CI Confidence Interval

ECB European Central Bank

EU European Union

FG Forward Guidance

GDP Gross Domestic Product

GFC Global Financial Crisis (2007–2009)

JST Jordà–Schularick–Taylor Macrohistory Database

LP Local Projections

MP Monetary Policy

NBB National Bank of Belgium

pp Percentage Points

QE Quantitative Easing

R-zone Red-zone episode, following Greenwood et al. (2022)

SE Standard Error

SR-VAR Sign-Restricted Vector Autoregression

UMP Unconventional Monetary Policy

VAR Vector Autoregression

APP Asset Purchase Programme

BVAR Bayesian Vector Autoregression

DK Driscoll–Kraay

ELB Effective Lower Bound

FE Fixed Effects

IRF Impulse Response Function

NW Newey–West

OLS Ordinary Least Squares

SVAR Structural Vector Autoregression

ZLB Zero Lower Bound

2 Introduction

Since 2008, central banks in advanced economies have kept interest rates at historically low levels and implemented unprecedented asset purchase programmes. These policies played an important role in stabilising economic activity and financial markets. But could they also have contributed to the build-up of financial vulnerabilities that makes the next crisis more likely? This is the central question of this thesis.

The recurrence of major financial crises over the last century has challenged the idea that financial instability is unpredictable. Many studies show that crises are often preceded by a gradual build-up of financial imbalances. The 2008 Global Financial Crisis, the European sovereign debt crisis that followed, and more recent financial tensions have all confirmed this pattern. Empirical evidence shows that rapid credit growth, debt accumulation, and rising asset prices can be observed before crises occur and can help predict future financial instability (Schularick and Taylor, 2012; Jordà et al., 2013; Greenwood et al., 2022).

In parallel, monetary policy has changed significantly since 2008. Since interest rates reached very low levels, central banks relied on unconventional tools such as forward guidance and quantitative easing. These policies aim to influence long-term interest rates by acting on the expected future path of monetary policy, rather than on its current level alone. This approach has a clear theoretical basis: Woodford (2003) shows that economic agents respond not only to current interest rates but to the entire expected future trajectory of monetary policy.

This transformation raises a crucial question. If financial vulnerabilities develop gradually over the long term, and if modern monetary policy increasingly works through expectations and long-term interest rates, could central banks unintentionally contribute to the accumulation of financial risk? This leads to a paradox at the heart of modern monetary policy. In the short run, accommodative monetary policy supports economic activity and stabilises financial markets. In the long run, by encouraging borrowing and raising asset prices, it may increase financial fragility.

This thesis studies the relationship between expectations-based monetary policy and the build-up of credit-driven financial vulnerabilities. It analyses whether conventional and unconventional monetary policy shocks contribute to the accumulation of financial imbalances that precede banking crises.

This thesis makes two central contributions, which are developed in greater detail in the next section. First, it provides a structural identification of conventional and unconventional monetary shocks using sign-restricted VARs. This addresses an important limitation of the approach used by Grimm et al. (2023): their monetary stance measure may capture not only policy accommodation, but also the economic conditions that led the central bank to adopt that policy. The shocks are identified within a VAR that includes inflation and real GDP growth, helping to separate monetary innovations from the systematic response of policy to economic conditions. Second, it shows that the financial stability consequences of monetary policy are state-dependent. The same expansionary shock generates very different outcomes depending on the initial level of public debt.

To address the research question, the thesis is divided into three steps:

1. **Establishing the predictability of systemic risk.** We replicate the overheating frameworks of Greenwood et al. (2022) and Grimm et al. (2023). These approaches show that rapid credit growth combined with rising asset prices (called red-zones) provides an important early warning signal of future banking crises. Entering a household red zone is associated with a much higher three-year crisis probability, increasing from 6.0% in the full sample to 32.7% following a household red-zone episode.

2. **Understanding the accumulation mechanism.** We study how monetary shocks affect debt and asset prices over time. We distinguish between conventional monetary policy, which operates through short-term interest rates, and unconventional monetary policy (UMP), which operates mainly through the term spread and long-term rate expectations. Both shocks increase the two components underlying the household red-zone configuration (household debt and house prices) but with different timing. The UMP shock acts relatively quickly, with the main responses appearing within two to five years. The conventional shock operates more gradually, with its effects emerging at longer horizons and proving more persistent.

3. **Analysing state-dependent financial fragility.** We show that the financial-stability consequences of monetary policy depend strongly on the initial level of public debt. In low-debt economies, the effect on household red-zone probability is concentrated at short horizons. In high-debt economies, by contrast, expansionary shocks generate larger and more persistent responses, especially through the unconventional policy channel. This result suggests that public indebtedness shapes the transmission of monetary policy to household balance sheets and housing-market vulnerabilities. Rather than being uniformly destabilising, monetary easing becomes more likely to generate financial fragility when it operates in an already highly indebted environment.

The most important result concerns unconventional monetary policy. In low-debt economies, the response of household red-zone probability is concentrated at shorter horizons and weakens thereafter.

The pattern becomes much stronger when public debt is high. At horizon $h = 5$, the effect reaches +10.1 percentage points. At horizon $h = 6$, it reaches +12.0 percentage points. Both effects are statistically significant at the 95% level. The difference between high-debt and low-debt regimes is also significant, reaching +13.8 percentage points at $h = 6$.

This is a central result of the thesis. The effect of unconventional monetary policy on household financial vulnerability depends on the initial level of public debt. In low-debt economies, the response is positive at short horizons but becomes weaker thereafter. In high-debt economies, the effect becomes considerably larger at medium horizons.

Figure 1 illustrates this result. It shows the response of the household red-zone probability to an expansionary UMP shock, separately for low-debt and high-debt economies. In low-debt economies, the response is concentrated at shorter horizons. In high-debt economies, it becomes larger and more persistent, especially between $h = 5$ and $h = 6$.

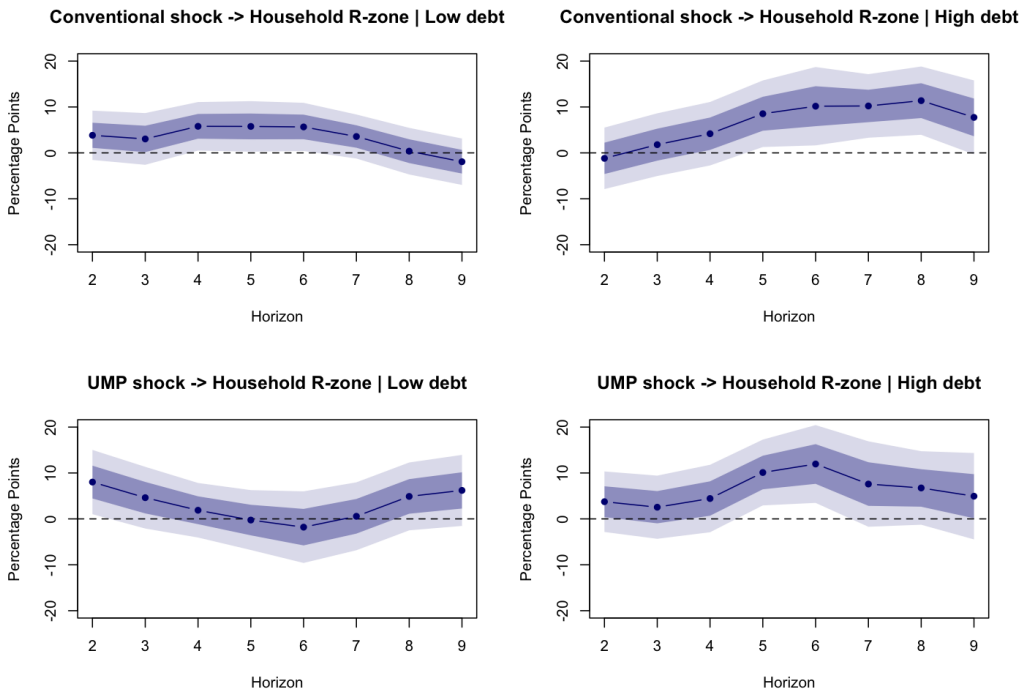


Figure 1: Effect of an expansionary UMP shock on household red-zone probability, by debt regime. The sample is split at the median public debt-to-GDP ratio (46%). Coefficients are in percentage points. Dark shaded bands show 68% confidence intervals and light shaded bands show 95% confidence intervals, both based on Newey–West standard errors. The low-debt response is concentrated at short horizons, while the high-debt response becomes larger and statistically significant at $h = 5$ and $h = 6$. The full analysis is developed in Section 7.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

3 Contributions of the Thesis

This thesis connects two areas of literature: the credit-cycle literature (Greenwood et al., 2022; Jordà et al., 2015) and the expectations-based monetary policy literature (Woodford, 2003). It argues that these mechanisms are closely linked, as monetary policy can influence the financial vulnerabilities that make banking crises predictable. The thesis makes five main contributions.

First, it replicates the financial vulnerability framework: We replicate the red-zone thresholds of Greenwood et al. (2022) on the post-1949 sample and obtain values very close to those reported in the original article. The 80th percentile thresholds for business and household debt growth are 4.72 and 6.08 respectively (versus 4.73 and 6.23 in the original study), while the 66.7th percentile thresholds for real equity and house-price growth are 22.34% and 12.59% (versus 22.82% and 12.84%). We also reproduce the predictive power of the red zones. A household red zone is associated with a three-year crisis probability of 32.7%, compared with 6.0% in the full sample. A business red zone is associated with a three-year crisis probability of 25.0%. These results confirm that the red-zone framework retains strong predictive power in our post-1949 sample.

Second, it extends the analysis of Grimm et al. (2023): A central contribution of this thesis is to extend the analysis of Grimm et al. (2023) by distinguishing between conventional and unconventional monetary policy shocks. While their reduced-form stance captures the overall degree of monetary accommodation, the structural identification used here separates innovations operating through the short-term policy rate from those operating primarily through the term spread. The conventional shock reproduces the broad medium-horizon relationship between monetary accommodation and banking-crisis risk documented by Grimm et al. (2023), while the unconventional shock reveals a distinct transmission mechanism operating primarily through household financial vulnerabilities.

Third, it provides a structural identification of monetary shocks: The thesis goes beyond the reduced-form monetary stance used by Grimm et al. (2023). It distinguishes conventional monetary shocks, operating through the short-term interest rate, from unconventional shocks operating through the term spread while leaving the policy rate approximately unchanged.

To identify these shocks, we estimate a country-level VAR with two lags and four variables: inflation, real GDP growth, the short-term rate, and the term spread. We then apply sign restrictions in line with Uhlig (2005) and Rubio-Ramírez et al. (2010). For each country, we draw 50,000 random orthogonal rotations and keep only the admissible ones. This approach makes it possible to study whether conventional and unconventional monetary policies have different effects on macro-financial stability.

Fourth, it documents the gradual accumulation mechanism: The thesis documents the transmission mechanism linking monetary policy to financial vulnerability. It shows that expansionary monetary shocks trigger a gradual build-up of debt and asset prices over several years. Using local projections (Jordà, 2005), we show that monetary shocks affect household debt, business debt, real house prices, and real equity prices, the exact variables used to define the red zones in Greenwood et al. (2022).

Our results show a crucial sectoral distinction, the transmission of unconventional monetary policy (UMP) shocks operates primarily through the household sector. The

UMP shock is followed by a simultaneous expansion of household debt and real house prices, creating the conditions associated with the household red-zone configuration, whereas its effect on the business sector is much less persistent.

Fifth, it identifies the state-dependent effects of monetary policy:

The thesis shows that the financial-stability consequences of monetary policy depend on the initial level of public debt. In low-debt economies, the UMP effect on household red-zone probability is positive at short horizons but weakens thereafter. In high-debt economies, defined as observations with a debt-to-GDP ratio above the sample median of 46%, the response becomes markedly larger at medium horizons, reaching 11.96 percentage points at $h = 6$. This result identifies public debt as an important condition shaping the transmission of unconventional monetary policy to household financial vulnerability.

Overall, the thesis moves from prediction to mechanism. It not only asks whether crises are predictable. It asks how monetary policy contributes to the vulnerabilities that make them predictable. The empirical chain can be summarized as follows:

$$\boxed{\text{Monetary accommodation} \implies \text{credit and asset-price boom} \implies \text{red zone} \implies \text{crisis}}$$

The main message is that monetary policy affects more than the short-run macroeconomic cycle; it can also shape the long-run financial cycle. Prolonged monetary accommodation may reduce visible risk in the short run, but it can contribute to the build-up of systemic financial fragility over the medium term. This intertemporal trade-off becomes critical in high-debt environments, such as the post-COVID euro area.

Table 1: Positioning of the thesis relative to the existing literature

Existing literature	**Contribution of this thesis**
Greenwood et al. (2022) show that red zones predict future banking crises.	Replicates and validates the red-zone framework on the post-1949 sample, confirming both the original thresholds and their predictive power for systemic crises.
Grimm et al. (2023) measure monetary accommodation using a reduced-form monetary stance.	Identifies structural conventional and unconventional monetary policy shocks using a sign-restricted VAR, allowing the two policy channels to be analysed separately.
Woodford (2003) explains how monetary policy operates through expectations and long-term interest rates.	Links expectations-based monetary policy to the accumulation of credit-driven vulnerabilities by documenting the full transmission mechanism from shocks to debt, asset prices, red zones, and crises.
The literature typically focuses on the average effects of monetary policy on financial stability.	Provides novel evidence that these effects are *state dependent*: household vulnerability responds in both debt regimes, but the response becomes larger and more persistent at medium horizons when public debt is already elevated.

4 Theoretical Framework & Literature Review

During the last decade, an increasing amount of macro-financial research has suggested that financial crises are not pure "unexpected events", but rather the result of long-term imbalances that accumulate gradually, especially through credit expansion and rising leverage (Schularick and Taylor, 2012; Greenwood et al., 2022). At the same time, modern monetary theory has increasingly emphasised expectations-driven transmission, in which the effects of monetary policy depend not only on the current policy rate but also on the expected future path of policy (Woodford, 2003). Combining this perspective with the credit-cycle literature raises the central question of this thesis: whether monetary policy can influence the gradual accumulation of credit-driven financial vulnerabilities. This idea provides a motivation for taking a closer look at both the credit-cycle literature and the expectations-based approach to monetary policy, to understand how policy expectations can influence credit-driven financial vulnerabilities.

To organise this discussion, the framework proceeds in three steps: it first considers the short-term policy rate and its transmission to risk-taking, then the term spread as a channel for long-term expectations, and finally the non-linear process through which credit and asset prices jointly generate systemic risk.

4.1 The Short-Term Indicator: The Policy Rate and the Risk-Taking Channel

The most traditional instrument of monetary policy is the short-term interest rate (`stir`), the conventional driver of the immediate cost of capital. Its influence, however, extends beyond the simple price of borrowing and operates through a risk-taking channel.

The notion of a risk-taking channel of monetary policy is explained in the work (Borio and Zhu, 2012). This notion highlights that interest rate movements affect the level of risk financial intermediaries accept. Expectations about the future of interest rates play an even larger role. They help determine how much risk institutions are willing to take. Their analysis shows that a persistent environment of low policy rates can push banks to expand their balance sheets. They also relax lending conditions and accept riskier exposures. This process accelerates credit growth and increases financial system fragility. The paper also emphasizes how capital regulation interacts with monetary conditions. When regulation is loose or easy to bypass, low interest rates motivate banks to adopt riskier behaviour.

Financial intermediaries play a central role in amplifying financial cycles. The work of (Adrian and Shin, 2010) provides strong evidence for this idea . Their analysis shows that leverage increases when financial conditions improve. The decline in risk premia and favorable market conditions encourage institutions to borrow more and expand their balance sheets. This increases liquidity in the market and leads to an increase in credit creation. In contrast, when economic conditions worsen, leverage falls quickly, which intensifies the downturn. This pro-cyclical pattern arises because intermediaries respond strongly to changes in asset values and funding conditions, both of which are affected by monetary policy.

The contribution of (Bernanke et al., 1999) is foundational to understand how financial frictions can amplify economic fluctuations. The study shows that firms in a weaker

financial position face higher borrowing costs, which can lead them to reduce investment. In environments with favorable economic conditions, businesses can more easily borrow money as interest rates decrease, leading to faster growth rates for those businesses. Conversely, in less favorable economic conditions, businesses experience decreased net worth and increased costs of financing, thereby causing additional damage to their businesses and decreasing the speed at which their businesses can grow. This amplification channel works regardless of the initial shock, it shows the central role of credit in the evolution of macroeconomic dynamics. Even if their model was developed before the recent focus on long-term monetary expectations, it still provides a key theoretical basis for linking financial conditions to the broader business cycle.

4.2 The Medium/Long-Term Indicator: The Term Spread as a Mirror of Expectations

While the policy rate governs the immediate cost of capital, the medium- and long-term stance of monetary policy is reflected in the term spread (`termspread`), which partly captures market expectations about the future path of interest rates (De Backer et al., 2019). Changes in the term spread can therefore affect long-term financing conditions, including those relevant for mortgage credit. This provides an important channel through which unconventional monetary policy may influence household balance sheets and housing markets.

An essential theoretical foundation for policy based on expectations is the research of Michael Woodford, particularly his book Interest and Prices which introduces a "neo-Wicksellian" model in which the central bank implements an interest-rate rule instead of managing monetary aggregates (Woodford, 2003). Within this context, private-sector decisions depend on expected future short-term rates and inflation, so that long-term interest rates reflect the expected path of monetary policy rather than current rates. Woodford highlights that monetary policy is essentially about managing expectations: Effective policy is marked by commitment and persistence, and unexpected policy changes matter less than the systematic pattern that economic agents come to expect over time. The equilibrium price level and output dynamics depend on expected real and nominal interest rates over time. This implies that reliable forward guidance or other long-term commitments can strongly influence financial conditions. This remains true even when current interest rates are constrained by the lower bound. This perspective implies that long-term monetary policy expectations can affect borrowing costs, valuation of assets, and intertemporal spending decisions, thereby providing a theoretical channel through which policy expectations might interact with credit dynamics and vulnerability accumulation.

The work Deconstructing Monetary Policy Surprises: The Role of Information Shocks by (Jarociński and Karadi, 2020) has clarified the role of announcements made by central banks in shaping public expectations . Their analysis suggests that financial market reactions to central bank decisions are not just a function of monetary policy rate changes. Central bank announcements influence expectations not only through policy rate decisions, but also through the signals they provide about future economic conditions. The authors combine high-frequency data collected at the time of European Central Bank (ECB) and Federal Open Market Committee (FOMC) announcements with a structural VAR approach. They distinguish the part of market reactions that comes from a change

in monetary policy from the part that results from new information communicated by the central bank. Even when policy rates are unchanged, the results show that financial markets adjust long-term yields, equity prices, and expectations. These market reactions exist because central banks' communication affects perceptions of future economic conditions. Long-term monetary policy expectations are shaped not only by the actions of central banks but also by the information they share. Therefore, any change in monetary policy expectations generated through communication will have an impact on the credit conditions of the economy, and accordingly, may contribute to the build-up of financial vulnerabilities in the economy over time.

The importance of central bank communication for shaping financial conditions is also presented by (Gürkaynak et al., 2005). Their study highlights the reactions of financial markets to changes in policy rates but also, and often more strongly, to the signals communicated by central banks. They show that long-term interest rates adjust to the forward-looking signals in the announcement, even when the policy rate is unchanged. Therefore, this result shows that monetary policy cannot be understood only through movements in short-term rates, expectations about future policy play a central role in shaping economic conditions.

According to (Rey, 2013), monetary transmission has a strong global component. In a world of free capital mobility, domestic financial conditions depend heavily on global financial cycles. These cycles are mainly driven by US monetary policy. This study shows that changes in global risk, international capital flows and asset prices often move together. This international movement reduces the ability of any single country to isolate its financial systems through its own monetary policies. Therefore, in many economies, long-term interest rates, credit dynamics and leverage are influenced by domestic policy decisions but also by expectations about future central bank policy, particularly the Federal Reserve. The interaction between global conditions and local credit cycles has to be understood to assess the long-term build-up of financial vulnerabilities.

4.3 The "Red Zone" Theory: Non-Linear Financial Overheating

The idea that financial stability can itself generate future instability predates the recent empirical credit-cycle literature. In his Financial Instability Hypothesis, Minsky (1978) argues that prolonged periods of favourable economic and financial conditions can encourage greater leverage and increasingly fragile financing structures. Financial instability can therefore emerge endogenously during periods that initially appear stable.

Building on this intuition, the credit-cycle literature documents how borrowing incentives and asset-price dynamics can translate, over time, into the accumulation of financial risk.

Regarding financial stability, the study of (Schularick and Taylor, 2012) offers a highly influential long-term study of credit and economic crises. Using a historical dataset covering 14 advanced economies from 1870 to 2008, they trace the progression of bank lending, money supply and economic output over nearly 140 years. Their key result is that credit growth, rather than monetary aggregates, serves as a strong indicator of

upcoming financial crises and adverse macroeconomic conditions. Their research shows that large and persistent credit booms tend to precede systemic banking crises, and that these episodes are associated with particularly severe and long-lasting recessions. In comparison, conventional indicators like inflation or short-term interest rates show less forecasting power for crises within their historical dataset. This evidence challenges macroeconomic frameworks that place limited emphasis on credit aggregates and supports the view that credit plays a central role in the build-up of financial instability. This paper shows that the costs of credit-driven vulnerabilities extend beyond the occurrence of financial crises. They are also associated with deeper recessions and slower recoveries, reinforcing the importance of monitoring the gradual build-up of credit risks.

Jordà, Schularick, and Taylor extend this long-run perspective in "When Credit Bites Back", emphasizing the influence of credit growth on the depth of recessions (Jordà et al., 2013). Analyzing data from 14 developed countries, between 1870 and 2008 they differentiate between recessions and those linked to financial crises. Their analysis shows two findings. First, recessions that coincide with financial crises are substantially deeper and more persistent than normal downturns. Second, the credit intensity of the preceding expansion, how much credit grows before the downturn, is strongly correlated with the severity of the subsequent recession, regardless of whether it is classified as a financial crisis. By applying local projection methods, they show that higher pre-recession credit growth leads to more pronounced declines in output, investment, and lending over the following years. In other words, credit booms leave a long "shadow" over the business cycle. This result reinforces the idea that credit dynamics are slow-moving and that vulnerabilities accumulate over multiple years before manifesting in macroeconomic stress. The paper shows that credit booms can have lasting consequences: when they end in a crisis, the subsequent recession is often deeper and the recovery slower.

Asset price booms also contribute to financial vulnerability. The research of (Jordà et al., 2015) in "Leveraged Bubbles" provides important evidence on this point. They analyzed long historical data for seventeen different advanced economies and differentiated between asset price booms funded by credit and those that are not. Their results show that asset price bubbles supported by fast credit expansion are far more likely to lead to financial crisis than bubbles driven mainly by changes in market valuations. When asset prices rises are associated with accelerating leverage, the probability of a financial crisis increases, and the following recessions tend to be deeper and last longer. This result highlights the amplifying role of credit. When credit grows quickly, ordinary fluctuations in asset prices become sources of systemic financial instability.

The concept of the financial cycle as a gradual but powerful source of macroeconomic fluctuations has been discussed by (Borio, 2014). In his article, Borio presents evidence from a global database that demonstrates that financial cycles are characterized by much longer phases of credit expansion and real estate price increases than those observed in traditional business cycles. Financial cycles typically last between 15 and 20 years, and their peaks are closely associated with periods of financial distress and significant recessions. According to Borio, credit growth and asset price increases are not simply effects of economic activity but key drivers of financial system vulnerability. If financial cycles are shaped by long-lasting credit growth, then monetary policy can significantly influence how these cycles evolve.

More recently, the book Predictable Financial Crises by (Greenwood et al., 2022) provides a modern and explicitly predictive view of financial fragility. Using data from 42

countries between 1950 and 2016, they analyze how combinations of credit growth and asset price growth forecast the probability of entering a financial crisis. They develop simple indicators of "credit-market overheating", referred to as "red-zone" conditions, defined by unusually high credit growth in either the household or non-financial corporate sector along with significant rises in housing or stock market values. Their main result is remarkable: when an economy is in this red zone, the probability of facing a financial crisis within the next three years can reach around 40–45%, compared to 7% in a normal situation. This evidence strongly challenges the idea that crises are sudden and unexpected events. Instead, the findings support the view that financial crises are often preceded by rapid credit growth and rising asset prices. The paper also explores policy implications, arguing that this predictability makes proactive financial stability policies necessary or even monetary policy actions designed to slow down credit booms. For this thesis, (Greenwood et al., 2022) offer a clear empirical framework for considering how early warning indicators should be used and the long-term accumulation of financial weaknesses, which can be related to the evolution of monetary policy expectations.

Building on this predictive approach, Grimm et al. (2023) examines whether monetary accommodation itself contains information about future banking crises. The study constructs a reduced-form measure of the monetary-policy stance and uses local projections on a long-run panel of advanced economies to show that prolonged periods of accommodative monetary conditions are associated with a higher probability of subsequent banking crises.

Crucially, this effect emerges only after several years, consistent with the gradual build-up of financial imbalances documented by Schularick and Taylor (2012) and Greenwood et al. (2022). Grimm's analysis therefore provides a particularly relevant empirical benchmark for the present thesis. However, the stance measure does not distinguish between conventional and unconventional monetary policy, nor does it fully separate unexpected policy innovations from the systematic response of central banks to economic conditions.

We first reproduce Grimm's main relationship and then examine whether structurally identified conventional and unconventional monetary policy shocks provide additional predictive information beyond this reduced-form stance. A central feature of the red-zone framework is its non-linearity: systemic risk does not increase gradually with credit, but rises sharply when both credit growth and asset prices exceed extreme historical thresholds. Following this approach, the present thesis defines a red zone as the joint crossing of a high debt-growth threshold, corresponding to the 80th percentile, and a high asset-price threshold, corresponding to the 66.7th percentile. This framework allows us to examine whether monetary policy shocks increase the probability that an economy enters a period of financial overheating.

4.4 The Gap: Monetary Expectations and the Build-up of Vulnerability

Collectively these findings create a consistent picture in which credit growth and leverage play a central role in the long-term build-up of financial vulnerabilities. While past credit

developments make crises and severe recessions largely predictable, the transition from vulnerability to crisis is not always linear. Nonetheless these works give limited consideration to the explicit influence of monetary policy expectations on these processes. For instance, Schularick and Taylor (2012) shortly discuss how monetary policy may have affected post-war leverage trends, but their main focus is on quantities of credit, rather than expectation-driven channels. Jordà et al. (2013) study the macroeconomic consequences of credit booms, yet they do not consider the possible influence of policy commitments or forward guidance on these developments. Greenwood et al. (2022) touch briefly on the policy implications of predictable crises. They note that monetary policy could intervene early, yet their empirical approach does not include measures of long-term policy expectations or central bank communication. In contrast, Woodford (2003)'s framework places expectations and policy commitment at the center of monetary transmission, but does not directly include credit-cycle patterns or indicators of financial vulnerability.

This conflict between the expectations of monetary policy literature and the credit-cycle research defines the gap that the present thesis aims to solve. On the one hand, expectations-based models suggest that long-term monetary policy expectations, based on interest-rate rules and forward guidance, influence long-term interest rates, risk premia, and the motivation to borrow and invest. On the other hand, empirical credit-cycle research shows that prolonged credit expansions and asset-price increases are warning signs of financial crises and severe recessions, suggesting that risks accumulate over several years before noticeable stress begins to appear. By combining these elements, the thesis examines whether changes in long-term monetary policy expectations are linked to the buildup of credit-driven financial risks. It asks whether periods of expected policy accommodation or clear long-term commitments tend to coincide with faster credit growth. It also considers whether these periods are associated with higher indicators of financial vulnerability.

4.5 Empirical Hypotheses

Based on the theoretical and empirical literature reviewed above, we formulate four testable hypotheses on how expansionary monetary policy affects credit dynamics and financial vulnerability.

H1 Accumulation Channel: *Expansionary monetary policy shocks increase credit growth and asset prices over several years.*

The credit-cycle literature suggests that monetary accommodation encourages borrowing and supports asset valuations, allowing financial vulnerabilities to build gradually over time (Schularick and Taylor, 2012; Borio, 2014).

H2 Differential Transmission: *Conventional and unconventional monetary policy shocks differ in the speed and sectoral composition of their effects.*

Conventional shocks operate mainly through the short-term interest rate, whereas unconventional shocks operate through the term spread. Because the term spread affects longer-term financing conditions, unconventional shocks are expected to have a faster and stronger effect on household debt and housing markets (Woodford, 2003; Garriga et al., 2021).

H3 Red-Zone Formation: *Expansionary monetary policy shocks increase the probability of entering a household financial red zone.*

By stimulating household credit and house prices, monetary easing may create the combination of rapid debt growth and rising asset prices associated with financial overheating (Greenwood et al., 2022; Grimm et al., 2023).

H4 State Dependence: *The effect of expansionary monetary policy on household financial vulnerability is stronger when public debt is high.*

The transmission of monetary shocks may depend on the initial macroeconomic environment. We therefore test whether the effect on red-zone probability differs between low- and high-public- debt economies.

4.6 Empirical Transmission Framework

The empirical strategy of this thesis is organised around a sequence of relationships that are examined separately. We first study how monetary policy shocks affect credit and asset prices, then whether these responses increase the probability of entering a financial red zone, and finally whether red-zone episodes are associated with a higher probability of a subsequent banking crisis. We also examine whether these relationships differ according to the initial level of public debt.

Figure 2 summarises this empirical framework. The arrows should be interpreted as the sequence of relationships investigated in the thesis rather than as a fully identified causal chain.

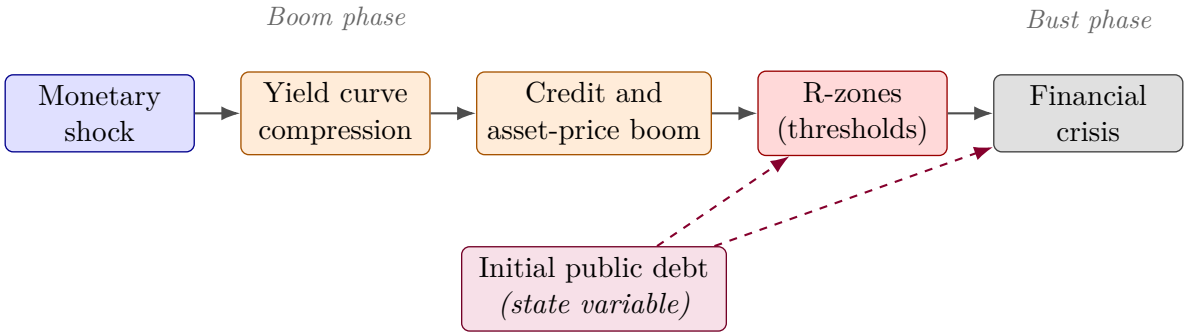


Figure 2: Empirical transmission framework examined in the thesis

Notes: The monetary shock is identified with a four-variable VAR and sign restrictions. This allows the thesis to separate the conventional channel, which works through the short-term rate, from the unconventional channel, which works through the term spread. Red zones are defined following Greenwood et al. (2022). They occur when credit growth and asset-price growth cross their respective thresholds. The effect on crisis probability is strongest three to six years after the shock. The role of debt is tested by splitting the sample at the median debt-to-GDP ratio and interacting this debt indicator with the monetary shock in the local projections.

5 Data, Econometric Methodology & Structural Identification

5.1 Sample Description and Descriptive Statistics

The empirical analysis uses the Jordà–Schularick–Taylor (JST) Macrohistory Database (Jordà et al., 2013; Schularick and Taylor, 2012), a long-run panel of advanced economies widely used in the credit-cycle literature. The sample covers 18 countries over the post-1949 period. The sample begins in 1949 because the household and business credit series required to construct the red-zone indicators are not consistently available across countries before that date. This choice also helps preserve comparability with the long-run empirical setting of Grimm et al. (2023), while avoiding the extreme macroeconomic disruptions associated with the two World Wars (1914–1918 and 1939–1945) and the German hyperinflation of 1922–1923. The panel contains 1,296 country-year observations. Missing values arise from two sources: the five-year moving average of the identified shocks requires four lagged observations, and the forward-looking dependent variables require future observations. Both are handled through listwise deletion within each local projection, so the effective sample varies across horizons and specifications.

Table 2 shows the sample coverage for each country, along with the number of systemic banking crises and the total of household and business red-zone episodes.

Table 2: Sample coverage and crisis episodes by country

Country	Start year	End year	Observations	Crises	R-zone hh	R-zone bus
AUS	1949	2020	72	1	11	3
BEL	1949	2020	72	1	3	1
CAN	1949	2020	72	0	0	0
CHE	1949	2020	72	2	6	3
DEU	1949	2020	72	1	0	5
DNK	1949	2020	72	2	8	7
ESP	1949	2020	72	2	10	9
FIN	1949	2020	72	1	6	4
FRA	1949	2020	72	1	6	1
GBR	1949	2020	72	3	14	4
IRL	1949	2020	72	1	0	0
ITA	1949	2020	72	2	2	6
JPN	1949	2020	72	1	0	15
NLD	1949	2020	72	1	10	6
NOR	1949	2020	72	1	6	5
PRT	1949	2020	72	1	6	0
SWE	1949	2020	72	2	8	4
USA	1949	2020	72	2	2	0
Total	–	–	**1,296**	**25**	**98**	**73**

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The sample includes 25 systemic banking crises. These include well-known historical episodes like the British secondary banking crisis of 1974, the Spanish banking crisis of the late 1970s, the U.S. Savings and Loan crisis of 1984, the Scandinavian banking crises

(Norway in 1988, Finland and Sweden in 1991), the Japanese banking crisis of 1997, and the Global Financial Crisis (GFC) of 2007–2008.

The GFC is the largest common event in the sample, affecting the US and the UK in 2007, followed by most continental European countries in 2008. The UK experienced three separate banking crises (1974, 1991, and 2007), which is the highest number in the sample. In contrast, Canada did not experience any banking crisis over the whole period.

Episodes of macro-financial overheating are relatively uncommon. In total, the sample contains 98 household red-zone episodes and 73 business red-zone episodes, representing about 7.6% and 5.7% of all country-year observations, respectively.

Table 3 reports descriptive statistics for the main variables used in the analysis. These include the short-term and long-term interest rates, the term spread, inflation, real GDP growth, the public debt-to-GDP ratio, and the three-year changes in household debt, business debt, house prices, and equity prices used to construct the red zones.[1]

Table 3: Descriptive statistics of the main variables

Variable	Mean	SD	p25	Median	p75	Min	Max	N
Short-term rate (`stir`, %)	5.19	4.21	2.11	4.31	7.39	-2.00	21.27	1,286
Long-term rate (`ltrate`, %)	6.35	3.81	3.89	5.52	8.54	-0.53	21.50	1,296
Term spread (`termspread`, pp)	1.15	1.77	0.30	1.16	1.96	-10.93	14.15	1,286
Inflation (%)	4.10	4.20	1.50	2.80	5.60	-7.10	32.10	1,278
Real GDP growth (%)	2.30	2.80	0.90	2.20	3.80	-11.90	21.50	1,278
Debt-to-GDP ratio (`debtgdp`)	0.54	0.36	0.30	0.46	0.67	0.04	2.54	1,285
Δ_3 Household debt (pp of GDP)	2.39	5.32	-0.11	1.75	5.09	-28.26	26.61	1,092
Δ_3 Business debt (pp of GDP)	0.81	6.66	-2.02	0.93	3.84	-37.78	34.46	1,087
Δ_3 log House prices (%)	6.95	17.29	-2.72	6.63	15.80	-62.42	96.89	1,091
Δ_3 log Equity prices (%)	6.30	40.85	-17.61	7.26	30.23	-239.83	185.07	1,075

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The short-term interest rate ranges from -2% to 21.3%. This reflects very different monetary policy environments, from the high inflation period of the 1970s to the ultra-low and negative interest rates observed after 2008.

The average term spread is 1.15 percentage points, but it becomes negative in about 18% of the observations, reaching a minimum of -10.9 percentage points. Yield curve inversions are generally associated with tighter monetary conditions, slower growth expectations, and pressures on bank profitability. They have historically preceded economic downturns, particularly in the United States (De Backer et al., 2019).

The median public debt-to-GDP ratio is 46%, which serves as the cutoff separating high and low-debt regimes. Using the sample median provides balanced subsamples, avoids imposing an arbitrary threshold, and allows us to study whether the effects of monetary policy differ systematically across debt environments rather than to identify a structural debt threshold.

[1]Inflation and real GDP growth are expressed in percentage points. The debt-to-GDP ratio is expressed as a fraction (e.g., 0.46 corresponds to 46%).

Asset prices show large fluctuations and a highly non-normal distribution, especially equity prices, which range from −239.8% to +185.1%. In the presence of such extreme values and fat tails, standard deviation-based thresholds would be sensitive to outliers and would not reliably identify periods of true overheating. Percentile thresholds are more robust because they depend only on the rank ordering of observations, not on the magnitude of extreme values. This is the approach adopted by Greenwood et al. (2022), who define boom thresholds as the 80th and 66.7th percentiles of the historical distributions of credit growth and asset price growth, respectively.

Finally, household debt grows faster than business debt on average. Over a three-year period, household debt increases by 2.39 percentage points of GDP, compared with 0.81 for business debt. This indicates that household borrowing has expanded more rapidly than business borrowing over the sample period.

These descriptive statistics highlight three important points for the empirical strategy. First, the sample covers many different monetary policy regimes, from the post-war period to the era of unconventional monetary policy. This variation is necessary to separately identify conventional and unconventional monetary shocks in the VAR. Second, banking crises are relatively rare events. The unconditional probability of experiencing a systemic banking crisis within the following three years is 6.0%. Local projections are well suited to this setting because they allow the dynamic effects of monetary shocks to be estimated flexibly at each horizon, without imposing the full dynamic structure of a VAR, and are relatively robust to model misspecification (Jordà, 2005). Third, red zones are also rare, but they are strongly associated with future crises: the three-year crisis probability rises from 6.0% in the full sample to 32.7% following a household red zone. This makes them informative early warning indicators of financial vulnerability.

Validation of the red-zone replication: Following Greenwood et al. (2022), a red zone is identified when both credit growth and asset-price growth are unusually high over the same three-year period. More precisely, debt growth must exceed the 80th percentile of its historical distribution, while real asset-price growth must exceed the 66.7th percentile. A household red zone therefore occurs when household debt and real house prices rise strongly at the same time. Similarly, a business red zone occurs when business debt and real equity prices jointly exceed their respective thresholds. Table 4 replicates these thresholds using our post-1949 sample.

Table 4: Replication of the red-zone thresholds (post-1949 sample)

Threshold	Original article	Our replication
Business credit, 80th pct ($p80_{bus}$)	4.73	4.72
Household credit, 80th pct ($p80_{hh}$)	6.23	6.08
Equity prices, 66.7th pct ($p667_{eq}$)	22.82	22.34
House prices, 66.7th pct ($p667_{hp}$)	12.84	12.59

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database and Greenwood et al. (2022).

Our estimated thresholds are very close to those reported by Greenwood et al. (2022). The differences are always smaller than 0.3 percentage points, confirming that the red

zones are correctly replicated. Applying these thresholds identifies 98 household red zones and 73 business red zones in our sample.

Crisis Risk after a Red-Zone Episode: Table 5 examines whether banking crises are more likely to occur after a household or business red zone.

Table 5: Three-year probability of crisis: unconditional vs. conditional on red zone

Sample	Observations	Crises within 3 years	Probability (%)
Full sample (unconditional)	1,242	75	6.0
After a household red zone	98	32	32.7
After a business red zone	72	18	25.0

Note: The three-year crisis probability is defined as the share of observations followed by a systemic banking crisis in at least one of the three subsequent years ($t+1$ to $t+3$).
Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database and Greenwood et al. (2022).

The results show that crises are much more likely after a red zone. In the full sample, the probability of a banking crisis within three years is only 6.0%. After a household red zone, it increases to 32.7%, multiplying the baseline risk by 5.5. After a business red zone, it reaches 25.0%, which is about 4.2 times higher than the baseline. This confirms that the red zones identified by Greenwood et al. (2022) are strong and reliable indicators of financial vulnerability.

5.2 Structural Identification through Sign Restrictions (VAR4)

The main methodological contribution of this thesis is to distinguish two types of monetary policy shocks: a conventional shock acting through the short-term interest rate, and an unconventional shock acting through the term spread while leaving the short-term rate almost unchanged. To identify these shocks, we estimate a structural VAR with sign restrictions for each country.

The reduced-form model: Before identifying monetary policy shocks, we first estimate a reduced-form VAR for each country. The purpose of this step is to describe how the main macroeconomic and financial variables evolve together over time, without yet imposing an economic interpretation on the innovations. The model includes inflation, real GDP growth, the short-term interest rate, and the term spread. Inflation and output growth capture the state of the economy, while the short-term rate and the term spread summarize the two monetary policy dimensions studied in this thesis. For each country, we estimate a four-variable VAR with two lags:

$$\underbrace{\mathbf{y}_t}_{4 \text{ variables}} = \mathbf{c} + \sum_{j=1}^{2} \mathbf{A}_j \mathbf{y}_{t-j} + \mathbf{u}_t, \tag{1}$$

where the vector of endogenous variables is:

$$\mathbf{y}_t = \begin{pmatrix} \pi_t \\ \Delta y_t \\ i_t \\ spread_t \end{pmatrix} = \begin{pmatrix} \text{Inflation} \\ \text{Real GDP growth} \\ \text{Short-term interest rate} \\ \text{Term spread} \end{pmatrix} = \begin{pmatrix} \texttt{inflation} \\ \texttt{growth_rgdp} \\ \texttt{stir} \\ \texttt{termspread} \end{pmatrix},$$

$\mathbf{c}$ is a vector of constants, $\mathbf{A}_j$ are 4×4 coefficient matrices for lags $j = 1, 2$, and $\mathbf{u}_t$ is the vector of reduced-form residuals with covariance matrix Σ.

The reduced-form residuals $\mathbf{u}_t$ isolate new information arriving at time t, but cannot be interpreted as pure monetary policy shocks since each residual may combine several simultaneous economic disturbances. Recovering structural shocks requires an additional identification step, described in the next section. Including inflation and real GDP growth is therefore important. It allows us to distinguish monetary innovations from the normal response of central banks to changes in inflation or economic activity.

The choice of two lags reflects a trade-off between capturing sufficient macroeconomic dynamics and preserving degrees of freedom. Lag-selection criteria applied across all 18 countries yield an average selected lag of 1.72 under the AIC and FPE criteria, 1.17 under HQ, and 1.00 under SC. Two lags therefore sit slightly above the cross-country average recommendation, allowing the VAR to capture persistence over a two-year window while avoiding the larger number of parameters implied by three- or four-lag specifications. Using the same lag order across countries also ensures that the structural shocks are identified from comparable specifications, which is particularly important given the limited annual sample available for each country. Lag-selection results for all countries are reported in Table 28 in the Appendix.

From reduced-form residuals to structural shocks: The next step is to separate the reduced-form innovations into economically meaningful structural shocks. We assume that the residuals are related to a vector of structural shocks, denoted $\boldsymbol{\varepsilon}_t$, through an impact matrix $\mathbf{B}$:

$$\mathbf{u}_t = \mathbf{B}\boldsymbol{\varepsilon}_t. \tag{2}$$

The matrix $\mathbf{B}$ determines how each structural shock affects the four variables on impact. Since the reduced-form VAR does not uniquely identify this matrix, additional restrictions are required.

Following the sign-restriction approach of Uhlig (2005) and the algorithmic implementation described in Rubio-Ramírez et al. (2010), we begin with the Cholesky decomposition of the residual covariance matrix and generate random orthogonal rotations via a QR decomposition of standard normal matrices. These restrictions allow us to distinguish the conventional monetary shock from the unconventional monetary shock.

The two monetary shocks: The sign restrictions are designed to distinguish the two main channels through which monetary policy affects financial conditions.

- **Conventional monetary policy shock:** Conventional monetary policy operates primarily through changes in the policy (short-term) interest rate. A restrictive monetary policy is therefore identified as an increase in the short-term rate. At the same time, the term spread is required to decline. This reflects the fact that long-term interest rates usually respond less than short-term rates during a conventional tightening, leading to a flatter yield curve.

$$B_{33} > 0, \qquad B_{43} < 0. \tag{3}$$

- **Unconventional monetary policy (UMP) shock:** Unconventional monetary policy mainly affects long-term interest rates through instruments such as large-scale asset purchases (quantitative easing) and forward guidance. These policies are typically implemented when the policy rate is constrained by the effective lower bound. Accordingly, the short-term interest rate is required to remain approximately unchanged, while the term spread increases under a restrictive UMP shock (or equivalently decreases under an expansionary UMP shock).

$$|B_{34}| < \tau, \qquad B_{44} > 0, \tag{4}$$

where $\tau = 0.05$ is a small tolerance allowing for a near-zero response of the short-term interest rate.

Throughout the thesis, we refer to this shock as an unconventional monetary policy shock for simplicity. More precisely, it is a term-spread shock satisfying restrictions consistent with unconventional monetary easing. This interpretation is most direct in the post-2008 period.

Since the sign restrictions are imposed for restrictive shocks, we reverse the sign of each identified shock to obtain its expansionary counterpart. A positive value of the expansionary shock therefore corresponds to an accommodative monetary impulse. The conventional shock corresponds to a standard interest-rate cut. The UMP shock corresponds to a compression of the term spread while the short-term policy rate remains approximately unchanged. This pattern is consistent with unconventional monetary easing, particularly in the post-2008 period.

For each country, several candidate impact matrices satisfy the sign restrictions. We retain the element-wise median of these admissible matrices as our representative identification. On average, 212 rotations satisfy the restrictions (between 117 and 381 depending on the country), providing a sufficiently large set of admissible solutions for every country.

$$\boldsymbol{\varepsilon}_t = \mathbf{B}_{med}^{-1}\mathbf{u}_t.$$

Following the approach of Grimm et al. (2023), who applies a five-year moving average to the monetary stance in the context of crisis prediction, we construct:

$$\varepsilon_{i,t}^{exp,5y} = \frac{1}{5}\sum_{j=0}^{4}\varepsilon_{i,t-j}^{exp} = \frac{\varepsilon_{i,t}^{exp} + \varepsilon_{i,t-1}^{exp} + \varepsilon_{i,t-2}^{exp} + \varepsilon_{i,t-3}^{exp} + \varepsilon_{i,t-4}^{exp}}{5}.$$

This moving average transforms the period-by-period structural shock into a measure of the cumulative medium-term monetary stance, capturing whether policy has been systematically accommodative or restrictive over the preceding five years. This is the shock variable used throughout the empirical analysis, following the approach of Grimm et al. (2023).

Why this identification matters: This identification goes beyond the reduced-form monetary stance used by Grimm et al. (2023). Their measure captures the overall degree of monetary accommodation, but it does not distinguish whether policy operates through the short-term interest rate or through long-term yields. Our identification explicitly separates these two transmission channels.

This distinction is particularly important after 2008, when short-term interest rates reached the effective lower bound and central banks increasingly relied on unconventional tools such as large-scale asset purchases and forward guidance. If financial vulnerabilities mainly arise through long-term interest rates, focusing only on the policy rate provides an incomplete picture of monetary transmission. Figure 3 summarizes the identification procedure.

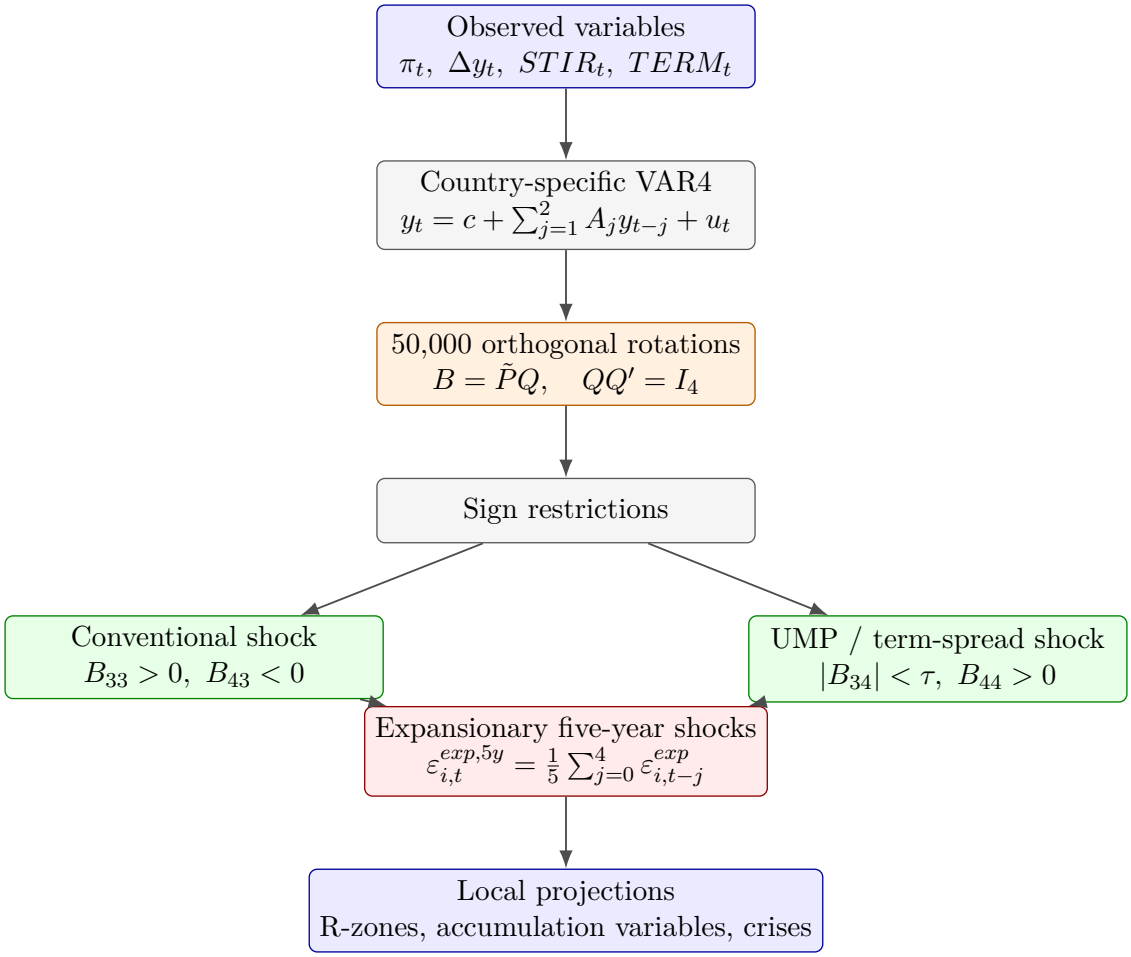


Figure 3: Identification strategy for conventional and unconventional monetary shocks

Notes: The figure summarizes the identification strategy. A country-specific VAR4 is estimated using inflation, real GDP growth, the short-term rate, and the term spread. Orthogonal rotations are retained only when they satisfy the sign restrictions. The restrictive shocks are then sign-reversed and averaged over five years to obtain the expansionary monetary stance used in the local projections.

5.3 From Shock Identification to Impulse Responses

The VAR and the local projections play complementary roles in the empirical strategy. The VAR is used primarily as an identification device. Its purpose is to recover conven-

tional and unconventional monetary policy shocks through sign restrictions, rather than to estimate the full set of dynamic responses examined in the thesis.

Once the structural shocks have been identified, their effects are estimated using local projections rather than VAR-based impulse responses. This choice provides greater flexibility for the empirical analysis. In particular, local projections allow the same identified shock to be related to a wide range of outcomes that are not included in the four-variable VAR, such as household and business debt, house and equity prices, red-zone indicators, and banking-crisis probability.

Local projections are also particularly convenient for the state-dependent analysis developed later in the thesis. They allow the response to a monetary policy shock to vary with the initial level of public debt without requiring the identification VAR itself to be expanded or re-estimated as a non-linear model. The VAR therefore provides a clear framework for structural shock identification, while local projections provide the flexibility required to trace the financial transmission of these shocks across outcomes, horizons, and debt regimes.

5.4 Are the Identified Shocks Predictable?

A structural monetary shock should capture an unexpected policy innovation rather than the systematic response of the central bank to economic conditions. This distinction is important because monetary policy is not conducted randomly. Central banks normally adjust their policy stance in response to inflation and economic activity.

This systematic behaviour is commonly described by a Taylor-type rule. When inflation rises or economic activity becomes unusually strong, the central bank is expected to tighten monetary policy. Conversely, weaker economic activity may lead to monetary easing. These predictable policy responses should therefore not be interpreted as structural monetary shocks.

Our identified shocks should instead capture the component of monetary policy that cannot be explained by information already available to the central bank. If the shocks could be systematically predicted using past inflation, output growth, debt, or financial conditions, they might partly reflect the normal policy response of the central bank rather than a genuine monetary surprise.

To examine this issue, we test whether each identified monetary shock can be predicted by its own recent history and by lagged macroeconomic information. For each shock, we estimate:

$$\varepsilon_{i,t} = \alpha_i + \sum_{j=1}^{3} \rho_j \varepsilon_{i,t-j} + \boldsymbol{\gamma}' \mathbf{X}_{i,t-1} + \eta_{i,t}, \tag{5}$$

where α_i denotes country fixed effects and the vector of lagged controls is given by

$$\mathbf{X}_{i,t-1} = \begin{pmatrix} \Delta_5 \log y_{i,t-1} \\ \Delta_5 \log p_{i,t-1} \\ \Delta_5 d_{i,t-1} \\ spread_{i,t-1} \end{pmatrix} = \begin{pmatrix} \text{Five-year change in real GDP} \\ \text{Five-year change in the price level} \\ \text{Five-year change in public debt-to-GDP} \\ \text{Term spread} \end{pmatrix}.$$

Under correct identification, the shock should be difficult to predict from its own lags and from past macroeconomic conditions. We therefore expect the coefficients on the lagged shocks to be small and statistically insignificant, and the regression to have limited explanatory power.

5.4.1 Conventional shock

We first apply the predictability test to the conventional monetary policy shock, `choc_mp_exp_var4`. Table 6 reports the main results.[2]

Table 6: Predictability test for the conventional monetary shock

Explanatory variable	Coefficient	t-statistic
Shock, first lag	0.021	0.63
Shock, second lag	0.045	1.47
Shock, third lag	0.012	0.39
Lagged real GDP growth	−0.963	−2.12**
Lagged inflation	−0.084	−0.52
Lagged public debt	0.270	1.20
Lagged term spread	−0.024	−1.36
Observations	1,161	
Country fixed effects	Yes	
R^2	0.018	

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

We include three annual lags of the identified shock to test whether recent monetary innovations contain predictive information for the current shock. This specification allows for short-run serial dependence while keeping the predictability test parsimonious. None of the three lagged shock coefficients is statistically significant, providing no evidence that the conventional shock can be predicted from its own recent history. Lagged inflation, public debt, and the term spread are also statistically insignificant.

Lagged real GDP growth is the only significant macroeconomic variable. Its negative coefficient indicates that stronger past economic activity is associated with a less expansionary monetary innovation. This relationship is economically plausible because central banks normally respond to the business cycle: stronger activity tends to be followed by tighter policy, while weaker activity tends to be followed by easing.

However, the overall explanatory power of the regression remains very low. The R^2 is only 1.8%, meaning that the lagged shocks and macroeconomic variables jointly explain less than two percent of the variation in the identified conventional shock. The significance of real GDP growth therefore does not imply that the shock is generally predictable.

Overall, the predictability test provides support for the interpretation of the conventional shock as an unexpected monetary policy innovation.

[2] ** significant at the 95% level. Standard errors are corrected using the Newey–West procedure.

5.4.2 Unconventional shock (UMP)

We then apply the same predictability test to the unconventional monetary policy shock. The regression again has very limited explanatory power, with an R^2 of 1.4%.

Table 7: Predictability test for the unconventional monetary shock

Explanatory variable	Coefficient	t-statistic
Shock, first lag	−0.018	−0.55
Shock, second lag	−0.094	−3.08**
Shock, third lag	−0.039	−1.09
Lagged real GDP growth	−0.409	−0.88
Lagged inflation	−0.365	−2.13**
Lagged public debt	0.046	0.21
Lagged term spread	−0.025	−1.05
Observations	1,161	
Country fixed effects	Yes	
R^2	0.014	

Notes: ** significant at the 95% level. Standard errors are corrected using the Newey–West procedure.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The first and third lags of the unconventional shock are not statistically significant. However, the second lag is negative and statistically significant ($t = -3.08$), indicating some residual serial dependence in the shock series. Lagged inflation is also statistically significant ($t = -2.13$), whereas lagged output growth, public debt, and the term spread are not.

The significant second lag suggests that the unconventional shock is somewhat less difficult to predict than the conventional shock. This is not entirely surprising, since unconventional monetary policy instruments such as asset purchase programmes are often implemented over extended periods rather than as isolated policy actions.

At the same time, the overall explanatory power of the regression remains very low. With an R^2 of only 1.4%, past macroeconomic conditions and the shock's own history explain only a small fraction of its total variation. The unconventional shock should therefore be interpreted with somewhat more caution than the conventional shock, but the evidence does not suggest that it is broadly predictable.

Overall assessment: Taken together, the predictability tests suggest that both identified shocks contain a substantial unexpected component. The conventional shock shows no significant serial dependence, while the unconventional shock exhibits some predictability at the second lag and through lagged inflation. Nevertheless, the very low R^2 values in both regressions indicate that past information explains only a small share of the variation in either shock. These results therefore provide additional support for using the identified series as monetary policy innovations in the local projection analysis, while calling for slightly greater caution in the interpretation of the unconventional shock.

6 Do Monetary Shocks Predict Banking Crises?

We now examine whether expansionary monetary shocks are followed by a higher probability of a systemic banking crisis. We first consider the conventional monetary shock and then turn to the unconventional monetary policy (UMP) shock.

Conventional monetary shock.

Figure 4 shows the response of banking crisis probability to an expansionary conventional monetary shock over horizons $h = 0$ to $h = 9$.

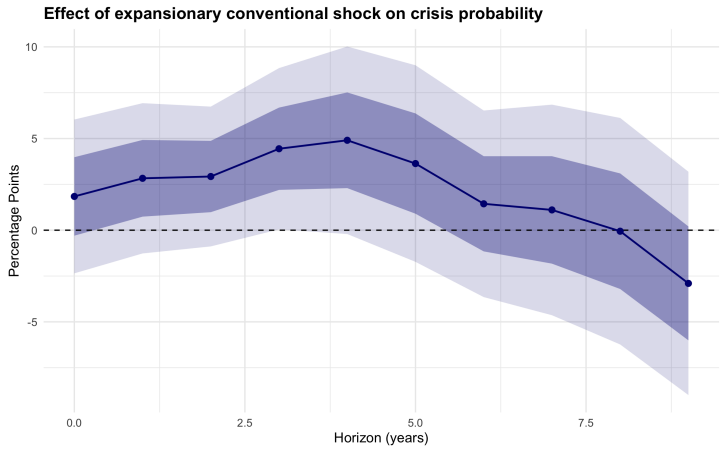


Figure 4: Effect of an expansionary conventional monetary shock on the probability of a banking crisis. Coefficients are expressed in percentage points. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The effect increases at medium horizons before gradually declining. Crisis probability rises after the shock and reaches its maximum after three to four years. The estimated effect reaches +4.44 percentage points at horizon $h = 3$, with a standard error of 2.24. The corresponding t-statistic is approximately 1.98, making the coefficient statistically significant at the 95% level. At horizon $h = 4$, the effect reaches +4.90 percentage points, with a standard error of 2.61, and is statistically significant at the 68% level.

The response remains positive from $h = 1$ to $h = 5$, with point estimates ranging from approximately +2.8 to +4.9 percentage points. The evidence therefore points to a higher banking-crisis probability at medium horizons, although statistical significance is strongest around $h = 3$.

At longer horizons, the response returns toward zero and becomes slightly negative. At $h = 9$, the coefficient is approximately -2.9 percentage points, but it is not statistically significant. We therefore interpret the long-horizon decline cautiously.

Comparison with Grimm et al. (2023): This result is broadly consistent with the evidence reported by Grimm et al. (2023). Using a reduced-form measure of persistent monetary accommodation on a long-run sample of advanced economies, they also find that accommodative monetary conditions are associated with a higher probability of financial

crises at medium horizons. Their estimated response increases after several years before eventually declining, although the effect appears somewhat later than in our estimates.

The magnitudes are not directly comparable because the two monetary-policy measures are expressed in different units. Grimm et al. (2023) rely on a reduced-form monetary-policy stance measure, whereas our analysis uses five-year averages of structurally identified monetary-policy shocks. This distinction allows us to separate conventional and unconventional monetary-policy channels rather than treating monetary accommodation as a single aggregate stance. Our analysis extends this result in two directions. First, rather than relying on a reduced-form measure of monetary accommodation, we identify structural monetary policy innovations using a sign-restricted VAR that includes inflation, real GDP growth, the short-term interest rate, and the term spread. The horse-race exercise in Section 13 shows that the conventional shock retains some predictive content beyond Grimm's stance at medium horizons, although the evidence becomes weaker once both measures are included simultaneously.

Second, we show in Section 7 that the average effects of monetary policy mask substantial heterogeneity across public-debt regimes. For the conventional shock, the increase in banking crisis probability is particularly pronounced in high-debt economies, reaching +8.76 percentage points at $h = 4$. For the unconventional shock, the strongest state dependence appears in household financial vulnerability: the probability of entering a household red zone rises substantially at medium horizons when public debt is high.

Unconventional monetary policy shock.

Figure 5 reports the response of banking crisis probability to an expansionary UMP shock.

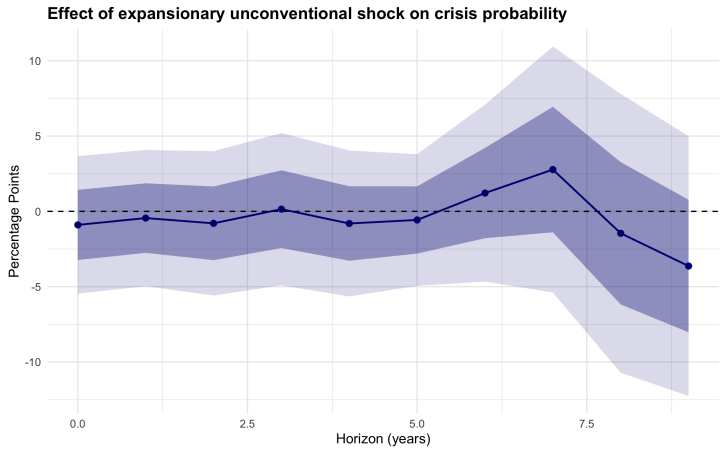


Figure 5: Effect of an expansionary unconventional monetary policy shock on the probability of a banking crisis. The specification is identical to Figure 4. Coefficients are expressed in percentage points, and shaded bands show 68% and 95% confidence intervals based on Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Unlike the conventional shock, the UMP shock does not have a statistically significant average effect on banking crisis probability. The estimated coefficients remain relatively close to zero throughout the horizon, and the 95% confidence intervals include zero at every horizon.

An important question is why the stronger household vulnerability channel does not translate into a statistically significant increase in banking-crisis probability for the UMP shock. One possible explanation is that household overheating alone may not be sufficient to generate a systemic banking crisis. While the UMP shock raises household red-zone probability, the corresponding evidence for the business sector is much weaker, with no statistically significant increase at the 95% level. A systemic crisis may require a broader accumulation of vulnerabilities across several parts of the financial system.

A second explanation is statistical. Banking crises are rare events, and the effect of monetary accommodation may operate through several intermediate stages before becoming visible in crisis outcomes. To assess whether the absence of a significant direct UMP effect is driven by the baseline specification, several alternative specifications were tested and are reported in the Appendix. The result remains statistically insignificant when using country-clustered standard errors, restricting the sample to larger UMP shocks, estimating a logit model, and extending the crisis window from three to five years. The absence of a significant direct effect therefore does not appear to be driven by a single modelling choice.

These explanations remain interpretations rather than mechanisms identified directly by the empirical model. The results therefore support a clear UMP effect on household financial vulnerability, but not a precisely estimated direct effect on systemic banking-crisis probability.

This distinction is also consistent with the state-dependent results reported in Section 7. When all countries and debt regimes are pooled together, the UMP shock does not systematically predict future banking crises. However, in high-debt economies, the probability of entering a household red zone increases by approximately 12 percentage points at horizon $h = 6$.

Overall, the crisis results reveal an important distinction between the two monetary channels. Conventional monetary easing has a positive and statistically significant average effect on banking crisis probability at medium horizons. By contrast, the UMP shock has no significant unconditional effect on banking crisis probability, but its effect on household red-zone probability becomes large and statistically significant in highly indebted economies.

6.1 From Monetary Shocks to Financial Vulnerabilities

The previous analysis shows that monetary policy shocks do not necessarily translate directly into a higher probability of a systemic banking crisis. This motivates an examination of the intermediate financial mechanisms through which monetary accommodation may contribute to future financial instability.

The empirical analysis therefore follows the transmission chain at the core of this thesis. First, we examine whether expansionary monetary policy shocks affect the financial variables that enter the red-zone definition of Greenwood et al. (2022). For households, these variables are household debt and real house prices; for businesses, they are business debt and real equity prices. Second, we test whether these responses translate into a higher probability of entering a household or business red zone. Finally, we examine whether red-zone episodes are associated with a higher probability of a systemic banking crisis within the following three years.

Figure 6 summarises the empirical sequence examined in the remainder of this section. The analysis begins with the unconventional monetary policy channel and then applies the same framework to the conventional monetary policy shock.

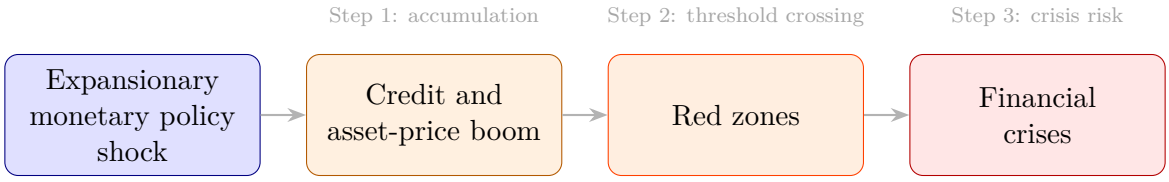


Figure 6: Empirical transmission chain examined in the thesis. Expansionary monetary policy shocks are first related to debt and asset-price responses, which jointly determine the probability of entering household and business red zones. The final step examines whether these red-zone episodes are associated with a higher probability of a systemic banking crisis within the following three years.

6.1.1 Local Projection Framework

To estimate each step of this transmission mechanism, we use local projections and allow the responses to vary across horizons. After identifying the monetary policy shocks, we use local projections to estimate their effects on financial variables at different horizons. The specification is estimated separately for each financial outcome and for each type of monetary policy shock:

$$Y^{m}_{i,t+h} = \alpha^{h}_{i} + \beta^{k}_{h}\varepsilon^{k}_{i,t} + \boldsymbol{\gamma}'_{h}\mathbf{X}_{i,t} + u^{m,k}_{i,t+h}, \tag{6}$$

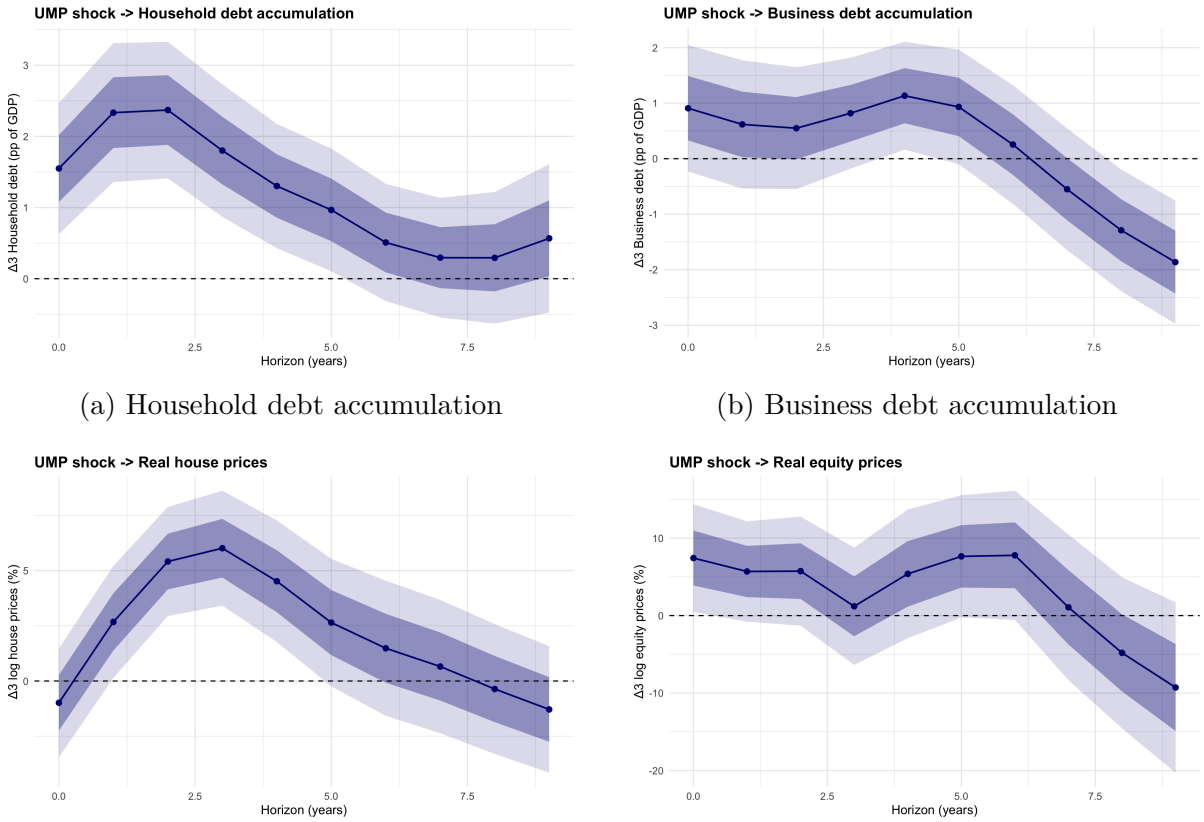
Table 8: Notation and variables used in the local projections

Notation	Definition
i	Country.
t	Year.
h	Local-projection horizon.
m	Type of financial outcome. HH denotes household debt, Bus business debt, HP real house prices, and EQ real equity prices.
$Y^{m}_{i,t+h}$	Financial outcome of type m measured at horizon h. For debt, the outcome is the three-year change in the debt-to-GDP ratio. For house and equity prices, it is the three-year change in log real prices.
$k \in \{\text{Conv}, \text{UMP}\}$	Type of monetary policy shock. Conv denotes the conventional monetary policy shock and UMP the unconventional monetary policy shock.
$\varepsilon^{k}_{i,t}$	Five-year moving average of the expansionary monetary policy shock of type k. The structural shocks are standardised within each country before the five-year moving average is constructed.
β^{k}_{h}	Estimated response of the financial outcome at horizon h to the expansionary monetary shock of type k.
α^{h}_{i}	Country fixed effects at horizon h.
$\mathbf{X}_{i,t}$	Vector of baseline controls containing $\Delta_5 \log GDP_{i,t}$, $\Delta_5 \log CPI_{i,t}$, $\Delta_5 Debt_{i,t}$, $Spread_{i,t}$, $\overline{Debt}_t$, and $Crisis_{i,t-j}$ for $j = 1, \ldots, 5$.
$\Delta_5 \log GDP_{i,t}$	Five-year change in real GDP.
$\Delta_5 \log CPI_{i,t}$	Five-year change in the price level.
$\Delta_5 Debt_{i,t}$	Five-year change in public debt-to-GDP.
$Spread_{i,t}$	Term spread.
$\overline{Debt}_t$	Cross-country average public debt-to-GDP in year t.
$Crisis_{i,t-j}$	Lagged systemic banking-crisis indicator, with $j = 1, \ldots, 5$.
$u^{m,k}_{i,t+h}$	Regression error term.

The coefficient of interest, β^{k}_{h}, captures the response of the financial outcome to the expansionary monetary shock at horizon h. The specification is estimated separately for conventional and unconventional shocks and for each financial outcome. The dependent variables are measured over three-year windows. Household and business debt are expressed in percentage points of GDP, while house and equity prices are measured as changes in log real prices. The control vector $\mathbf{X}_{i,t}$ captures recent macroeconomic conditions, public debt dynamics, the term spread, global debt conditions, and recent banking-crisis history. Country fixed effects absorb time-invariant cross-country differences. Standard errors are corrected using the Newey–West procedure, with the lag length increasing with the projection horizon.

6.1.2 The Unconventional Monetary Policy Channel

Figure 7 reports the responses of household debt, business debt, real house prices, and real equity prices over a ten-year horizon following an expansionary UMP shock.



(a) Household debt accumulation

(b) Business debt accumulation

(c) Real house prices

(d) Real equity prices

Figure 7: Response of key financial variables to an expansionary unconventional monetary policy shock (UMP). Local projection estimates include country fixed effects and the control variables used by Grimm et al. (2023). Debt responses are expressed in percentage points of GDP and correspond to three-year changes in the debt-to-GDP ratio. Real house-price and equity-price responses are expressed in percent and correspond to three-year log changes multiplied by 100. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

The household channel: The strongest and most persistent effects of the UMP shock appear in the household sector. Household debt increases immediately and peaks at +2.37 percentage points after two years. The response remains positive and statistically significant until horizon $h = 5$.

Real house prices follow a similar pattern. They rise sharply after the shock and peak at approximately +6.01% at horizon $h = 3$. The effect remains statistically significant until $h = 4$ before gradually returning toward zero.

These two responses overlap over the same period. The UMP shock therefore produces a simultaneous increase in household debt and house prices. This combination corresponds closely to the household red-zone configuration defined by Greenwood et al. (2022).

The business channel: The business sector responds differently. Business debt increases initially, reaching +1.13 percentage points at $h = 4$ ($t = 2.29$, significant at the 95% level). At longer horizons, the response reverses and becomes significantly negative, reaching −1.86 percentage points at $h = 9$ ($t = -3.29$, significant at 95%). This reversal suggests that firms adjust more quickly than households once the initial monetary easing fades.

Real equity prices react immediately (+7.43% on impact, $t = 2.10$), but the response becomes volatile and inconsistent at longer horizons. The wide confidence intervals prevent any clear interpretation beyond the short run.

Overall, the business sector does not exhibit the persistent joint increase in debt and asset prices that characterises the household red zone. The UMP transmission channel operates primarily through the household sector.

From UMP to Red Zones

The previous results show that an expansionary UMP shock raises household debt and real house prices over overlapping horizons, two variables that jointly define the household red-zone indicator. We therefore examine whether the shock also increases the probability of entering a household red zone.

Figure 8 summarises this transmission mechanism.

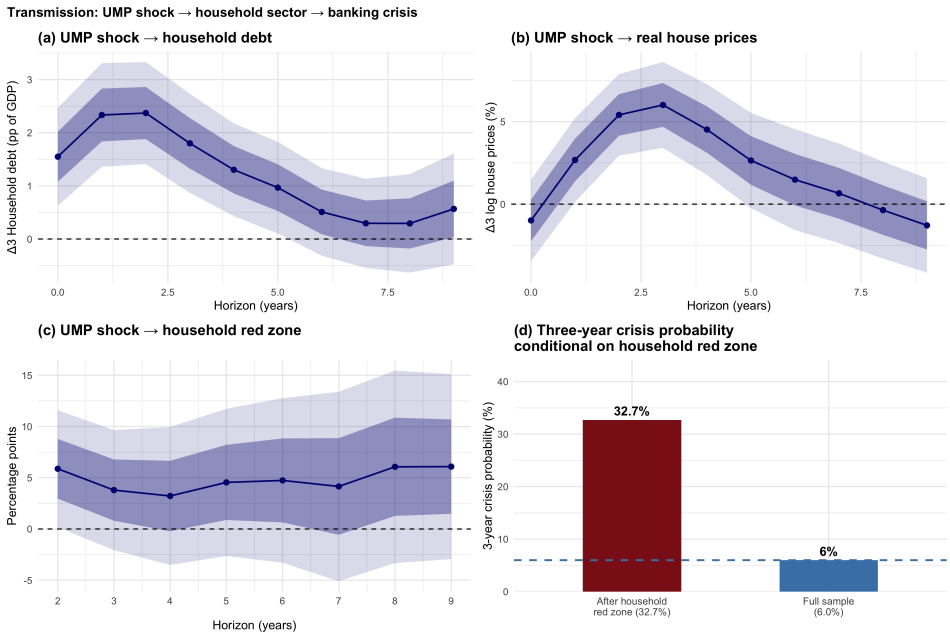


Figure 8: Transmission mechanism from unconventional monetary policy to household financial vulnerability. Panels (a)–(c) report the responses of household debt, real house prices, and household red-zone probability to an expansionary UMP shock. Panel (d) compares the three-year banking-crisis probability in the full sample and following a household red zone. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

The first two panels show that household debt and real house prices increase over overlapping horizons. Panel (c) indicates that the UMP shock also raises the probability

of entering a household red zone, with an effect of +5.88 percentage points at $h = 2$ ($t = 2.02$), significant at the 95% level. Panel (d) shows that the probability of a crisis within the following three years is 32.7% after a household red zone, compared with 6.0% in the full sample, or approximately 5.5 times higher.

Figure 9 presents the corresponding mechanism for the business sector.

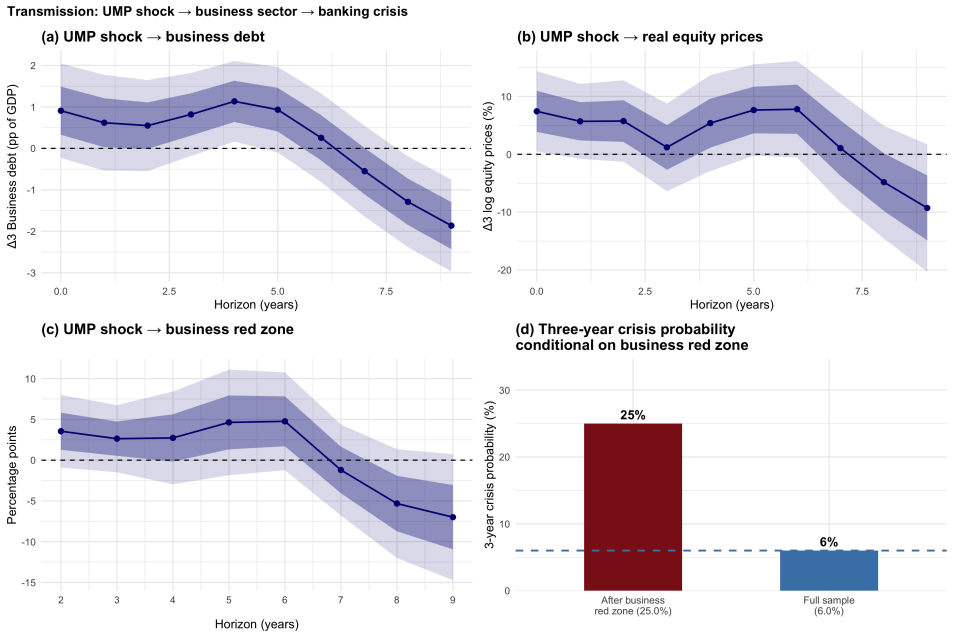


Figure 9: Transmission mechanism from unconventional monetary policy to business-sector financial vulnerability. Panels (a)–(c) report the responses of business debt, real equity prices, and business red-zone probability to an expansionary UMP shock. Panel (d) compares the three-year banking-crisis probability in the full sample and following a business red zone. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source for Figures 7-8-9: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The business-sector channel is less clear. Although business debt and equity prices respond to the UMP shock, the business red-zone response is not statistically significant at the 95% level. Nevertheless, the probability of a crisis within the following three years is 25.0% after a business red zone, compared with 6.0% in the full sample, or approximately 4.2 times higher.

The stronger response of the household sector relative to the business sector is economically consistent with the nature of unconventional monetary transmission. Household borrowing is largely composed of long-term mortgage credit and is therefore particularly sensitive to longer-term interest rates. Business financing is more diversified, making its response to lower long-term yields less direct. The strong response of real house prices further reinforces the household channel.

6.1.3 The Conventional Monetary Policy

The previous results focused on unconventional monetary policy. We now ask whether conventional monetary easing generates a similar accumulation of household and business financial vulnerabilities, and whether it translates into higher red-zone probability. Figure 10 reports the corresponding local projections.

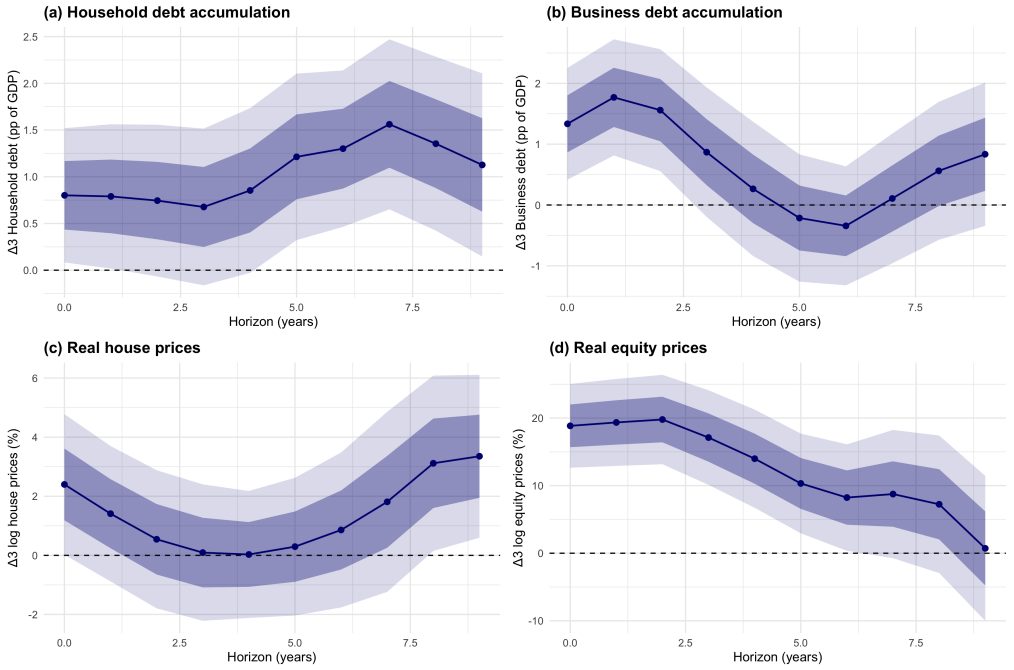


Figure 10: Response of key financial variables to an expansionary conventional monetary shock. The specification is identical to Figure 7. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

The conventional shock also increases debt and asset prices, but the timing and sectoral distribution differ substantially from the UMP shock.

The household channel: Household debt responds gradually, becoming statistically significant from $h = 5$ and peaking at +1.56 percentage points at $h = 7$ ($t = 3.36$, significant at the 95% level). Real house prices also react slowly, reaching their maximum response of +3.35% at $h = 9$ ($t = 2.39$, significant at the 95% level).

The business channel: By contrast, the business sector reacts more rapidly to conventional easing. Business debt peaks at +1.77 percentage points at $h = 1$ ($t = 3.63$, significant at the 95% level), while equity prices increase by +18.85% on impact and peak at +19.78% at $h = 2$ ($t = 5.86$, significant at the 95% level).

From Conventional Monetary Policy to Red Zones

We now examine whether conventional monetary easing contributes to the build-up of household and business financial vulnerabilities. Figures 11 and 12 summarise the corresponding transmission mechanisms.

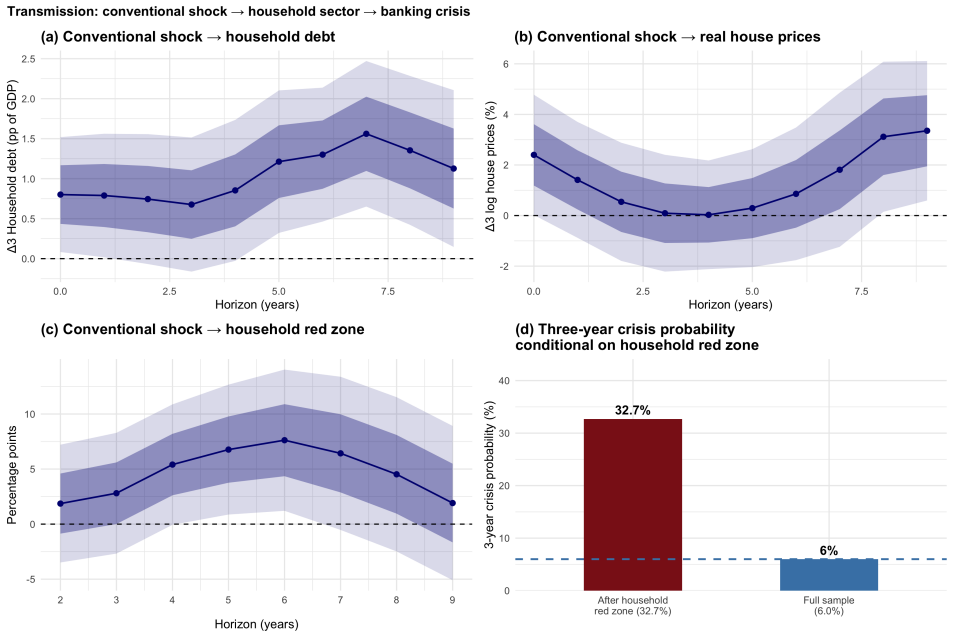


Figure 11: Transmission mechanism from conventional monetary policy to household financial vulnerability. Panels (a)–(c) report the responses of household debt, real house prices, and household red-zone probability to an expansionary conventional monetary shock. Panel (d) compares the three-year banking-crisis probability in the full sample and following a household red zone. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

The household channel: Household debt responds positively throughout the projection horizon and reaches a maximum increase of +1.56 percentage points of GDP at $h = 7$ ($t = 3.36$). Real house prices display a less regular response, but increase significantly again at longer horizons, reaching +3.35% at $h = 9$ ($t = 2.39$). Consistent with this gradual accumulation, the household red-zone probability rises significantly from $h = 5$ and peaks at +7.62 percentage points at $h = 6$ ($t = 2.33$). The probability of a banking crisis within the following three years is 32.7% after a household red zone, compared with 6.0% in the full sample, or approximately 5.5 times higher.

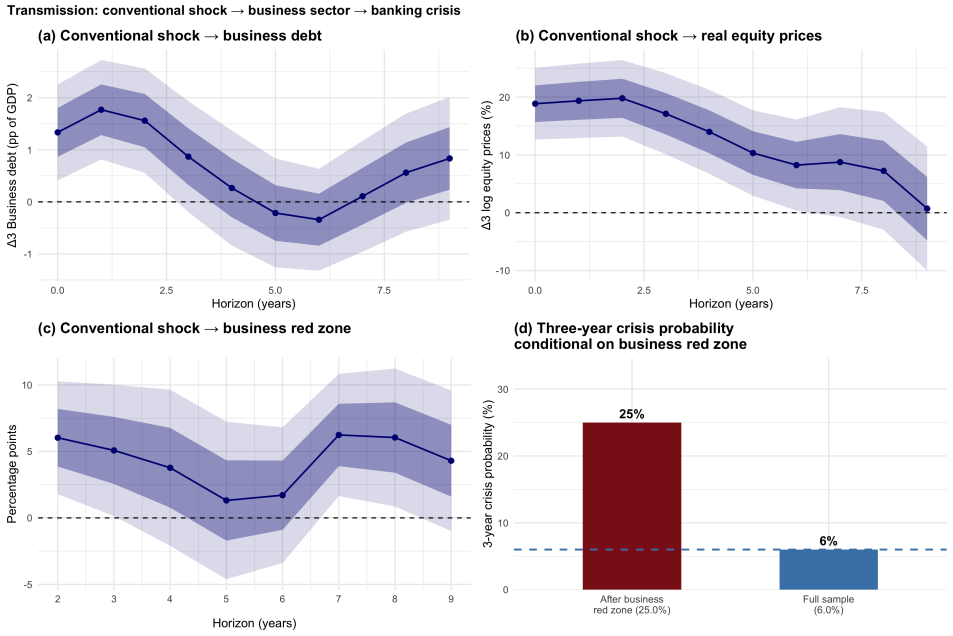


Figure 12: Transmission mechanism from conventional monetary policy to business-sector financial vulnerability. Panels (a)–(c) report the responses of business debt, real equity prices, and business red-zone probability to an expansionary conventional monetary shock. Panel (d) compares the three-year banking-crisis probability in the full sample and following a business red zone. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source for Figures 10-11-12: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The business channel: The business sector reacts more rapidly. Business debt peaks at +1.77 percentage points at $h = 1$ ($t = 3.63$), while real equity prices rise by +18.85% on impact and peak at +19.78% at $h = 2$ ($t = 5.86$). The business red-zone probability also increases, with significant effects at short horizons and again at $h = 7$–8, although the dynamic response is less regular than for households. The three-year crisis probability is 25.0% following a business red zone, compared with 6.0% in the full sample, or approximately 4.2 times higher.

Overall, conventional monetary easing affects both sectors but with different timing. The business sector reacts quickly through debt and equity prices, while household vulnerabilities accumulate more gradually and are associated with a higher subsequent crisis probability.

6.1.4 Comparison and Discussion

Table 9 summarizes the peak responses for each variable across both policy shocks.

Table 9: Peak transmission effects by monetary shock

	UMP shock		Conventional shock	
Variable	Peak	Horizon	Peak	Horizon
Household debt	+2.37** pp	$h = 2$	+1.56** pp	$h = 7$
Business debt	+1.13** pp	$h = 4$	+1.77** pp	$h = 1$
Real house prices	+6.01**%	$h = 3$	+3.35**%	$h = 9$
Real equity prices	+7.43**%	$h = 0$	+19.78**%	$h = 2$

Notes: The table reports the largest positive point estimate over horizons $h = 0$ to $h = 9$. ** denotes significance at the 95% level ($|t| > 1.96$), and * denotes significance at the 68% level ($|t| > 1.00$). Peaks without stars are not statistically significant.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The two shocks differ mainly in their timing. The UMP shock generates a rapid and simultaneous increase in household debt and house prices within 2 to 3 years. Conventional monetary easing acts much more strongly on equity markets in the short run, while its effect on household balance sheets develops far more slowly. The table is intended to compare the timing and magnitude of the peak point estimates; statistical significance is assessed from the full response functions reported above.

Contribution relative to Grimm et al. (2023): These results refine the findings of Grimm et al. (2023), who show that monetary accommodation is followed by credit and asset-price growth before crisis probability rises. By distinguishing between conventional and unconventional monetary shocks, we show that the transmission dynamics differ substantially across the two policy channels. The UMP shock generates a rapid household credit and housing response, whereas the conventional shock produces a stronger short-run response in equity prices and a slower accumulation of household debt.

Interpretation and limits: These estimates describe the aggregate financial responses to monetary shocks rather than the precise microeconomic mechanisms through which they operate. They nevertheless show that the UMP shock is followed by a rapid joint increase in household debt and house prices, creating the conditions associated with a household red zone.

The next section examines whether the accumulation of financial vulnerabilities depends on the initial level of public debt.

7 Does the Initial Level of Public Debt Matter?

The preceding sections established that expansionary monetary policy shocks contribute to the build-up of financial vulnerabilities and, through the conventional channel, to a higher probability of systemic banking crises. A natural question is whether these effects are uniform across macroeconomic environments, or whether they depend on initial conditions. This section examines one dimension of state dependence: the initial level of public debt.

The motivation is straightforward. Highly indebted economies may be more sensitive to changes in financing conditions, as lower interest rates provide greater relief on debt-servicing costs and stronger incentives to expand borrowing. At the same time, private agents in high-debt economies may respond more aggressively to monetary easing if they perceive the policy stance as more persistent or if collateral values react more strongly. Figure 13 illustrates the transmission chain examined in this section: the monetary policy shock is hypothesized to affect red-zone probability and banking-crisis risk, with both effects potentially amplified when public debt is already elevated.

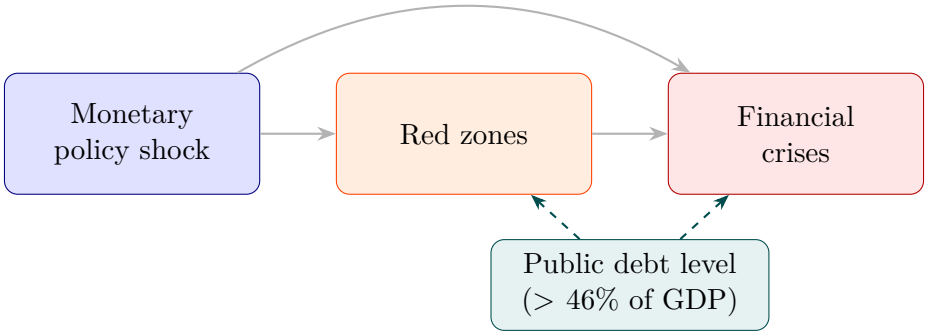


Figure 13: State-dependent transmission chain examined in Section 7. The monetary policy shock affects red-zone probability and banking-crisis risk directly and indirectly through red zones, with both effects potentially amplified when the initial level of public debt exceeds the sample median of 46% of GDP (dashed arrows).

7.1 Local Projection Framework

We split the sample at the median public debt-to-GDP ratio of 46%, yielding 642 low-debt and 643 high-debt observations. The regime analysis includes 1,285 observations, as 11 observations have missing public-debt data. We then estimate local projections in which the monetary shock is interacted with a high-debt indicator.

$$Y^m_{i,t+h} = \alpha^h_i + \beta^k_h \varepsilon^k_{i,t} + \theta_h D^{high}_{i,t} + \delta^k_h \left(\varepsilon^k_{i,t} \times D^{high}_{i,t}\right) + \boldsymbol{\gamma}'_h \mathbf{X}_{i,t} + u_{i,t+h}, \tag{7}$$

where i indexes countries, t years, h projection horizons, $k \in \{\text{Conv}, \text{UMP}\}$ the type of monetary policy shock, and $m \in \{\text{Crisis}, \text{HH}, \text{Bus}\}$ the dependent variable.

Table 10: Variables used in the state-dependent local projections

Symbol	**Definition**
$Y^m_{i,t+h}$	Dependent variable at horizon h: banking-crisis, household red-zone, or business red-zone indicator.
$\varepsilon^k_{i,t}$	Five-year average of expansionary structurally identified monetary policy shocks, where $k = \text{Conv}$ denotes the conventional shock and $k = \text{UMP}$ the unconventional shock.
$D^{high}_{i,t}$	Indicator equal to one when public debt-to-GDP is above the sample median and zero otherwise.
$\varepsilon^k_{i,t} \times D^{high}_{i,t}$	Interaction between the monetary policy shock and the high-debt indicator.
β^k_h	Response to shock k in low-debt economies ($D^{high}_{i,t} = 0$).
δ^k_h	Difference in the shock response between high- and low-debt economies.
$\beta^k_h + \delta^k_h$	Response to shock k in high-debt economies ($D^{high}_{i,t} = 1$).
θ_h	Difference in the level of the dependent variable between high- and low-debt economies when the monetary shock is zero.
Controls included in $\mathbf{X}_{i,t}$	
$\Delta_5 \log GDP_{i,t}$	Five-year change in real GDP.
$\Delta_5 \log CPI_{i,t}$	Five-year change in the price level.
$\Delta_5 Debt_{i,t}$	Five-year change in public debt-to-GDP.
$Spread_{i,t}$	Term spread.
$\overline{Debt}_t$	Cross-country average public debt-to-GDP.
$Crisis_{i,t-j}$, $j = 1, \ldots, 5$	Five annual lags of the banking-crisis indicator.
α^h_i	Country fixed effects.
$u_{i,t+h}$	Regression error term.

The coefficient β_h captures the effect in low-debt economies ($D^{high}_{i,t} = 0$), while $\beta_h + \delta_h$ gives the total effect in high-debt economies ($D^{high}_{i,t} = 1$). The threshold is the sample median of 46% of GDP. The control vector $\mathbf{X}_{i,t}$ is identical to that defined above.

7.2 From Monetary Shocks to Red Zones

7.2.1 Household Red Zones

Figure 14 reports the response of the household red zone probability to each monetary shock, separately for low-debt and high-debt economies.

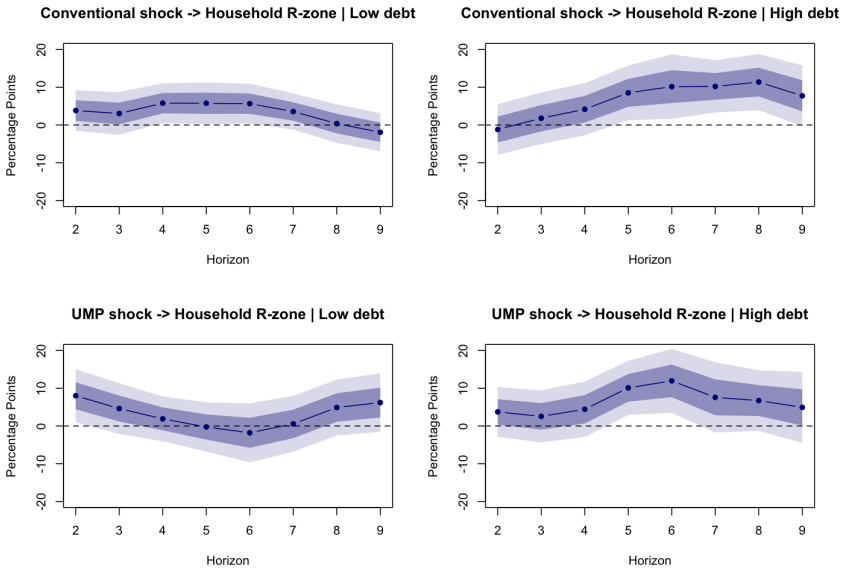


Figure 14: Effect of monetary shocks on the probability of entering a household red zone, conditional on the initial level of public debt. The top panels show the conventional shock and the bottom panels show the UMP shock. Left panels report results for low-debt economies (debt-to-GDP below 46%) and right panels for high-debt economies (above 46%). Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Conventional shock: In low-debt economies, the effect of the conventional shock on household red zone probability remains close to zero and is never statistically significant. In high-debt economies, the response is much stronger. The probability of entering a household red zone starts to rise from $h = 4$ and peaks at +11.38 percentage points at $h = 8$ ($t = 3.00$, significant at the 95% level). The effect remains statistically significant between $h = 5$ and $h = 8$. Over the same horizons, the difference between high- and low-debt economies is also statistically significant, showing that high initial public debt amplifies the effect of the monetary shock.

UMP shock: The same asymmetry appears for the unconventional shock, but with a faster timing. In low-debt economies, the response is positive at shorter horizons, with a statistically significant increase at $h = 2$, but it weakens thereafter. In high-debt economies, the probability of entering a household red zone increases rapidly, reaching +10.10 percentage points at $h = 5$ ($t = 2.76$) and peaking at +11.96 percentage points at $h = 6$ ($t = 2.77$, significant at the 95% level). The estimated difference between the two regimes reaches +13.8 percentage points at $h = 6$ and is statistically significant, confirming that the UMP response is stronger in high-debt economies. This is a remarkably fast transmission: the UMP shock generates household vulnerability within five to six years, compared with seven to eight years for the conventional shock.

These results suggest that monetary easing does not have the same consequences in every macro-financial environment. In low-debt economies, the household red-zone response is more concentrated at short horizons. In high-debt economies, the response becomes larger and more persistent at medium horizons, especially for the unconventional monetary policy shock.

7.2.2 Business Red Zones

Figure 15 repeats the same exercise for the business sector.

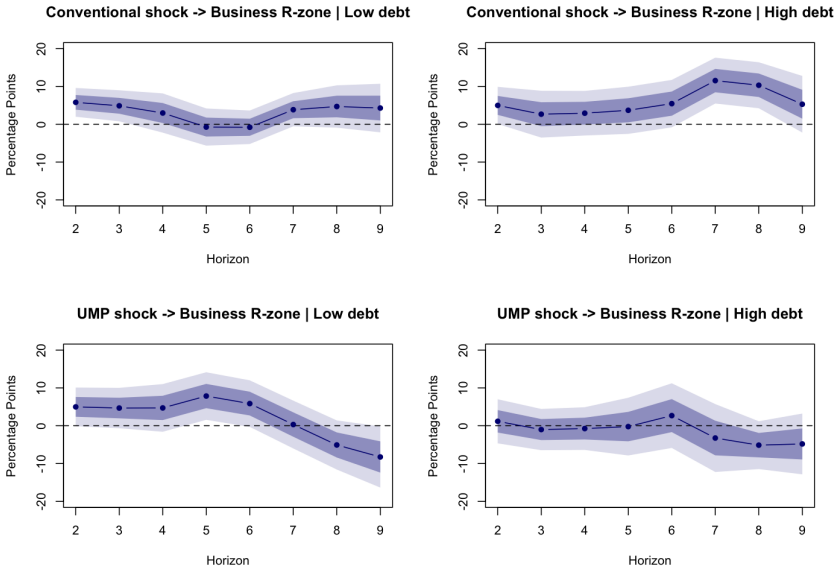


Figure 15: Effect of monetary shocks on the probability of entering a business red zone, conditional on the initial level of public debt. Same specification as Figure 14.

Conventional shock: The business red-zone response differs across debt regimes. In low-debt economies, the effect is concentrated at short horizons, reaching +5.79 percentage points at $h = 2$ ($t = 2.99$). In high-debt economies, the response becomes much stronger at longer horizons, reaching +11.54 percentage points at $h = 7$ ($t = 3.74$) and +10.31 percentage points at $h = 8$ ($t = 3.33$). Importantly, the high–low difference is statistically significant at $h = 7$ (+7.70 pp, $t = 2.26$), providing some evidence that high public debt amplifies the longer-horizon business red-zone response to conventional monetary easing. Given the irregular pattern across horizons, this result should nevertheless be interpreted cautiously.

UMP shock: The UMP response is more irregular. In low-debt economies, the business red-zone probability reaches +7.85 percentage points at $h = 5$ ($t = 2.45$), before turning negative at longer horizons. In high-debt economies, the response is not statistically significant at the 95% level at any horizon. Moreover, the difference between high- and low-debt economies is never significant at the 95% level. Unlike the household sector, the business sector therefore provides no clear evidence that high public debt systematically amplifies the UMP effect on financial vulnerability.

Overall, initial debt appears to matter much more for household vulnerabilities than for business vulnerabilities. This contrast is consistent with the earlier finding that house-

hold debt and house prices respond more persistently to monetary easing than business debt and equity prices. The state-dependent amplification operates primarily through the household sector.

7.3 Effect of Monetary Shocks on Banking Crisis Probability

Figure 16 reports the response of banking crisis probability to each monetary shock, separately for low-debt and high-debt observations.

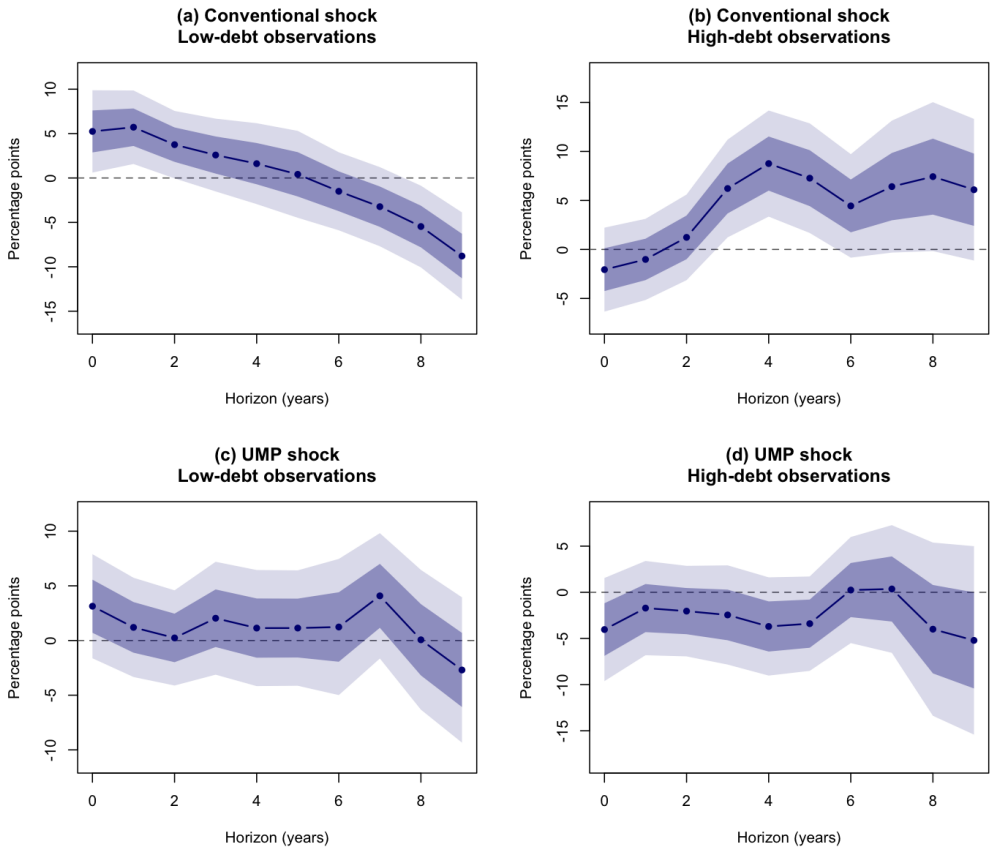


Figure 16: Effect of monetary shocks on banking crisis probability, conditional on the initial level of public debt. Panel (a) reports the responses to the conventional shock and Panel (b) reports the responses to the UMP shock. In each panel, the navy line shows the response in low-debt observations and the dark red line shows the response in high-debt observations. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Conventional shock: The two debt regimes display markedly different responses. In low-debt observations, the conventional shock initially increases crisis probability, reaching +5.71 percentage points at $h = 1$ ($t = 2.71$, significant at the 95% level). The response then declines and becomes significantly negative at longer horizons, reaching -5.47 percentage points at $h = 8$ ($t = -2.33$) and -8.79 percentage points at $h = 9$ ($t = -3.51$), both significant at the 95% level. This pattern indicates that the response changes sign over time in low-debt observations, with an initial increase in crisis probability followed by a negative response at longer horizons.

In high-debt observations, the response follows a different pattern. Crisis probability rises from $h = 3$ and peaks at +8.76 percentage points at $h = 4$ ($t = 3.17$, significant at the 95% level). The effect is also significant at $h = 3$ (+6.22 pp, $t = 2.45$) and $h = 5$ (+7.27 pp, $t = 2.55$), and remains positive through $h = 9$. Unlike the low-debt regime, the response does not reverse at longer horizons. The difference between the two regimes is statistically significant at several horizons. It reaches +7.15 percentage points at $h = 4$ ($t = 2.18$), +12.90 percentage points at $h = 8$ ($t = 2.83$), and +14.89 percentage points at $h = 9$ ($t = 3.14$), all significant at the 95% level. This indicates that high initial public debt amplifies the effect of conventional monetary easing on banking crisis probability at medium and longer horizons.

UMP shock: The pattern for the unconventional shock is different and less pronounced. In low-debt observations, the UMP shock produces no statistically significant effect on crisis probability at the 95% level. The point estimates fluctuate around zero, without displaying a clear or persistent dynamic pattern. In high-debt observations, the response is generally negative, but it also remains statistically insignificant at the 95% level at every horizon. The largest negative estimate is −5.21 percentage points at $h = 9$ ($t = -1.00$). The difference between regimes is statistically significant at the 95% level only at $h = 0$ (−7.17 pp, $t = -2.03$). Since this difference does not persist at subsequent horizons, it does not provide evidence of a sustained state-dependent effect on crisis probability.

These results indicate that the state-dependent transmission of the UMP shock operates primarily through the accumulation of household financial vulnerabilities, as documented in the red-zone analysis above, rather than through a direct effect on banking crisis probability. When pooled across debt regimes, the UMP shock does not predict crises on average. When conditioned on public debt, the crisis response remains statistically insignificant at the 95% level in both regimes, while the household red-zone channel is clearly active in high-debt observations.

Taken together, the crisis results reinforce the importance of initial public debt for the transmission of conventional monetary policy. In low-debt observations, conventional easing initially increases crisis probability, but the response subsequently declines and becomes negative. In high-debt observations, the increase emerges at medium horizons and remains positive thereafter. For the unconventional shock, state dependence is visible in the accumulation of household financial vulnerabilities, but it does not translate into a persistent or statistically significant difference in banking crisis probability across debt regimes.

Source for Figures 14-15-16: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

7.4 Does Public Debt Amplify the Red-Zone to Crisis Link?

The previous analysis showed that monetary shocks increase red-zone probability more strongly in high-debt observations. We now examine whether the relationship between red-zone episodes and subsequent banking crises also differs across public-debt regimes. Table 11 reports the unconditional three-year crisis probability for each combination of red-zone status and debt regime.

Table 11: Three-year crisis probability by red-zone status and debt regime

	Household R-zone		Business R-zone	
	Low debt	High debt	Low debt	High debt
No red zone	3.9%	6.2%	5.4%	7.6%
Red zone	35.1%	29.3%	27.1%	20.8%

Note: Each cell reports the share of observations followed by a banking crisis within three years. The sample is split at the median public debt-to-GDP ratio of 46%.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Two descriptive patterns stand out. First, in the absence of a red-zone signal, high-debt observations are associated with a higher three-year crisis probability than low-debt observations. The crisis frequency rises from 3.9% to 6.2% for the household classification and from 5.4% to 7.6% for the business classification. Second, among observations already classified as red zones, the unconditional crisis frequency is not higher in the high-debt regime. It reaches 29.3% rather than 35.1% for household red zones and 20.8% rather than 27.1% for business red zones. These descriptive statistics therefore do not suggest that high public debt further amplifies the association between red-zone status and three-year crisis risk.

Figures 17 and 18 examine the dynamic pattern using local projections, showing how crisis probability evolves over time following a red-zone episode, separately for low-debt and high-debt observations.

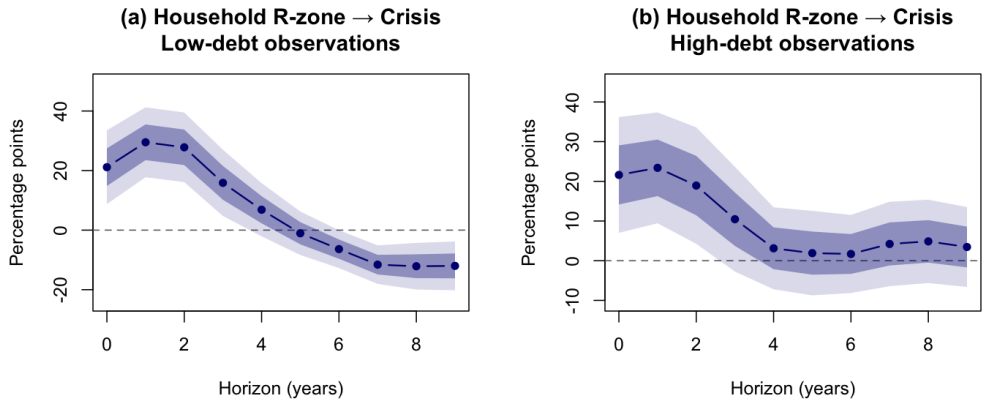


Figure 17: Response of banking crisis probability to a household red-zone episode, conditional on the initial level of public debt. Panel (a) reports results for low-debt observations and Panel (b) for high-debt observations. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Household red zone: In low-debt observations, a household red zone is associated with a sharp and immediate increase in crisis probability. The effect peaks at +29.50 percentage points at $h = 1$ ($t = 4.93$, significant at the 95% level) and remains large and significant through $h = 3$ (+15.87 pp, $t = 2.80$). The response then declines and becomes significantly negative from $h = 6$ onward, reaching −12.13 percentage points at $h = 8$ ($t = -3.04$, significant at the 95% level). This negative long-horizon response should not be interpreted as evidence that a household red zone becomes protective. Rather, it suggests that the increase in crisis risk is concentrated in the years immediately following the red-zone episode. By later horizons, part of the associated crisis risk may already have materialised, leaving fewer new crisis events in the subsequent three-year windows.

In high-debt observations, crisis probability also rises immediately following a household red zone, reaching +23.40 percentage points at $h = 1$ ($t = 3.29$, significant at the 95% level). The response subsequently declines and becomes statistically insignificant at longer horizons. The difference between the two regimes becomes statistically significant from $h = 7$ onward, reaching +17.00 percentage points at $h = 8$ ($t = 2.29$, significant at the 95% level). This indicates that the long-horizon response differs across debt regimes because it remains close to zero in high-debt observations, whereas it becomes negative in low-debt observations.

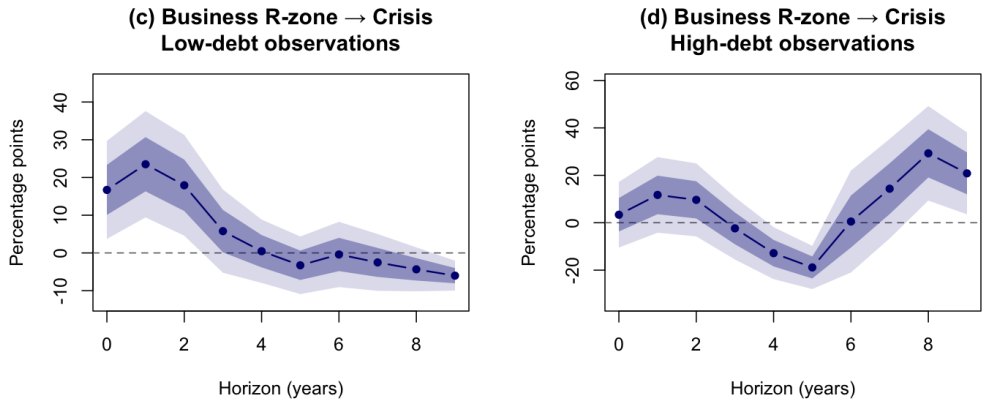


Figure 18: Response of banking crisis probability to a business red-zone episode, conditional on the initial level of public debt. Same specification as Figure 17.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Business red zone: The business sector displays a more irregular dynamic pattern. In low-debt observations, a business red zone is associated with an increase in crisis probability at short horizons, peaking at +23.50 percentage points at $h = 1$ ($t = 3.27$, significant at the 95% level). The effect then declines and becomes significantly negative at $h = 9$ (-6.02 pp, $t = -2.99$, significant at the 95% level).

In high-debt observations, the response does not follow a clear increasing or decreasing pattern across horizons. Crisis probability is initially positive but statistically insignificant from $h = 0$ to $h = 2$. It then becomes significantly negative at $h = 4$ (-12.83 pp, $t = -2.30$) and $h = 5$ (-18.86 pp, $t = -4.06$), before turning positive again at longer horizons. The response reaches +29.27 percentage points at $h = 8$ ($t = 2.88$) and +20.83 percentage points at $h = 9$ ($t = 2.36$), both significant at the 95% level. Given this non-monotonic pattern, the business-sector estimates should be interpreted with caution.

Taken together, these additional results clarify the role of public debt in the relationship between red zones and subsequent banking crises. Red-zone episodes are associated with substantially higher crisis probability at short horizons in both debt regimes, especially for household red zones. However, the initial increase is not significantly larger in high-debt observations. The business-sector estimates are considerably more irregular and should be interpreted cautiously. Overall, the evidence suggests that public debt more clearly conditions the effect of monetary shocks on the accumulation of household vulnerabilities than the subsequent relationship between red-zone episodes and banking crises.

7.5 Why Does Initial Public Debt Matter?

The results indicate that the financial-stability consequences of monetary policy are state dependent. The same expansionary shock can generate different outcomes depending on the level of public debt at the time of the shock. In particular, the transmission to household financial vulnerability is stronger in high-debt observations.

Public debt appears to matter more clearly for the transmission of monetary shocks to the accumulation of household vulnerabilities than for the subsequent transition from

a red zone to a banking crisis. The red-zone analysis shows that household red-zone episodes are associated with a higher probability of crisis in both debt regimes, but high public debt does not clearly amplify this relationship. By contrast, the effect of monetary easing on household red-zone probability becomes stronger when public debt is already elevated.

Several mechanisms may help explain this pattern. First, a high level of public indebtedness may reflect an environment in which fiscal policy has also contributed to sustaining aggregate demand and financial expansion. Monetary accommodation in such an environment may reinforce already favourable financing conditions and support stronger household borrowing and housing demand.

Second, high public debt may reduce fiscal space. Governments with more limited room for fiscal intervention may be less able to offset financial imbalances or respond forcefully once financial stress emerges. This may increase the sensitivity of the economy to the accumulation of private financial vulnerabilities.

These mechanisms are not identified directly in the empirical specification and should therefore be interpreted as possible explanations for the observed state dependence rather than as separate causal effects of public debt.

The result has a direct policy implication. Monetary easing is not inherently destabilising, but its medium-term financial-stability consequences depend on the initial macrofinancial environment. In economies with elevated public debt, monetary accommodation may therefore require closer monitoring of household leverage and housing-market developments, together with an appropriate use of macroprudential tools.

8 Validation of the Identified Monetary Shocks

The credibility of the preceding results depends on whether the identified shocks capture meaningful monetary innovations rather than statistical noise or the predictable response of monetary policy to economic conditions. We therefore perform several validation exercises.

8.0.1 Cross-Country Consistency

Because the structural VAR is estimated separately for each country, the identified shocks may contain country-specific components. A useful validation exercise is therefore to examine whether they also display a common cross-country pattern.

For each monetary shock, we compute pairwise correlations across the 18 countries, yielding 153 country pairs. Table 12 summarizes the main statistics.

Table 12: Cross-country correlations of the identified monetary shocks

Shock	Mean correlation	Median	Positive pairs	Corr. > 0.30
Conventional shock	0.39	0.42	94%	73%
UMP shock	0.30	0.35	86%	54%

Notes: Correlations are computed for all 153 country pairs. The last column reports the share of correlations exceeding 0.30.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The conventional monetary shock displays a clear common component across countries. The average pairwise correlation is 0.39, the median is 0.42, and almost all country pairs (94%) exhibit a positive correlation. This indicates that the identified shocks capture broadly similar monetary innovations across advanced economies while still allowing for country-specific monetary conditions.

Cross-country correlations are somewhat lower for the UMP shock, with an average correlation of 0.30 and a median of 0.35. This lower synchronization is economically plausible. Unlike conventional monetary policy, unconventional measures were introduced at different times and through different instruments across countries. For example, Japan adopted unconventional policies well before the Global Financial Crisis, whereas the Federal Reserve, the European Central Bank, and other central banks followed different policy paths after 2008.

Overall, the positive correlations provide evidence that both identified shock series capture a common international monetary component. At the same time, the correlations remain well below one, indicating that the country-specific VARs preserve meaningful national variation. While these results do not prove the structural identification, they provide a useful consistency check on the estimated shocks.

8.0.2 Historical Consistency of the Identified Shocks

A second validation exercise examines whether the identified shocks reproduce well-known episodes of monetary tightening and easing. If the identification is economically meaningful, periods commonly associated with restrictive or accommodative monetary policy should be reflected in the estimated shock series.

The conventional monetary shock: Figure 19 plots the cross-country average of the expansionary conventional monetary shock between 1949 and 2020. The shaded area represents the cross-country dispersion around the yearly average.

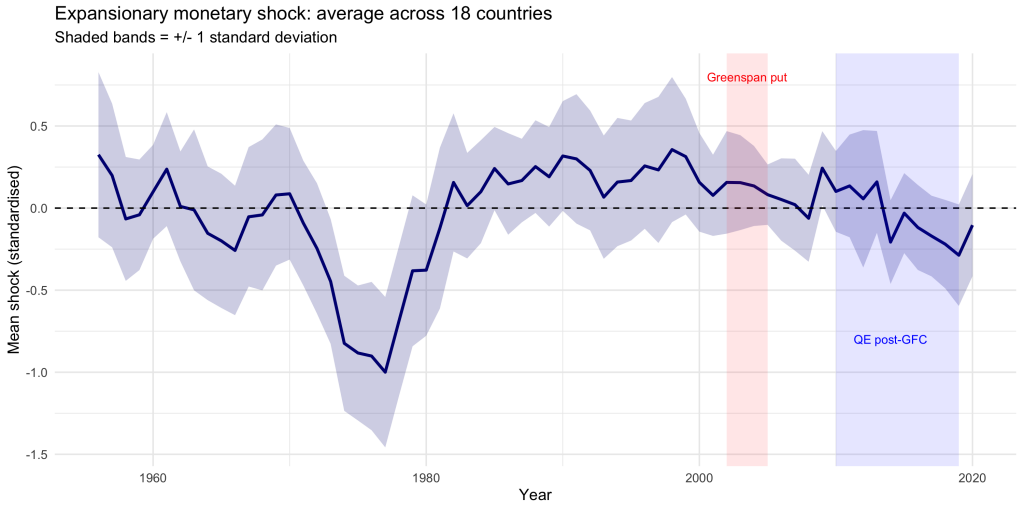


Figure 19: Expansionary conventional monetary shock: cross-country average for 18 advanced economies, 1949–2020. The shaded area represents ±1 cross-country standard deviation around the annual mean.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The conventional shock closely follows major historical monetary cycles. The strongest contractionary episode occurs during the second half of the 1970s. The cross-country average reaches approximately −1.00 in 1977, consistent with the widespread monetary tightening that followed the oil shocks and preceded the Volcker disinflation.

Conversely, the series identifies several well-known episodes of monetary easing. Expansionary shocks are visible during the easing cycle of the early 1990s, around the Asian financial crisis and Long-Term Capital Management episode in 1998, and following the collapse of the dot-com bubble in the early 2000s. Monetary accommodation also became highly synchronized during the Global Financial Crisis: in 2009, nearly 89% of the countries experienced an expansionary conventional shock.

The figure also shows that monetary shocks became more synchronized over time. The average cross-country standard deviation declines from approximately 0.39 before 1990 to 0.31 afterwards. This pattern is consistent with the growing convergence of monetary policy frameworks, the widespread adoption of inflation targeting, and deeper financial integration across advanced economies.

Overall, the historical evolution of the conventional shock is consistent with well-known monetary episodes, providing a useful validation of the identification strategy.

The unconventional monetary shock: Figure 20 plots the cross-country average of the five-year average of standardized expansionary UMP shocks between 1949 and 2020. The shaded area represents the cross-country dispersion around the yearly average.

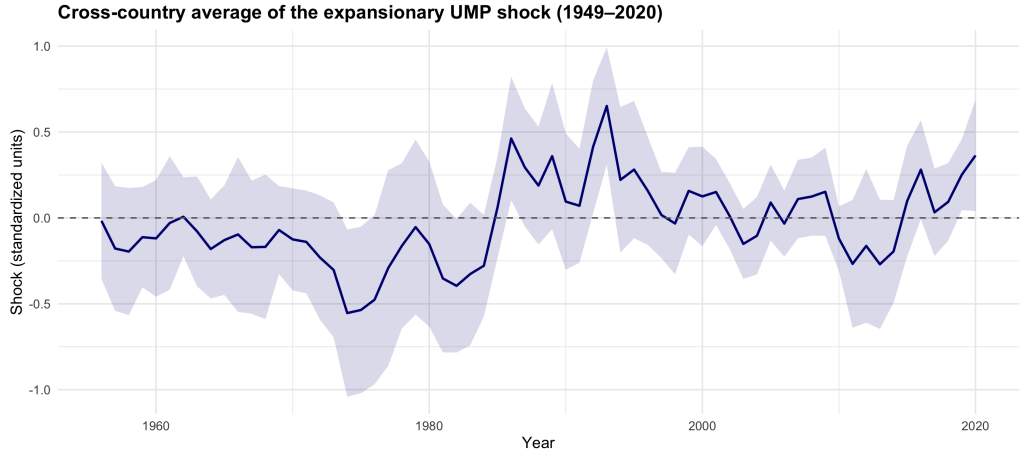


Figure 20: Cross-country average of the five-year average of standardized expansionary UMP shocks, 1949–2020. The solid line shows the unweighted cross-country mean and the shaded area represents plus and minus one standard deviation across countries. Positive values indicate more expansionary unconventional monetary policy conditions, associated with a compression of the term spread while the short-term interest rate remains broadly unchanged.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The historical interpretation of the UMP shock differs from that of the conventional shock because it captures movements in the term spread while the short-term interest rate remains broadly unchanged. The most expansionary episodes are concentrated in the late 1980s and early 1990s, with cross-country averages reaching +0.65 in 1993, +0.46 in 1986, and +0.41 in 1992. The most restrictive episodes occur during the mid-1970s, with averages of −0.55 in 1974 and −0.54 in 1975.

The COVID-19 crisis provides a particularly informative example. In 2020, the conventional shock is slightly restrictive on average (−0.10), while the UMP shock is strongly positive (+0.36). This contrast is consistent with the policy response adopted by many central banks, which relied heavily on large-scale asset purchases and forward guidance alongside very low short-term interest rates.

The period from 2010 to 2014 presents a more ambiguous picture. Despite the use of unconventional monetary policy measures by major central banks, the cross-country average UMP shock is negative throughout, ranging from −0.12 in 2010 to −0.27 in 2011 and 2013. This pattern is consistent with the sovereign debt tensions in the euro area, which generated increases in long-term yields and term spreads in several countries. The country-level identification may therefore attribute such term-spread movements to

restrictive UMP shocks even when they reflect financial stress rather than deliberate monetary tightening. The shock turns positive again from 2015 onwards, reaching +0.28 in 2016 and +0.36 in 2020. The positive values in the mid-2010s coincide in particular with the ECB's expanded asset purchase programme, while the strong increase in 2020 is consistent with the renewed use of unconventional monetary policy during the COVID-19 crisis.

This illustrates both a strength and a limitation of the country-level identification. By relying on country-specific VAR information, the estimated shocks capture national financial conditions that a single aggregate measure would overlook. At the same time, movements in the term spread cannot always be attributed exclusively to deliberate unconventional monetary policy, particularly during periods of sovereign stress or financial turmoil. This limitation motivates the additional predictability tests and the horse-race exercise discussed in the following sections.

8.0.3 Comparison with Grimm's Monetary Stance

Our final validation exercise compares the structurally identified monetary policy shocks with the reduced-form monetary stance proposed by Grimm et al. (2023). To conduct this comparison, the monetary-policy stance variable from Grimm et al. (2023) is merged with the JST panel by country and year, allowing both measures to be evaluated on a common sample.

The comparison proceeds in two steps. We first examine the correlation between the structural shocks and Grimm's stance. We then estimate a horse-race specification in which the structural shock and Grimm's stance are included jointly in the same local projection.

If the measures capture a common component of monetary accommodation, they should be positively correlated. At the same time, correlations well below one would indicate that the structural identification captures information that is not fully contained in Grimm's stance.

The correlation between Grimm's stance and the conventional shock is 0.51, while the correlation with the UMP shock is 0.45. Both correlations are positive and statistically significant at the 1% level.

These results indicate that the structural shocks capture an important monetary component already reflected in Grimm's stance. However, the correlations remain well below one, suggesting that the two approaches are related but not equivalent. The stronger correlation with the conventional shock is economically intuitive because Grimm's measure is closely linked to movements in short-term monetary conditions. By contrast, the UMP shock isolates changes in the term spread while the short-term interest rate remains broadly unchanged.

Horse-race specification: Correlation alone does not establish whether the structural shocks contain information beyond Grimm's monetary stance. If the identified shocks simply reproduced the information already contained in the reduced-form stance, their coefficients should become insignificant once both variables are included in the same regression. Conversely, a remaining effect would indicate that the structural identification captures additional information.

This exercise is related to the literature comparing alternative measures of monetary policy shocks. Ettmeier and Kriwoluzky (2019) show that commonly used shock measures can have different empirical properties and need not capture the same monetary policy innovation.

We estimate the following local projection:

$$crisis_{i,t+h} = \alpha_i^h + \beta_h^k \varepsilon_{i,t}^k + \phi_h^k \text{stance}_{i,t} + \boldsymbol{\gamma}_h' \mathbf{X}_{i,t} + u_{i,t+h}, \qquad k \in \{\text{Conv}, \text{UMP}\}. \tag{8}$$

Here, $\varepsilon_{i,t}^k$ denotes either the conventional monetary policy shock or the unconventional monetary policy shock. For each specification, the structural shock and Grimm's monetary stance are included jointly. The coefficient β_h^k therefore measures the effect of the structural shock after controlling for Grimm's stance, while ϕ_h^k measures the association with Grimm's stance after controlling for the structural shock.

The control vector $\mathbf{X}_{i,t}$ contains:

Symbol	Definition	R variable
$\Delta_5 \log y_{i,t}$	Five-year change in real GDP	`d5_log_rgdp`
$\Delta_5 \log p_{i,t}$	Five-year change in the price level	`d5_log_cpi`
$\Delta_5 d_{i,t}$	Five-year change in public debt-to-GDP	`d5_debtgdp`
$spread_{i,t}$	Term spread	`termspread`
$\bar{d}_t$	Global average public debt-to-GDP	`global_debtgdp`
$\text{crisis}_{i,t-j}$	Five lags of the crisis indicator	`b_lag1`,...,`b_lag5`

Conventional monetary shock: Table 13 reports the results for the conventional monetary shock.

Table 13: Horse race: conventional shock vs. Grimm stance

	Conventional shock		Grimm stance	
Horizon	Coef. (pp)	t-stat	Coef. (pp)	t-stat
$h = 0$	−0.12	−0.07	+1.10	2.24**
$h = 1$	+1.32	0.86	+0.87	1.81*
$h = 2$	+1.29	0.86	+0.97	2.14**
$h = 3$	+2.87	1.70*	+0.98	2.31**
$h = 4$	+3.56	1.81*	+0.88	2.10**
$h = 5$	+3.01	1.38*	+0.47	1.06*
$h = 6$	+1.33	0.63	+0.09	0.18
$h = 7$	+1.79	0.74	−0.63	−1.08*
$h = 8$	+1.41	0.56	−1.49	−2.20**
$h = 9$	−1.32	−0.58	−1.77	−2.51**

Notes: ** significant at the 95% level ($|t| > 1.96$); * significant at the 68% level ($|t| > 1.00$). Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database and the monetary-policy stance measure from Grimm et al. (2023).

At short horizons, Grimm's monetary stance contains more precisely estimated information about crisis risk, while the conventional structural shock is not statistically

significant. At medium horizons, however, the structural shock becomes significant at the 68% level at $h = 3$–5, reaching +3.56 percentage points at $h = 4$. Grimm's stance also remains significant over much of this period.

Because the two measures enter the same regression, these results suggest that the conventional structural shock retains some predictive content beyond Grimm's stance. The evidence is nevertheless weaker than in the baseline specification, since the structural-shock coefficients are no longer significant at the 95% level.

At longer horizons, the conventional structural shock becomes statistically insignificant, while Grimm's stance turns negative and is significant at the 95% level at $h = 8$ and $h = 9$. These distant horizon estimates should be interpreted cautiously.

Unconventional monetary policy shock: Table 14 reports the corresponding horse-race exercise for the UMP shock.

Table 14: Horse race: UMP shock vs. Grimm stance

	UMP shock		Grimm stance	
Horizon	Coef. (pp)	t-stat	Coef. (pp)	t-stat
$h = 0$	−2.93	−1.39*	+1.26	2.53**
$h = 1$	−2.26	−1.07*	+1.12	2.18**
$h = 2$	−2.78	−1.41*	+1.25	2.49**
$h = 3$	−2.06	−0.93	+1.35	2.68**
$h = 4$	−3.03	−1.50*	+1.38	2.92**
$h = 5$	−1.74	−0.85	+0.81	1.74*
$h = 6$	+1.05	0.44	+0.13	0.28
$h = 7$	+3.63	1.54*	−0.71	−1.43*
$h = 8$	+0.06	0.02	−1.40	−2.57**
$h = 9$	−1.93	−0.56	−1.76	−2.92**

Notes: ** significant at the 95% level ($|t| > 1.96$); * significant at the 68% level ($|t| > 1.00$). Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database and the monetary-policy stance measure from Grimm et al. (2023).

Unlike the conventional shock, the UMP shock is not statistically significant at the 95% level at any horizon once Grimm's monetary stance is included. Several coefficients are significant at the 68% level, but the estimates are less precise and vary in sign across horizons.

This result does not imply that UMP is unrelated to financial vulnerability. Rather, it is consistent with the broader results of the thesis, which indicate that its effects are strongly state-dependent. As shown in Section 7, the household red-zone response is substantially stronger in high-public-debt observations at medium horizons, reaching almost 12 percentage points around $h = 6$.

By contrast, Grimm's stance remains significant at the 95% level at several short and medium horizons after controlling for the UMP shock. Grimm's reduced-form measure therefore retains substantial predictive information for banking crises in the full sample, while the UMP shock appears to operate more clearly through conditional financial-vulnerability channels.

Overall, the correlation and horse-race exercises show that the structural shocks and Grimm's monetary stance capture related but distinct dimensions of monetary accommodation. The conventional shock retains some predictive content at medium horizons after controlling for Grimm's stance, although the evidence becomes weaker than in the baseline specification reported in Section 6. In that specification, the conventional effect reaches +4.44 percentage points at $h = 3$, where it is significant at the 95% level, and the point estimate reaches +4.90 percentage points at $h = 4$.

The UMP shock, by contrast, does not display a precisely estimated direct full-sample effect on banking crisis probability in the horse-race specification. Its stronger effects instead emerge through the state-dependent transmission mechanisms documented earlier.

These findings highlight the contribution of the structural identification. Grimm's monetary stance summarises the overall degree of monetary accommodation, whereas our approach separates the conventional policy-rate channel from the unconventional term-spread channel. This distinction provides additional information about the channels and conditions through which monetary policy may contribute to the build-up of financial vulnerabilities.

8.0.4 Summary of the Validation Exercises

Taken together, the validation exercises support the interpretation of the identified series as economically meaningful monetary shocks. The identification strategy aims to isolate unexpected monetary innovations from the systematic response of monetary policy to past macroeconomic conditions, as captured by a Taylor-type rule. The identified shocks are also positively correlated with the reduced-form monetary stance of Grimm et al. (2023), while remaining sufficiently distinct to provide additional information on the transmission of monetary policy. Although these exercises cannot prove the validity of the identification, they provide consistent evidence that the estimated shocks are suitable for the empirical analysis developed in the remainder of the thesis.

9 Robustness

We now check whether our main results hold under alternative specifications. We perform four robustness exercises. First, we vary the tolerance parameter used in the approximate zero restriction underlying the identification of the UMP shock. Second, we exclude the COVID period. Third, we restrict the sample to euro area countries. Finally, we use a two-year crisis window instead of three years. Additional robustness exercises are reported in Appendix C.

Sensitivity to the approximate zero restriction (τ).

Table 15: Sensitivity to the tolerance parameter τ

	$\tau = 0.02$	$\tau = 0.05$ (baseline)	$\tau = 0.10$
Shock correlations			
Corr. with baseline ($\tau = 0.05$)	0.963	—	0.976
Conventional shock: peak effect on crisis probability			
Peak coefficient (pp)	+4.23	+4.90	+4.86
Horizon	$h = 3$	$h = 4$	$h = 4$
Significant at 95%	Yes	Yes	Yes
UMP shock: household red-zone response			
Peak coefficient (pp)	+7.24	+6.09	+5.39
Horizon	$h = 8$	$h = 9$	$h = 2$
Significant at 95%	Yes	No	Yes
UMP shock: crisis probability and business red zone			
Significant at 95% (any horizon)	No	No	No

Note: The tolerance parameter τ controls the approximate zero restriction on the short-term interest rate response to the UMP shock. Correlations are computed between the five-year moving averages of the shock series across specifications.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

The baseline identification imposes an approximate zero response of the short-term interest rate to the UMP shock, using a tolerance of $\tau = 0.05$. Following the methodological concerns discussed by Arias et al. (2018), we test the sensitivity of the results to alternative values of $\tau = 0.02$ and $\tau = 0.10$. The former imposes a tighter zero restriction, while the latter allows a wider range around zero.

The identified UMP shock series remain highly correlated across the three specifications, with pairwise correlations ranging from 0.94 to 0.98. This indicates that the identified shock series is highly robust to the choice of the tolerance parameter.

The main qualitative conclusions are also preserved. Across all values of τ, the conventional monetary shock increases banking crisis probability by roughly four to five percentage points around $h = 3$–4. The UMP shock remains statistically insignificant at the 95% level for aggregate crisis probability and for the business red-zone response across all specifications.

The household red-zone response is more sensitive to the choice of τ. The estimated response remains positive, but its peak horizon and statistical precision vary across specifications. Under $\tau = 0.10$, the response peaks at +5.39 percentage points at $h = 2$ and is significant at the 95% level. Under $\tau = 0.02$, it peaks at +7.24 percentage points at $h = 8$ and is also significant at the 95% level. Under the baseline value of $\tau = 0.05$, the peak reaches +6.09 percentage points at $h = 9$, but is not significant at the 95% level.

Overall, the sensitivity analysis indicates that the approximate zero restriction does not materially affect the main qualitative conclusions. The most noticeable sensitivity concerns the timing and statistical precision of the household red-zone response, while its estimated response remains positive across specifications.

Robustness of the conventional monetary policy results.

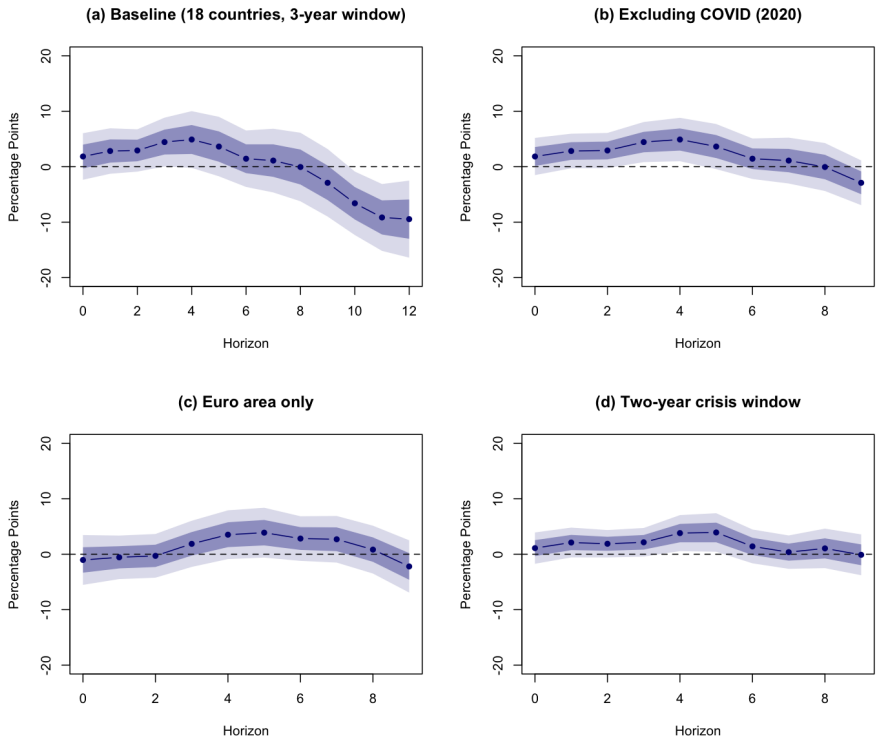


Figure 21: Robustness checks: effect of the conventional shock on the probability of a banking crisis. Panel (a) shows the baseline specification (18 countries, three-year crisis window). Panel (b) excludes the COVID year (2020). Panel (c) restricts the sample to nine euro area countries. Panel (d) uses a two-year crisis window. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Baseline (panel a): The baseline result shows the hump-shaped response documented in the previous section. The effect peaks at +4.44 percentage points at $h = 3$ ($t = 1.98$, significant at 95%). This serves as the reference point for the three robustness checks below.

Excluding COVID (panel b): The results are slightly stronger without 2020. The effect peaks at +4.90 percentage points at $h = 4$ ($t = 2.46$, significant at 95%). The

coefficients are significant at 95% at $h = 3$ and $h = 4$. This confirms that the COVID period does not drive our findings. If anything, the results are cleaner without this unusual episode.

Euro area only (panel c): We restrict the sample to nine euro area countries (BEL, DEU, ESP, FIN, FRA, IRL, ITA, NLD, PRT), giving 648 observations. The results remain positive at medium horizons. The effect peaks at +3.89 percentage points at $h = 5$ ($t = 1.70$). The confidence intervals are wider, which is expected with fewer countries. The main pattern is preserved but significance is reduced. This suggests that the result is not driven by non-euro countries such as the United States or Japan.

Two-year crisis window (panel d): We replace the three-year crisis window with a two-year window. The results remain significant. The effect peaks at +3.92 percentage points at $h = 5$ ($t = 2.22$, significant at 95%). The peak horizon shifts slightly from $h = 3$–4 to $h = 4$–5, but the main finding is unchanged.

Overall, the main result is robust across all specifications. The conventional shock consistently predicts a higher probability of banking crises at medium horizons. The magnitude and significance vary across specifications, but the sign and timing are stable. These results are consistent with the broader evidence in the financial crisis prediction literature (Grimm et al., 2023; Schularick and Taylor, 2012).

Robustness of the unconventional monetary policy results.

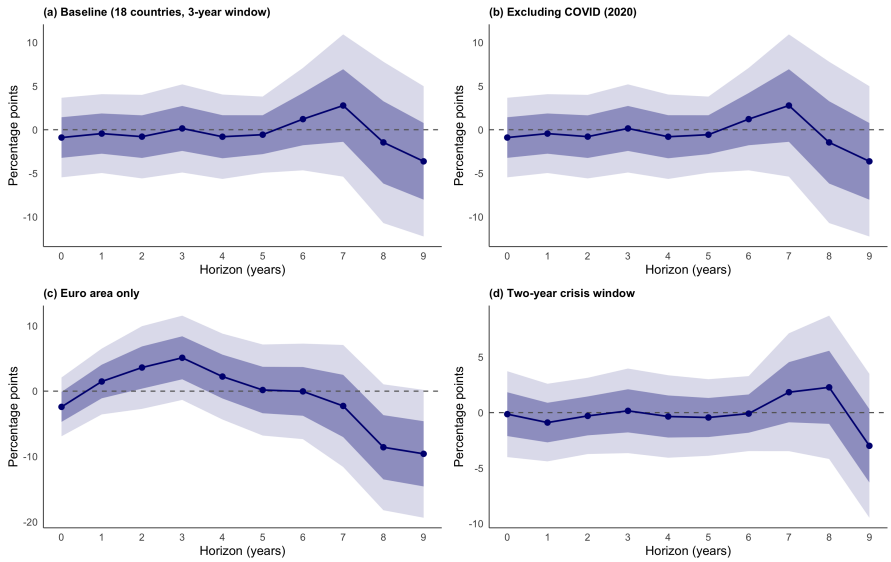


Figure 22: Robustness checks: effect of the UMP shock on the probability of a banking crisis. Panel (a) shows the baseline specification (18 countries, three-year crisis window). Panel (b) excludes the COVID year (2020). Panel (c) restricts the sample to nine euro area countries. Panel (d) uses a two-year crisis window. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Baseline (panel a): The baseline result shows that the UMP shock has no statistically significant effect on banking crisis probability at any horizon. The point estimates

fluctuate around zero, ranging from −3.63 percentage points at $h = 9$ to +2.78 percentage points at $h = 7$, none of which is significant at the 68% level. The average full-sample effect of the UMP shock on crisis probability is therefore not precisely estimated.

Excluding COVID (panel b): Removing the year 2020 produces results that are identical to the baseline at all horizons. This confirms that the full-sample result is not driven by the COVID observation.

Euro area only (panel c): Restricting the sample to nine euro area countries (BEL, DEU, ESP, FIN, FRA, IRL, ITA, NLD, PRT), giving 648 observations, produces a somewhat different pattern. The point estimates turn positive at medium horizons, reaching +5.10 percentage points at $h = 3$ ($t = 1.55$, 68% level) and +3.61 percentage points at $h = 2$ ($t = 1.12$). At longer horizons, the estimates turn negative and reach −9.58 percentage points at $h = 9$ ($t = -1.92$, 68% level). None of these effects reaches the 95% significance threshold, and the confidence intervals are considerably wider than in the baseline, as expected with fewer countries. The less stable pattern may reflect the specific monetary and financial conditions experienced in the euro area over the sample.

Two-year crisis window (panel d): Replacing the three-year crisis window with a two-year window does not change the conclusion. The point estimates remain small and statistically insignificant at all horizons, ranging from −2.99 percentage points at $h = 9$ to +2.28 percentage points at $h = 8$.

Overall, the absence of a statistically significant effect of the UMP shock on banking crisis probability at the 95% level is robust across all four specifications. The result is not specific to the baseline sample, the treatment of the COVID period, or the choice of crisis window. As discussed in Section 7, the stronger effects of UMP instead appear in the state-dependent transmission to financial vulnerabilities.

10 Limitations and Avenues for Future Research

Although our empirical findings remain robust across a wide range of specifications, several limitations should be acknowledged, each providing promising directions for future research.

Methodological identification of UMP shocks: The unconventional monetary policy shock is identified by imposing an approximate zero restriction on the impact response of the short-term interest rate, controlled by the tolerance parameter τ. Our sensitivity analysis shows that the main results are similar when this tolerance is made tighter or looser, suggesting that the findings are not driven by the exact value chosen for τ. However, the UMP shock is still identified under this assumption. The results should therefore be interpreted as conditional on the validity of the approximate zero restriction. As emphasized by Arias et al. (2018), sign- and zero-restricted VARs do not identify structural shocks independently of the restrictions imposed by the researcher. Future research could therefore compare these results with alternative identification strategies, such as external instruments based on narrative measures or high-frequency monetary surprises around central bank announcements.

Historical interpretation of the term-spread shock: Second, the interpretation of the term-spread shock as unconventional monetary policy is most direct after the 2008 Global Financial Crisis, when asset purchases and forward guidance became explicit policy tools. Before 2008, movements in the term spread may also reflect changes in term premia, expectations about future economic activity, or other financial disturbances. The long historical sample provides useful variation, but the pre-2008 estimates should therefore be interpreted more cautiously. Future research could compare this long-run structural identification with high-frequency event-study measures restricted to the post-2008 period.

Alternative dimensions of state dependence: Third, our state-dependent analysis measures initial macro-financial vulnerability solely through the public debt-to-GDP ratio. While this indicator offers a transparent and standardized threshold across advanced economies, the transmission of monetary shocks to financial stability may also depend on private leverage levels, such as baseline household debt or corporate indebtedness. Extending the interaction analysis to private debt regimes would provide a more comprehensive mapping of state-dependent monetary transmission.

Microeconomic transmission channels: Finally, while this thesis documents that expansionary UMP shocks increase household red-zone probabilities in highly indebted economies, it identifies the aggregate outcome rather than the underlying microeconomic behavior. Several distinct mechanisms documented in the literature: such as bank portfolio rebalancing, the risk-taking channel, or the search-for-yield mechanism, could produce similar aggregate patterns. Future research could use bank or household level data to better distinguish between these channels.

11 Conclusion

This thesis investigates whether monetary policy contributes to the build-up of financial vulnerabilities that ultimately lead to banking crises. While the literature has extensively documented the macroeconomic effects of monetary policy, much less is known about its longer-run implications for financial stability, particularly when distinguishing between conventional and unconventional monetary policy.

Using annual data for 18 advanced economies over the period 1949–2020, we identify conventional and unconventional monetary policy shocks within a structural VAR using sign restrictions. These shocks are then incorporated into a local projection framework to estimate their dynamic effects on banking crises and on the accumulation of financial vulnerabilities.

The results reveal a clear distinction between the two monetary policy regimes. Conventional monetary easing increases the probability of future banking crises at medium horizons and contributes to the build-up of household financial vulnerabilities. The effects are economically meaningful, remain robust across a wide range of alternative specifications, and display a largely symmetric pattern between expansionary and contractionary shocks.

The effects of unconventional monetary policy are more nuanced. On average, expansionary UMP shocks do not significantly increase banking crisis risk. However, this average masks substantial heterogeneity across countries. Once differences in public indebtedness are taken into account, UMP shocks generate larger and more persistent increases in household financial vulnerabilities in highly indebted economies, while the response in lower-debt economies is concentrated at shorter horizons. These findings suggest that the financial stability consequences of unconventional monetary policy are strongly state dependent.

Overall, the evidence indicates that monetary policy cannot be evaluated solely through its effects on inflation and economic activity. Its interaction with financial vulnerabilities should also be considered, especially when balance sheet conditions amplify the transmission of monetary easing. While unconventional monetary policy remains an essential tool during periods of severe economic stress, our results suggest that its longer-run implications for financial stability deserve careful attention.

More broadly, these findings contribute to the growing literature on the interaction between monetary policy and financial stability by highlighting that the effects of unconventional monetary policy depend not only on the policy shock itself, but also on the financial environment in which it is implemented. Incorporating such state dependence into monetary policy analysis may therefore improve our understanding of the conditions under which financial imbalances accumulate and eventually translate into systemic banking crises.

Appendices

The appendices provide additional results, robustness checks, and methodological details supporting the empirical analysis. Appendix A presents supplementary figures. Appendix B reports the asymmetry analysis. Appendix C reports additional validation and robustness exercises. Appendix D lists the crisis and red-zone episodes included in the sample. Appendix E details the construction of the variables, the control variables, and the identification procedure. Appendix F reports the country codes and variable names used throughout the thesis.

A Additional Figures

A.1 Monetary shocks across countries

Figures 23 and 24 report the identified conventional and term-spread shocks for each country over the 1949–2020 period. These figures illustrate the substantial cross-country variation in monetary and financial conditions. The interpretation of the term-spread shock as unconventional monetary policy is most direct in the post-2008 period.

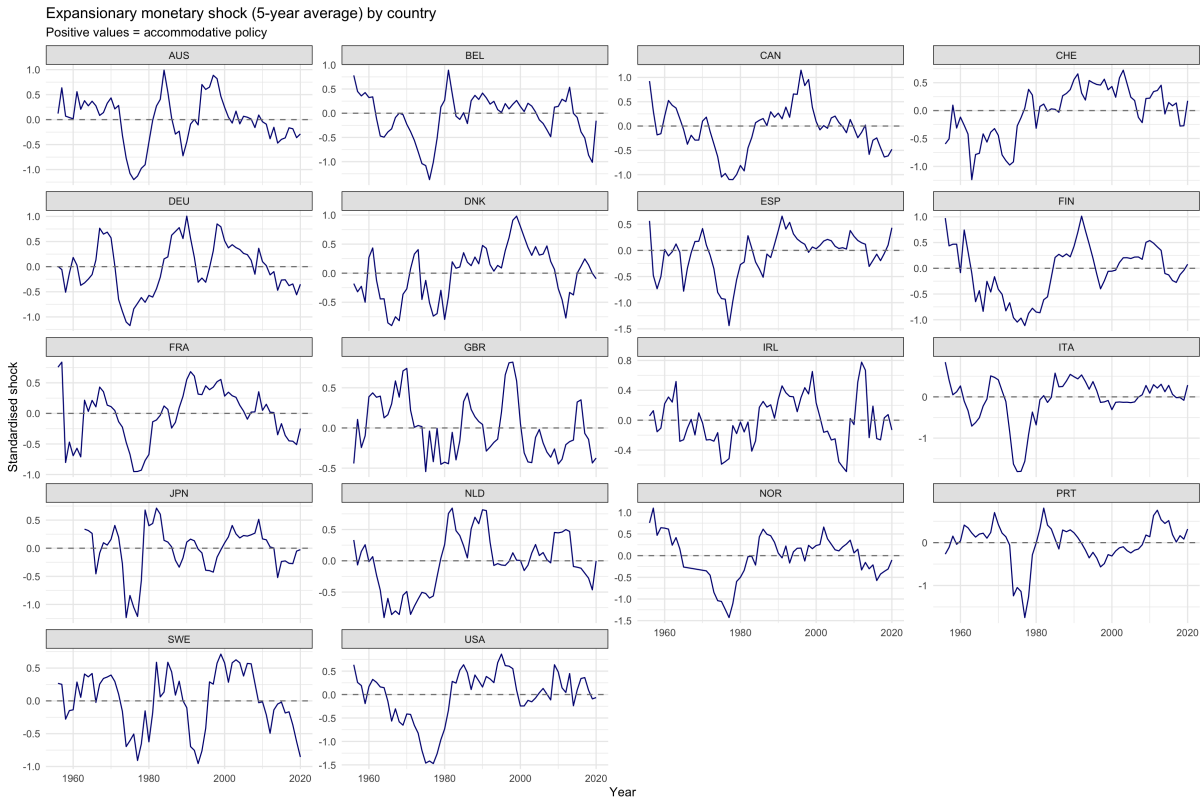


Figure 23: Expansionary conventional monetary shock (5-year moving average) by country, 1949–2020. Each panel plots the country-specific identified shock from the VAR4 sign-restricted estimation.

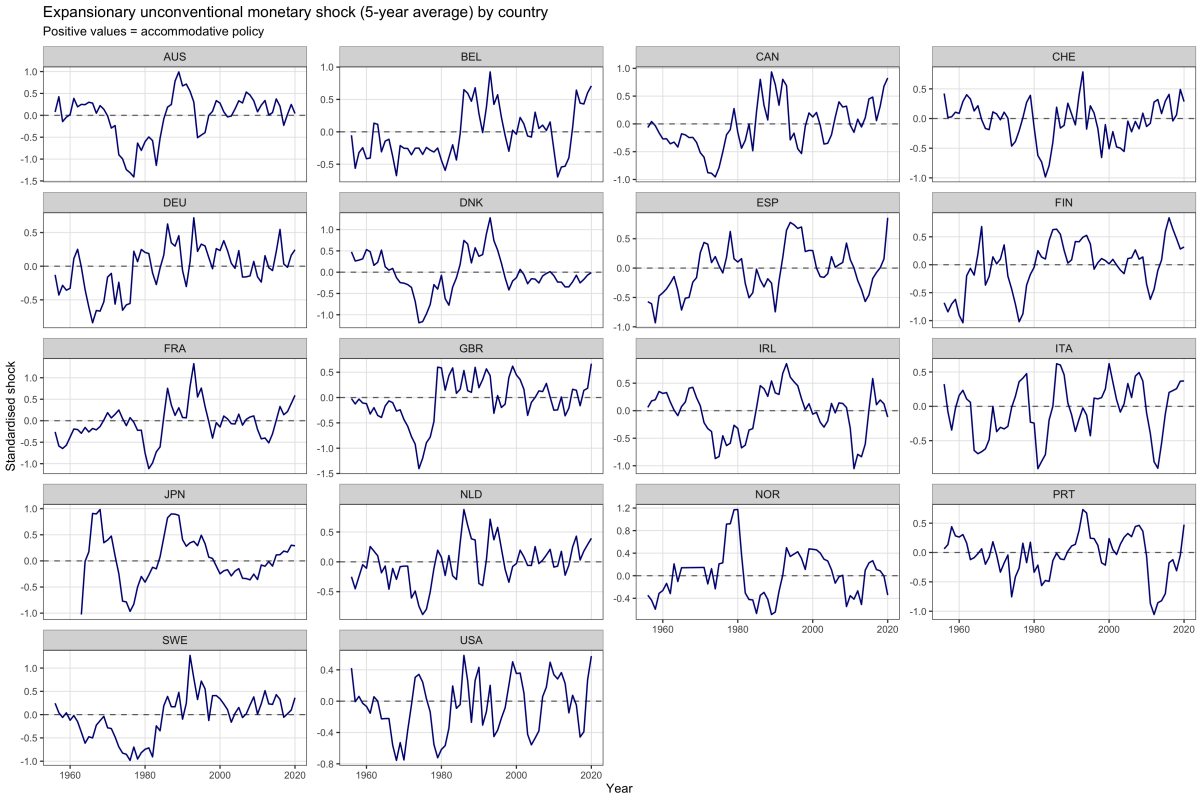


Figure 24: Expansionary term-spread shock (five-year moving average) by country. The series captures cross-country variation in long-term monetary and financial conditions. Its interpretation as an unconventional monetary policy shock is most direct after 2008.

B Asymmetric Effects of Monetary Shocks

This appendix examines whether contractionary monetary shocks produce effects of the same magnitude and opposite sign as expansionary shocks. These results complement the baseline analysis but are not required for the main state-dependence result.

B.1 Conventional Monetary Policy Shock

Figure 25 compares the response of household red-zone probability to expansionary and contractionary conventional monetary shocks.

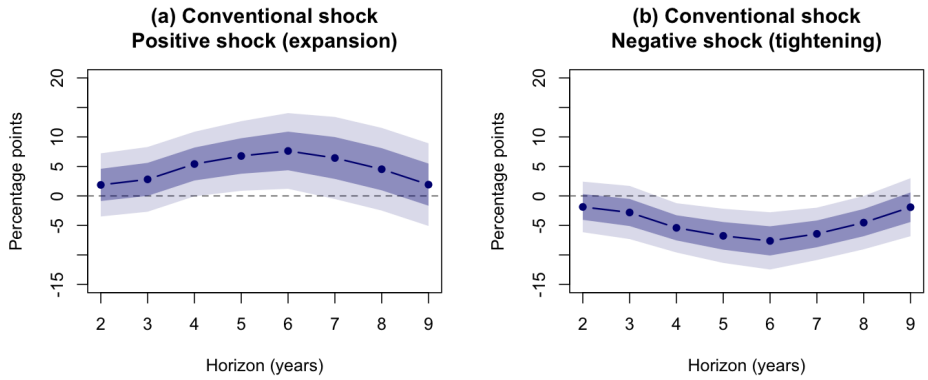


Figure 25: Asymmetric effects of conventional monetary shocks on household red-zone probability. Panel (a) reports the response to an expansionary conventional shock, while Panel (b) reports the response to a contractionary conventional shock. Shaded bands show 68% (dark) and 95% (light) confidence intervals based on Newey–West standard errors.

B.2 Unconventional Monetary Policy Shock

Figure 26 reports the same exercise for the unconventional monetary policy shock.

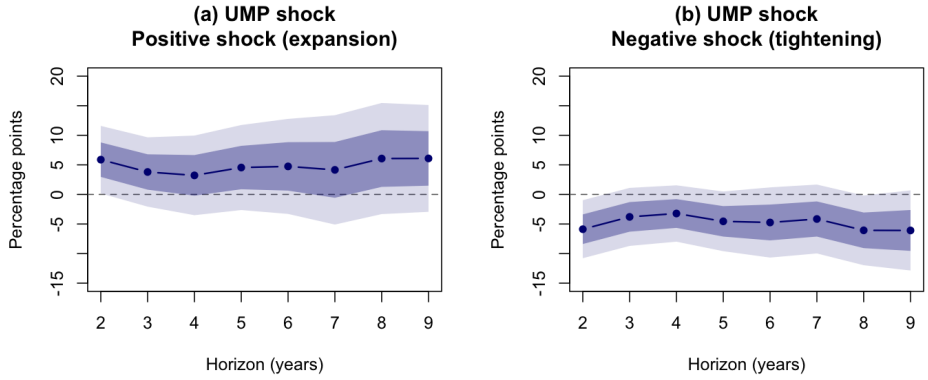


Figure 26: Asymmetric effects of unconventional monetary policy shocks on household red-zone probability. Panel (a) reports the response to an expansionary UMP shock, while Panel (b) reports the response to a contractionary UMP shock. The specification and confidence intervals are identical to Figure 25.

C Additional Validation and Robustness Results

C.1 Country-level diagnostic of the VAR4 identification

Table 16 reports the number of admissible orthogonal rotations obtained for each country out of 50,000 draws. The number ranges from 117 for Spain to 381 for the United States. Although the acceptance rate is low, every country provides more than one hundred admissible impact matrices. This leaves a sufficiently large set of candidate solutions from which to construct the representative median impact matrix.

Table 16: Country-level diagnostic: number of valid rotations in the VAR4 sign-restricted identification

Country	Observations	Valid rotations	% valid (/50,000)
AUS	71	160	0.32
BEL	71	240	0.48
CAN	71	254	0.51
CHE	71	195	0.39
DEU	71	250	0.50
DNK	71	151	0.30
ESP	71	117	0.23
FIN	71	153	0.31
FRA	71	237	0.47
GBR	71	180	0.36
IRL	71	126	0.25
ITA	71	312	0.62
JPN	64	296	0.59
NLD	71	146	0.29
NOR	70	175	0.35
PRT	71	258	0.52
SWE	71	179	0.36
USA	71	381	0.76
Average		212	0.42
Minimum		117	0.23
Maximum		381	0.76

Note: Each draw consists of a random orthogonal matrix Q drawn uniformly from $O(4)$ using a QR decomposition of a standard normal matrix. A rotation is retained when the implied impact matrix $B = PQ$ satisfies the sign restrictions $B_{33} > 0$, $B_{43} < 0$, $|B_{34}| < \tau$, $B_{44} > 0$ with $\tau = 0.05$ and 50,000 draws per country. The number of admissible rotations is reported as a diagnostic of the feasibility of the sign restrictions. It should not be interpreted as formal proof that the structural identification is unique or valid.

C.2 Selected Baseline Local Projection Estimates

Table 17 reports selected local projection coefficients from the baseline specification. Panel A presents the conventional monetary shock and Panel B the unconventional monetary policy shock. The full dynamic responses are reported in the figures presented in

the main text.

Table 17: Selected local projection estimates from the baseline specification

Shock	Outcome	Horizon	Coef (pp)	SE	95% CI	Sig.
Panel A: Expansionary conventional shock 5y						
Conv.	Crisis	0	+1.84	2.14	[−2.35; 6.03]	No
Conv.	Crisis	1	+2.83	2.09	[−1.27; 6.93]	No
Conv.	Crisis	2	+2.93	1.94	[−0.88; 6.74]	No
Conv.	Crisis	3	+4.44	2.24	[0.04; 8.84]	Yes
Conv.	Crisis	4	+4.90	2.61	[−0.21; 10.02]	No
Conv.	Crisis	5	+3.63	2.73	[−1.73; 9.00]	No
Conv.	Crisis	6	+1.44	2.60	[−3.65; 6.53]	No
Panel B: Expansionary unconventional shock 5y						
UMP	Crisis	0	−0.90	2.33	[−5.46; 3.67]	No
			⋮			

Note: All coefficients are in percentage points.

Standard errors are Newey–West with horizon-dependent lags.

C.3 Robustness specifications: complete results

Table 18 summarizes the robustness specifications for the conventional monetary shock. Since the baseline sample already starts in 1949, an explicit exclusion of pre-war episodes and the German hyperinflation of 1922–1923 is not necessary. The robustness checks therefore focus on sub-periods and alternative crisis definitions.

Table 18: Robustness of the central result across alternative specifications

Specification	Coef. at $h = 3$ (pp)	SE	Sig. at 95%
Baseline (18 countries, 1949–2020)	+4.44	2.24	Yes
Post Bretton Woods ($\geq$ 1973)	+5.92	2.71	Yes
Great Moderation ($\geq$ 1984)	+0.57	4.66	No
Euro area (9 countries)	+1.87	2.54	No
Excluding COVID ($\leq$ 2019)	+4.44	2.24	Yes
2-year crisis window	+2.15	1.39	No
Exact crisis (no window)	+0.96	0.72	No

Note: Each row reports the estimated coefficient at horizon $h = 3$ from an independent local projection with Newey–West standard errors. The baseline result is significant at the 95% level ($|t| = 1.98$). The Great Moderation sub-sample starts in 1984, which significantly reduces the number of crisis episodes available for estimation. The corresponding response functions across all horizons are reported in the robustness figures presented in the main text.

C.4 Robustness for unconventional shock

Table 19 reports the equivalent robustness checks for the unconventional monetary shock at horizon $h = 3$. Across all five specifications, the UMP shock produces no statistically significant effect on crisis probability. The coefficients are close to zero in the baseline (+0.15 pp), when COVID is excluded (+0.15 pp), under the two-year crisis window (+0.16 pp), and under the exact crisis definition (+0.55 pp). The euro area sub-sample yields a slightly larger coefficient (+5.10 pp) but remains insignificant. These results show

that the absence of a significant average effect of the UMP shock on crisis probability is preserved across the alternative specifications considered here. This remains consistent with the state-dependent results reported in Section 7.

Table 19: Robustness of the unconventional shock effect on crisis probability

Specification	Coef. at $h = 3$ (pp)	SE	Sig. at 95%
UMP Baseline (18 countries)	+0.15	2.58	No
UMP Euro area	+5.10	3.29	No
UMP Excluding COVID	+0.15	2.58	No
UMP 2-year crisis window	+0.16	1.94	No
UMP Exact crisis	+0.55	1.11	No

Note: Each row reports the estimated coefficient at horizon $h = 3$ from an independent local projection with Newey–West standard errors. The absence of a significant average effect is consistent across the specifications considered here and remains compatible with the state-dependent results reported in Section 7. The corresponding response functions across all horizons are reported in the robustness figures presented in the main text.

D Sample and Crisis Episodes

D.1 List of systemic banking crises in the sample

Table 20 reports the 25 systemic banking crises identified in our sample using the JST crisis dating (Jordà et al., 2013). These include the major post-1949 crises documented in the literature: the Scandinavian banking crises of the early 1990s, the Japanese crisis of 1997, and the Global Financial Crisis of 2007–2008.

Table 20: List of systemic banking crises in the sample (JST dating)

Country	Year	Episode
United Kingdom	1974	Secondary banking crisis
Spain	1977	Spanish banking crisis
United States	1984	Savings and Loan crisis
Denmark	1987	Danish banking crisis
Norway	1988	Scandinavian banking crisis
Australia	1989	Australian banking crisis
Italy	1990	Italian banking crisis
Switzerland	1991	Swiss banking crisis
Finland	1991	Scandinavian banking crisis
United Kingdom	1991	UK banking crisis
Sweden	1991	Scandinavian banking crisis
Japan	1997	Japanese banking crisis
United Kingdom	2007	Global Financial Crisis
United States	2007	Global Financial Crisis (subprime)
Belgium	2008	Global Financial Crisis
Switzerland	2008	Global Financial Crisis
Germany	2008	Global Financial Crisis
Denmark	2008	Global Financial Crisis
Spain	2008	Global Financial Crisis
France	2008	Global Financial Crisis
Ireland	2008	Global Financial Crisis
Italy	2008	Global Financial Crisis
Netherlands	2008	Global Financial Crisis
Portugal	2008	Global Financial Crisis
Sweden	2008	Global Financial Crisis

Note: The 25 crises are identified by `crisisJST = 1` in the JST Macrohistory Database R6 for the post-1949 period. The United Kingdom experienced three separate crises (1974, 1991, 2007), the highest number in the sample. Canada experienced no crisis over the full period.

D.2 R-zone episodes by country

Tables 21 and 22 report the household and business R-zone episodes identified in the sample, country by country. The 98 household R-zones and 73 business R-zones represent the periods of joint credit expansion and asset price appreciation that define the empirical concept of Greenwood et al. (2022). Canada and Ireland record no R-zone episode of either type over the full sample period.

Table 21: Household R-zone episodes by country

Country	Years
Australia	1989, 1990, 2000, 2001, 2002, 2003, 2004, 2005, 2015, 2016, 2017
Belgium	1979, 2007, 2008
Switzerland	1987, 1988, 1989, 2003, 2004, 2013
Denmark	1973, 1985, 1986, 1998, 1999, 2005, 2006, 2007
Spain	1988, 1989, 1990, 2001, 2002, 2003, 2004, 2005, 2006, 2007
Finland	1988, 1989, 2004, 2005, 2006, 2007
France	1961, 1988, 2005, 2006, 2007, 2008
United Kingdom	1981, 1985, 1986, 1987, 1988, 1989, 1990, 2000, 2001, 2002, 2003, 2004, 2005, 2006
Italy	1990, 1991
Netherlands	1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2017
Norway	1986, 1987, 1988, 2004, 2005, 2007
Portugal	1998, 1999, 2000, 2001, 2006, 2007
Sweden	1988, 1989, 2004, 2005, 2006, 2007, 2008, 2014
United States	2003, 2004
No episodes	Canada, Germany, Ireland, Japan

Note: A household R-zone is defined as a year in which the three-year change in the household debt-to-GDP ratio exceeds the 80th percentile of its historical distribution *and* the three-year log change in real house prices exceeds the 66.7th percentile, following Greenwood et al. (2022). Total: 98 episodes across 14 countries.

Table 22: Business R-zone episodes by country

Country	Years
Australia	2005, 2006, 2007
Belgium	1989
Switzerland	1962, 1968, 1969
Germany	1954, 1955, 1990, 1997, 1998
Denmark	1960, 1985, 2000, 2005, 2006, 2007, 2020
Spain	1969, 1970, 1971, 1973, 1999, 2000, 2005, 2006, 2007
Finland	1987, 1988, 2000, 2001
France	2007
United Kingdom	1960, 1989, 2006, 2007
Italy	1953, 1954, 1955, 1960, 1961, 2000
Japan	1953, 1954, 1957, 1958, 1959, 1960, 1971, 1972, 1973, 1983, 1984, 1985, 1986, 1987, 1988
Netherlands	1998, 1999, 2000, 2005, 2006, 2007
Norway	1986, 1989, 1990, 1999, 2007
Sweden	1987, 1988, 1989, 2007
No episodes	Canada, Ireland, Portugal, United States

Note: A business R-zone is defined as a year in which the three-year change in the business debt-to-GDP ratio exceeds the 80th percentile of its historical distribution *and* the three-year log change in real equity prices exceeds the 66.7th percentile, following Greenwood et al. (2022). Total: 73 episodes across 14 countries. Japan accounts for 15 episodes, concentrated in the high-growth period of the 1950s–1980s.

D.3 Additional Tests on the UMP Transmission Channel

This appendix reports additional exercises examining why the unconventional monetary policy shock does not produce a statistically significant direct increase in banking-crisis probability. These results complement the discussion in the main text.

Table 23: Two-Step Household Vulnerability Mechanism

	UMP → HH Red Zone		HH Red Zone → Crisis		UMP → Crisis	
h	Coef. (pp)	t-stat	Coef. (pp)	t-stat	Coef. (pp)	t-stat
2	5.88	2.35	22.16	4.17	-0.79	-0.32
3	3.80	1.52	21.42	4.05	0.15	0.06
4	3.22	1.33	19.89	3.84	-0.81	-0.33
5	4.55	1.77	19.77	3.79	-0.57	-0.26
6	4.74	1.57	21.87	3.99	1.21	0.41
7	4.15	1.40	22.96	3.95	2.78	0.67
8	6.07	2.02	25.41	4.17	-1.46	-0.31
9	6.09	1.76	25.10	3.96	-3.63	-0.83

Note: The first two columns report the response of household red-zone probability to an expansionary UMP shock. The middle columns report the association between household red-zone status and banking-crisis probability while controlling for the UMP shock and the baseline controls. The final columns report the direct UMP response of banking-crisis probability. Coefficients are expressed in percentage points. Newey–West standard errors are used with lag length $h + 1$. This exercise is intended to document the transmission mechanism and should not be interpreted as a formal causal mediation test.
Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Table 24: Robustness of the UMP Effect on Banking-Crisis Probability

Specification	Coefficient	Standard Error	t-stat
Baseline: three-year crisis window, Newey–West SE	-0.0081	0.0185	-0.43
Country-clustered standard errors	-0.0081	0.0220	-0.37
Large UMP shocks only	-0.0194	0.0212	-0.91
Logit specification	-0.0482	0.3761	-0.13
Five-year crisis window	0.0138	0.0431	0.32

Note: Results refer to horizon $h = 4$. The baseline specification uses the three-year forward crisis window and Newey–West standard errors. The alternative specifications use country-clustered standard errors, restrict the sample to observations in the upper tercile of the absolute UMP-shock distribution, estimate a logit model, or extend the forward crisis window from three to five years. None of the estimated UMP effects is statistically significant at the 95% level.
Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

Table 25: UMP Shock and Banking-Crisis Probability: Five-Year Crisis Window

Horizon	Coefficient (pp)	Standard Error (pp)	t-stat
0	-0.99	2.88	-0.34
1	-1.44	3.14	-0.46
2	-1.24	3.20	-0.39
3	-0.33	3.48	-0.10
4	1.38	4.31	0.32
5	-1.61	5.46	-0.30
6	-1.55	6.26	-0.25
7	0.51	6.12	0.08
8	0.51	5.80	0.09
9	1.18	5.38	0.22

Note: The dependent variable equals one when a systemic banking crisis occurs within the five years following horizon h. Coefficients and standard errors are expressed in percentage points. Newey–West standard errors are computed with lag length $h + 1$. The UMP response remains statistically insignificant at all horizons.
Source: Author's calculations based on the Jordà–Schularick–Taylor Macrohistory Database.

E Methodology Details

E.1 Variable Definitions

Table 26 provides the definition and source of the main variables used in the empirical analysis.

Table 26: Variable definitions and sources

Variable	Definition	Source
`stir`	Short-term interest rate (annual, %)	JST
`ltrate`	Long-term government bond yield (annual, %)	JST
`termspread`	Long-term interest rate minus short-term interest rate (pp)	JST, constructed
`rgdpmad`	Real GDP per capita	JST
`cpi`	Consumer Price Index	JST
`debtgdp`	Public debt-to-GDP ratio	JST
`tbus`	Business credit	JST
`thh`	Household credit	JST
`eq_capgain`	Real equity capital gain	JST
`housing_capgain`	Real housing capital gain	JST
`crisisJST`	Systemic banking crisis indicator	JST
`stance`	Reduced-form monetary stance	Constructed following Grimm et al. (2023)

E.2 Baseline Control Variables

The baseline local projections include the control variables used by Grimm et al. (2023). Table 27 summarizes their construction.

Table 27: Control variables included in the baseline local projections

Control variable	Definition
Real GDP dynamics	Five-year change in real GDP (`d5_log_rgdp`).
Price dynamics	Five-year change in the consumer price level (`d5_log_cpi`).
Public debt dynamics	Five-year change in the public debt-to-GDP ratio (`d5_debtgdp`).
Term spread	Difference between the long-term and short-term interest rates (`termspread`).
Global debt level	Cross-country average of the public debt-to-GDP ratio (`global_debtgdp`).
Crisis history	Five lags of the banking crisis indicator (`b_lag1`,...,`b_lag5`).
Country fixed effects	Country-specific intercepts (`iso_factor`).

E.3 Red-Zone Construction

A *red zone* is defined by the simultaneous crossing of two thresholds calculated from three-year changes:

- **Household red zone:**

$$\Delta_3\text{HH debt-to-GDP} > p_{80}^{hh} \quad \wedge \quad \Delta_3 \log(\text{house prices}) > p_{66.7}^{hp}.$$

- **Business red zone:**

$$\Delta_3\text{business debt-to-GDP} > p_{80}^{bus} \quad \wedge \quad \Delta_3 \log(\text{equity prices}) > p_{66.7}^{eq}.$$

The thresholds estimated on the post-1949 sample are:

$$p_{80}^{bus} = 4.72, \qquad p_{80}^{hh} = 6.08, \qquad p_{66.7}^{eq} = 22.34, \qquad p_{66.7}^{hp} = 12.59.$$

E.4 Impact Matrix and Structural Interpretation

Table 28: Lag-order selection by country

Country	AIC	HQ	SC	FPE
AUS	1	1	1	1
BEL	1	1	1	1
CAN	1	1	1	1
CHE	1	1	1	1
DEU	2	1	1	2
DNK	2	1	1	2
ESP	2	1	1	2
FIN	1	1	1	1
FRA	1	1	1	1
GBR	2	2	1	2
IRL	3	1	1	3
ITA	2	2	1	2
JPN	1	1	1	1
NLD	1	1	1	1
NOR	2	1	1	2
PRT	4	2	1	4
SWE	1	1	1	1
USA	3	1	1	3

Note: The table reports the lag order selected by the Akaike Information Criterion (AIC), Hannan–Quinn criterion (HQ), Schwarz criterion (SC), and Final Prediction Error (FPE), allowing for a maximum of four lags. The criteria were computed separately for each country using the four-variable VAR employed in the structural identification.

The reduced-form VAR residuals can be written as linear combinations of structural shocks:

$$\mathbf{u}_{i,t} = B_i \boldsymbol{\varepsilon}_{i,t}, \tag{9}$$

where $\mathbf{u}_{i,t}$ is the vector of reduced-form innovations, $\boldsymbol{\varepsilon}_{i,t}$ contains the structural shocks, and B_i is the contemporaneous impact matrix for country i.

The VAR contains four variables ordered as

$$\mathbf{y}_{i,t} = \begin{pmatrix} \pi_{i,t} \\ \Delta y_{i,t} \\ r_{i,t} \\ spread_{i,t} \end{pmatrix}, \tag{10}$$

where $\pi_{i,t}$ denotes inflation, $\Delta y_{i,t}$ real GDP growth, $r_{i,t}$ the short-term interest rate, and $spread_{i,t}$ the term spread. The corresponding impact matrix can therefore be represented as

$$B_i = \begin{pmatrix} B_{11} & B_{12} & B_{13} & B_{14} \\ B_{21} & B_{22} & B_{23} & B_{24} \\ B_{31} & B_{32} & B_{33} & B_{34} \\ B_{41} & B_{42} & B_{43} & B_{44} \end{pmatrix}. \tag{11}$$

Each element B_{jk} measures the immediate response of variable j to structural shock k. The rows therefore correspond to the four variables in the VAR, while the columns correspond to different structural shocks.

The third and fourth columns are used to identify the two monetary policy shocks of interest. Column 3 is assigned to the conventional monetary policy shock, while column 4 is assigned to the term-spread shock used to identify unconventional monetary policy. These column labels are not inherent properties of the reduced-form VAR; they result from the restrictions imposed during the identification procedure.

Before the final sign normalization, the restrictions identify contractionary monetary policy innovations. For the conventional shock, the short-term interest rate is required to increase while the term spread decreases:

$$B_{33} > 0, \qquad B_{43} < 0. \tag{12}$$

The conventional shock is therefore identified through a positive impact response of the short-term interest rate combined with a negative response of the term spread.

For the unconventional monetary policy shock, the short-term interest rate is required to remain approximately unchanged, while the term spread increases:

$$|B_{34}| < \tau, \qquad B_{44} > 0, \tag{13}$$

where the baseline tolerance is $\tau = 0.05$. The approximate zero restriction allows the short-term rate to move within a narrow range around zero rather than imposing an exact zero response.

No impact restrictions are imposed on inflation or real GDP growth. The identifying restrictions can therefore be summarized as follows:

Table 29: Interpretation of the restricted elements of the impact matrix

	Conventional shock	UMP shock
Inflation	Unrestricted	Unrestricted
Real GDP growth	Unrestricted	Unrestricted
Short-term interest rate	$B_{33} > 0$	$\lvert B_{34}\rvert < \tau$
Term spread	$B_{43} < 0$	$B_{44} > 0$

Note: The table reports the restrictions imposed during the identification stage, before sign normalization. They therefore identify contractionary conventional and term-spread innovations. The identified shocks are subsequently multiplied by -1, so that positive shock values used in the empirical analysis represent monetary expansions.

After an admissible impact matrix has been obtained, the structural shocks are recovered from

$$\boldsymbol{\varepsilon}_{i,t} = B_i^{-1}\mathbf{u}_{i,t}. \tag{14}$$

In the implementation used in this thesis, many admissible matrices are generated through random orthogonal rotations. The element-wise median of the admissible impact matrices is then used as the representative matrix for each country. The complete identification algorithm is described in the following subsection.

E.5 Sign-Restriction Algorithm

Table 30 summarizes the contemporaneous responses of the identified shocks after their signs have been normalized so that positive shock values represent monetary expansions.

Table 30: Sign restrictions used to identify expansionary monetary shocks

	Impact response	
Variable	Conventional shock	UMP shock
Short-term interest rate (`stir`)	$-$	≈ 0
Term spread (`termspread`)	$+$	$-$
Inflation (`inflation`)	unrestricted	unrestricted
Real GDP growth (`growth_rgdp`)	unrestricted	unrestricted

Note: The table reports the contemporaneous responses of the identified shocks after their signs have been normalized so that positive shock values represent monetary expansions. A minus sign indicates a negative impact response, a plus sign indicates a positive impact response, and ≈ 0 denotes an approximate zero restriction implemented with tolerance $\tau = 0.05$. "Unrestricted" means that no restriction is imposed on the contemporaneous response of the variable. No restrictions are imposed at subsequent horizons.

For each country i, the identification procedure follows these steps:

1. Estimate a reduced-form VAR(2) containing inflation, real GDP growth, the short-term interest rate, and the term spread. Recover the residual covariance matrix Σ_i.

2. Compute the lower-triangular Cholesky factor P_i such that:

$$P_i P_i' = \Sigma_i.$$

3. For each of 50,000 iterations:

   (a) Draw a random matrix:

$$Z \sim \mathcal{N}(0, I_{4\times 4}).$$

   (b) Obtain an orthogonal matrix using a QR decomposition:

$$Q = \text{qr.Q}(\text{qr}(Z)).$$

   (c) Construct the candidate impact matrix:

$$B = P_i Q.$$

   (d) Retain the rotation when the following restrictions are satisfied:

$$\begin{aligned} B_{3,3} > 0, \quad & B_{4,3} < 0 \quad && \text{(conventional shock)}, \\ |B_{3,4}| < \tau, \quad & B_{4,4} > 0 \quad && \text{(term-spread shock)}, \end{aligned}$$

   where $\tau = 0.05$.

4. Compute the element-wise median of all admissible impact matrices:

$$\bar{B}_i = \text{median}\left\{B : B \in \mathcal{V}_i\right\}.$$

5. Recover the structural shocks:

$$\boldsymbol{\varepsilon}_t = \bar{B}_i^{-1} \mathbf{u}_t.$$

6. Standardize each shock within country and reverse its sign. The restrictions above identify contractionary conventional and term-spread innovations, while the sign reversal ensures that positive values in the empirical analysis represent expansionary monetary shocks.

7. Construct the five-year moving average:

$$\varepsilon_{i,t}^{exp,5y} = \frac{1}{5} \sum_{j=0}^{4} \varepsilon_{i,t-j}^{exp}.$$

E.6 Newey–West Standard Errors

All local projection regressions use Newey–West heteroskedasticity- and autocorrelation-consistent standard errors. The bandwidth is set equal to $h + 1$, where h denotes the projection horizon.

This adjustment accounts for the serial correlation generated by overlapping dependent variables. For example, a forward crisis indicator at horizon h may use information from several consecutive future years.

F Country Codes, and Dataset Variables

F.1 Country Codes

Table 31: Country codes used in the empirical analysis

Code	Country	Code	Country
AUS	Australia	GBR	United Kingdom
BEL	Belgium	IRL	Ireland
CAN	Canada	ITA	Italy
CHE	Switzerland	JPN	Japan
DEU	Germany	NLD	Netherlands
DNK	Denmark	NOR	Norway
ESP	Spain	PRT	Portugal
FIN	Finland	SWE	Sweden
FRA	France	USA	United States

F.2 Dataset Variables

Table 32: Main variables used in the empirical analysis

Variable	**Meaning**
`stir`	Short-term interest rate
`ltrate`	Long-term government bond yield
`termspread`	Long-term interest rate minus short-term interest rate
`debtgdp`	Public debt-to-GDP ratio
`hhdebt_gdp`	Household debt-to-GDP ratio
`busdebt_gdp`	Business debt-to-GDP ratio
`d3_hhdebt`	Three-year change in the household debt-to-GDP ratio
`d3_busdebt`	Three-year change in the business debt-to-GDP ratio
`d3log_hp`	Three-year log change in real house prices
`d3log_eq`	Three-year log change in real equity prices
`rzone_hh`	Household red-zone indicator
`rzone_bus`	Business red-zone indicator
`crisisJST`	Systemic banking crisis indicator
`stance`	Reduced-form monetary stance
`global_debtgdp`	Cross-country average of the public debt-to-GDP ratio

List of Resource Persons

- Pierrick Clerc – Thesis supervisor
- Bruno De Backer – Resource person

Use of artificial intelligence

In line with the ULiege guidelines on the responsible use of generative artificial intelligence in academic work, the author acknowledges the use of generative AI tools during the preparation of this thesis. The tool was used as a linguistic assistant to improve the clarity and formulation of written sections, and as a technical coding assistant to support the implementation and debugging of Python and Stata code used for data preparation and econometric analysis.

The research design, methodological decisions, empirical implementation, interpretation of the results, and final conclusions were developed and validated by the author. All AI-assisted suggestions were reviewed critically and, where appropriate, modified before being incorporated into the thesis. The author remains fully responsible for the content of the work.

Bibliography

Adrian, T. and Shin, H. S. (2010). Liquidity and leverage. *Journal of Financial Intermediation*, 19(3):418–437.

Arias, J. E., Rubio-Ramírez, J. F., and Waggoner, D. F. (2018). Inference based on structural vector autoregressions identified with sign and zero restrictions: Theory and applications. *Econometrica*, 86(2):685–720.

Bernanke, B. S., Gertler, M., and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In Taylor, J. B. and Woodford, M., editors, *Handbook of Macroeconomics*, volume 1, pages 1341–1393. Elsevier.

Borio, C. (2014). The financial cycle and macroeconomics: What have we learnt? Technical Report 395, Bank for International Settlements.

Borio, C. and Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism? *Journal of Financial Stability*, 8(4):236–251.

De Backer, B., Deroose, M., and Van Nieuwenhuyze, C. (2019). Is a recession imminent? the signal of the yield curve. *NBB Economic Review*.

Ettmeier, S. and Kriwoluzky, A. (2019). Same, but different? testing monetary policy shock measures. *Economics Letters*, 184:108640.

Garriga, C., Kydland, F. E., and Šustek, R. (2021). Monk: Mortgages in a new-keynesian model. *Journal of Economic Dynamics and Control*, 123:104059.

Greenwood, R., Hanson, S. G., Shleifer, A., and Sørensen, J. (2022). Predictable financial crises. *Journal of Finance*.

Grimm, M., Jordà, Ò., Schularick, M., and Taylor, A. M. (2023). Loose monetary policy and financial instability. *NBER Working Paper Series*, 30958.

Gürkaynak, R. S., Sack, B., and Swanson, E. (2005). Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. *International Journal of Central Banking*, 1(1):55–93.

Jarociński, M. and Karadi, P. (2020). Deconstructing monetary policy surprises: The role of information shocks. *American Economic Journal: Macroeconomics*, 12(2):1–43.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1):161–182.

Jordà, Ò., Schularick, M., and Taylor, A. M. (2013). When credit bites back. *Journal of Money, Credit and Banking*, 45(s2):3–28.

Jordà, Ò., Schularick, M., and Taylor, A. M. (2015). Leveraged bubbles. Technical Report 2015-10, Federal Reserve Bank of San Francisco.

Minsky, H. P. (1978). The financial instability hypothesis: A restatement. *Thames Papers in Political Economy*.

Rey, H. (2013). Dilemma not trilemma: The global financial cycle and monetary policy independence. Technical Report 21162, National Bureau of Economic Research.

Rubio-Ramírez, J. F., Waggoner, D. F., and Zha, T. (2010). Structural vector autoregressions: Theory of identification and algorithms for inference. *Review of Economic Studies*, 77(2):665–696.

Schularick, M. and Taylor, A. M. (2012). Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008. *American Economic Review*, 102(2):1029–1061.

Uhlig, H. (2005). What are the effects of monetary policy on output? results from an agnostic identification procedure. *Journal of Monetary Economics*, 52(2):381–419.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.

EXECUTIVE SUMMARY

This thesis examines whether expansionary monetary policy contributes to the build-up of financial vulnerabilities preceding systemic banking crises, distinguishing between conventional and unconventional monetary policy and investigating whether their effects depend on the initial level of public debt.

Using annual data for 18 advanced economies over 1949–2020, monetary policy shocks are identified for each country through a sign-restricted structural VAR. Local projections then estimate their effects on banking-crisis probability, debt, asset prices, and red-zone indicators of financial vulnerability.

The results reveal important differences across policy channels. Expansionary conventional monetary policy raises banking-crisis probability at medium horizons, with an effect of approximately +4.4 percentage points after three years, and increases both household and business financial vulnerabilities.

The unconventional monetary policy (UMP) shock has no precisely estimated average effect on crisis probability in the full sample. Its strongest effects appear through the household sector: UMP raises household debt and house prices and increases household red-zone probability. This transmission is substantially amplified when public debt is high, with the household red-zone response reaching nearly 12 percentage points around six years after the shock.

Red-zone episodes are strongly associated with subsequent crises. The three-year crisis probability is 32.7% after a household red zone and 25.0% after a business red zone, compared with 6.0% in the full sample.

Overall, monetary accommodation can contribute to financial vulnerability, but the transmission mechanism differs across policy types. Conventional easing has a clearer direct link with future banking crises, whereas unconventional easing operates primarily through household financial vulnerabilities whose response is substantially stronger when public debt is high.

Keywords: monetary policy shocks, unconventional monetary policy, financial vulnerabilities, banking crises, local projections, sign restrictions, household debt, red-zone indicators, state dependence, public debt.

Word count: 17 686