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Monetary Tightening, Inflation Drivers and Financial Stress

F. Boissay* F. Collard† C. Manea‡ A. Shapiro§¶

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Abstract

The paper explores the state–dependent effects of a monetary tightening on financial stress, focusing on a novel dimension: the nature of supply *versus* demand inflation at the time of policy rate hikes. We use local projections to estimate the effect of high frequency identified monetary policy surprises on a variety of financial stress measures, differentiating the effects based on whether inflation is supply–driven (*e.g.* due to adverse supply or cost–push shocks) or demand–driven (*e.g.* due to positive demand factors). We find that financial stress flares up after a policy rate hike when inflation is supply–driven, but it remains roughly unchanged, or even declines when inflation is demand–driven. Our findings point to a particular tension between price stability and financial stability when inflation is high and largely supply–driven.

Keywords: supply– versus demand–driven inflation, monetary tightening, financial stress

JEL classification: E1, E3, E6, G01.

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1 Introduction

Since the Great Financial Crisis (GFC), financial stability risks have become a central consideration in central banks' decision making process.[1] One reason is that financial instability may prevent central banks from achieving their primary objectives. Another is that monetary policy may *on its own* inadvertently usher in stress in the financial system. Recent empirical studies suggest that financial stress may follow a (persistent) loosening and/or a tightening of monetary policy (*e.g.* Schularick, ter Steege, and Ward (2021a) and Grimm, Jordà, Schularick, and Taylor (2023), Jiménez, Kuvshinov, Peydró, and Richter (2022)).

Raising the policy rate to address inflationary pressures may cause existing financial vulnerabilities to surface and may lead to financial stress. In theory, a key determinant of whether and how far a central bank can raise its policy rate without creating financial stress is the *nature* of inflationary pressures that prompted the tightening of monetary policy in the first place. More particularly, the analysis in Boissay, Collard, Galí, and Manea (2023) suggests that a key element to take into consideration is whether inflation is due to adverse supply shocks or positive demand shocks.

The aim of this paper is to assess empirically how financial stress responds to a monetary tightening and whether the response varies if inflationary pressures are demand– or supply–driven. To answer this question, we estimate the dynamic effects of high frequency identified monetary policy surprises on a variety of financial stress measures using local projections à la Jordà (2005). As we do so, we further differentiate the effects based on whether inflation is supply–driven or demand–driven using Shapiro (2022)'s inflation decomposition.

Our findings are twofold.

First, policy rate hikes *increase* financial stress in the short and medium term in the presence of supply–driven inflation —that is of adverse supply or cost–push shocks. Furthermore, the estimated reaction increases in the level of supply–driven inflation, and hence of underlying adverse supply pressures. This finding points to a particular tension between price stability and financial stability when inflation is high and largely supply–driven. There are several explanations for this finding. When central banks raise rates in response to supply–driven inflation, the economy is typically also experiencing negative pressures on output. Adverse supply shocks (*e.g.* supply chain disruptions, high energy prices) not only spur inflation but also

[1] Stein (2012), Smets (2018), Goldberg, Klee, Prescott, and Wood (2020), European Central Bank (2021).

weigh on borrowers' cash flows, undermining their usual role as "natural buffers". By contracting aggregate demand, a policy rate hike further reduces borrowers' cash flows and leads to a rise in credit default risk. Financial frictions make borrowers excessively sensitive to rate hikes. When credit markets are subject to frictions (*e.g.* moral hazard, asymmetric information, costly state verification), higher default risk induces lenders to require additional guarantees in the form of yet higher credit spreads and external finance premia, thereby further increasing borrowers' default risk — the so–called "financial accelerator" (Bernanke, Gertler, and Gilchrist (1999a), Bernanke and Gertler (1995), Gilchrist and Zakrajšek (2012), Gertler and Karadi (2015)). The excess sensitivity of borrowers' financing conditions to policy rate hikes further leads to excess sensitivity of counter–party risk. Thus, at times, counter–party risk may become so elevated that financial markets freeze and the economy slips into a financial crisis as in Boissay, Collard, Galí, and Manea (2023).

Our second finding is that policy rate hikes may leave unaffected or *reduce* financial stress in the presence of demand–driven inflation —especially if the latter is strong. When aggregate demand is growing, borrowers' cash flows tend to increase as well. Strong cash flows act as natural buffers against the tightening of monetary policy, allowing borrowers to deleverage through the tightening cycle without experiencing severe strains. Furthermore, consistent with the analysis in Boissay, Collard, Galí, and Manea (2023), when the central bank increases its policy rate to address strong demand–driven inflationary pressures, borrowers deleverage, financial vulnerabilities recede, and the risk of financial stress dissipates.

Our empirical results are consistent with the dynamics of financial stress during the current monetary tightening episode (Figure 1). In the US, when the Federal Reserve began to raise its policy rate in early 2022 (left panel, black lines), financial stress flared up (left panel, orange line) and moved in sync with the monetary policy contraction. In the fall of 2022, however, financial stress (left panel, orange line) eased despite the further tightening of monetary policy. The switch of financial stress broadly coincided with a fall in *supply*–driven inflation (right panel, red line) as supply constraints alleviated and energy shocks receded, as well as with a rise in *demand*–driven inflation (right panel, green line) due to post–pandemic pent–up demand. Given our empirical findings, the lower sensitivity of financial stress in the later stage of the current monetary tightening episode may be explained by the switch of the main inflation drivers from supply to demand factors.

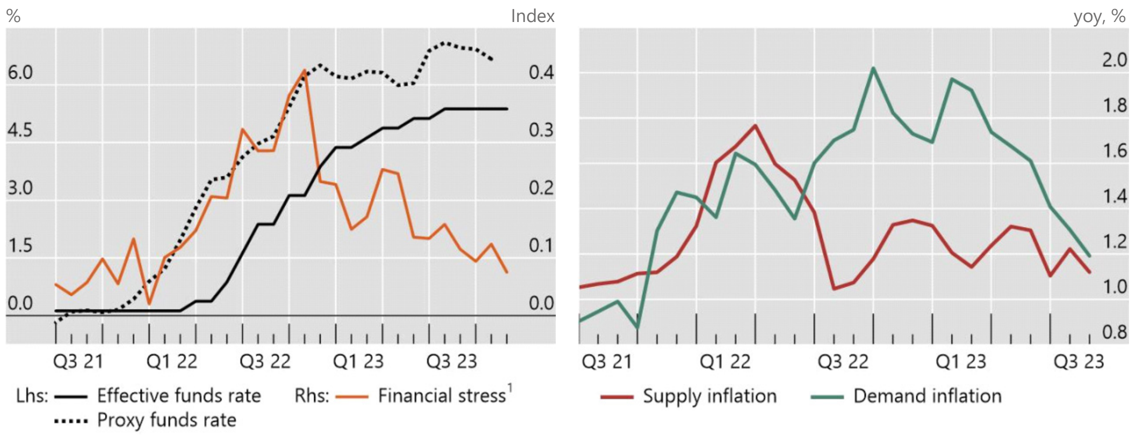

Figure 1: Financial stress and inflation drivers during the monetary tightening cycle in the US

Notes: Financial stress: composite index of systemic stress (CISS) from the ECB. Proxy funds rate: proxy rate adjusted for the effects of forward guidance from San Francisco Fed. Supply/demand inflation: supply and demand components of core PCE year-on-year inflation computed with the methodology in Shapiro (2022) net of the prepandemic 2015-2019 average.

Hereafter, the paper is structured as follows. Section 2 reviews related literature. Section 3 describes the empirical strategy and the data. Section 4 shows the empirical findings. Section 5 gives possible explanations for the results, and discusses policy implications. Section 6 concludes.

2 Related literature

Our work is related to four main strands of literature.

The first encompasses the recent papers by Eickmeier and Hofmann (2022) and Shapiro (2022) which propose methodologies to decompose inflation in demand and supply factors. We use the methodology in the second paper because it allows us to compute the supply– and demand–driven inflation series at monthly instead of quarterly frequency. As discussed later, using monthly instead of quarterly demand–/supply–driven inflation series makes our identification strategy more precise. Our paper contributes to this literature by describing how supply– and demand–driven inflation interact with monetary policy transmission.

The second strand of related papers examines the state–dependent effects of monetary policy. Papers in this literature looked so far at asymmetric effects of monetary policy between booms and recessions (e.g. Lo and Piger (2005), Santoro, Petrella, Pfajfar, and Gaffeo (2014), Tenreyro and Thwaites (2016)) or between monetary expansions and contractions (e.g. Angrist, Jordà, and Kuersteiner (2018), Barnichon and Matthes (2018), Alessandri, Jorda, and Venditti (2023)). While conclusions of the first set of papers are mixed, those in the second set unanimously find that policy rate hikes have larger effects than policy rate cuts on real activity and credit spreads.

Our paper focuses on the effect of policy rate hikes during inflationary episodes and explores a novel state-dependency dimension: the nature of supply versus demand inflation at the time of monetary tightening. Our analysis primarily studies asymmetric effects on financial stability, but documents similar evidence for unemployment.

The third related strand of literature deals with the credit channel of monetary policy. Previous papers conclude that modest movements in short-term rates lead to large movements in term premia and credit spreads, consistently with the existence of a credit channel of monetary policy (e.g. Gertler and Karadi (2015), Caldara and Herbst (2019)). Our results suggest that credit spreads are particularly sensitive, and hence the credit channel is especially strong, when the central bank raises the policy rate to fight high levels of supply–driven inflation. More generally, the state-dependency of the effect of policy rate hikes on credit spreads suggests that the credit channel of monetary policy does not operate in a linear fashion. Through the lens of these findings, extending workhorse linear frameworks (e.g. Bernanke, Gertler, and Gilchrist (1999b), Iacoviello (2005)) along the lines of non-linear models with occasional binding constraints (e.g. Guerrieri and Iacoviello (2017)) or of fully non-linear models à la Ottonello and Winberry (2020) may provide a more accurate theoretical description of this channel.

Finally, our analysis speaks to the empirical literature on the effects of monetary policy on financial stability. Some of the previous papers in this literature argue that expansionary monetary policy (”Low–rate–for–long”) can nourish financial imbalances and lead to boom–bust scenarios (e.g. Borio and Lowe (2002), Taylor (2011), Grimm, Jordà, Schularick, and Taylor (2023)). Other related studies further concluded that raising policy rates can trigger a financial crisis, with the odds of such an event being particularly high on the heels of a credit/asset boom (e.g. Schularick, ter Steege, and Ward (2021a), Boissay, Borio, Leonte, and Shim (2023)), or after a ”low–rate–for–long” period (Jiménez, Kuvshinov, Peydró, and Richter (2022)). Our analysis qualifies the conclusions of the second set of papers, suggesting that the effects of a policy rate hike on financial stability may depend on the nature of shocks in the economy at the time of the monetary policy intervention. In particular, according to our findings, a monetary tightening severely affects financial stress in the presence of supply–driven inflation, but can leave financial stress unchanged or can reduce it in the presence of demand–driven inflation.

3 Empirical analysis

This section illustrates our empirical strategy. We start by laying out our baseline econometric specification. We then move on to describe the data. Finally, we report our estimation results and discuss their robustness.

3.1 Econometric specification

To trace out the effect of a policy rate hike on financial stress, we estimate impulse response functions through local projections. In particular, we estimate a sequence of linear regressions to assess how a rise in the policy rate affects financial stress over a 36–month horizon (that is, a 3-year horizon). In our empirical exercise, we face the well-known reverse causality problem: monetary policy responds to developments in the economy and also impacts them (Nakamura and Steinsson (2018)). For this reason, instead of using the policy rate as explanatory variable, we use high-frequency identified monetary policy surprises which are a measure of exogenous variations in interest rates[2].

Our baseline econometric specification writes as follows:

$$
\begin{aligned}
y_{t+h} - y_{t-1} = & \alpha_h + \beta_h^T \mathbb{1}\{mps_t > 0\} mps_t + \beta_h^{TS} \mathbb{1}\{mps_t > 0\} mps_t \pi_t^s + \beta_h^{TD} \mathbb{1}\{mps_t > 0\} mps_t \pi_t^d \\
& + \beta_h^L \mathbb{1}\{mps_t < 0\} mps_t + \beta_h^{LS} \mathbb{1}\{mps_t < 0\} mps_t \pi_t^s + \beta_h^{LD} \mathbb{1}\{mps_t < 0\} mps_t \pi_t^d \\
& + A_h \sum_{\tau=1}^{L} \mathscr{C}_{t-\tau} + e_{t+h}, \qquad (1)
\end{aligned}
$$

for $h = 1, 2, ..., 36$. The dependent variable y is a measure of financial stress, mps_t is a monetary policy surprise, $\mathbb{1}\{mps_t > 0\}$ is an indicator variable for a tightening, $\mathbb{1}\{mps_t < 0\}$ is an indicator variable for a loosening, $\pi_t^{s/d}$ is supply– or demand–driven PCE inflation (year on year), and $\mathscr{C}_t$ is a vector of additional control variables. We report Newey-West standard errors to account for serial autocorrelation.

We include a rich set of control variables to address the confounding factor problem, namely that results may be driven by other factors than monetary policy. Specifically, our baseline specification features contemporaneous values and six lags of the following macroeconomic

[2] Monetary policy surprises are appealing in these applications because their focus on interest rate changes in a narrow window of time around FOMC announcements plausibly rules out reverse causality and other endogeneity problems. For other studies using monetary policy surprises, see for instance, Kuttner (2001); Bernanke and Kuttner (2005); Gürkaynak, Sack, and Swanson (2005); Hanson and Stein (2015); and Swanson (2021) use monetary policy surprises to estimate the effects of monetary policy on asset prices, while Cochrane and Piazzesi (2002); Faust and Rogers (2003); Faust, Swanson, and Wright (2004); Gertler and Karadi (2015); Ramey (2016b); and Stock and Watson (2018) use them to help estimate the effects of monetary policy on macroeconomic variables in a structural vector autoregression (SVAR) or Jordà (2005) local projections (LP) framework.

variables: the demand–driven contribution to PCE inflation (year-on-year), the supply–driven contribution to PCE inflation (year-on-year), the log of industrial production, the unemployment rate, the Gilchrist and Zakrajšek (2012) series of excess bond premium and corporate credit spreads[3]. We also include six lags of both the dependent variable and interaction variables in equation (1). Finally, since we use the high precision version of the inflation decomposition in Shapiro (2022), we include interaction terms of the ambiguous contribution to PCE inflation (together with their lags) similar to those for supply– or demand–driven inflation.[4]

To facilitate the exposition of empirical findings later on, several observations on the key regression coefficients are in order.

First, β_h^T coefficients capture the responses of financial stress to a one percentage point rise in the policy rate at horizon $h = 0, 1, 2, ..$ independent of the level of inflation, relative to no surprise change in the policy rate. The inclusion of β_h^L, the response of financial stress to a one percentage point decline in the policy rate (i.e., monetary loosening), ensures that the omitted category are periods with no surprise change in the policy rate. Looking at these coefficients over the chosen horizon allows us to study the unconditional dynamic effect of the monetary tightening.

Second, the interaction coefficients β_h^{TS} and β_h^{TD} capture the additional effects of a policy rate hike on financial stress at horizon h for each percentage point of supply– and demand–driven inflation prevailing at the time of the monetary tightening[5]. Note that our specification allows us to study how both the *level* and *composition* of inflation, and implicitly the nature and strength of underlying inflation drivers, shape the response of financial stress to a monetary tightening[6]. In particular, level effects are captured by the statistical significance of the two interaction coefficients: if the two coefficients are insignificant, the rise in the policy rate has the same effect on financial stress independent of the level of inflation (and hence, of the strength of underlying factors driving it). Composition effects are further captured by the difference between

[3]Results are also robust to adding the log of commodity prices, and changes in the federal funds rate or in the Wu-Xia "shadow rate". Note that we include the time t realizations of all core independent variables and dependent variables. We thus take a conservative stance with respect to the contemporaneous response of the dependent variable to monetary policy, effectively attributing as much as possible of that response to contemporaneous variation in the independent variables and controls and not to the unexpected monetary policy intervention. These controls are conventionally used in local projection analyses with monthly data (see for instance Bauer and Swanson (2023) or Ramey (2016a)).

[4]The ambiguous contribution to PCE inflation represents those categories in a given month that could not be identified as either supply– or demand–driven.

[5]To allow for distinct state–dependent effects of a monetary tightening versus a loosening, we further include as control groups the effects of a loosening during supply– and demand–driven inflation captured by β_h^{LS} and β_h^{LD}.

[6]The level and composition of inflation proxy for the nature and strength of (unobserved) business cycle shocks at the time of the monetary tightening.

the two inflation interaction coefficients: if the difference is insignificant (i.e., the coefficients are equal), then, for a given inflation level, a rise in the policy rate has the same effect irrespective of whether inflation is driven by supply or demand factors.

3.2 Data

Since we are ultimately interested in the effects of monetary policy on financial stability, ideally we would like to use a financial crisis indicator variable as our dependent variable. Such series, however, are only available at annual (e.g. Laeven and Valencia (2018), Reinhart and Rogoff (2009)) or semiannual (e.g. Romer and Romer (2017)) frequency, which makes them incompatible with our key independent variables (the demand/supply–driven inflation series and the high frequency identified monetary policy surprises) which are available at higher frequencies and only for a short period of time.

Financial stress indices (FSIs) track quite well the most granular index of financial crises developed by Romer and Romer (2017)[7]. Such indices quantify the aggregate level of stress in financial markets by compressing a certain number of individual stress indicators into a single statistic, and are available at high frequency over the time span of our key independent variables. We thus choose one such index as our dependent variable to proxy financial instability.

Our baseline FSI for the US is an updated version of the index used by Hubrich and Tetlow (2015) which was developed by the staff of the Federal Reserve Board to assess in real time the degree of financial markets dysfunction during the GFC[8]. The index is a simple demeaned sum of nine spread and volatility components in key financial markets in the US (Table 1) and follows closely the Romer and Romer (2017) granular index of financial crises (Figure 2). We choose this FSI as baseline for both transparency reasons and in view of recent findings by Arrigoni, Bobasu, and Venditti (2020) that simple averages of market–specific financial stress indices tend to perform better ex-post in gauging financial stress than indices based on more elaborate statistical techniques.

We check the robustness of our results with other well-know FSIs (Table A1) such as Kansas City Fed FSI, Saint Louis Fed FSI, Bloomberg FSI, ECB's Composite Indicator of Systemic

[7] Romer and Romer (2017) differentiate crisis severity in fifteen categories. Studying the semiannual OECD Economic Outlook as a real-time source of information, they first identify and categorise financial stress events into five groups, from pure credit disruptions, minor crisis, moderate crisis, major crisis up to extreme crisis. Severity of stress within each group is further differentiated into three subcategories (minus, regular, and plus events), such that they obtain a measure of "financial distress" with values ranging from 0 for non-distress periods to a maximum of 15 for an extreme crisis-plus.

[8] This index was built based on the methodology proposed by Nelson and Perli (2007).

Table 1: Components of the Federal Reserve Board Staff's Financial Stress Index

#	Description	Source	Stddev
1.	AA rate-Treasury spread, const. maturity	Merrill & Bloomberg	66.3
2.	BBB rate-Treasury spread, const. maturity	Merrill & Bloomberg	96.2
3.	Federal funds rate less 2-yr Treasury yield	FRB & Bloomberg	0.70
4.	10-year Treasury bond implied volatility	Bloomberg	1.40
5.	Private long-term bond implied volatility	Bloomberg	2.30
6.	10-Year Treasury on-the-run premium	Bloomberg	9.43
7.	2-year Treasury on-the-run premium	Bloomberg	3.60
8.	S&P 500 earnings/price less 10-year Treasury	I/B/E/S & FRB	2.01
9.	S&P 100 implied volatility (VIX)	Bloomberg	8.53

Notes: Baseline FSI for the US. The index is computed as a simple demeaned sum of the nine components shown, weighted as a function of the inverse of their sample standard deviations.

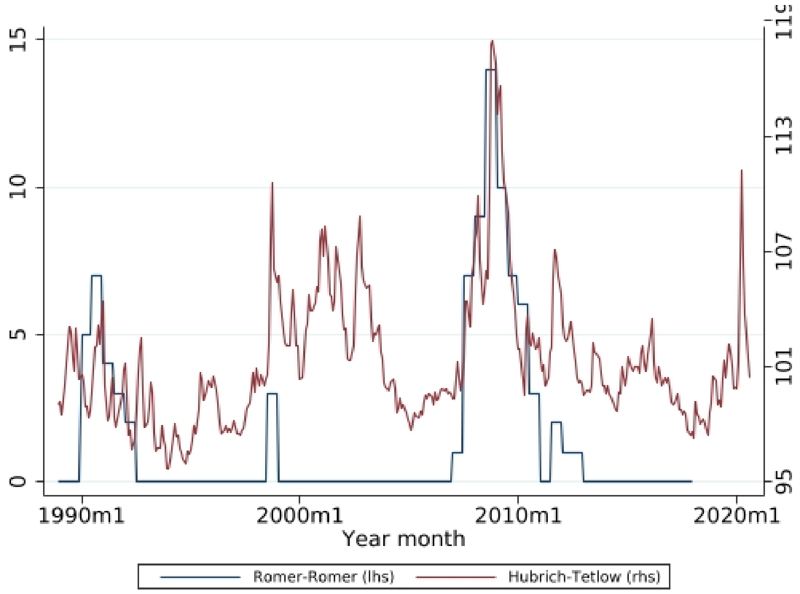

Figure 2: Baseline financial stress measure for the US

Notes: The figure plots for the United States our baseline FSI (Hubrich-Tetlow, red line) along with the Romer and Romer (2017) qualitative financial crisis indicator (blue line). Data is shown monthly from December 1988 to August 2020 for the FSI, and semiannual until 2017:2 for Romer and Romer.

Stress (CISS), or the Gilchrist and Zakrajšek (2012) corporate spread and equity bond premium indices. We also complement our analysis with financial conditions indices (FCIs) such as the Chicago Fed National FCI and the Goldman Sachs FCI.

The key independent variables in our regression are the monetary policy surprises and the demand–/supply–driven inflation series. In our baseline specification for the US, we choose the latest publicly available series of high frequency identified monetary policy surprises from Bauer and Swanson (2023)[9]. We follow the literature and transform the monetary surprises

[9]Monetary policy surprises are typically viewed as unpredictable with any publicly available information that

to monthly frequency by summing up daily observations within each month. As demand and supply components of inflation (Figure A2), we borrow the series from Shapiro (2022). All control variables (e.g. industrial production, unemployment rate, Gilchrist and Zakrajšek (2012) excess bond premium and corporate credit spreads) are standard and downloaded from Haver.

The baseline analysis for the US is conducted at monthly frequency over the period January 1990 to December 2019. The beginning of our sample is dictated by the availability of demand–/supply–driven inflation series in Shapiro (2022), while the end of the sample corresponds to the end of the series of monetary policy surprises in Bauer and Swanson (2023).

3.3 Results

We first report results for the estimates of β_h^T—the impact of an unexpected monetary policy tightening independent of inflation. Figure 3 shows that the policy rate hike works to raise financial stress consistent with previous findings in the credit channel literature (e.g. Gertler and Karadi (2011)). Nevertheless, in contrast to the swift average reaction estimated with linear SVAR models, we find that the unconditional effect starts materialising only sluggishly one year after the policy rate hike.

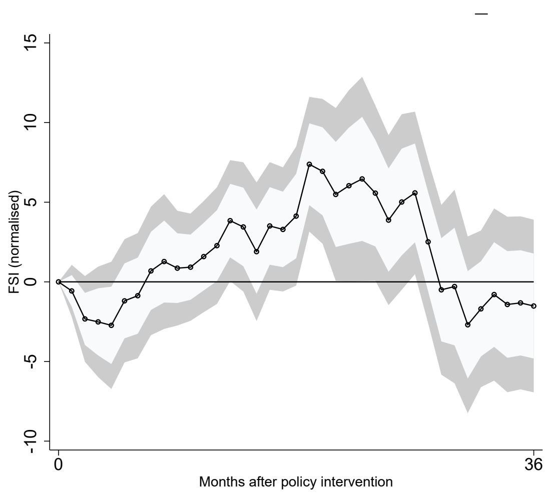

Figure 3: Unconditional effect of a monetary tightening on financial stress

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^T for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Fed Board Financial Stress Index and 6 lags. 90% confidence bands, Newey-West standard errors. US monthly data from January 1990 to December 2019. Findings robust to specifications including the optimal lag order according to the AIC and BIC criteria equal to three and four, respectively.

predates the FOMC announcement. This view is supported by the standard argument that, otherwise, financial market participants would be able to trade profitably on that predictability and drive it away in the process. A few recent studies, however (e.g. Cieslak (2018), Miranda-Agrippino and Ricco (2021), and Bauer and Swanson (2023)) have documented substantial correlation of monetary policy surprises with publicly available macroeconomic or financial market data that predate the FOMC announcement, which undermines the standard assumption that monetary policy surprises represent exogenous changes. Bauer and Swanson (2023) address this issue by removing the component of the monetary policy surprises that is correlated with economic and financial data.

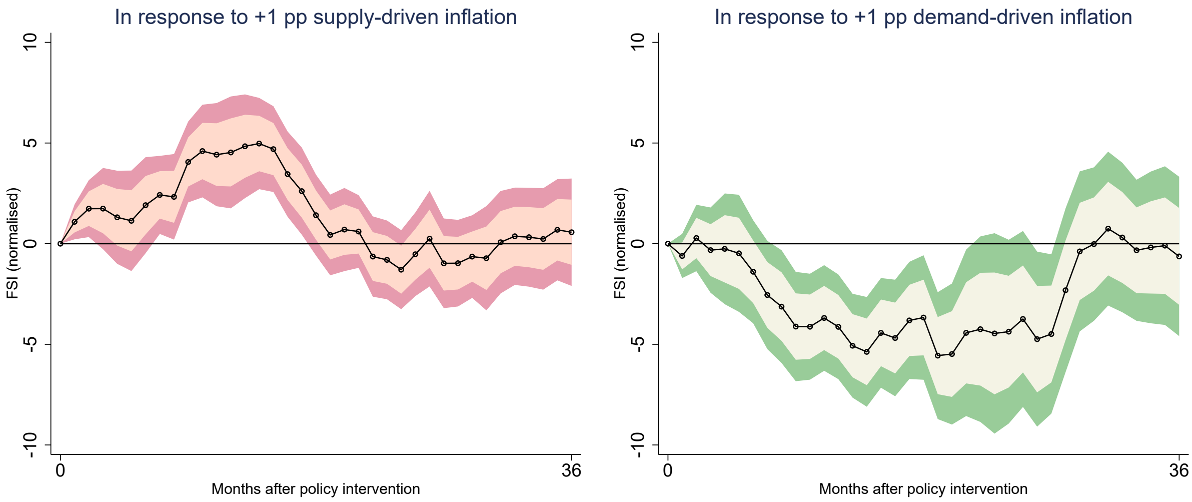

Figure 4: Additional asymmetric effect of a monetary tightening on financial stress

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Fed Board Financial Stress Index and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. Findings robust to specifications including the optimal lag order according to the AIC and BIC criteria equal to three and four, respectively.

Interestingly, our analysis further suggests that the unconditional effect of a policy rate hike on financial stress can be compounded or totally reversed by the type of shocks buffeting the economy at the time of the monetary policy intervention. In particular, raising the policy rate when the economy experiences large adverse supply shocks has very different effects than amid a strong demand–driven inflationary boom.

Consider first the case of a monetary tightening when supply–driven inflation is positive. The *positive* interaction coefficients of the policy rate hike with supply–driven inflation (Figure 4, left panel) reveal that the adverse supply shocks underlying inflation work to amplify the effect of the monetary tightening on financial stress. The stronger the adverse shocks reflected in higher supply–driven inflation, the stronger the amplification (Figure A4, right panel). Notably, the additional effect amid supply–driven inflation becomes statistically significant sooner than the unconditional effect reported in Figure 3. Precisely, the effect materialises during the first month of the hike as opposed to one year later. The additional effect remains significant for eighteen months. Our results thus suggest that the adverse supply shocks work not only to amplify, but also to expedite the effect of the monetary tightening on financial stress.

What about the effect of a monetary tightening on financial stress amid demand–driven inflation? Different from supply–driven inflation, the interaction coefficients of the rate hike with demand–driven inflation are *negative* for almost the entire horizon of interest (Figure 4, right panel). Their negative sign suggests that, in contrast to adverse supply shocks, expansionary demand shocks work to dampen, and not amplify, the unconditional effect of a rate hike, with the magnitude of the dampening increasing in the level of demand inflation (Figure A4, left panel). In terms of transmission lags, the interaction coefficients become significant roughly six months after the policy rate hike, and remain so for around two more years. Thus, our findings suggest that expansionary demand shocks work to dampen the effect of a rate hike with a lag, but do so in a persistent manner.

Depending on the inflation level, one can distinguish two notable scenarios amid demand inflationary booms. In one scenario, positive demand shocks and resulting inflation are relatively low, and work to dampen the unconditional effects of the policy rate hike, but the net effect of the monetary tightening remains positive. In the other scenario, positive demand shocks and resulting inflation are high enough to outright reverse the unconditional effects of the monetary tightening. In this case, policy rate hikes work to reduce, and not increase, financial stress (Figure A4, left panel).

Our findings are robust to excluding observations during the 2007-2008 GFC and the ZLB periods and to using as dependent variable a wide range of FSIs documented in Table A1 (see Sections 6.2.1 and 6.2.2 in the Appendix). Furthermore, notably, similar patterns arise when considering as dependent variable macroeconomic variables such as unemployment (Figures 5 and 6).

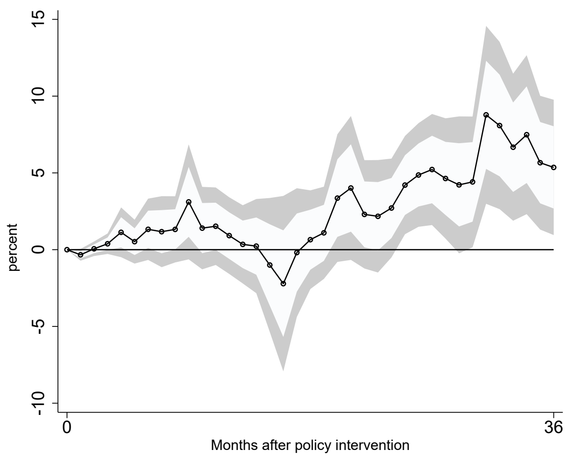

Figure 5: Unconditional effect of a monetary tightening on unemployment

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^T for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy shocks, core inflation, unemployment rate as dependent variable and 6 lags. US monthly data from January 1990 to December 2019. 90% confidence bands, Newey-West standard errors.

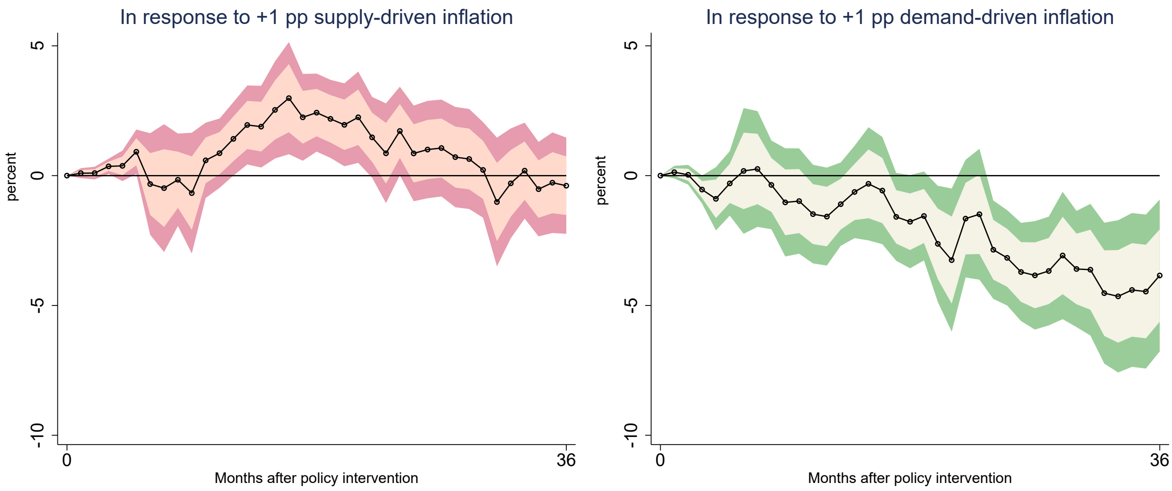

Figure 6: Additional asymmetric effect of a monetary tightening on unemployment

Notes: Dynamic responses to a 25 bp monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy shocks, core inflation, unemployment rate as dependent variable and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. 90% confidence bands, Newey-West standard errors.

In a nutshell, when supply (demand)–driven inflation is positive, financial stress increases by more (less) in response to a policy rate hike than in the absence of inflation. Moreover, provided demand–driven inflation is high enough, financial stress can decrease in response to a monetary tightening. When both inflation drivers are active, the ultimate effect of a policy rate hike on financial stress will depend on both the level and supply versus demand composition of inflation.

Financial stress components Similar patterns emerge for financial stress components such as Gilchrist and Zakrajšek (2012) corporate credit spreads and excess bond premium indices, or the CISS subindices of financial stress in the bond market, the equity market (nonfinancial/financial firms), and the foreign exchange market (see Section 6.2.3 in the Appendix). The broad-based nature of results points to a systemic asymmetry of the effect of rate hikes on financial stress in supply– versus demand–driven inflationary environments.

Financial conditions versus financial stress We further consider FCIs (e.g., Goldman Sachs FCIs, Chicago Fed National FCI and its credit, risk, and leverage subindices) as dependent variable instead of measures of financial stress. In contrast to FSIs, which are computed based on credit spreads and volatilities, FCIs are geared towards capturing the actual cost of financing for economic agents, and give a predominant role to the level of interest rates, as well as to equity valuations. For this reason, compared to FSIs, FCIs are less in sync with the Romer and Romer (2017) granular measure of financial crises (e.g. Figures C14 and C16 in the Appendix).

Specifications with FCIs deliver similar patterns as those with FSIs, albeit less salient (see Section 6.2.4 in the Appendix). The lower salience suggests that the asymmetric effects identified in our analysis apply especially to financial stress components, and less to financial conditions more broadly.

Other countries We also check the robustness of our findings by conducting our empirical exercise for a number of other non-US countries. The additional countries, Canada, United Kingdom (UK), France, Australia and Sweden, are chosen based on the joint availability of demand– and supply–driven inflation series and monetary policy surprises.

The identification strategy is less precise for these countries compared to the US because of several constraints imposed by the data. First, given the frequency of statistical releases, the demand– and supply–driven inflation series can only be computed at quarterly as opposed to monthly frequency. Since we use daily monetary policy surprises as a measure of exogenous variation in the policy rate, the availability of demand– and supply–driven inflation series at quarterly frequency reduces the precision of our identification strategy relative to our baseline analysis conducted for the US using monthly data. Second, the series of monetary policy surprises for these additional countries (Table C1) are usually shorter and their exogeneity has been less scrutinised than in the case of US series. Third, a smaller number of financial stress measures are available for these countries compared to the US. Whenever possible, we use a systemic financial stress index such as the CISS as our baseline dependent variable and we then check the robustness of our findings with measures of market-specific financial stress such as credit spreads and financial market volatility (Table C2).

Despite these limitations, we obtain similar patterns for these countries as under our baseline monthly specification for the US, albeit less smooth (Section 6.3.2 in the Appendix). Notably, the results for these additional countries look very similar, or are even more salient, than those for the US obtained with quarterly instead of monthly data (Figure C24).

Limits of our analysis The generality and external validity of our findings may be limited by the relative short time period captured in our estimation samples. Note also that our results concern the effect of *unexpected* movements in the policy rate (i.e. monetary policy surprises), and not of expected monetary policy actions to which central banks implicitly commit under rule–based monetary policy regimes. As shown later on, however, the latter feature does not seem to be a serious constraint in the context of our analysis.

4 Interpretation of results

Why does financial stress increase following a policy rate hike when inflation is supply–driven, whereas it remains roughly unchanged or it recedes when inflation is demand–driven? The nature of the shocks driving inflation lies at the core of the transmission channel.

Adverse supply shocks (*e.g.* supply chain disruptions or an unexpected rise in energy prices) not only spur inflation but also generally weigh on borrowers' cash flows and ability to repay their debt, and the real activity at large. When inflation is driven by adverse supply shocks, policy rate hikes induce yet another contraction in real activity through aggregate demand, which tends to amplify credit default risk. Consistent with the transmission of policy rate hikes through credit default risk, we find that credit spreads, the equity finance premium, loan delinquencies and corporate bankruptcies all rise by more following a policy rate hike, if the hike takes place in a context of supply–driven inflation (Figure C17, Sections 6.5 and 6.2.3 in the Appendix).

In addition, when credit markets are subject to frictions (*e.g.* moral hazard, asymmetric information, costly state verification), higher default risk induces lenders to require additional guarantees in the form of yet higher credit spreads and external finance premia, thereby further increasing borrowers' default risk — the so–called "financial accelerator" (Bernanke, Gertler, and Gilchrist (1999a), Bernanke and Gertler (1995), Gilchrist and Zakrajšek (2012), Gertler and Karadi (2015)). The excess sensitivity of borrowers' financing conditions to policy rate hikes further lead to excess sensitivity of counter–party risk. Thus, at times, counter–party risk may become so elevated that financial markets freeze and the economy slips into a financial crisis as in Boissay, Collard, Galí, and Manea (2023)[10]. This scenario has likely preceded the financial crisis in the UK in the seventies, the Scandinavian financial crises in the nineties, and the environment in most advanced economies during the GFC.

The macroeconomic backdrop is very different amid demand–driven inflation. Contrary to supply–driven inflation, demand–driven inflation is due to expansionary shocks. Thus, in the presence of demand–driven inflation, central banks raise their policy rate when aggregate demand is strong, the economy is growing, and firms' operating profits and households' incomes tend to increase. In this context, buoyant profits and incomes provide firms and households with a "natural hedge" against policy rate hikes — at least in the early phase of the monetary tightening— which dampens the effect of the latter on credit default and bankruptcy risks. Thus, firms and

[10] Consistently, Jiménez, Kvshinov, Peydró, and Richter (2022) document a strong causal link between monetary policy tightening, non-performing loans, and the probability of a financial crisis.

households fare through the tightening without severe strains, while higher policy rates induce them to deleverage. This intuition is consistent with the more muted responses of financial stress, credit spreads, equity finance premium, loan delinquencies, firm bankruptcies and subindices of financial stress in the corporate and financial sectors estimated in those contingencies (Figure 4, right panel; Figure C17; Sections 6.5 and 6.2.3 in the Appendix).

When the demand–driven inflationary boom is large, our empirical analysis further uncovers that a monetary tightening works to persistently reduce financial stress in the years to come. Since the policy rate hike offsets the effect of demand shocks, this finding suggests that without the monetary tightening, the positive demand shock would have nourished financial imbalances and would have increased financial stress in the economy. Such a possibility is embedded in the model with endogenous financial crises in Boissay, Collard, Galí, and Manea (2023). In that framework, positive demand shocks left unaddressed can lead to potentially unsustainable booms, and usher the economy in a financially fragile region where the probability of a financial crisis is high. The build–up of financial imbalances and associated crises can be avoided in the model if the central bank commits to raising rates more forcefully in response to inflation, or if it unexpectedly contracts monetary policy to offset the positive demand shocks[11]. Thus, in the model, consistent with our empirical results, fighting demand–driven inflation works against the build-up of financial imbalances, and eases financial stress.

In the theoretical analysis of Boissay, Collard, Galí, and Manea (2023), the asymmetric effects of higher policy rates on financial stress in demand–driven versus supply–driven inflationary environments mostly focus on expected monetary policy actions, while in our empirical analysis they concern unexpected movements in the policy rate (i.e. monetary policy surprises). To create a more direct link between the empirical findings reported in Section 3.3 and the analysis in Boissay, Collard, Galí, and Manea (2023), we run a local projection exercise with monetary policy surprises based on simulated data from the model and compare the estimation results to those uncovered in our empirical analysis.

Ideally, one would like to run the regressions based on the full version of the model including both demand and supply shocks (besides policy monetary surprises). In a fully non-linear framework solved with a global solution method as the one in Boissay, Collard, Galí, and Manea (2023), however, one cannot solve separately for the paths of demand– and supply–driven

[11]The central bank can commit to respond more forcefully to inflation by increasing, for instance, the inflation coefficient in the ”Taylor rule” or by switching to strict inflation targeting.

inflation. In this case, the closest one can get to our empirical specification described by equation (1) is to run our regressions separately in models with supply and, respectively, demand shocks, and idiosyncratic monetary policy surprises. To calibrate the models, we set the persistence and standard deviation of supply/demand shocks to 0.95 and 0.008, and the standard deviation of monetary policy surprises to 0.0017 to replicate the volatility of inflation and output in normal times. The default cost θ equals 0.5242 in the simulations with supply shocks and 0.537 in the simulations with demand shocks such that the economy spends 10% of time in crisis consistent with historical evidence for advanced economies in Romer and Romer (2017) and Romer and Romer (2019). All other parameters are set as in Boissay, Collard, Galí, and Manea (2023).

To run our local projection exercise based on simulated data, we generate each time one million time series observations from the model with supply/demand shocks and monetary policy surprises. We use these simulated time series to run local projections similar to those in our empirical exercise (1), namely

$$\begin{aligned} y_{t+h} - y_{t-1} =& \alpha_h + \beta_h^T \mathbb{1}\{mps_t > 0\} mps_t + \beta_h^{TS/D} \mathbb{1}\{mps_t > 0\} mps_t \pi_t^{s/d} \\ &+ \beta_h^L \mathbb{1}\{mps_t < 0\} mps_t + \beta_h^{LS/D} \mathbb{1}\{mps_t < 0\} mps_t \pi_t^{s/d} \\ &+ A_h \sum_{\tau=1}^{L} \mathscr{C}_{t-\tau} + e_{t+h}, \end{aligned} \tag{2}$$

for $h = 1, 2, ..., 36$. The dependent variable y is the one- period-ahead probability of a financial crisis, mps_t is the monetary policy surprise, $\mathbb{1}\{mps_t > 0\}$ is an indicator variable for a tightening, $\mathbb{1}\{mps_t < 0\}$ is an indicator variable for a loosening, $\pi_t^{s/d}$ is year-on-year supply/demand–driven inflation, and $\mathscr{C}_t$ is the vector of control variables including the contemporaneous values and six lags of year-on-year supply/demand–driven inflation and the log of output, as well as six lags of both the dependent variable and the interaction variables in equation (2).

The local projection exercise based on simulated data from the model in Boissay, Collard, Galí, and Manea (2023) delivers results (Figure 7) consistent with the empirical estimates previously reported in Figures 3 and 4. Specifically, in the model, all else equal, an unexpected policy rate hike increases the probability of a financial crisis, with the effect being amplified amid supply–driven inflation, and hence, adverse supply shocks (Figure 7, left panel), and dampened amid demand–driven inflation, and hence positive demand shocks (Figure 7, right panel). Further conditioning in our econometric specification on the early stages of booms, before financial imbalances are formed, the negative effects of rate hikes on financial stress become very

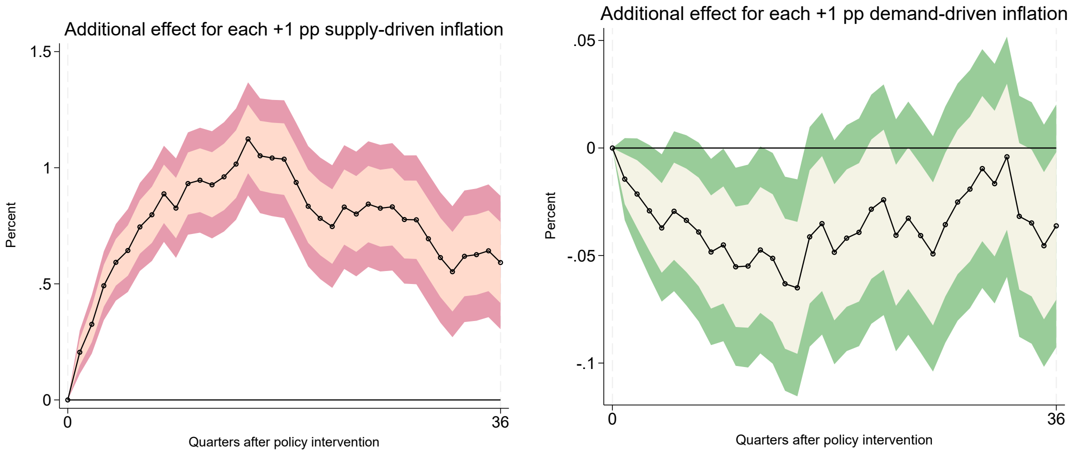

Figure 7: Additional effect of a monetary tightening on one-period-ahead probability of a crisis

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Left panel: regression coefficients β_h^{TS} for $h = 0, ..., 36$. Right panel: regression coefficients β_h^{TD} for $h = 0, ..., 36$. Based on simulated time series from the model in Boissay, Collard, Galí, and Manea (2023) with supply shocks and monetary policy surprises (left panel), and with demand shocks and monetary policy surprises (right panel). Specification with 6 lags similar to our baseline empirical specification for the US. 90% confidence bands.

salient both in terms of magnitude and significance (Figure D5 in the Appendix) consistent with their role in obstructing the build–up of credit booms and of associated financial vulnerabilities.

5 Conclusions

We explore the state–dependent effects of a monetary tightening on financial stress, focusing on a novel dimension: the nature of supply *versus* demand inflation at the time of policy rate hikes.

Our empirical analysis uncovers a novel asymmetry of the effects of policy rate hikes on financial stress amid supply– versus demand–driven inflation. During our estimation sample, when inflation is high and largely supply–driven, the reaction of financial stress is particularly severe, pointing to a tension between price stability and financial stability at those times. By contrast, when inflation is high but largely demand–driven, we find that policy rate hikes reduce financial stress, without a price–financial stability trade–off emerging.

Taken at face value, our results have implications for the conduct of both monetary and macroprudential policies. Through their lens, during inflationary episodes, not only the level of inflation, but also its supply/demand composition are relevant for calibrating the response of monetary policy. In this context, the decomposition of inflation in demand and supply factors (e.g. Figures A2 or C18 in the Appendix) may be a useful tool to gauge the odds of a ”hard” financial landing during monetary tightening episodes. In addition, given the conflict between price stability and financial stability identified when supply–driven inflation is high, one could envisage tailoring macroprudential tools to align the two objectives in those particular contingencies.

Our analysis is meant to be a first pass on this topic and set the stage for future related research. We currently plan to expand our dataset along both time and country dimensions by using an alternative methodology of measuring supply– versus demand–driven inflation, and use it to perform a ”Trilemma-of-international finance” exercise as in Jordà, Schularick, and Taylor (2020), or Schularick, ter Steege, and Ward (2021b).

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6 Appendix

6.1 Baseline specification

Table A1: Overview Financial Stress Indices for the US

#	Index	Source (description)	Type
1.	Fed Staff's Board FSI	Hubrich and Tetlow (2015)	stress
2.	Bloomberg FCI	Rosenberg (2009)	stress
3.	NEW CISS	Chavleishvili and Kremer (2023)	systemic stress
4.	Kansas City FED FSI	Hakkio, Keeton, et al. (2009)	stress
5.	VIX	Chicago Board Options Exchange	stress
6.	Saint Louis Fed FSI	Kliesen, Smith, et al. (2010)	stress & conditions
7.	Chicago Fed National FCI	Brave and Butters (2011)	stress & conditions
8.	Goldman Sachs FCI	Hatzius and Stehn (2018)	stress & conditions
9.	GZ corporate spreads index	Gilchrist and Zakrajšek (2012)	stress
10.	GZ equity premium index	Gilchrist and Zakrajšek (2012)	stress
11.	Loan delinquency rates	Fed Board Statistics	stress
12.	Firm bankruptcies	United States Courts	stress

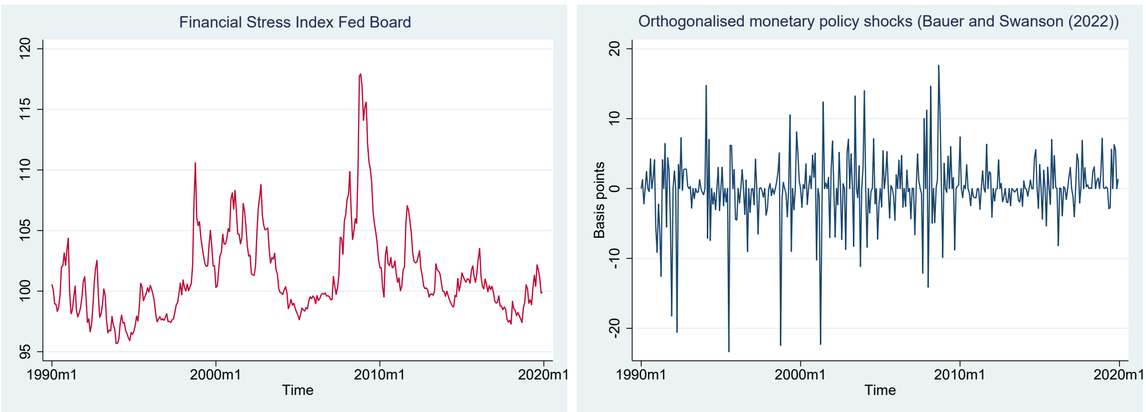

Figure A1: Data baseline specification

Notes: Data is stationary at 5% level (ADF tests)

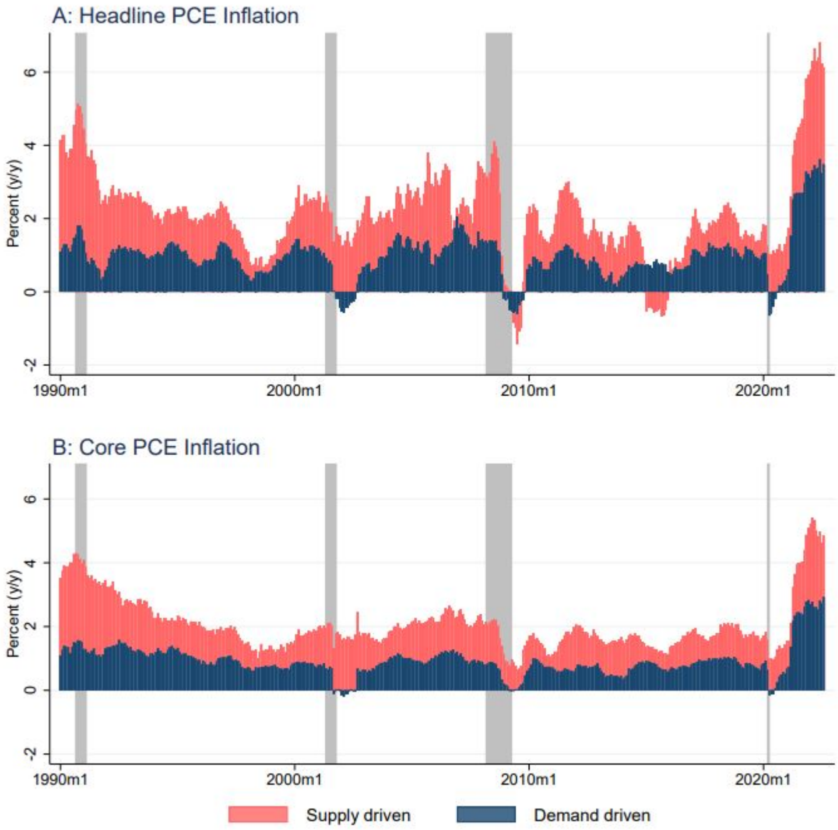

Figure A2: Inflation decomposition into demand and supply factors: US

Source: Shapiro (2022)

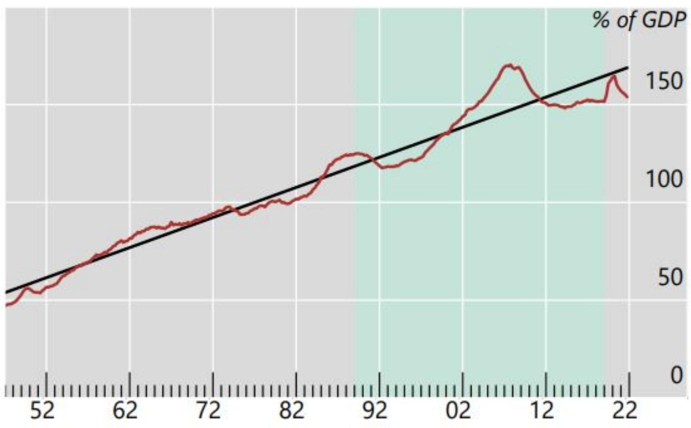

Figure A3: Private credit to gdp ratio during the estimation period in the US

Notes: Shaded area: estimation period. Source: National Data, BIS.

Disentangling the role of inflation level and composition The estimated effect of a 25 basis points monetary tightening on financial stress conditional on a 100 basis points supply-driven inflation π_t^s at horizon h equals:

$$\left.\frac{\partial y_{t+h} - y_{t-1}}{\partial \mathbb{1}\{mps_t > 0\} mps_t}\right|_{\pi_t^s \neq 0,\ \pi_t^d = 0} = \hat{\beta}_h^T + \hat{\beta}_h^{TS} \pi_t^s \tag{3}$$

Both $\hat{\beta}_h^T$ (Figure 3) and $\hat{\beta}_h^{TS}$ (Figure 4, left panel) are positive, indicating that policy rate hikes during supply–driven inflationary episodes unambiguously rise financial stress. Furthermore, the positive coefficient of the interaction term $\hat{\beta}_h^{TS}$ implies that a higher level of supply–driven inflation π_t^s is associated with a stronger marginal effect of the tightening on financial stress (Figure A4, right panel).

The estimated effect of a 25 basis points monetary tightening on financial stress conditional on demand–driven inflation π_t^d is given by:

$$\frac{\partial y_{t+h} - y_{t-1}}{\partial \mathbb{1}\{mps_t > 0\} mps_t}_{|\pi_t^s \neq 0,\ \pi_t^d = 0} = \hat{\beta}_h^T + \hat{\beta}_h^{TD} \pi_t^d$$

The estimated interaction coefficients $\hat{\beta}_h^{TD}$ are negative (Figure 4, right panel), suggesting that the effect of policy rate hikes on financial stress is dampened during demand–driven inflationary episodes and may even turn negative when the demand–driven inflationary boom is strong enough. Specifically, when demand–driven inflation π_t^d is relatively mild, the positive effect due to $\hat{\beta}_h^T > 0$ prevails over the small negative effect due to $\hat{\beta}_h^{TD} \pi_t^d < 0$ and the rate hike leads overall to a rise in financial stress. By contrast, in the presence of a high level of demand inflation π_t^d, the negative effect due to $\pi_t^d \hat{\beta}_h^{TD} < 0$ will more than offset the positive effect due to the tightening *per see* $\hat{\beta}_h^T > 0$, and in those instances the policy rate hike will work to reduce financial stress.

Finally, to sum up, the total estimated effect of a 25 basis points monetary tightening on financial stress at horizon h is given by:

$$\frac{\partial y_{t+h} - y_{t-1}}{\partial \mathbb{1}\{mps_t > 0\} mps_t}_{|\pi_t^s \neq 0,\ \pi_t^d \neq 0} = \hat{\beta}_h^T + \hat{\beta}_h^{TS} \pi_t^s + \hat{\beta}_h^{TD} \pi_t^d \tag{4}$$

and will depend on the levels of supply-driven inflation π_t^s and demand-driven inflation π_t^d prevailing at the time of the tightening. At one extreme, in periods with high inflation driven mainly by supply factors, a rate hike will rise financial stress. At the other extreme, in periods with high inflation driven mainly by demand factors, a rate hike will reduce financial stress.

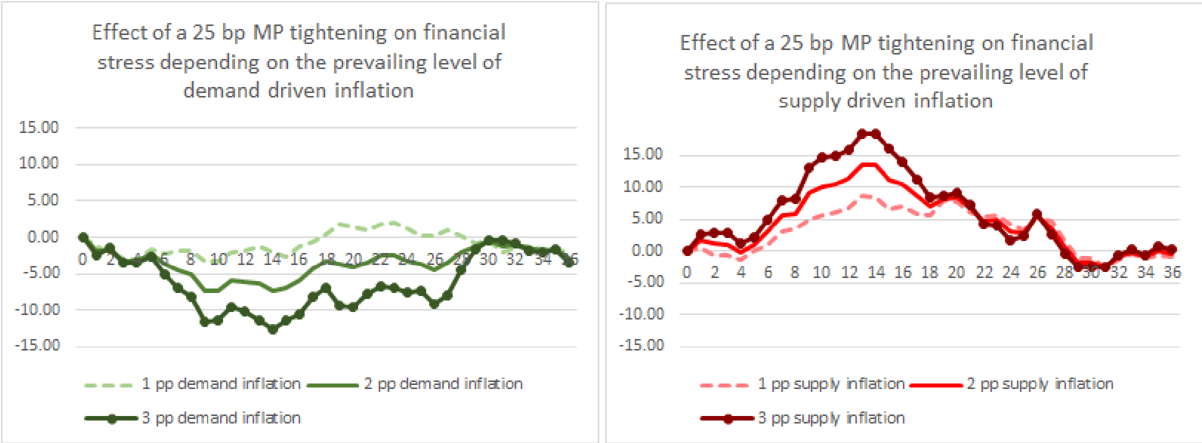

Figure A4: Asymmetric effect of a monetary tightening on financial stress

Notes: Dynamic responses to a 25 basis points positive monetary policy . Shown are the combination of regression coefficients $\beta_h^T + \beta_h^{TD}\pi_t^d$ (left) and $\beta_h^T + \beta_h^{TS}\pi_t^s$ (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Fed Board Financial Stress Index and 6 lags. US monthly data from January 1990 to December 2019.

6.2 Robustness checks: US specification

6.2.1 Subsamples

Figure C1: Additional asymmetric effect of a monetary tightening on financial stress - no GFC

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, GZ corporate credit spreads and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019 excluding the 2007-2008 GFC period.

Figure C2: Additional asymmetric effect of a monetary tightening on financial stress - no ZLB

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, GZ corporate credit spreads and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019, excluding the ZLB period between 2010 and 2015.

6.2.2 Other financial stress indices

Figure C3: Additional effect of a monetary tightening on financial stress: Bloomberg FCI

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Bloomberg FCI and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. We take the negative value of the Bloomberg FCI because for this index a positive value indicates accommodative financial conditions, while a negative value indicates tighter financial conditions. This index can be classified as a stress index because it is computed mainly based on spreads and volatilities. Specifically, its components are: the US Ted spread, the Libor/OIS spread, the commercial paper/T-bills spread, the US High Yield /10Y Treasury spread, the US Muni/10Y Treasury spread, the Swaption Volatility index, S&P500 and the VIX.

Figure C4: Additional effect of a monetary tightening on financial stress: KC Fed FSI

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Kansas City Fed FSI and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The KC Fed FSI is a pure FSI index with eleven components represented by spreads, volatility, "flight to quality" and "asymmetric information" proxies in main segments of financial markets. Its precise components are: TED spread, Swap spread, Off-the-run/on the run-spread, Aaa/Treasury spread, Baa/Aaa spread, High-yield/Baa spread/ Consumer ABS/Treasury spread, Stock-bond correlation, Stock market volatility (VIX), IVOL-banking industry, CSD-banks (see Table 1 in Hakkio, Keeton, et al. (2009)).

Figure C5: Additional asymmetric effect of a monetary tightening on financial stress: CISS

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the CISS and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The CISS is an index of systemic financial stress which aggregate 15 components capturing stress symptoms in money, bond, equity and foreign exchange markets. It incorporates mainly volatility and spreads and is similar to a continuous version of Romer and Romer (2017) – see Chavleishvili and Kremer (2023), Figure 1 (panel B).

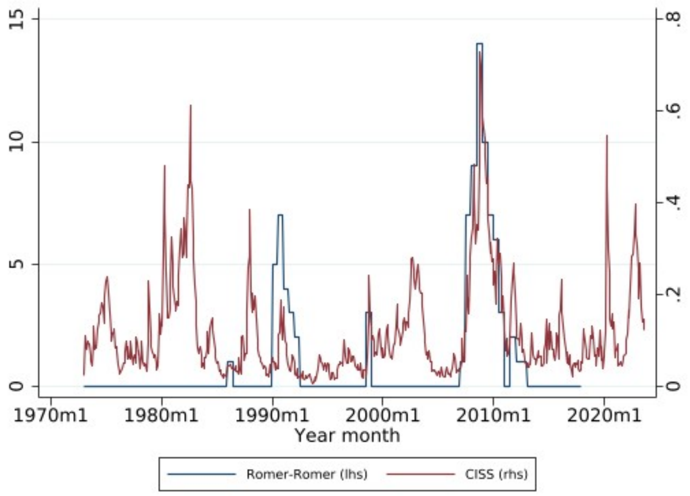

Figure C6: Alternative (composite) financial stress index for the US: CISS

Notes: The figure plots for the United States the CISS systemic financial stress index (red line) along with the Romer and Romer (2017) qualitative financial crisis indicator (blue line). Data is shown monthly from January 1973 to August 2023 for the CISS, and semiannual until 2017:2 for Romer and Romer.

6.2.3 Financial stress components

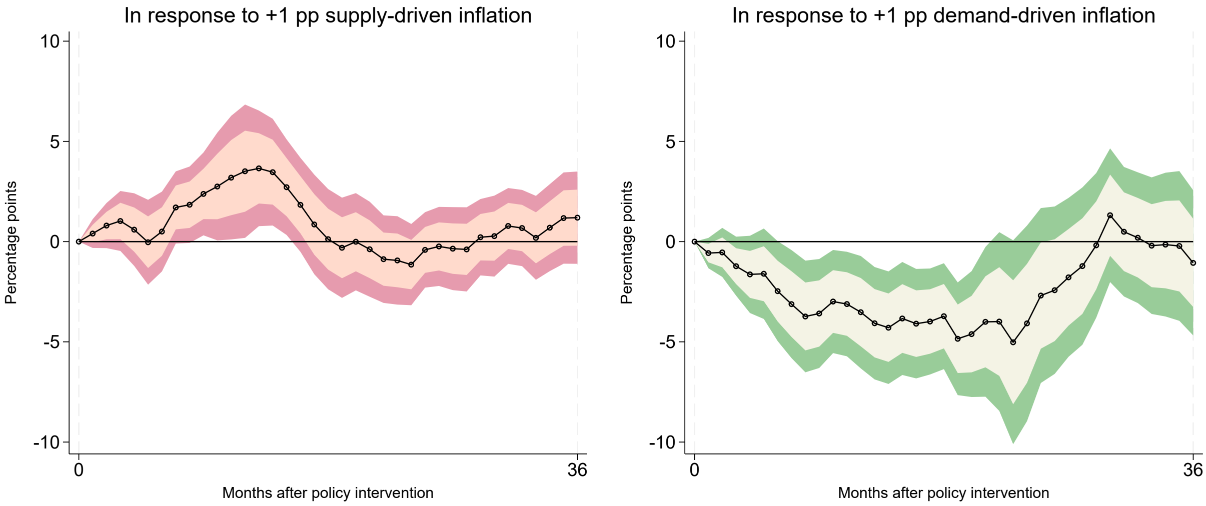

Figure C7: Additional effect of a monetary tightening on the GZ corporate credit spreads

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Gilchrist and Zakrajšek (2012) (GZ) corporate credit spreads and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019.

Figure C8: Additional effect of a monetary tightening on the GZ equity finance premium

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Gilchrist and Zakrajšek (2012) (GZ) Equity Finance Premium and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019.

Figure C9: Additional effect of a monetary tightening on financial stress: Bond Market CISS

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Bond Market CISS subindex and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The CISS is an index of systemic financial stress which aggregate 15 components capturing stress symptoms in money, bond, equity and foreign exchange markets. It incorporates mainly volatility and spreads and is similar to a continuous version of Romer and Romer (2017) – see Chavleishvili and Kremer (2023), Figure 1 (panel B).

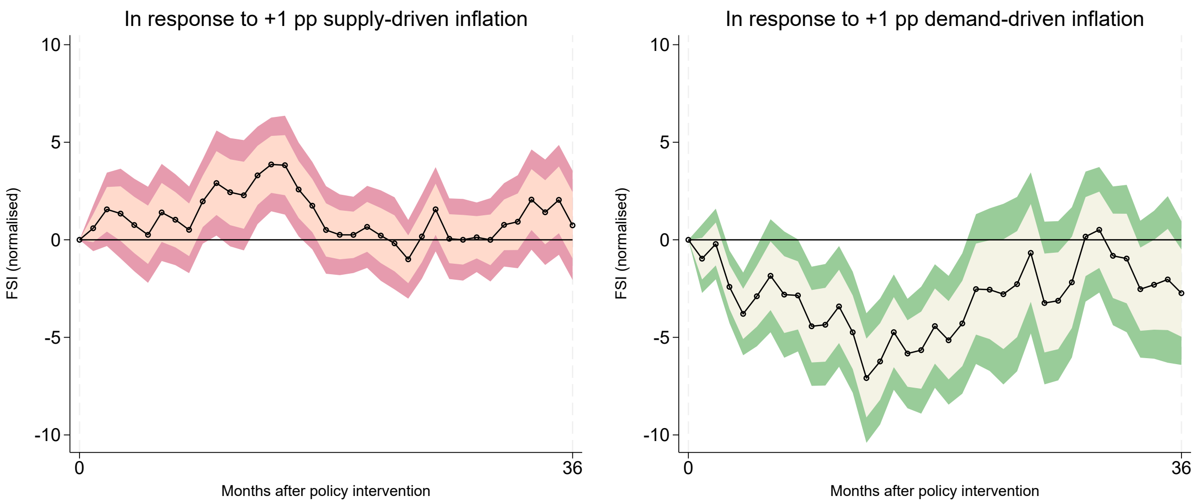

Figure C10: Additional effect of a monetary tightening on financial stress: NFC CISS

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Non-financial corporations Equity Market CISS subindex and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The CISS is an index of systemic financial stress which aggregate 15 components capturing stress symptoms in money, bond, equity and foreign exchange markets. It incorporates mainly volatility and spreads and is similar to a continuous version of Romer and Romer (2017) – see Chavleishvili and Kremer (2023), Figure 1 (panel B).

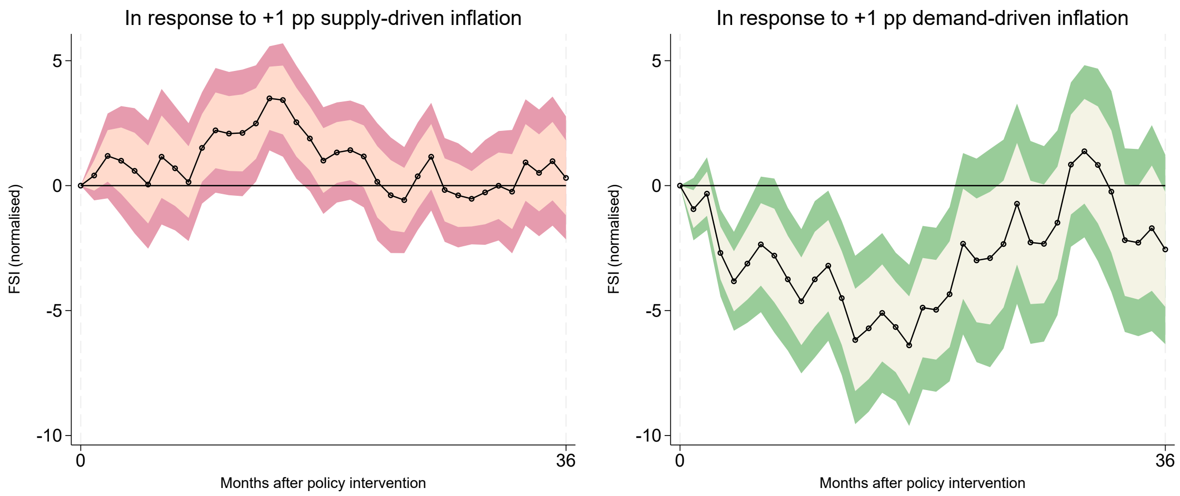

Figure C11: Additional effect of a monetary tightening on financial stress: Financial CISS

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Financial Corporations Equity Market CISS subindex and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The CISS is an index of systemic financial stress which aggregate 15 components capturing stress symptoms in money, bond, equity and foreign exchange markets. It incorporates mainly volatility and spreads and is similar to a continuous version of Romer and Romer (2017) – see Chavleishvili and Kremer (2023), Figure 1 (panel B).

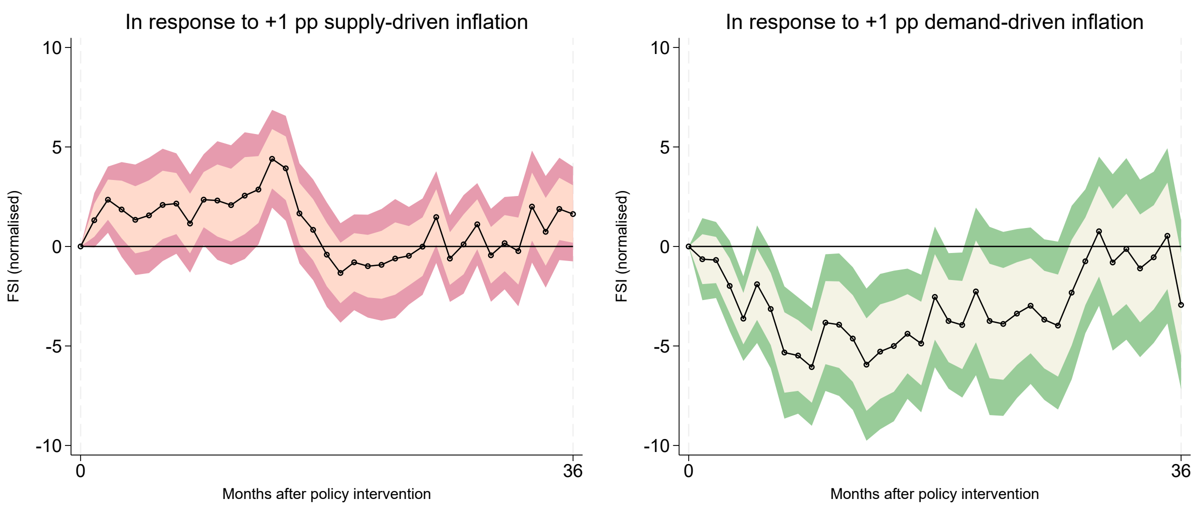

Figure C12: Additional asymmetric effect of a monetary tightening on financial stress: FX CISS

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Foreign Exchnage Market CISS subindex and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The CISS is an index of systemic financial stress which aggregate 15 components capturing stress symptoms in money, bond, equity and foreign exchange markets. It incorporates mainly volatility and spreads and is similar to a continuous version of Romer and Romer (2017) – see Chavleishvili and Kremer (2023), Figure 1 (panel B).

6.2.4 Financial conditions indices

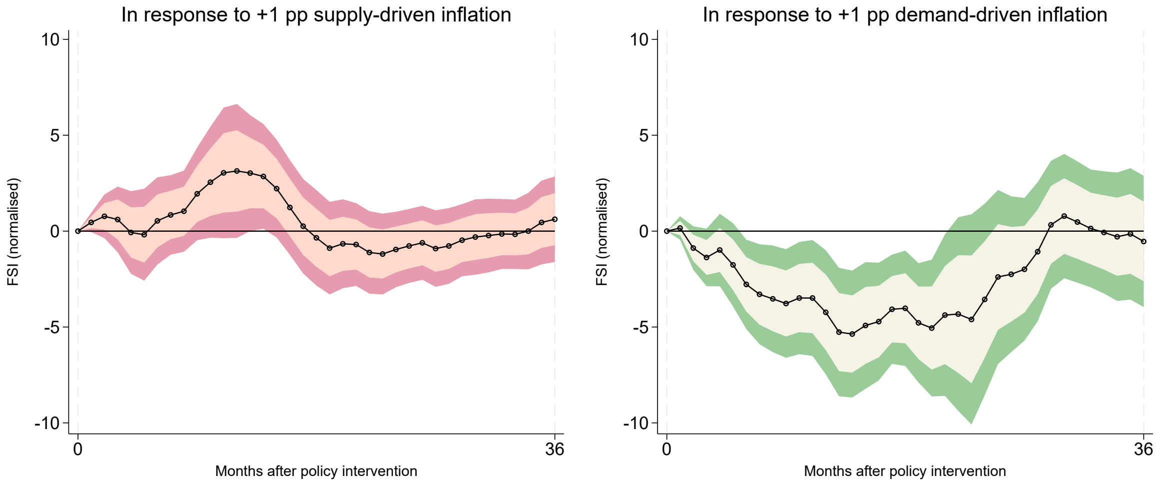

Figure C13: Additional effect of a monetary tightening on financial stress: Chicago Fed NFCI

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Chicago FED NFCI and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019, baseline specification. The Chicago Fed National FCI is computed using 109 financial market variables including both spread/volatility measures (with substantial weights) as well as interest rate levels and asset prices, and provides a comprehensive index of financial conditions in money markets, debt and equity markets, and the traditional and "shadow" banking systems. (see Table A1 in Brave and Butters (2011)).

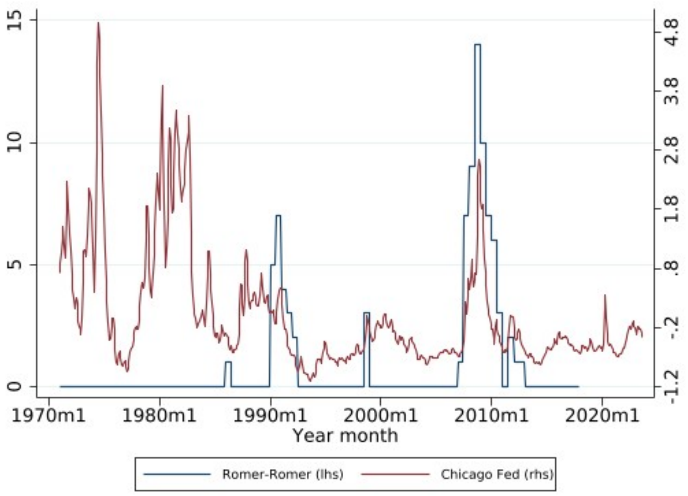

Figure C14: A financial conditions index for the US: the Chicago Fed NFCI

Notes: The figure plots for the United States the Chicago Fed NFCI (red line) along with the Romer and Romer (2017) qualitative financial crisis indicator (blue line). Data is shown monthly from January 1971 to August 2023 for the Chicago Fed NFCI, and semiannual until 2017:2 for Romer and Romer.

Figure C15: Additional effect of a monetary tightening on financial stress: Goldman Sachs FCI

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Goldman Sachs FCI and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The Goldman Sachs FCI is constructed as a weighted average of short-term interest rates, long-term interest rates, the trade-weighted dollar, an index of credit spreads, and the ratio of equity prices to the 10-year average of earnings per share. The weights are set using the estimated impact of surprises to each variable on real GDP growth over the following four quarters using a stylized macro model. The weight on corporate credit spreads equals 39.6% (see Table B3 in Hatzius and Stehn (2018)).

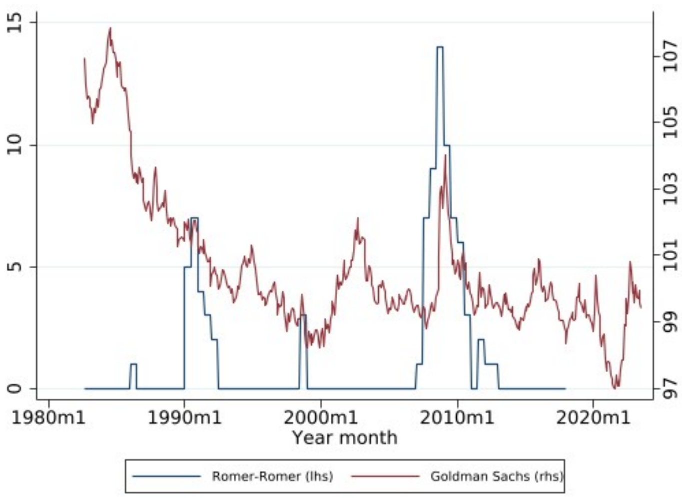

Figure C16: A financial conditions index for the US: the Goldman Sachs FCI

Notes: The figure plots for the United States the Goldman sachs FCI (red line) along with the Romer and Romer (2017) qualitative financial crisis indicator (blue line). Data is shown monthly from September 1982 to August 2023 for the Chicago Fed NFCI, and semiannual until 2017:2 for Romer and Romer.

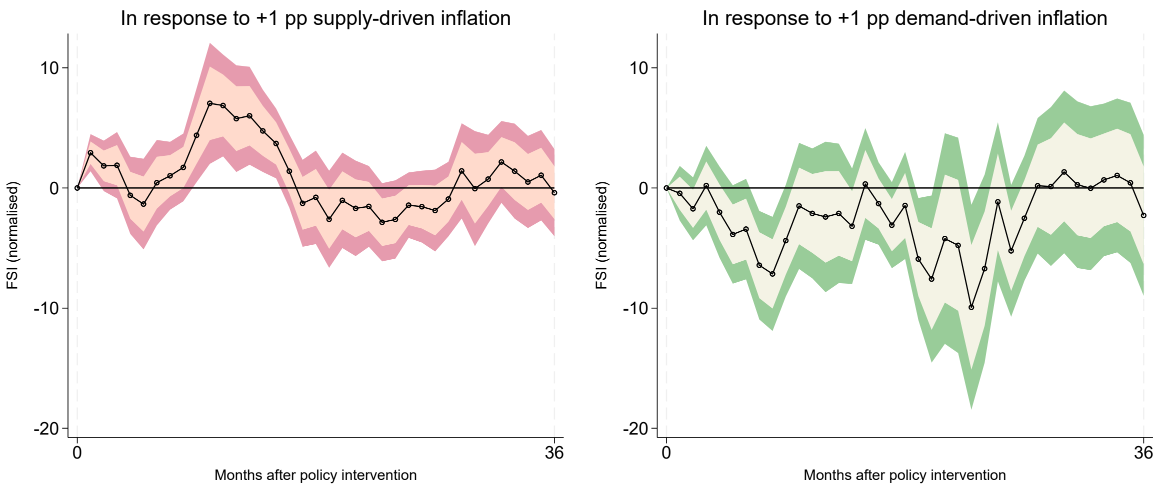

Figure C17: Additional effect of a monetary tightening on financial stress: Saint Louis Fed FSI

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, the Saint Louis Fed FSI and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. The Saint Louis Fed FSI measures the degree of financial stress in the markets and is constructed from 18 weekly data series: seven interest rate series, six yield spreads and five other indicators. Each of these variables captures some aspect of financial stress (Kliesen, Smith, et al. (2010)).

6.3 Robustness checks: other countries

6.3.1 Data

Table C1: Overview Monetary Policy surprises by Country

#	Reference	Type	Remarks
	Canada		
	Champagne and Sekkel (2018)	Narrative	Romer & Romer type
	United Kingdom		
	Gerko and Rey (2017)	High-frequency	(sign)-correction
	France		
	Jarociński and Karadi (2020)	High-frequency	(sign)-correction
	Sweden		
	Kilman et al. (2022), Sandström (2018)	High-frequency	
	Australia		
	Bishop and Tulip (2017)	Narrative	

Table C2: Overview Financial Stress Indices by Country

#	Index	Source (description)	Type
	Canada		
1.	Canadian FSI	Duprey (2020)	systemic stress
	United Kingdom		
1.	NEW CISS	Chavleishvili and Kremer (2023)	systemic stress
2.	Bloomberg FCI	Rosenberg (2009)	stress
3.	CLIFS	Duprey, Klaus, and Peltonen (2017)	systemic stress
4.	Goldman Sachs FCI	Hatzius and Stehn (2018)	stress & conditions
	France		
1.	NEW CISS	Chavleishvili and Kremer (2023)	systemic stress
2.	CLIFS	Duprey, Klaus, and Peltonen (2017)	systemic stress
3.	Goldman Sachs FCI	Hatzius and Stehn (2018)	stress & conditions
	Sweden		
1.	CLIFS	Duprey, Klaus, and Peltonen (2017)	systemic stress
	Australia		
1.	ADB FSI	Park and Mercado Jr (2014), ADB Database	stress
2.	Corporate Credit Spreads	Investment Grade Index BofA Merrill Lynch	stress
3.	RBA FCI	Hartigan and Wright (2021)	stress & conditions

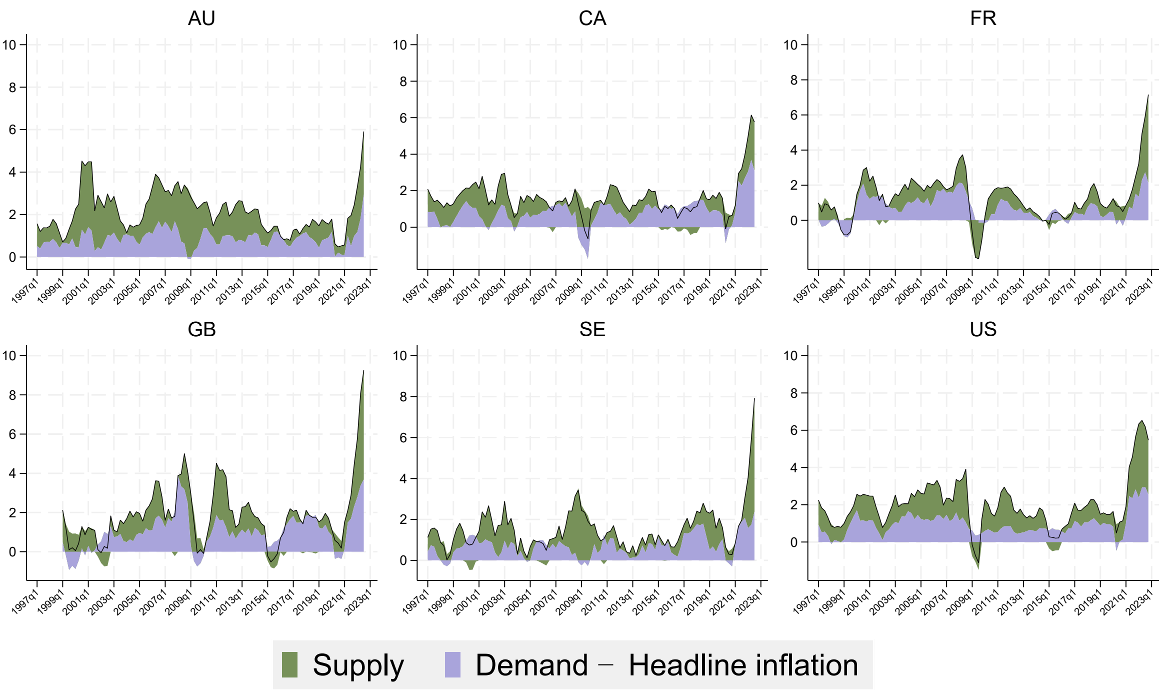

Figure C18: Inflation decomposition into demand and supply factors

Notes: Headline inflation, quarterly frequency, year-on-year. Y–axis: percent. Source: OECD

6.3.2 Findings

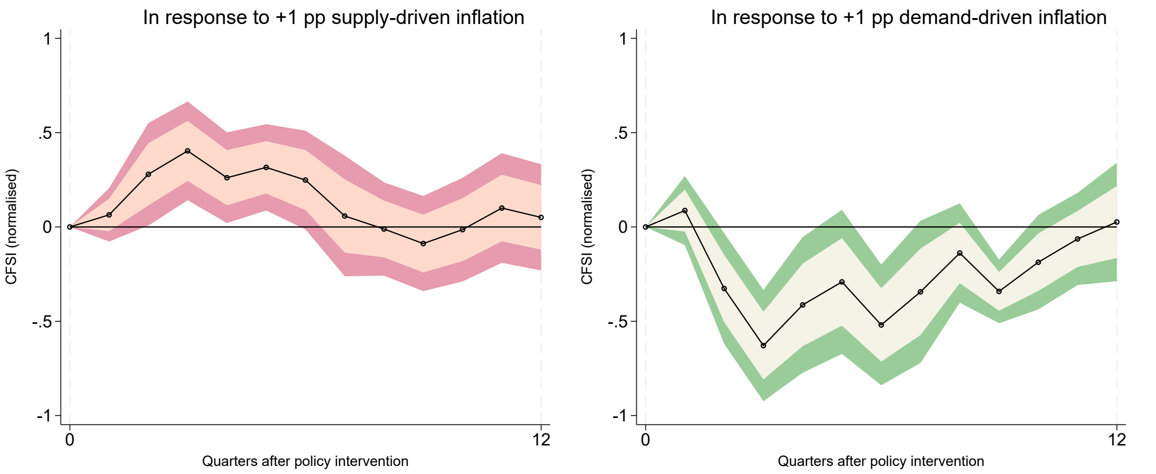

Figure C19: Additional asymmetric effect of a monetary tightening on financial stress in Canada

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 12$. Baseline specification described by (1) with Champagne and Sekkel (2018) (narrative) monetary policy surprises, core year-on-year inflation, and CFSI (Duprey (2020)) financial stress index. Quarterly data from 1984Q1 to 2015Q3. The sample is dictated by the availability of demand/supply inflation series which starts in 1984Q1 and of the series of monetary policy surprises which ends in 2015Q3. Specification with 4 lags (optimal lag order according to the AIC criterion). Findings robust with a specification with 2 lags (optimal lag order according to the BIC criterion). 90% confidence bands.

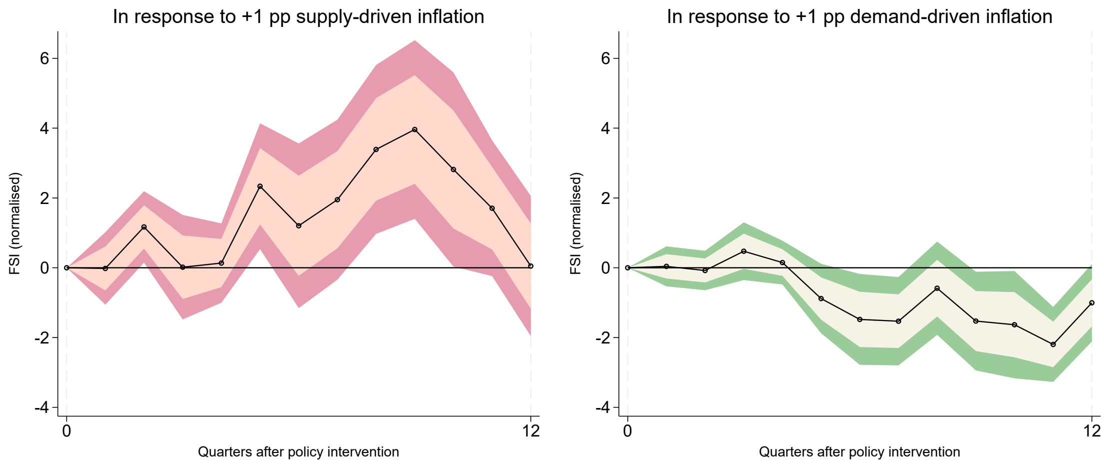

Figure C20: Additional asymmetric effect of a monetary tightening on financial stress in the UK

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 12$. Baseline specification described by (1) with Gerko and Rey (2017) monetary policy surprises, headline year-on-year inflation, and the CISS financial stress index. Quarterly data from 1999Q1 to 2014Q4. The sample is dictated by the availability of demand/supply inflation series which starts in 1999Q1 and of the series of monetary policy surprises which ends in 2014Q4. Headline inflation only available for the UK. Results very salient when using the Bloomberg financial stress index (Rosenberg (2009)), and hold also for CLIFS, the Goldman Sachs financial condition index and the Goldman Sachs Corporate Spreads FCI. Specification with 4 lags (optimal lag order according to the AIC and BIC lag selection criterion). 90% confidence bands.

Figure C21: Additional asymmetric effect of a monetary tightening on financial stress in France

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 12$. Baseline specification described by (1) with Jarociński and Karadi (2020) monetary policy surprises, headline year-on-year inflation, and the CISS financial stress index. Quarterly data from 1999Q1 to 2014Q4. The sample is dictated by the availability of demand/supply inflation series which starts in 1999Q1 and of the series of monetary policy surprises which ends in 2019Q2. Headline inflation only available for France. Similar results for CLIFS, with the effect of supply-driven inflation frontloaded. Similar patterns for the GS FCI index, but with less salient effect for the supply interaction. Specification with 4 lags (the optimal lag order according the AIC and BIC lag selection criteria). 90% confidence bands.

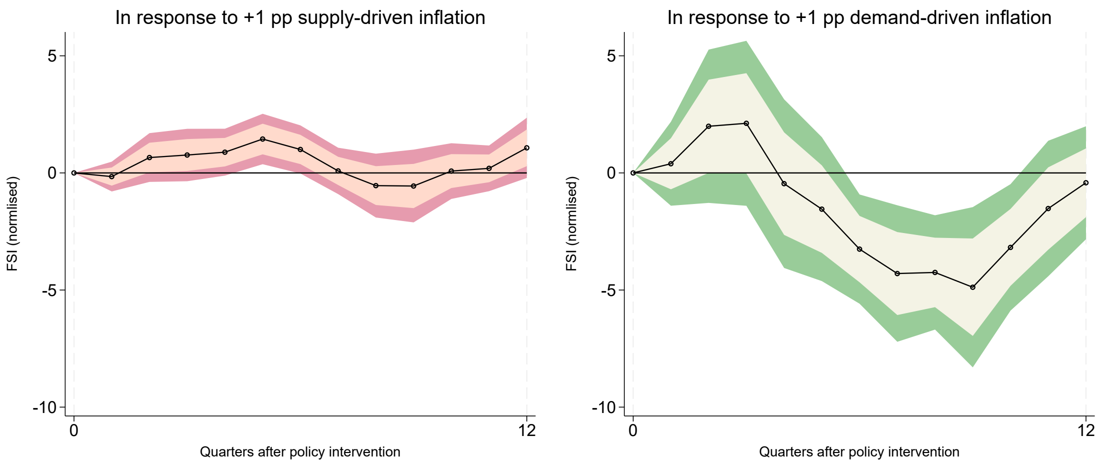

Figure C22: Additional asymmetric effect of a monetary tightening on financial stress in Australia

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 12$. Baseline specification with Bishop and Tulip (2017) narrative monetary policy surprises, headline year-on-year inflation, and the ADB financial stress index. Specification with 4 lags (optimal lag order according to the AIC lag selection criterion). Quarterly data from 1997Q1 to 2019Q4. The sample is dictated by the availability of monetary policy surprises. Headline inflation only available for Australia. 90% confidence bands. The ADB FSI is a composite index that measures the degree of financial stress covering the 4 major financial markets: the banking sector, the foreign exchange market, the equity market, and the debt market. The index is tailored to Open Economies/EMEs (see Park and Mercado Jr (2014) and ADB Database). Similar patterns for corporate credit spreads (e.g. investment grade BofA Merrill Lynch), with the negative reaction of the demand interaction term being particularly salient in that case. Similar patterns with the RBA FCI (Hartigan and Wright (2021)), but with a less salient positive interaction term associated to supply–driven inflation.

Figure C23: Additional asymmetric effect of a monetary tightening on financial stress in Sweden

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 12$. Baseline specification described by (1) with Kilman et al. (2022) monetary policy surprises, headline year-on-year inflation, and the CLIFS financial stress index. Quarterly data from 2002Q1 to 2021Q2. The sample is dictated by the availability of high-frequency monetary policy surprises. Headline inflation only available for Sweden. Specification with 2 lags due to limited data availability of high frequency monetary policy surprises. 90% confidence bands.

6.4 US: quarterly version

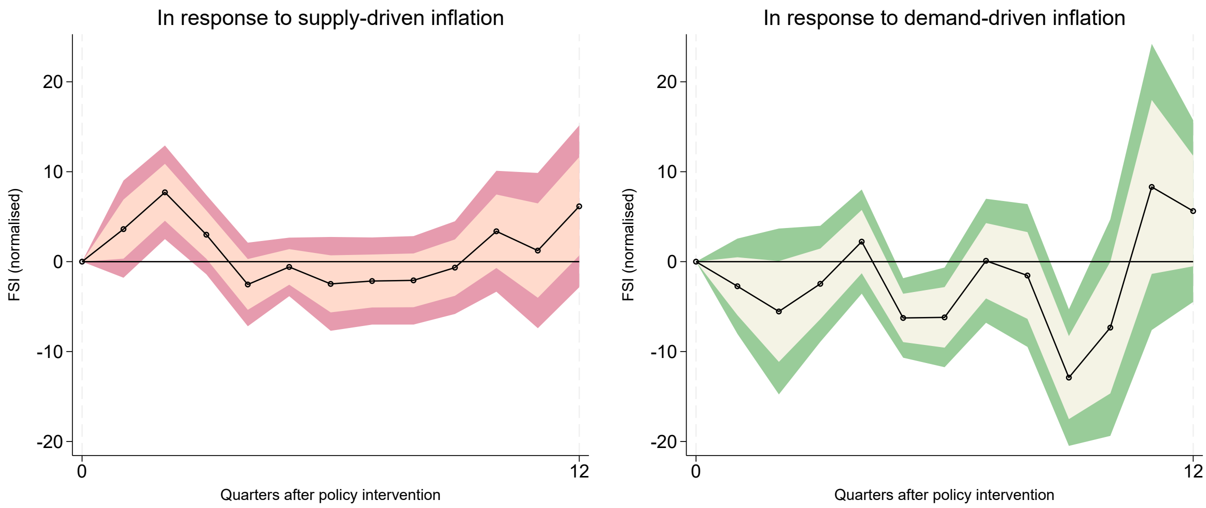

Figure C24: Additional effect of a monetary tightening on financial stress (baseline, quarterly)

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, Fed Board Financial Stress Index and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. Findings robust to specifications including the optimal lag order according to the AIC and BIC criteria equal to three and four, respectively.

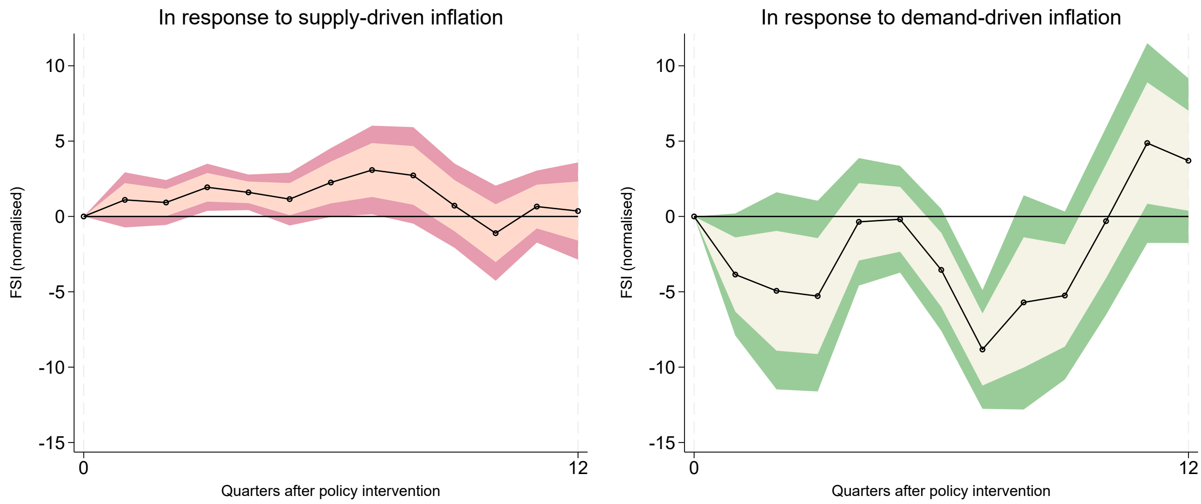

Figure C25: Additional effect of a monetary tightening on financial stress (headline, quarterly)

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, headline inflation, Fed Board Financial Stress Index and 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. Findings robust to specifications including the optimal lag order according to the AIC and BIC criteria equal to three and four, respectively.

6.5 Underlying mechanisms

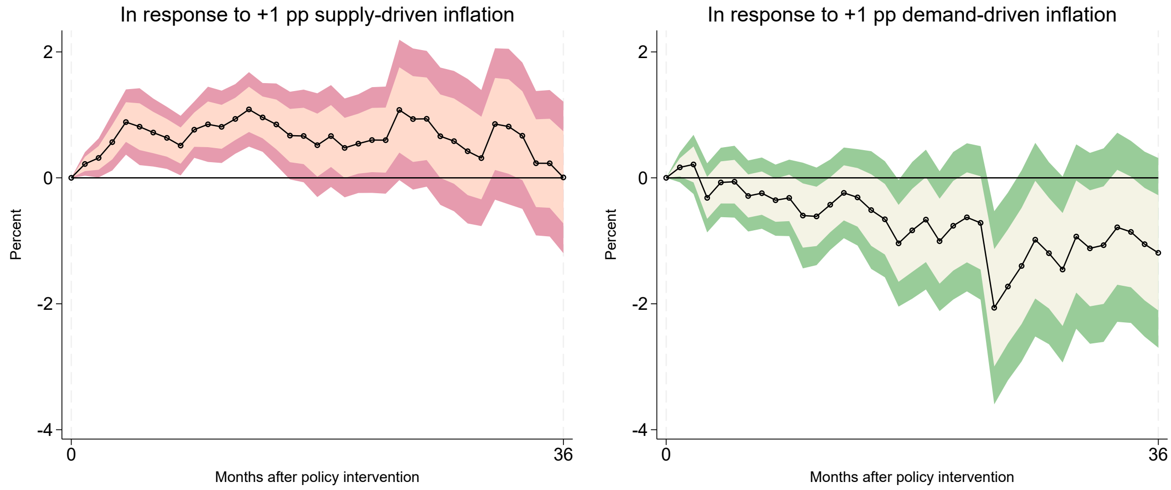

Figure D1: Additional asymmetric effect of a monetary tightening on firm bankruptcies

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, total of businesses bankruptcies filling (quarterly), 4 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019.

Figure D2: Additional asymmetric effect of a monetary tightening on the loan delinquency rate

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, ..., 36$. Baseline specification described by (1) with Bauer and Swanson (2023) monetary policy surprises, core inflation, loan delinquency rate (quarterly) for total loans and leases, 6 lags. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019. Delinquency Rates on Loans and Leases at Commercial Banks are taken from Fed Board's website.

6.6 Financial crises dynamics in Boissay, Collard, Galí, and Manea (2023)

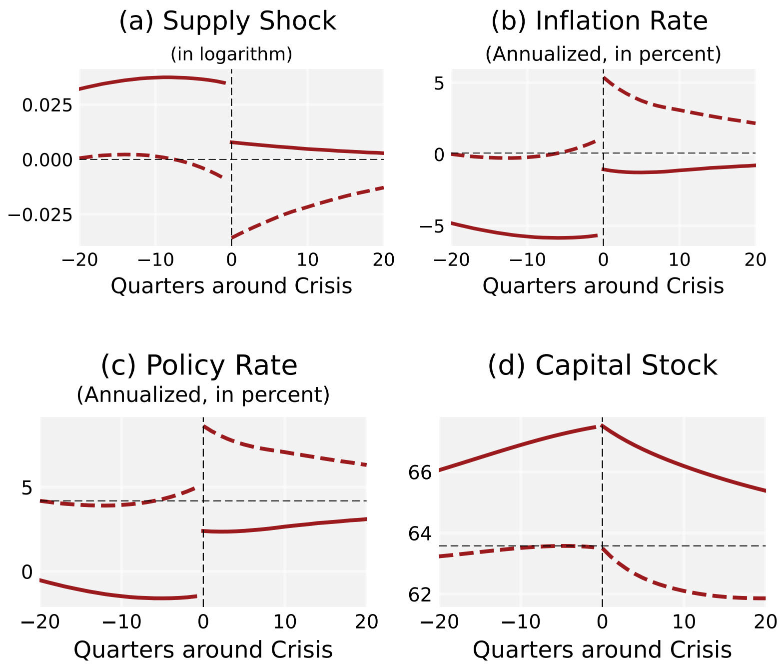

Figure D3: Dynamics around financial crises in an economy with supply shocks only

Notes: Simulations of the model in Boissay, Collard, Galí, and Manea (2023) with supply shocks only. Solid lines: predicted crises. Dotted lines: unpredicted crises. Predicted and unpredicted crises are distinguished based on the distribution of the one-step-ahead probability of a crisis before a crisis is realised. Crisis in the bottom 10% are labeled "unpredicted", while crises in the top 10% are labeled "predicted".

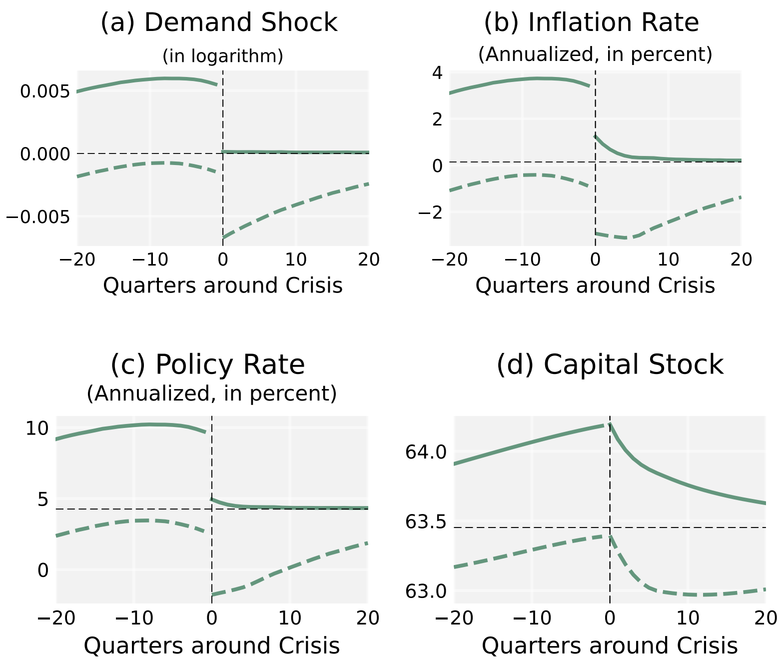

Figure D4: Dynamics around financial crises in an economy with demand shocks only

Notes: Simulations of the model in Boissay, Collard, Galí, and Manea (2023) with demand shocks only. Solid lines: predicted crises. Dotted lines: unpredicted crises. Predicted and unpredicted crises are distinguished based on the distribution of the one-step-ahead probability of a crisis before a crisis is realised. Crisis in the bottom 10% are labeled "unpredicted", while crises in the top 10% are labeled "predicted".

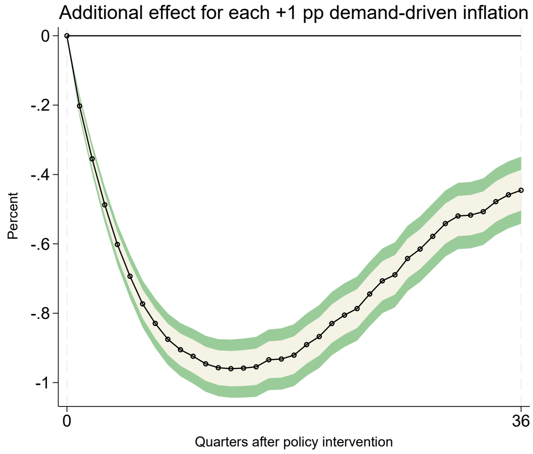

Figure D5: Additional effect of a policy rate hike on one-period-ahead probability of a crisis for each percentage point of year-on-year demand–driven inflation in early stages of credit booms

Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Regression coefficients β_h^{TD} for $h = 0, ..., 36$ interacted with a dummy that credit/capital stock is in the bottom quantile based on simulated time series from the model in Boissay, Collard, Galí, and Manea (2023) with demand shocks and monetary policy surprises. Specification described by equation (2), where the additional effects captured by the interaction of the policy rate with demand inflation for the monetary tightening (β_h^{TD}) and loosening (β_h^{LD}) are further split using a dummy variable between effects in the early stages of booms (i.e. when credit/capital stock is in the bottom quantile), and otherwise. 90% confidence bands.

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