Regional Monetary Policies and the Great Depression*

Pooyan Amir-Ahmadi†
University of Illinois at Urbana-Champaign

Gustavo S. Cortes‡
University of Florida

Marc D. Weidenmier§
Chapman University & NBER

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Abstract

The Great Depression provides a unique setting to test the impact of monetary policies on economic activity in a monetary union within the same country during a severe crisis. Until the mid-1930s, the 12 Federal Reserve banks had the ability to set their own discount rates and conduct independent monetary policy. Using a structural VAR with sign restrictions and new monthly data for each Federal Reserve district between 1923-33, we extract a national monetary policy factor from the 12 discount rates of the Federal Reserve banks. We then identify the region-specific component for each Fed district by subtracting the common factor component of monetary policy from the discount rate of each Federal Reserve bank. Our findings suggest that there was significant variation in regional monetary policy and that the district reserve banks played a key role in the economic contraction.

Keywords: Monetary Policy, Great Depression, Federal Reserve districts
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†Department of Economics, University of Illinois at Urbana-Champaign. 214 David Kinley Hall, 1407 W. Gregory Dr, Urbana, IL, 61801, pooyan@illinois.edu.

‡Warrington College of Business, University of Florida. 306 Stuzin Hall, PO Box 117168, Gainesville, FL 32611-7168, gustavo.cortes@warrington.ufl.edu.

§Argyros School of Business and Economics, Chapman University and NBER. 306F Beckman Hall, Orange, CA, 92866, weidenmi@chapman.edu.

"Why was monetary policy so inept? (...) The monetary system collapsed, but it clearly need not have done so (...) pursuit of the policies outlined by the [Federal Reserve] System itself (...) would have prevented the catastrophe."
— Milton Friedman and Anna J. Schwartz (1963)

"I would like to say to Milton and Anna: regarding the Great Depression. You're right, we did it. We're very sorry. But thanks to you, we won't do it again."
— Ben S. Bernanke (2002), Governor of the Federal Reserve System

1 Introduction

The Great Depression is the most severe economic downturn in the last 100 years and one of the most studied events in the history of economics. Friedman and Schwartz (1963) argued in their seminal work, *"A Monetary History of the United States,"* that the Federal Reserve did not respond to the one-third decline in the money supply. The Fed failed to play the role of a lender-of-last-resort and provide liquidity assistance to banks which led to bank failures and bank suspensions. The Fed's inadequate response turned a "garden variety recession" into a depression (Hamilton (1987); Bordo (1989); Bordo et al. (2000); Bordo and Rockoff (2013)). Bernanke (1983) subsequently argued that the collapse of the banking system played an important role in the depth and duration of the Great Depression because firms had reduced access to credit and therefore could not undertake profitable investment opportunities. Financially solvent banks also reduced lending because they were concerned about the possibility of a bank run.

Unlike today when monetary policy decision-making is centralized in Washington DC, the twelve regional Federal Reserve banks had the power to set their own discount rate until the mid-1930s. The decentralized nature of US monetary policy during this period raises an important question: To what extent was the economic contraction of the Great Depression driven by regional and national monetary shocks? We address this question by studying regional and national variations in monetary policy during the Great Depression. Chandler (1971), for example, noted that the New York Fed had the most aggressive and expansionary monetary policy of all the Federal Reserve banks during the Great Depression. On the other hand, many of the Federal Reserve district banks adhered to the real bills doctrine and did not believe in aggressive countercyclical monetary policy.

Regional monetary policy has been explored using the border approach pioneered by Richardson and Troost (2009). The authors examine bank failures along the border of the Atlanta and St. Louis Federal Reserve Reserve Districts that basically splits Mississippi in half. They find that bank failures were lower in the Atlanta Fed District (which aggressively loaned to illiquid banks) compared to the St. Louis Fed (that followed the real bills doctrine).[1] Although the Mississippi experiment sheds light on the importance of regional monetary policy during the Great Depression, our study employs vector autoregressions to simultaneously quantify the aggregate and dynamic effects of *national and regional* monetary policy shocks on economic activity in each of the twelve Federal Reserve districts. We construct a new database of economic and financial time series for the period 1923-33. We employ a structural VAR with sign restrictions, pioneered by Uhlig (2005), Faust (1998) and Canova and De Nicolò (2002) and further advanced among others by Rubio-Ramírez et al. (2010) and Arias et al. (2018) to impose only the mildest, uncontroversial restrictions (i.e., those widely accepted by standard macroeconomic theory) to identify the impact of monetary policy shocks on real activity. Ramey (2016) provides a comprehensive overview and evaluation of the recent advances in the identification of macroeconomic shocks to explain economic fluctuations. Our results suggest that there was significant regional heterogeneity in monetary policy. Region-specific VARs show that monetary policy had a significant effect on local retail sales, building permits, as well as short-term interest rates and prices. A monetary policy shock explains between 10 and 25 percent of the forecast error variance of retail sales in the twelve Federal Reserve districts after five years. With respect to building permits, a 25 basis point increase in the discount rate explains, at the mean, between 9 and 22 percent of the movements in building permits. The baseline results are robust to imposing the sign restrictions for as little as 1 quarter and to not imposing sign restrictions on real-economic variables.

We follow up the baseline empirical analysis by directly tackling the question of whether national- or regional-led monetary policy mattered more for real activity. To do so, we extract a common factor from the twelve Federal Reserve discount rates. We then construct the orthogonal region-specific component of a Federal Reserve's discount rate by subtracting the discount rate in a given Fed district by the common factor. Again, we find strong evidence that regional monetary policy shocks mattered. They explain, at the mean, about 10 to 25 percent of the forecast error variance of local retail sales at a five-year horizon. National monetary shocks, on the other hand, only explain about 10 percent of the forecast error variance in retail sales. With respect to building permits, we find that a contractionary monetary policy

[1] Jalil (2014) would later confirm that Richardson and Troost's (2009) results hold for a relatively more general setting, i.e., across the entire border of the Federal Reserve Bank of Atlanta. Ziebarth (2013) also uses Richardson and Troost's (2009) setting and finds that bank failures in Mississippi had a negative effect on revenue stemming from a fall in physical output, but finds mixed results on employment (no effect on plant-level despite a large decline on county-level employment). National-level analyses of US monetary policy during the Great Depression can be found, among others, in Ritschl and Woitek (2000), Amir-Ahmadi and Ritschl (2010), and Breitenlechner et al. (2019).

shock reduces building permits and accounts for between 9 and 23 percent of the forecast error variance in the real estate variable at a five-year horizon.

We then analyze the monetary policy actions of the Federal Reserve Bank of Atlanta given that the 6th District aggressively provided assistance to troubled banks (Richardson and Troost (2009)). We find that monetary policy shocks in the Atlanta Federal Reserve District are milder than conventional (discount-window) policy would suggest. Overall, our results are consistent with the findings of Richardson and Troost (2009) and also provide insight into the dynamic effects of the Atlanta Fed's bank assistance program on economic activity.

Next, we test our baseline results with a battery of robustness checks. Uhlig's (2005) main critique is that conventional identification strategies impose questionable timing and zero restrictions on the contemporaneous response of output to a monetary policy shock. This motivates his agnostic identification strategy via sign restrictions leaving output unrestricted. Uhlig (2005) finds ambiguous output effects to an unexpected monetary tightening. More recently, Ramey (2016) confirmed and reiterated this critique across various identification strategies. To address this critique we first show that our results do not depend on including restrictions for the real activity variables (i.e., retail sales and building permits) in our set identification of monetary policy shocks. In other words, the basic tenor of our results is obtained even following Uhlig's (2005) fully-agnostic approach that places no restrictions on the response of real activity to monetary shocks. We then augment our baseline VAR model with the spread of the discount rate of each Federal Reserve bank with respect to the discount rate of the New York Federal Reserve to capture the influence of New York Fed policy as discussed in Friedman and Schwartz (1963). We then incorporate failed bank deposits into our baseline VARs (Calomiris and Mason (2003); Anari et al. (2005)). We find that the credit channel measure does not alter the baseline results. There remains considerable heterogeneity in the impact of a contractionary monetary policy shock across the twelve Federal Reserve districts. Again, the findings suggest that contractionary monetary policy shocks at the regional Federal Reserve banks had a larger negative impact on economic activity than national monetary policy shocks or an increase in the discount rate by the New York Fed. We then use narrative sign restrictions (Antolín-Díaz and Rubio-Ramírez (2018)) to inform our impulse-responses with minimal restrictions in line with the historical narrative regarding one of the most studied episodes of monetary policy: the April 1932 expansionary open market operations (Hsieh and Romer (2006); Bordo and Sinha (2016)). The tenor of our baseline results remains unchanged. Finally, we discuss the robustness of our conclusions by comparing the baseline responses with prior-robust identified sets. Specifically addressing the critique regarding sign-identified SVARs and following the transparent reporting standards detailed in Baumeister and Hamilton (2015, 2020), Schorfheide (2017), Granziera et al. (2018), and Watson (2019), we report our baseline results along with their respective identified sets (i.e. the maximum and minimum estimates reported as bounds).[2] Again, we find remarkably similar dynamic responses driven by evidence in the data. The similarity of results using both methods suggest our conclusions on the substantial heterogeneity of monetary policy across Fed districts are robust.

The remainder of the paper proceeds as follows. Section 2 discusses the institutional evolution of the Fed from its inception in 1913 until the centralization of monetary policy in the mid-1930s. Section 3 describes the data and our empirical strategy. Section 4 presents the results of the empirical analysis. We first report the findings for the baseline VAR model, followed by our examination of the impact of regional and national monetary policy on economic activity in the twelve Federal Reserve districts. Section 5 provides robustness tests of the baseline results. Section 6 concludes with a discussion of the implications of the results for future research.

2 The Federal Reserve System before the Centralization of Monetary Policy

President Woodrow Wilson signed the Federal Reserve Act on December 23, 1913. The legislation established a central bank in the United States following a series of financial crises — often characterized by bank runs and bank suspensions — during the classical gold standard period. A central bank could provide a more elastic currency and play the role of a lender of last resort during a financial panic to assist illiquid banks (Miron (1986); Bernstein et al. (2010)).

The Federal Reserve Act created a public-private partnership where the Federal Reserve Board in Washington, DC provided oversight of the twelve Federal Reserve banks. Regional banks were established in large cities within each district.[3] Each Federal Reserve bank had the power to set their own discount rate and cover ratio to maintain the gold standard. The head of each Fed-

[2] In recent work, Baumeister and Hamilton (2020) discuss various useful tools and strategies for reporting results and drawing conclusions in set-identified SVARs.

[3] Boston (1st District), New York (2nd), Philadelphia (3rd), Cleveland (4th), Richmond (5th), Atlanta (6th), Chicago (7th), St. Louis (8th), Minneapolis (9th), Dallas (10th), Kansas City (11th), and San Francisco (12th).

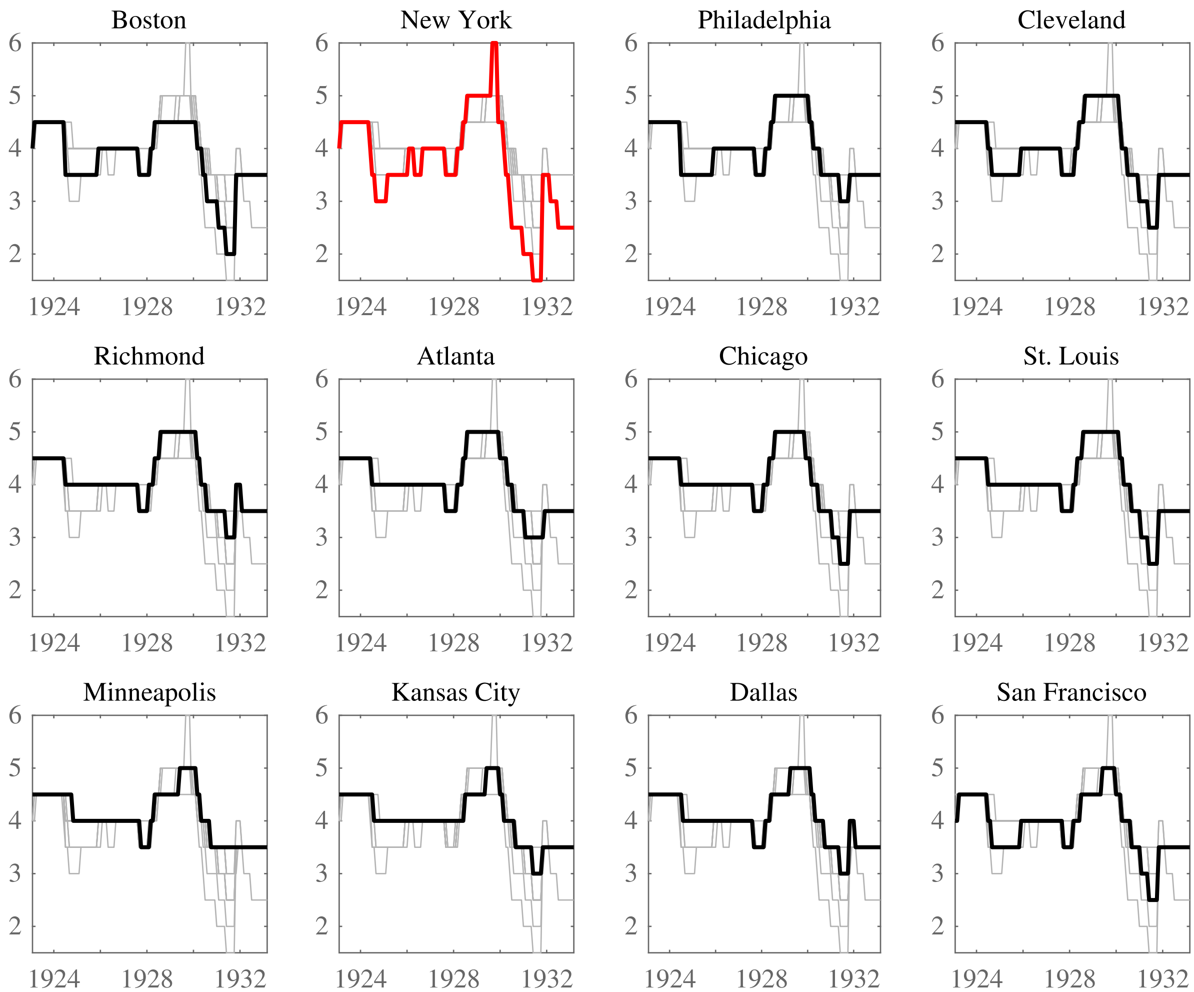

Figure 1. Discount Rate set by each Federal Reserve district. Each panel plots the discount rates of the 12 Federal Reserve banks. The black thick line represents the data for the respective Fed District indicated in the title of the panel, and the data for the remaining Fed districts are depicted in grey for comparison purposes. To highlight the New York Fed District, we depict its time series in red in its respective panel.

eral Reserve bank was given the title of governor which signified that the district banks exercised considerable control over monetary policy in each region.

The regional Fed banks formed the Open Market Investment Committee (OMIC) to discuss monetary policy. The group regularly met beginning in 1923 and sometimes coordinated monetary policy among the Federal Reserve district banks. The Fed system learned that the buying and selling of government bonds influenced short-term interest rates. Open market purchases helped stimulate economic activity in 1924 and 1927. The actions of the OMIC were not binding, however, and reserve bank governors could implement their own monetary policy if they did not agree with the recommendations of the OMIC. As Figure 1 shows, there was substantial heterogeneity in the discount rates across Federal Reserve banks. One episode that exemplifies such disagreement was the Great Crash of 1929, when regional Federal Reserve banks differed in their response to the stock market crash. The New York Fed stepped in and provided liquidity to financial markets, a lender-of-resort action praised by Friedman and Schwartz (1963). Many of the regional Federal Reserve banks did not change their discount rate and provide liquidity to their local stock exchange. Rather, the dissenting governors believed that central banks should not respond to large changes in asset prices.

The New York Fed continued to reduce discount rates after the Great Crash. By the end of 1929, its discount rate was 4.5 percent. Following six more rate cuts, the discount rate of the New York Fed bottomed out at 1 percent. In contrast, six other Federal Reserve banks lowered their discount rate from 5 to 3.5 percent and four Federal Reserve banks cut their discount rate from 5 to 2.5 percent. The exception was the Boston Fed which lowered its discount rate from 5 to 2 percent. Chandler (1971) concluded that the New York Fed was by far the most aggressive Federal Reserve bank in reducing its discount rate in the early years after the onset of the Great Depression.

As shown by Chandler (1971), many of the regional Federal Reserve banks did not believe in expansionary and interventionist monetary policy. Fed officials were often proponents of the real bills doctrine, that called for a *reduction* in lending during economic downturns. A letter by William McChesney Martin, Governor of the St. Louis Federal Reserve Bank, outlines the governor's reasoning for supporting non-interventionist monetary policy during the banking panic of 1930 (Chandler (1971, p. 142) *apud* Jalil (2014)):

> *"I cannot see how the situation can be benefited by putting 50 millions of dollars, or, in fact, any other amount, into the general market at this time... The reason that more money is not being used is because it is not needed, and when there is already money to meet the expressed needs, seems to me unwise to artificially to add to the amount already sufficient in order to encourage a use which because based on a redundancy of money rather than actual needs may be hazardous."*

Several other Federal Reserve banks held the same position on monetary interventions as the St. Louis Fed. Chandler (1971) points out that the Dallas and Richmond Federal Reserve banks also embraced the real bills doctrine and did not support activist monetary policy. A notable exception was the Atlanta Federal Reserve Bank which, as noted above, aggressively lent funds to member and non-member banks during the Great Depression.

As pointed out by Bernanke (2002) and Friedman and Schwartz (1963), Federal Reserve leadership was another important factor in the coordination of monetary policy in the early years of the central bank. Benjamin Strong, the President of the New York Fed, was an influential leader in the Federal Reserve System. He helped coordinate monetary policy among the 12 Federal Reserve districts on many occasions even though he frequently disagreed with policy recommendations from the Federal Reserve Board in Washington, DC. Friedman and Schwartz (1963) argued that he understood the importance of the lender-of-last-resort function for central banks. Notably, they believed that the Great Depression would have been less severe if Strong did not die in 1928. Without his guidance, there was a leadership vacuum at the Fed.

The Banking Acts of 1933 and 1935 introduced new banking regulation and largely transformed the Federal Reserve System into its current makeup. Known as the Glass-Steagall Act, the 1933 legislation created deposit insurance and called for the separation of commercial and investment banking. The law also included Regulation Q, which prohibited the payment of interest on checking accounts. In addition, the Banking Act of 1933 created the Federal Open Market Committee (FOMC), but did not provide the Federal Reserve Board with voting rights. The Banking Act of 1935 reorganized the structure of the Federal Reserve (Richardson et al. (2013)). The Board of Governors of the Federal Reserve System — which replaced the Federal Reserve Board — became more independent from the executive branch of government. The Secretary of the Treasury and the Comptroller of the Currency were no longer members of the Federal Reserve Board. The regional Federal Reserve banks lost much of their control over monetary policy. The head of the regional Federal Reserve banks were no longer called governors. Instead, they were given the new title of "president," which symbolized a reduction in the power of the regional banks to implement their own monetary policy. The regional Federal Reserve banks could no longer conduct open market operations in their respective districts. Rather, the newly created Federal Reserve Open Market Committee (FOMC) determined the size and scope of open market operations, which centralized monetary policy decision-making in the nation's capital.

3 Empirical Strategy

3.1 Data

We briefly present the economic and financial time series used in the empirical analysis. For greater details, the reader can consult the data appendix (Internet Appendix A). Retail sales for each of the twelve Federal Reserve districts are from Park and Richardson (2012), who compiled monthly data from the archives of the Board of Governors of the Federal Reserve System. The building permits data are taken from Cortes and Weidenmier (2019). The construction measure covers 215 cities across the United States. The data were collected from several issues of *Dun & Bradstreet's*, a well-known monthly business and financial publication in the 1920s and the 1930s. The real-time data are assembled from building inspector reports collected by the *F. W. Dodge Division*, a *McGraw-Hill Information Systems* company. The value of building permits is based on the estimated cost of new commercial and residential buildings provided by building inspectors. Food prices for 50 cities are taken from several issues of the Bulletin of the U.S. Bureau of Labor Statistics. The monetary aggregate, M1, is constructed by adding total currency in circulation and total demand deposits of member banks for each Federal Reserve district. The monetary data along with the discount rates and commercial paper rates are collected from various issues of the Federal Reserve Bulletin. The database covers the period 1923:M01–1933:M02, when the Federal Reserve Bulletin stopped reporting detailed data on the regional Federal Reserve banks. As a result, the sample period covers most of the 1920s and the entire NBER-defined Great Depression period — except for March 1933, the last month of the downturn.

3.2 Region-Specific VARs

For our baseline specification, we follow Arias et al. (2018) and estimate a Bayesian VAR for each regional Federal Reserve district with data on retail sales (rs_t), building permits (bp_t), food prices (p_t), M1 (m_t), commercial paper rates (cp_t), and the respective Federal Reserve district discount rates (r_t). We model the regional dynamics of the following vector of observables:

$$\mathbf{y_t} = \begin{pmatrix} rs_t, & bp_t, & p_t, & m_t, & cp_t, & r_t \end{pmatrix}'. \tag{1}$$

All variables for each region enter the VAR in log levels except for the interest rate data, which enter in levels. We consider a Gaussian VAR in the $n \times 1$ vector of observables $\mathbf{y_t}$. The VAR is given by

$$\mathbf{y_t}'\mathbf{A_0} = \sum_{p=1}^{P} \mathbf{y_{t-p}}'\mathbf{A_p} + \mathbf{c} + \epsilon_t', \tag{2}$$

with $\epsilon_t \sim \mathcal{N}(0, \mathbf{I_n})$, for $1 \leq t \leq T$, where $\mathbf{c}$ is the constant term, ϵ_t is an $n \times 1$ vector of orthogonal structural shocks that have an economic interpretation, $\mathbf{A_p}$ is an $n \times n$ matrix of structural parameters for $0 \leq p \leq P$ with $\mathbf{A_0}$ invertible, P is the lag length, and T is the sample size. The SVAR described in equation (2) can be written as

$$\mathbf{y_t}'\mathbf{A_0} = \mathbf{x_t}'\mathbf{A_+} + \epsilon_t', \tag{3}$$

where $\mathbf{A_+}' = \left[\mathbf{A_1}' \cdots \mathbf{A_p}' \quad \mathbf{c}'\right]$ and $\mathbf{x_t}' = [\mathbf{y_{t-1}}' \cdots \mathbf{y_{t-P}}' \quad 1]$. The dimension of $\mathbf{A_+}'$ is $m \times n$, where $m = nP + 1$. We refer to $\mathbf{A_0}$ and $\mathbf{A_+}$ as the structural parameters. The reduced-form vector autoregression (VAR) implied by equation (3) is

$$\mathbf{y_t}' = \mathbf{x_t}'\mathbf{B} + \mathbf{u}_t', \tag{4}$$

where the reduced form coefficient matrix is $\mathbf{B} = \mathbf{A_+}\mathbf{A_0^{-1}}$, the innovation vector is $\mathbf{u}_t' = \epsilon_t'\mathbf{A_0^{-1}}$, and the innovation covariance matrix can be factored as $\mathbb{E}\left[\mathbf{u}_t\mathbf{u}_t'\right] = \mathbf{\Sigma} = \mathbf{A_0}\mathbf{A_0^{-1}}$. Let $\mathbf{\Theta} = (\mathbf{A_0}, \mathbf{A_+})$ collect the value of the structural parameters.

3.2.1 Impulse Response Functions

Given a value $\mathbf{\Theta}$ of the structural parameters, one can compute the impulse response functions (IRFs). The response of the ith variable to the jth structural shock at horizon k corresponds to the element in row i and column j of the matrix $\mathbf{L_k}(\mathbf{\Theta})$ which is defined recursively by

$$\begin{aligned}
\mathbf{L_0}(\mathbf{\Theta}) &= \left(A_0^{-1}\right)' \\
\mathbf{L_k}(\mathbf{\Theta}) &= \sum_{p=1}^{k}\left(A_pA_0^{-1}\right)'\mathbf{L_{k-p}}(\mathbf{\Theta}), && \text{for} \quad 1 \leq k \leq P, \\
\mathbf{L_k}(\mathbf{\Theta}) &= \sum_{p=1}^{P}\left(A_pA_0^{-1}\right)'\mathbf{L_{k-p}}(\mathbf{\Theta}), && \text{for} \quad P \leq k \leq \infty,
\end{aligned}$$

3.2.2 Structural Shocks and Historical Decomposition

Given a value $\mathbf{\Theta}$ of the structural parameters and the data, the structural shocks at time t are

$$\epsilon_t'(\mathbf{\Theta}) = \mathbf{y_t}'\mathbf{A_0} - \mathbf{x_t}'\mathbf{A_+}. \tag{5}$$

The historical decomposition calculates the cumulative contribution of each shock to the observed unexpected change in the variables between two periods. Formally, the contribution of the jth shock to the observed unexpected change in the ith variable between periods t and $t+h$ is

$$\mathbf{H}_{i,j,t,t+h}\left(\mathbf{\Theta}, \epsilon_t, \ldots, \epsilon_{t+h}\right) = \sum_{p=0}^{h} \mathbf{e}_{i,n}' \mathbf{L_p}'\left(\mathbf{\Theta}\right) \mathbf{e}_{j,n} \mathbf{e}_{j,n}' \epsilon_{t+h-p}, \tag{6}$$

where $\mathbf{e}_{j,n}$ the jth column of $\mathbf{I}_n$, for $1 \leq i,j \leq n$ and for $h \geq 0$.

3.2.3 Estimation and Identification

As it is well-known, structural VARs require additional identifying restrictions to map the reduced-form innovations (u_t) to structural shocks (ϵ_t). For set-identified SVAR models, this typically involves factoring Σ by a Cholesky decomposition with a lower-triangular factor denoted by $\tilde{\mathbf{A}}^{-1}$ and a rotation matrix $\mathbf{Q}$, where $\mathbf{Q} \in \mathcal{O}(n)$ is the set of all orthogonal $n \times n$ matrices (see, e.g., Uhlig (2005), Rubio-Ramírez et al. (2010) and Arias et al. (2018)). For the reduced form representation, this can be summarized as:

$$u_t' = \epsilon_t' \tilde{\mathbf{A}}^{-1}\mathbf{Q}, \qquad \Sigma = \tilde{\mathbf{A}}^{-1}\mathbf{Q}\left(\tilde{\mathbf{A}}^{-1}\mathbf{Q}\right)', \qquad \mathbf{Q}\mathbf{Q}' = I_n. \tag{7}$$

In set-identified SVARs, the key identifying restrictions in the mapping of innovations to structural shocks formally constrains the domain of the rotation matrix $\mathbf{Q}$ such that the qualitative sign restriction on the resulting impulse-response functions are satisfied. We can write our full model as:

$$p(\mathbf{y^T}, \mathbf{B}, \mathbf{\Sigma}, \mathbf{Q}) = \ell(\mathbf{B}, \mathbf{\Sigma}|\mathbf{y^T})\pi_0(\mathbf{B}, \mathbf{\Sigma})\pi_{\mathbf{Q}}(\mathbf{Q}|\mathbf{B}, \mathbf{\Sigma}), \tag{8}$$

where $\mathbf{y^T}$ collects the history of observables, $\ell(\cdot)$ is the likelihood function, $\pi_0(\cdot)$ denotes the prior over the identifiable reduced-form parameters, and $\pi_{\mathbf{Q}}(\cdot)$ denotes the prior over $\mathbf{Q}$ that incorporates restrictions on impulse responses. For the estimation of the model, we use a uniform-normal-inverse-Wishart distribution for the priors over the orthogonal reduced-form parameterization. In our empirical implementation, we use a standard Minnesota-type prior over $(\mathbf{B}, \mathbf{\Sigma})$ and otherwise specifically follow Antolín-Díaz and Rubio-Ramírez (2018) to do causal inference for the orthogonal reduced-form parameterization implementing Algorithm 1, set the lag length to 6 and the standard Minnesota prior implemented with dummy observation priors.[4]

3.3 Identification of Monetary Policy Shocks

3.3.1 Sign Restrictions

Since the seminal papers by Faust (1998), Canova and De Nicolò (2002) and, most prominently Uhlig (2005), sign-restricted SVARs have become an increasingly popular tool for estimating dynamic causal effects in macroeconomics. Many researchers use Uhlig's (2005) algorithm or its variants to impose a few theory-based or uncontroversial restrictions on the sign of impulse response functions to identify a shock of interest. As these types of identifying constraints restrict the resulting identified responses to a bounded set, we refer to these models as set-identified. Over the past few years, a growing literature has proposed important methodological refinements and advances (e.g., Rubio-Ramírez, Waggoner, and Zha (2010); Baumeister and Hamilton (2015); Antolín-Díaz and Rubio-Ramírez (2018); Arias, Rubio-Ramírez, and Waggoner (2018); Granziera, Moon, and Schorfheide (2018)).

The main advantages of the approach are that the identifying sign constraints are theoretically well motivated, minimal, and uncontroversial. Its limitations are that the identifying sign constraints typically offer *weak* identification, i.e., restricting only the direction by means of the sign of a few IRFs for a few periods. In many applications, this results in notably large error bands that are either insignificant or inconclusive. Therefore, it is difficult and rare to find robust evidence and clear conclusions among competing hypotheses on the sources of business cycle fluctuations when employing these methods.[5]

Among the many important advances, Antolín-Díaz and Rubio-Ramírez (2018) show that combining the standard approach with simple *narrative* sign restrictions (NSR) on the structural shocks and/or the historical decomposition tend to be highly informative. This

[4]A thorough discussion of the hyperparameters and its choices for Bayesian VARs can be found in Giannone et al. (2015) and Del Negro and Schorfheide (2011). Following the notation of Del Negro and Schorfheide (2011), we choose an overall tightness parameter of $\lambda_1 = .2$, a decay parameter of $\lambda_2 = 2$, prior for the covariance matrix of error terms $\lambda_3 = 1$, sums-of-coefficients prior with $\lambda_4 = 1$ and co-persistence prior with $\lambda_5 = 1$.

[5]Uhlig (2005) argues that this is precisely why sign restrictions offer a useful and new perspective. They offer a transparent assessment of what we can robustly conclude from the data while imposing only what macroeconomists believe they know.

approach imposes the sign of the identified shock series at specified points in time to agree with the established narrative account of these episodes.

3.3.2 Baseline Identification

Our basic identification restrictions for a contractionary monetary policy shock essentially follows Uhlig (2005), imposing the impulse response functions of retail sales (rs_t), building permits (bp_t), food prices (p_t), and money aggregate M1 (m_t) to be negative following the shock for 6 months, while the impulse-response functions of the Federal Reserve discount rate (r_t) is constrained to be positive for that period and the commercial paper rate is left unconstrained. Beyond its transparent nature to impose only what macroeconomic theory established as facts, in our case we do not have to take a stance on a specific policy instrument in place. Our baseline sign restrictions are summarized in Table 1. While we do not impose any narrative sign restrictions in our baseline specification, we present robustness checks that include variations of our standard sign restrictions and the inclusion of narrative sign restrictions in Section 5.

— Place Table 1 About Here —

3.3.3 Monetary Policy and the Great Depression

We now describe four monetary policy events during the Great Depression that Friedman and Schwartz (1963) considered to be exogenous to define narrative sign restrictions as in Antolín-Díaz and Rubio-Ramírez (2018).[6] For convenience, all narrative sign restrictions discussed in detail here are also briefly described in Table 2.

— Place Table 2 About Here —

The first episode is a monetary contraction. In the words of Bernanke (2002), it was *"a deliberate tightening of monetary policy that began in the Spring of 1928 and continued until the stock market crash of October 1929. Why did the Federal Reserve tighten in early 1928? A principal reason was the Board's ongoing concern about speculation on Wall Street."* Friedman and Schwartz (1963) point out that by July 1928 the discount rate of the New York Fed had been raised to 5 percent, its highest level since 1921. The holdings of government securities by the Federal Reserve System also

[6] This section borrows the rich narrative description from Friedman and Schwartz (1963) and Bernanke (2002).

fell from $600 million at the end of 1927 to $210 million by August 1928. They concluded that this period represented a tightening in monetary policy not related to economic conditions. This leads us to define our first narrative sign restriction:

Narrative Sign Restriction 1 ***(Monetary Policy Contraction in April 1928)****. Beyond standard sign restrictions on the impulse response functions, the sign of the monetary policy shock must be positive in April 1928 to represent an identified monetary policy shock.*

The second episode is also a monetary contraction. The Federal Reserve raised the discount rate from 1 to 2 percent on October 9, 1931. The increase was then followed by another rise in the discount rate to 3 percent on October 16, 1931. The policy was a response to the speculative attacks on the pound sterling that led the UK to abandon the gold standard. Again, the interest rate increase is exogenous to US economic conditions since the policy was directly aimed at preventing a run on the dollar. Friedman and Schwartz (1963) argued that the 200 basis point increase in the discount rate increased bank failures and bank runs, with 522 commercial banks closing their doors in October alone. The policy tightening contributed to the decline in the money supply as well as economic activity. We therefore define our second narrative sign restriction as:

Narrative Sign Restriction 2 ***(Monetary Policy Contraction in October 1931)****. Beyond standard sign restrictions on the impulse response functions, the sign of the monetary policy shock must be positive in October 1931 to represent an identified monetary policy shock.*

The third episode we study is an expansionary intervention. Friedman and Schwartz (1963), Hsieh and Romer (2006), and Bordo and Sinha (2016) argue that the monetary expansion of April 1932 was one of the most important monetary policy shocks in US history. In fact, the open market expansion was the largest in the history of the Federal Reserve at the time of its implementation. All 12 Federal Reserve banks participated in the monetary expansion that was largely undertaken because of political pressure from Congress. The Board of Governors eventually acquiesed to moral suasion and conducted large-scale open market operations between April and June of 1932. The large quantitative easing program appears to have temporarily increased economic activity before fizzling out following the removal of the monetary stimulus in the late summer of 1932.

Figure 2 shows the holdings of US government securities for the 12 regional Federal Reserve banks. The New York Fed stands out as it accounts for about 40 percent of the total government

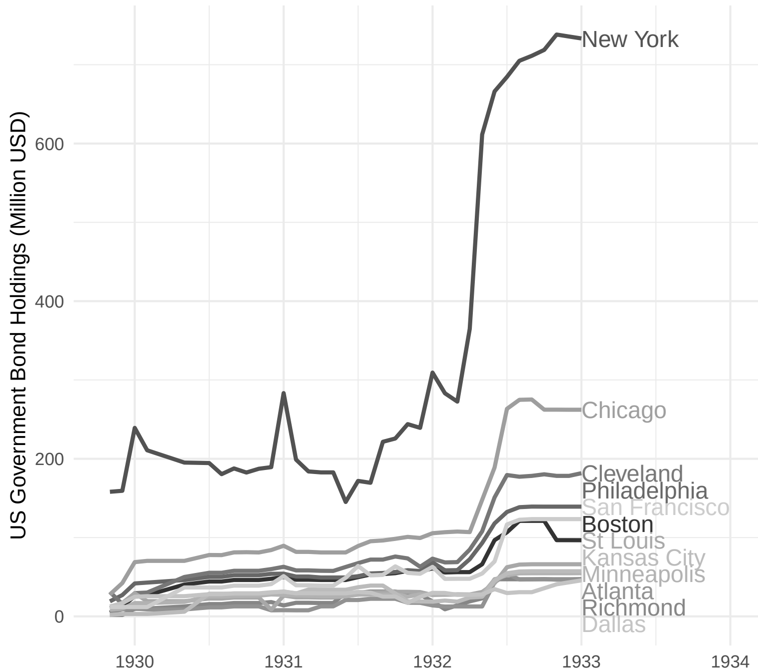

Figure 2. The 1932 Monetary Policy Expansion. This figure depicts the time series of US government bond holdings of the twelve Federal Reserve districts around the 1932 monetary policy expansion episode. The data are from the Federal Reserve Bulletins and are in million USD.

securities in the system. The size of the Federal Reserve banks' portfolio of government securities varies considerably across the 12 Federal Reserve districts, but its expansionary stance is unambiguous across districts. This leads us to define our third narrative sign restriction:

Narrative Sign Restriction 3 ***(Monetary Policy Expansion in April 1932)****. Beyond standard sign restrictions on the impulse response functions, the sign of the monetary policy shock must be negative in April 1932 to represent an identified monetary policy shock.*

The fourth and last episode studied by Friedman and Schwartz (1963) was a contractionary shock from January 1933 to the banking holiday in March 1933. There was considerable economic uncertainty during this period given that President Roosevelt was elected in November 1932 but did not take office until March of 1933. Market participants were unclear about the future direction of US economic policy, although many speculated that Roosevelt might devalue the dollar or leave the gold standard altogether. Some people converted their cash into gold which pressured the banking system and the gold reserves of the Federal Reserve (Bernanke (2002)). Between September 1932 and March 1933, the United States experienced its largest decline in economic activity during the Great Depression.

Narrative Sign Restriction 4 ***(Monetary Policy Contraction in January 1933)****. Beyond standard sign restrictions on the impulse response functions, the sign of the monetary policy shock must be positive in January 1933 to represent an identified monetary policy shock.*

Finally, we focus again on the monetary stimulus of April 1932. Given its expansionary effects, we consider an additional narrative sign restriction that imposes a *magnitude* restriction on the importance of monetary shocks in April 1932. Specifically, the narrative sign restriction requires the monetary policy shock to be the most important contributor to the Federal Reserve discount rate shock in April 1932. This is formalized by defining a "strong" expansion on our fifth and last narrative sign restriction:[7]

Narrative Sign Restriction 5 ***(Strong Monetary Policy Expansion in April 1932)****. Let Narrative Sign Restriction 3 be dominant for r_t, i.e., for the periods specified by Narrative Sign Restriction 3, monetary policy shocks are the most important and dominant contributor to the movements in the Fed discount rate, r_t.*

3.4 Modelling National and Regional Monetary Policies: Factor-Augmented VARs

We model the distinction between national and regional monetary policy shocks using a dynamic factor model for the regional discount rate. We estimate the following specification using data on the twelve discount rates $d_{n,t}$ of each Federal Reserve district $n = 1, \ldots, N$:

$$d_{n,t} = \gamma_i f_t + r_{n,t} \qquad r_{n,t} \sim N(0, \sigma_n^2) \tag{9}$$

$$f_t = \phi(L) f_{t-1} + u_t \qquad u_t \sim N(0, \Sigma_f) \tag{10}$$

where f_t is the national factor of discount rates that captures the common component of the twelve discount rates, γ_i is the factor loading of region n and $r_{n,t}$ is the idiosyncratic component which captures the regional-specific component of monetary policy. The dynamics of the national monetary policy factor are captured by the lag polynomial $\phi(L)$, the variance of regional monetary policy in region n is captured by σ_n^2 and Σ_f is the covariance matrix of the national monetary policy innova-

[7] In the language of Antolín-Díaz and Rubio-Ramírez (2018), a "strong" narrative sign restriction means that the absolute value of the contribution of monetary policy shocks is larger than the absolute value of the contribution of any other structural shock.

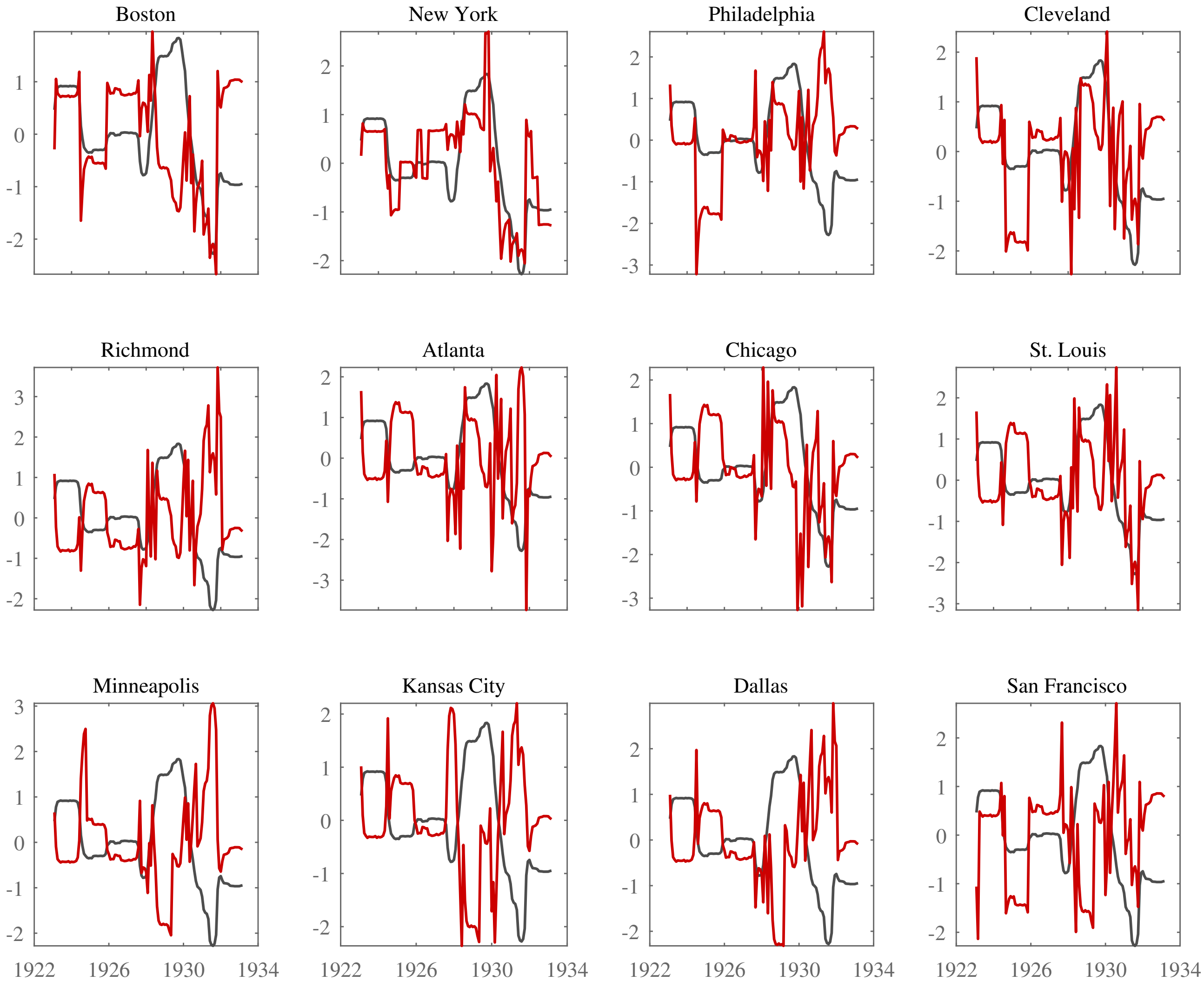

Figure 3. Common Factor (in grey) *vs.* Regional-specific (in red) discount rates. This figure depicts the standardized national and regional components for each Federal Reserve district. All panels depict the time series (in grey) of the national component, which is the same on all districts. The red line represents the regional component of monetary policy, i.e., the discount rate's idiosyncratic factor of each Fed district.

tion. Equations (9) and (10) form a state space model that we estimate with Bayesian methods and standard priors. More details on the estimation are provided in the Internet Appendix C.[8]

The time series of the national and the regional components of discount rates are shown in Figure 3. We can see that the discount rate of the New York Fed closely matches the national

[8]The decomposition of regional discount rate data into national and regional specific is not sensitive to the specific estimation and factor extraction approach. We try different specifications such as (i) a Bayesian forward-filtering backward sampling approach employing natural conjugate prior for the parameters and hyperparameters, allowing for uncertainty in the measure of the respective unobserved components and (ii) a traditional dynamic principal component approach that delivers an exact decomposition without uncertainty. As both approaches deliver virtually the same results, we report results for the former approach for brevity. The implemented priors for the parameter estimation of the state model (9)-(10) are standard flat priors; a normal-inverse Gamma prior for the former, and a Normal-inverse Wishart prior for the latter equation.

component of monetary policy. This finding is consistent with Friedman and Schwartz's (1963) view that New York was the center of the US financial system and carried out a large share of the open market operations in the Federal Reserve System. This also suggests that the New York Federal Reserve Bank exerted some leadership in monetary policy.

4 Results

We start by presenting results for our baseline region-specific VARs in the next subsection. Then, we present results for the Factor-Augmented VAR model that distinguishes between the national and regional component of monetary policy shocks. We conclude showing results that revisit key episodes of monetary policy during the Great Depression through the lens of our empirical framework.

4.1 Region-Specific VARs

The impulse response function (IRF) analysis for the baseline vector autoregressions appear in Figures 4 through 7. For comparison purposes, all panels include (in grey) the IRF of the New York Fed. The graphs show the impact of a 25 basis point increase in the discount rate for each of the 12 regional Federal Reserve banks. The impulse responses show the posterior median and 68% error bands. A 25 basis point shock is employed for the impulse response analysis since it is the median rate increase over the sample period. Figure 4 shows that a shock to the discount rate significantly reduces retail sales for all Federal Reserve Districts. The findings for the New York District are particularly interesting because a contractionary monetary policy shock has less of an impact on retail sales than any of the other Federal Reserve districts. There is also some evidence that an increase in the discount rate by the Boston Federal Reserve has a smaller impact on retail sales than the other regional Federal banks. For the remaining districts, a contractionary monetary policy shock has a much larger effect in reducing retail sales.

The forecast error variance decompositions (FEVD) in Table 3 portray a similar story. Panel A shows that a shock to the New York Fed discount rate can only explain about 10 percent of the movements in retail sales after 60 months. For Boston, we find that a discount rate shock explains about 15 percent of the forecast error variance after 5 years. In contrast, a contractionary monetary policy shock accounts for about 20 percent of the fluctuations in retail sales for Atlanta,

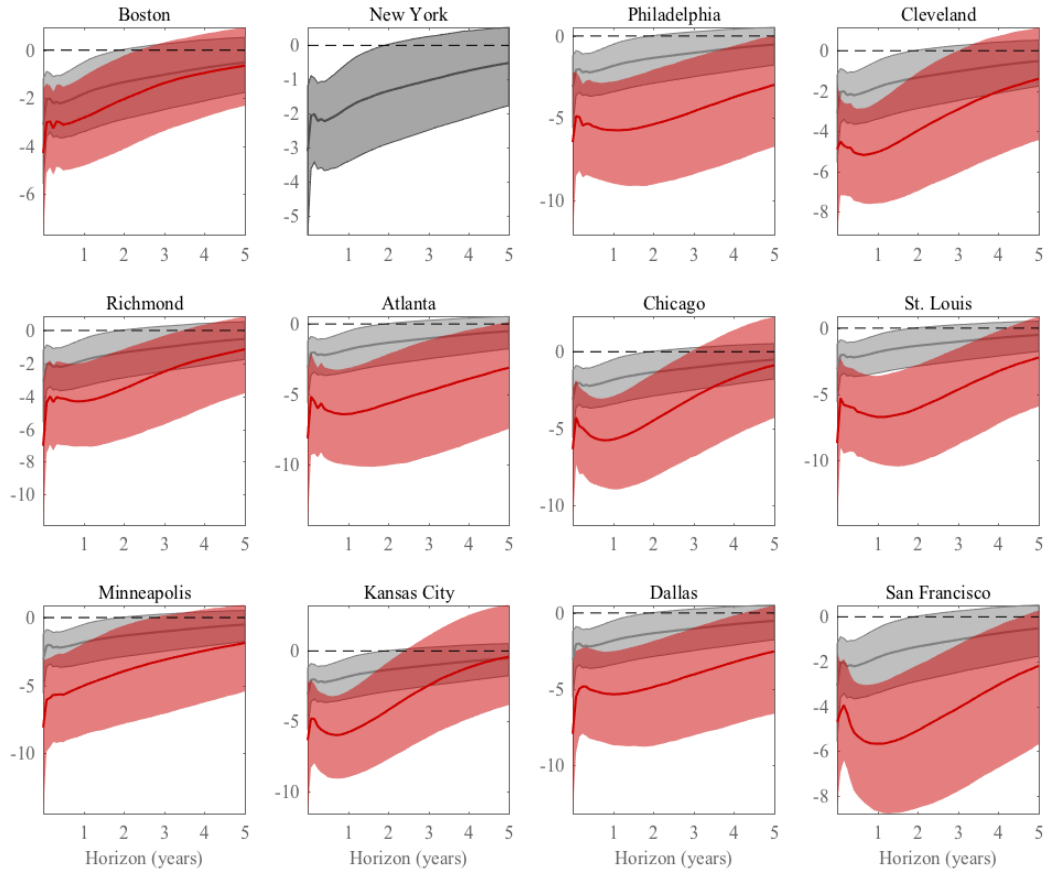

Figure 4. VAR Impulse-Response Functions for Retail Sales. This figure depicts the response of retail sales in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

Cleveland, Philadelphia, Chicago, St. Louis, Richmond, Kansas City, Minneapolis, and the San Francisco Federal Reserve District. Panel B shows the maximum median FEVD and the horizon for which this maximum is achieved across all Fed districts. The maximum median FEVD for retail sales surpasses 20 percent in almost all districts. The horizons for which the maximum median FEVD is reached are longer than a year for all districts, with the exception of New York.

— Place Table 3 About Here —

In Figure 5, we find qualitatively similar responses for building permits, a forward-looking economic indicator that is sensitive to interest rates. A shock to the discount rate for the New York Fed has a much smaller impact on building permits than in the other Federal Reserve districts. The forecast error variance decompositions in Table 3 show that the New York Fed discount rate can explain about 18 percent of the movements in the construction variable after five

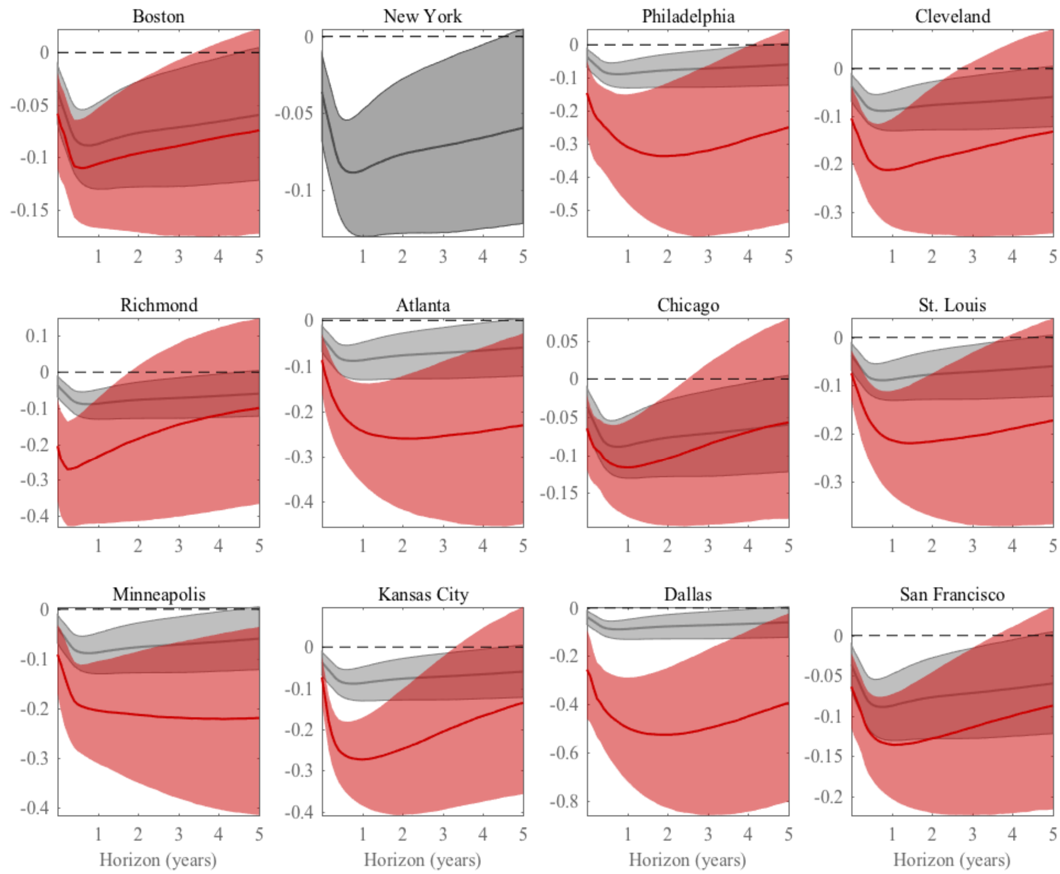

Figure 5. VAR Impulse-Response Functions for Building Permits. This figure depicts the response of building permits in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

years. The IRF for the Boston Fed shows a similar pattern. A 25 basis point increase in the discount rate of the Boston Fed has a significant but small impact on building permits. A much different story emerges if we look at the remaining Federal Reserve banks, however. The FEVD shows that a one-standard deviation shock to the discount rate can explain between 15 and 25 percent of the movements in the real estate variable.

The regional Federal Reserve money supply estimates also display significant variation across the districts. Figure 6 shows that an increase in the discount rate significantly reduces M1 in all twelve Federal Reserve bank districts. Notably, the responses of the New York and Boston Federal Reserve districts show much less persistence in the decrease of the money supply in response to a discount rate increase. The findings align with our baseline results. Specifically, the decline in M1 in response to a contractionary monetary policy shock becomes insignificant in less than a year in

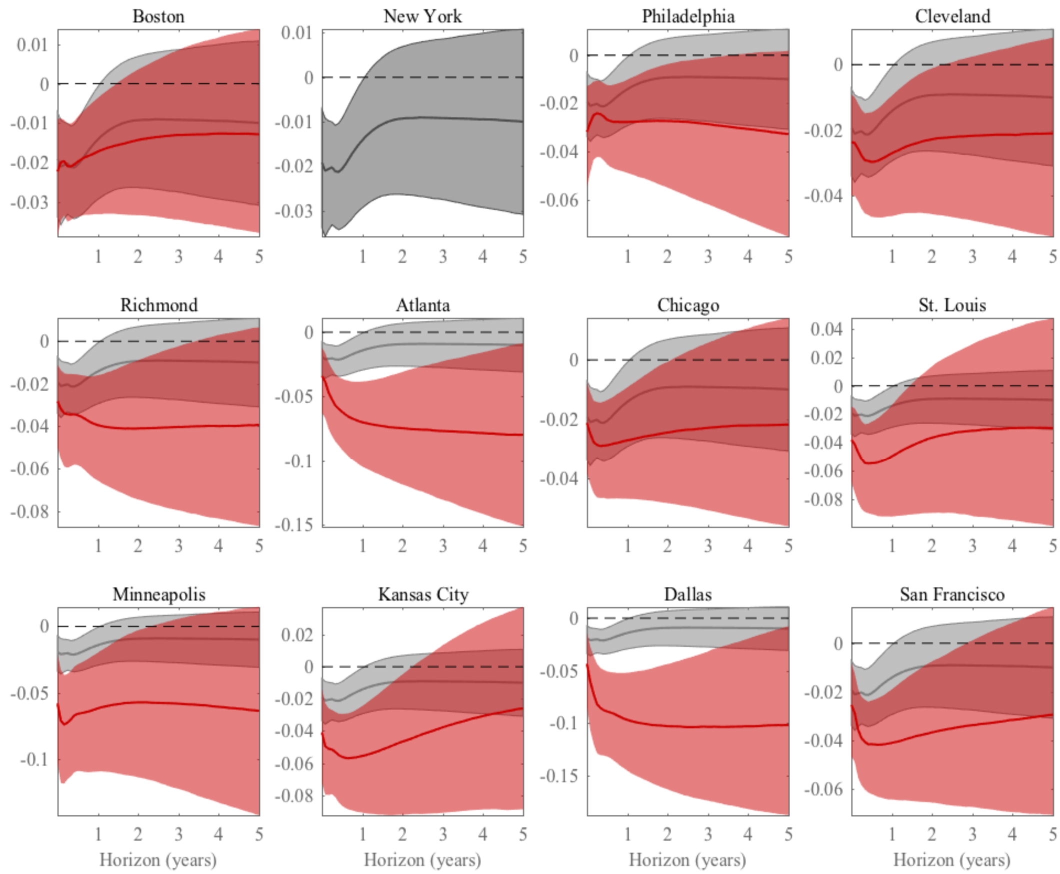

Figure 6. VAR Impulse-Response Functions for M1. This figure depicts the response of the monetary aggregate M1 in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve district. The sign-restriction of the monetary policy shock is binding for 6 months.

Boston and New York. M1 declines for up to five years in the other Federal Reserve districts. The FEVDs in Table 3, Panel B indicate that monetary policy shocks account for about 15-25 percent of the movements of the money supply across the twelve Federal Reserve districts.

Finally, Figure 7 reports the IRFs for food prices in each Fed district. A contractionary monetary policy shock consistently reduces the price level in all twelve Federal Reserve districts. As before, the responses of prices to monetary policy contractionary shocks display heterogeneity in persistence and magnitude across Fed districts. The IRFs for the remaining variables of the baseline VAR — shown in Section B.1 of the Internet Appendix — are statistically significant and conform to economic theory. For example, we find that a 25 basis point increase in the discount rate accounts for 20 to 30 percent of the movements of commercial paper rates.

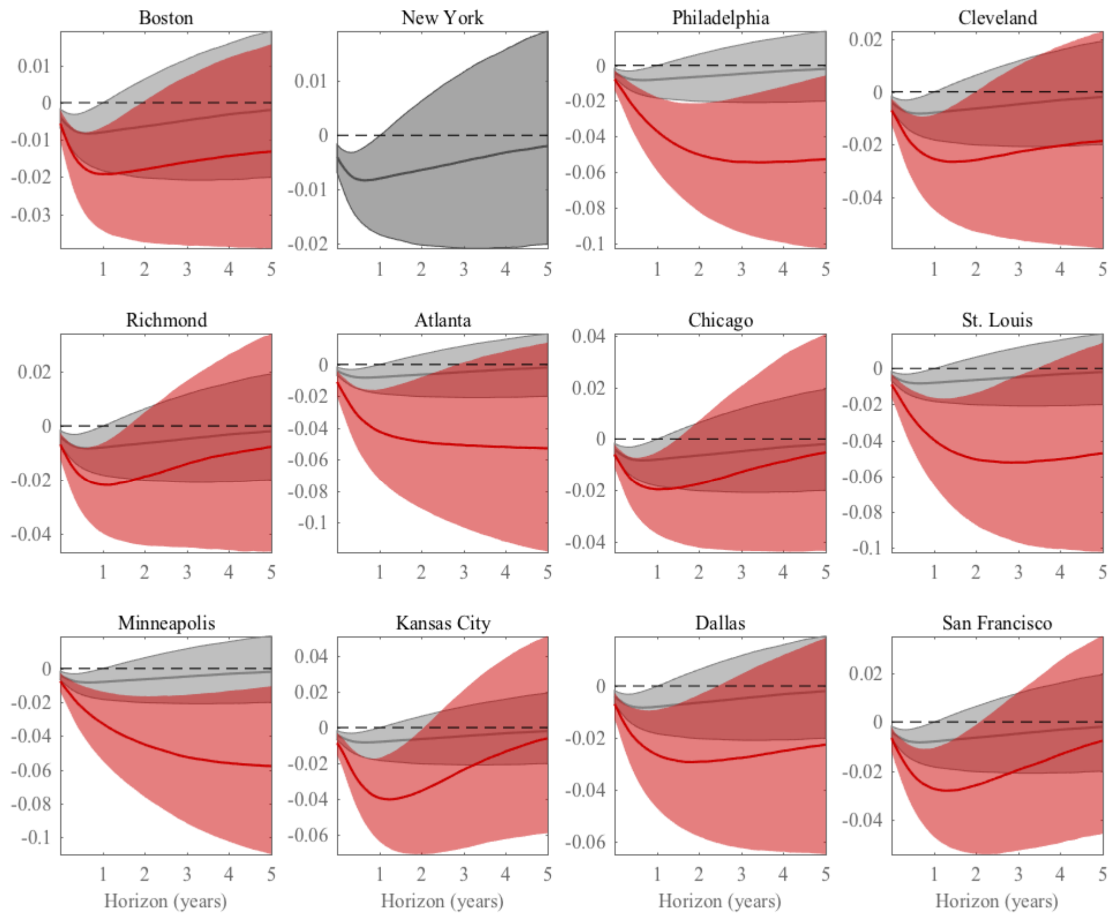

Figure 7. VAR Impulse-Response Functions for Food Prices. This figure depicts the response of food prices in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

4.2 National and Regional Factor-Augmented VAR

We now present results for the national and regional components of monetary policy shocks.[9] We begin analyzing the impact of monetary policy shocks on retail sales. Figure 8 shows that retail sales decrease in all districts in response to a *national* monetary policy contraction. With few exceptions, most IRFs look similar to the baseline response of the New York Fed District, suggesting that the common component of monetary policy affects regions similarly. This is in stark contrast with the response of retail sales to *regional-specific* monetary policy shocks, shown in Figure 9. In the regional case, most IRFs differ from the New York Fed District's IRF (with the exception of Boston,

[9]For conciseness, we present results on the effects of monetary policy on real-side variables, i.e., retail sales and building permits. The figures for the responses of remaining variables to national (regional) monetary policy shocks are shown in Section B.2 (Section B.3) of the Internet Appendix.

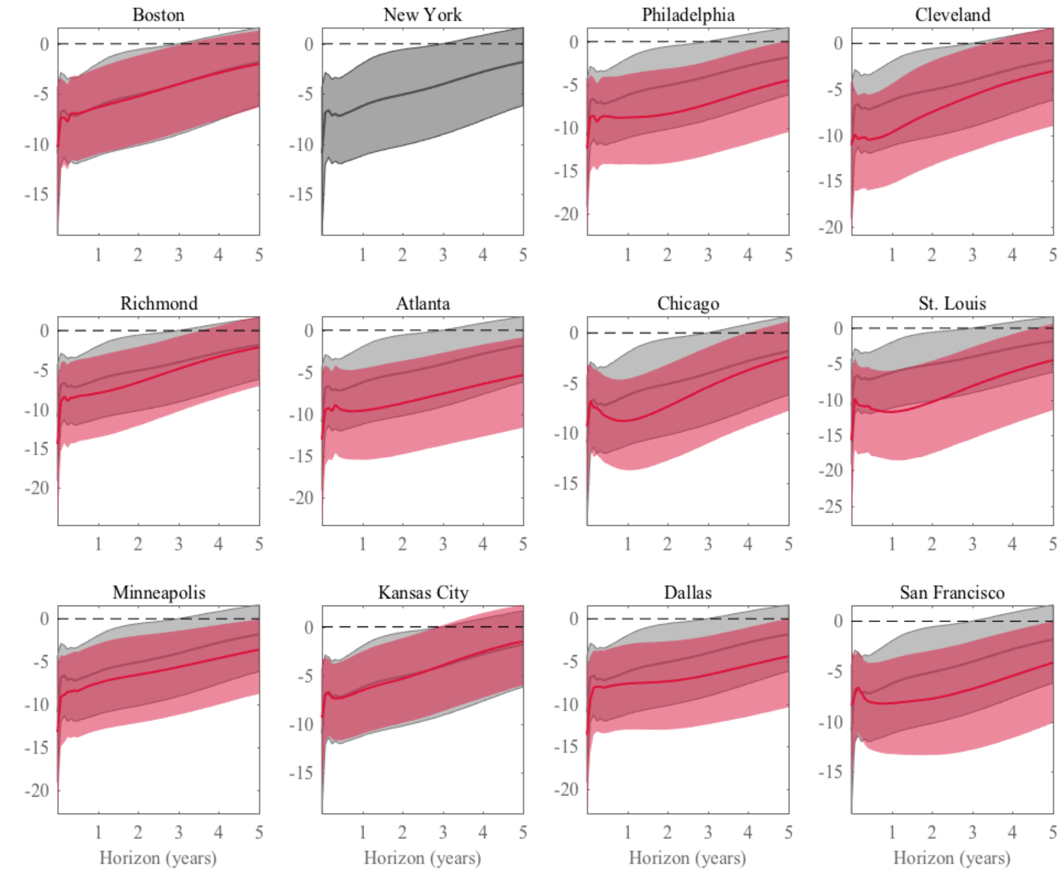

Figure 8. Factor-Augmented VAR Impulse-Response Functions for Retail Sales: National Monetary Policy. This figure depicts the response of the monetary aggregate M1 in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

as expected from our previous results). The responses of retail sales are significantly more negative and more persistent than that of the New York Fed District.

The response of building permits also suggests that regional-specific monetary policy shocks matter more for economic activity. Figure 10 shows that most districts display similar IRFs than that of the New York Fed District. An exception is the Dallas Fed District, which presents a significantly more negative and persistent response as compared to the New York Fed's response. Similarly, the regional component of monetary policy shocks has a much more pronounced effect on other Fed Districts. As shown by Figure 11, the IRF of the New York Fed District is significantly less negative, despite being as persistent as the IRFs of the other Fed districts.

Forecast error variance decompositions for the national monetary policy factor relative to retail sales shown in Table 4 deliver a similar conclusion. Panel A of Table 4 shows that ten out of the

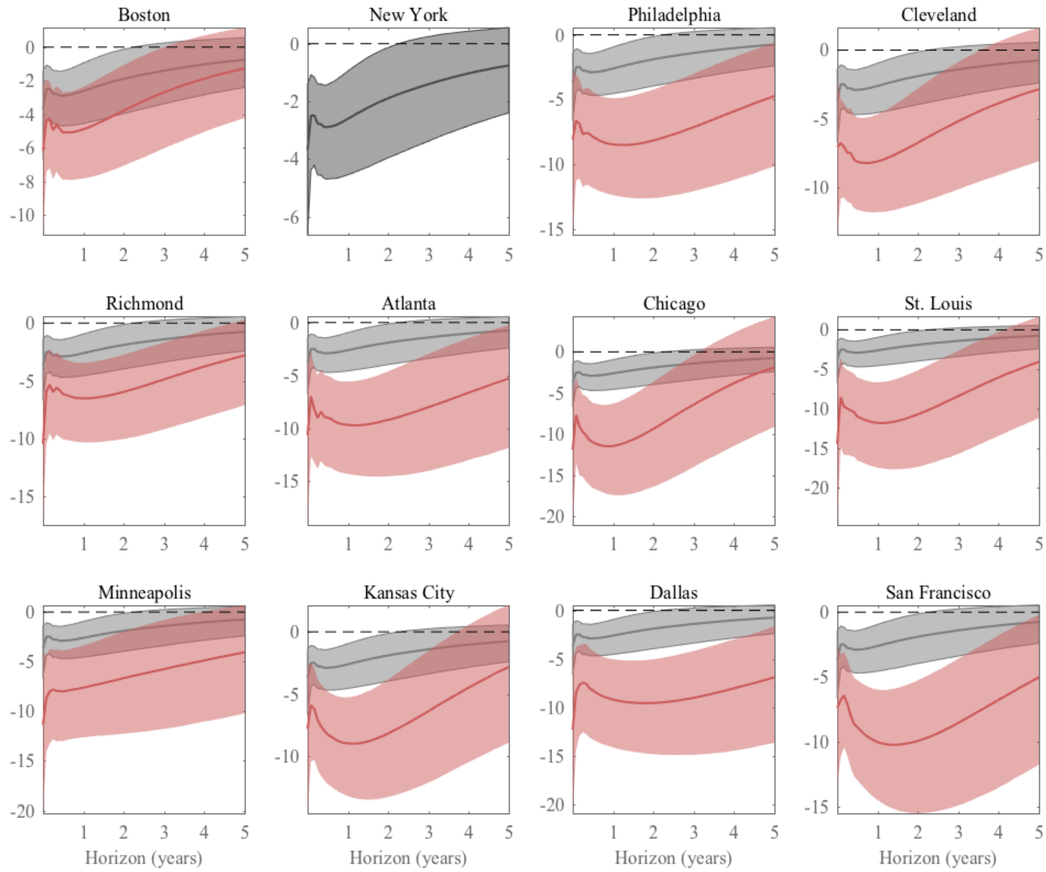

Figure 9. Factor-Augmented VAR Impulse-Response Functions for Retail Sales: Regional Monetary Policy. This figure depicts the response of the monetary aggregate M1 in the twelve Federal Reserve Districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Fed's district. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

twelve districts display FEVDs below 20 percent of retail sales' forecast error variance across districts five years later. In addition, Panel B indicates that there are only three Federal Reserve districts where the peak FEVD exceeds 20 percent. Overall, national-level monetary policy contractions explain between 12 and 22 percent of the forecast error variance five years later. In contrast, Table 5 reports that regional monetary contractions matter more for economic activity than national monetary shocks. Only three out of twelve districts present FEVDs below 20 percent after five years. In fact, many districts display FEVDs of 27 percent or higher. Regional monetary shocks can explain between 14 and 33 percent of the forecast error variance of retail sales five years later.

The same pattern arises when comparing the FEVD of national *versus* regional-level monetary policy contractions for building permits across Fed districts. A national monetary policy shock explains between 9 and 22 percent of the movements in the building permits across the Federal

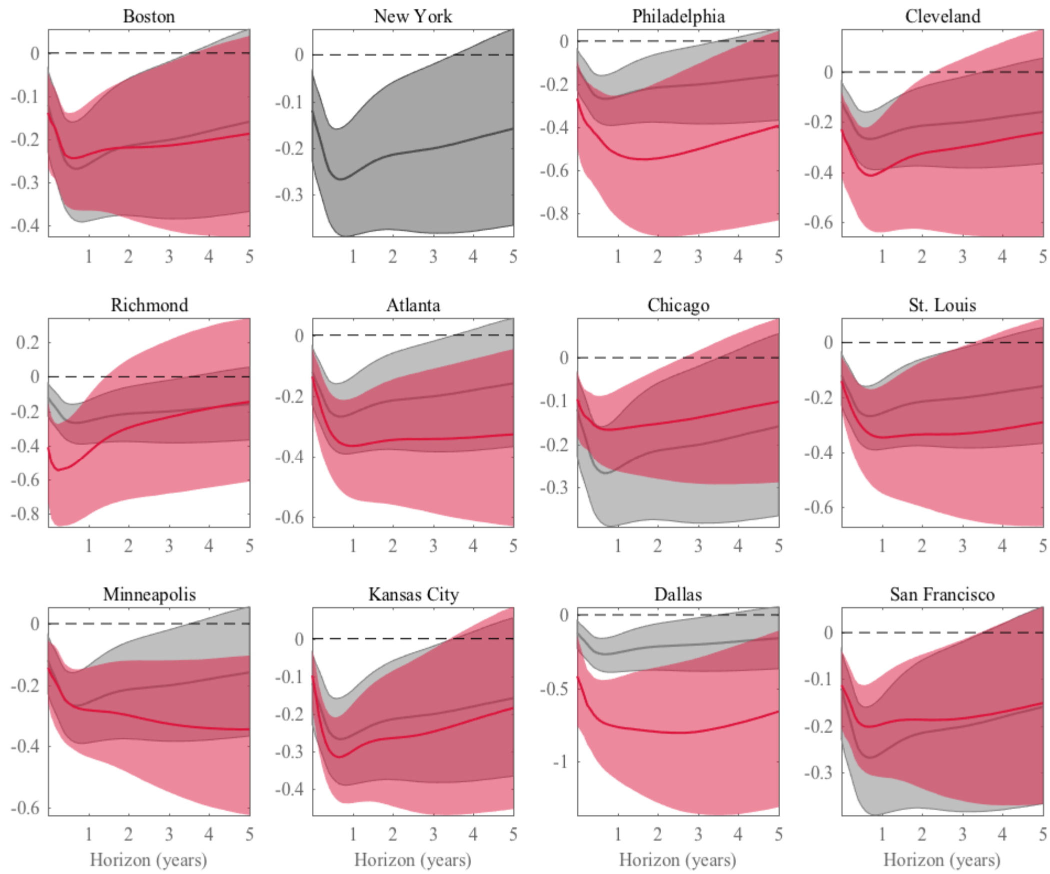

Figure 10. Factor-Augmented VAR Impulse-Response Functions for Building Permits: National Monetary Policy. This figure depicts the response of the monetary aggregate M1 in the twelve Federal Reserve Districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

Reserve System after 5 years. There are only two districts that have FEVDs greater than 20 percent at a five-year forecast horizon for building permits (Atlanta and Dallas). The maximum median FEVD exceeds 25 percent for only four out of the 12 regional Federal Reserve banks. For a regional monetary policy shock, we find that an increase in the discount rate explains between 11 and 32 percent on the movements in building permits. Eight of the 12 Federal Reserve districts have FEVDs greater than 20 percent after five years. The maximum median FEVD is also 25 percent or greater for eight of the 12 Federal Reserve Districts.

— PLACE TABLE 4 AND TABLE 5 ABOUT HERE —

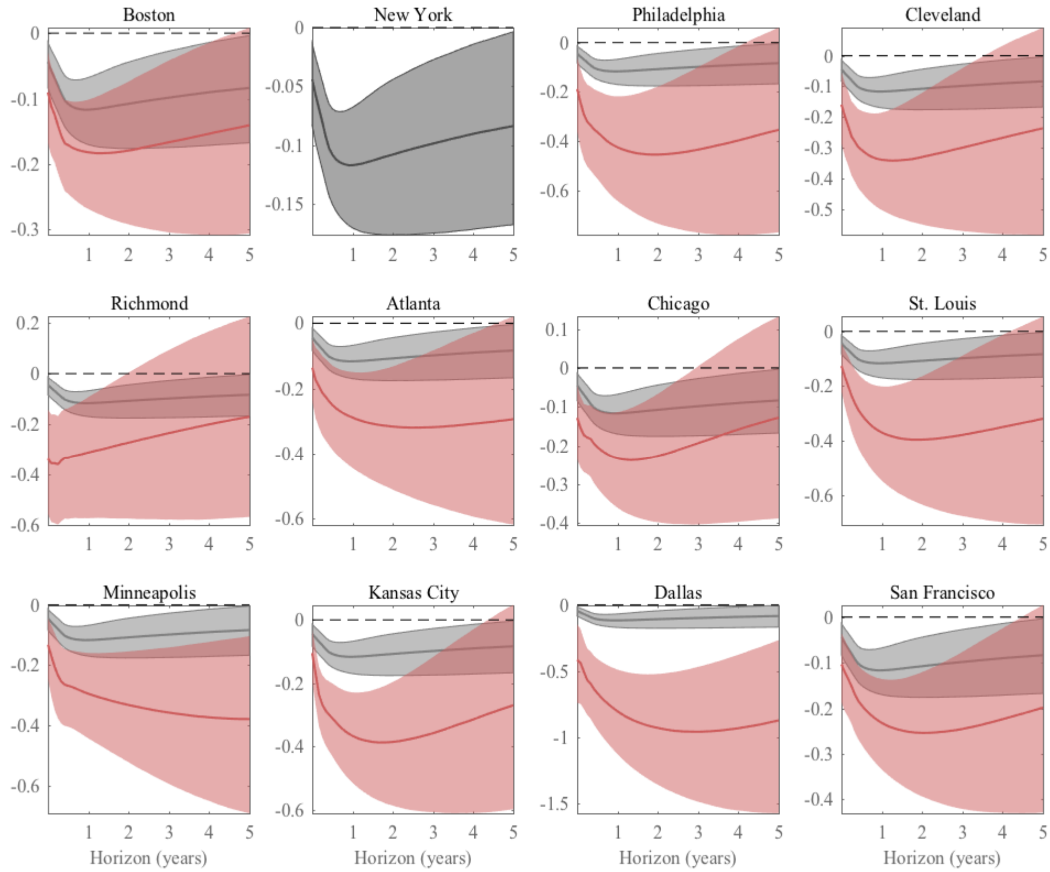

Figure 11. Factor-Augmented VAR Impulse-Response Functions for Building Permits: Regional Monetary Policy. This figure depicts the response of the monetary aggregate M1 in the twelve Federal Reserve districts to a 25-basis-point contractionary monetary policy shock. For comparison purposes, all panels include (in grey) the IRF of the New York Federal Reserve District. The sign-restriction of the monetary policy shock (Uhlig (2005)) is binding for 6 months and is detailed in Table 1.

4.3 Monetary Policy and Bank Failures

We now present the results of our FAVAR model augmented with the rate of failed bank deposits to total deposits in each Fed district. For brevity, we present results relative to the three Federal Reserve districts that were previously analyzed by the literature (New York, Atlanta, and St. Louis). Panel A of Figure 12 shows the histogram of the impact response of failed bank deposits to a contractionary monetary policy shock for each Fed district identified as described in Table 6. A striking feature of the histogram is the probability mass concentration in lower values for New York and Atlanta *vis-à-vis* the St. Louis Fed district. This suggests that the effect of monetary policy contractions on bank failures are notably severe in the St. Louis district, a result also backed by the natural experiment approach of Richardson and Troost (2009). Panels B, C, and D of Figure 12 show IRFs in

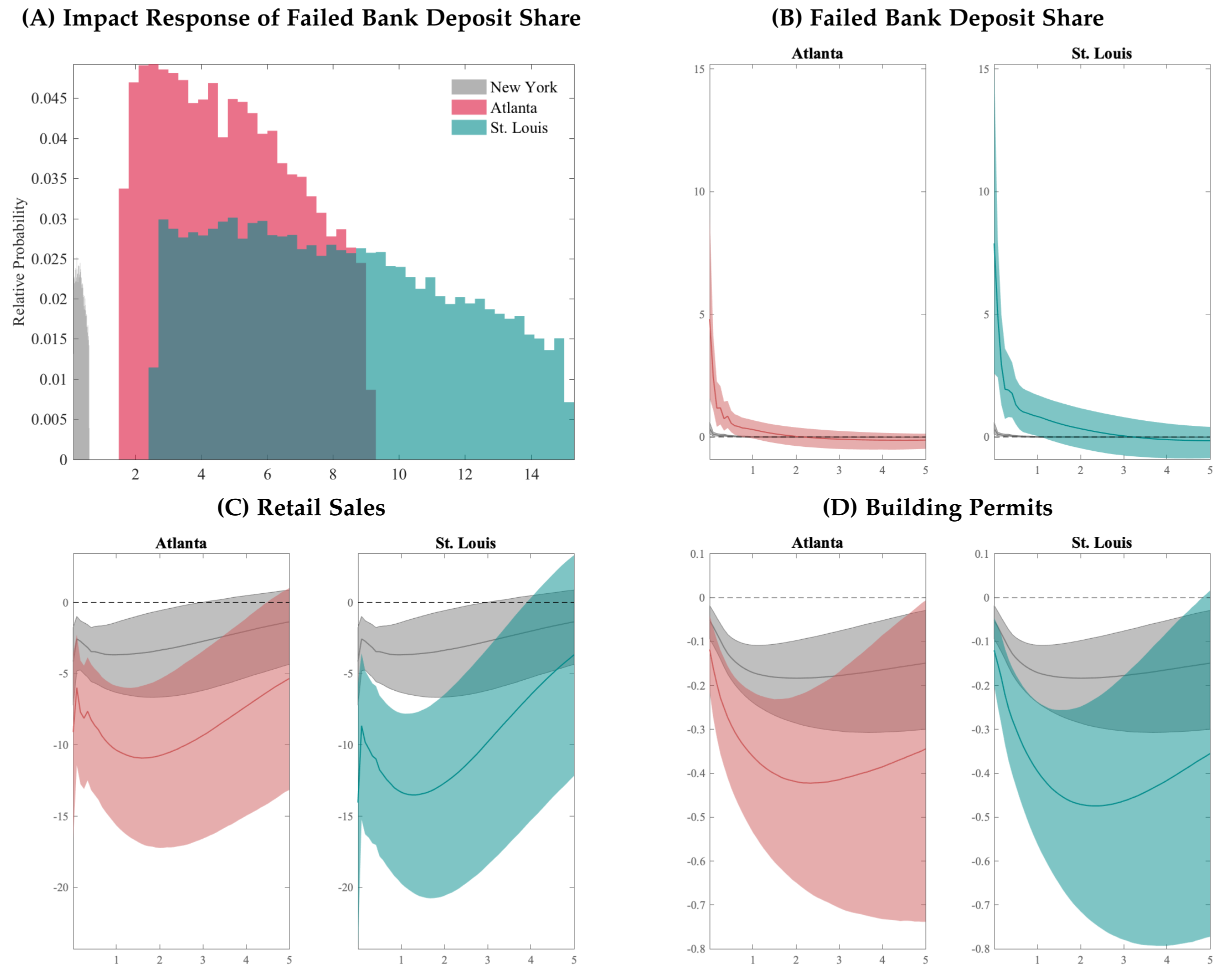

Figure 12. Contractionary Monetary Policy Shocks, Bank Failures, and Real Economic Activity. This figure displays the impulse-response function of the share of failed bank deposits to total deposits to a contractionary monetary policy shock.

their standard presentation for the impact of monetary policy contractions on failed bank deposits, retail sales, and building permits. An interesting result from comparing these responses is that real activity as measured by retail sales (Panel C) displays a more negative response to monetary policy shocks in St. Louis than in Atlanta, which is also consistent with the real effects of the distinct Federal Reserve policies across both districts discussed in Richardson and Troost (2009).

— PLACE TABLE 6 ABOUT HERE —

5 Robustness Checks

We now turn to robustness checks and variations of our model. As before, we focus our discussion on the responses of real-side variables (retail sales and building permits) to monetary policy shocks. The findings for all variables in the robustness models are quite similar to our baseline results and are available from the authors upon request.

Variations in Sign Restrictions. Our baseline results rely on sign restrictions that bind for 6 months. In Section B.4 of the Internet Appendix, we report IRFs using alternative horizons for sign restrictions of 1 quarter as described in Table 7.[10] We can see that the conclusions of our baseline IRFs remain unchanged. Furthermore, Section B.5 of the Internet Appendix shows that the basic tenor of the results remains unchanged when we use the sign restrictions described earlier in Table 2, where retail sales and building permits are left unrestricted and the narrative approach of Antolín-Díaz and Rubio-Ramírez (2018) is employed by exploiting the four "exogenous" monetary policy shocks discussed by Friedman and Schwartz (1963) and Bernanke (2002).

— Place Table 7 About Here —

Deviations from New York Federal Reserve Policy. The baseline empirical results do not control for the impact of the New York Fed, which conducted a large share of the country's open market operations. New York was also the center of the US financial system. As a result, we augment our baseline, regional-specific vector autoregressions with the spread between each Federal Reserve district and the discount rate of the New York Federal Reserve. As Figure 1 shows, the discount rate of the New York Fed can be interpreted as an approximation of national monetary policy. The interest-rate differential is a measure of the idiosyncratic component of monetary policy for a given Fed district. We then estimate a VAR for each Federal Reserve district using the idiosyncratic deviation of monetary policy for a given district from the discount rate of the New York Fed (see Table 8). The impulse responses of retail sales and building permits to a 25 basis point increase in the idiosyncratic component of monetary policy for each Federal Reserve district are shown in Section B.6. The results of the New York Fed spread specification are similar to the baseline FAVAR.

[10] We only report IRFs to be parsimonious in the number of tables and figures. Forecast error variance decompositions or historical decompositions for these alternative variations are available from the authors upon request.

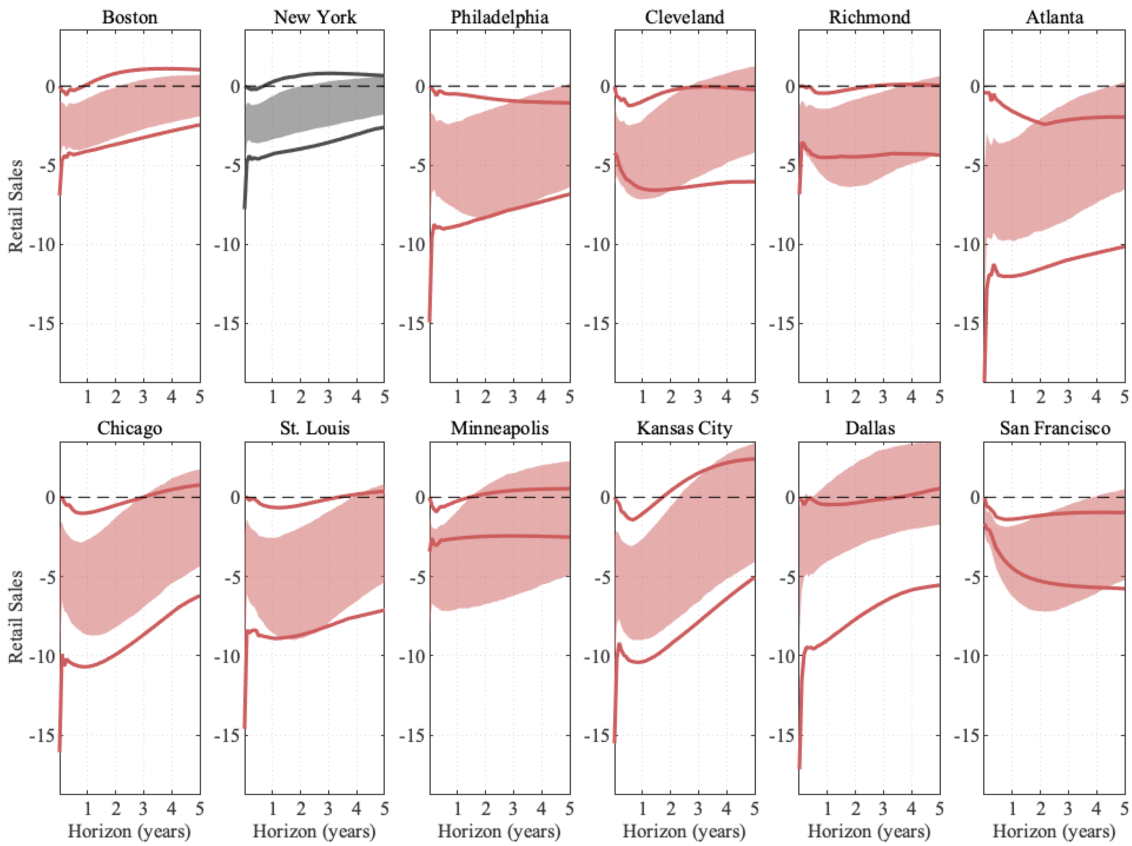

Figure 13. Comparison of identified set with posterior error bands: Retail Sales. This figure compares the identified set of the impulse response functions (solid lines) with the respective posterior error bands (shaded area) for retail sales.

Regional monetary policy shocks, proxied by the idiosyncratic component, are statistically and economically significant. The IRFs are in line with our baseline IRFs, that retail sales and building permits decrease in response to a contractionary monetary policy shock.

— PLACE TABLE 8 ABOUT HERE —

Incorporating Failed Bank Deposits. In the previous section, we augmented the FAVAR model with failed bank deposits. Section B.7 of the Internet Appendix presents impulse responses of real activity variables for all Fed districts using the bank-failure augmented model previously described in Table 6. The impulse responses for the failed bank deposit-augmented model are similar to the baseline responses. A contractionary monetary policy shocks reduces retail sales and building permits.

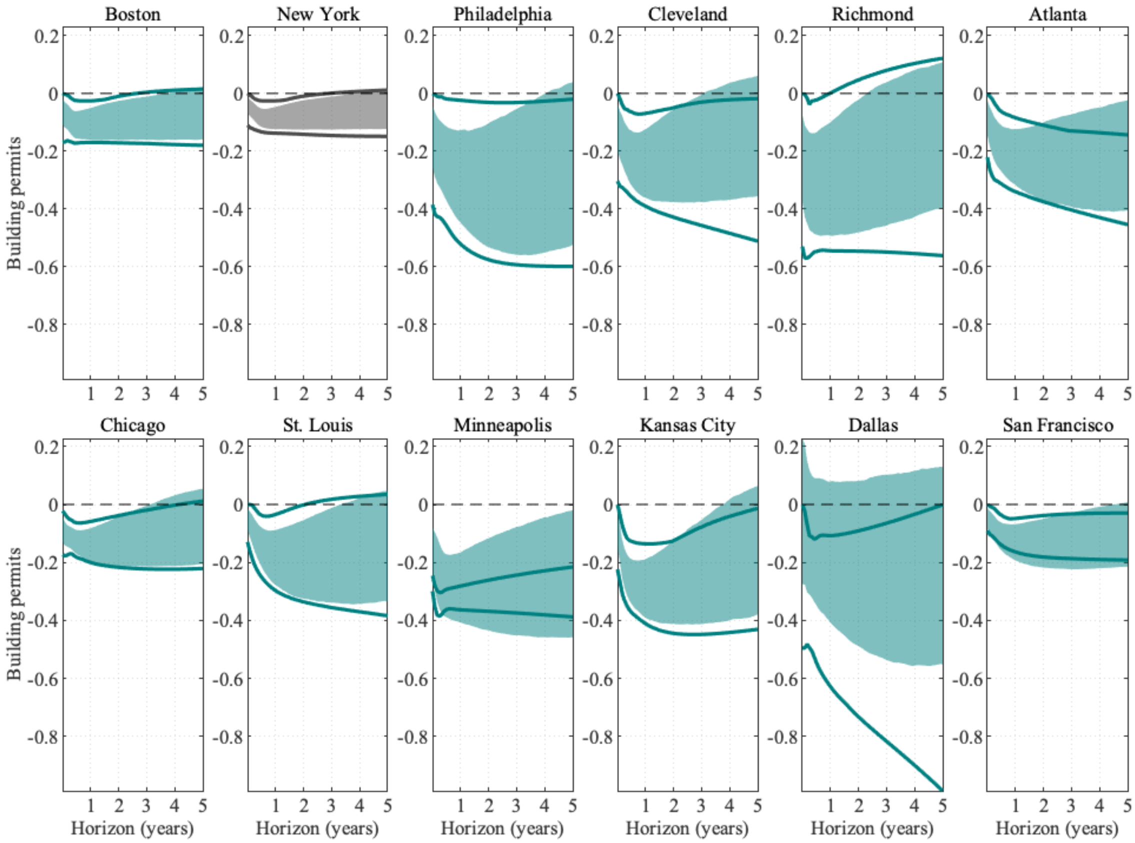

Figure 14. Comparison of identified set with posterior error bands: Building Permits. This figure compares the identified set of the impulse response functions (solid lines) with the respective posterior error bands (shaded area) for building permits.

Minimal Narrative Sign Restrictions. In one of the robustness checks above, we used our narrative sign restrictions all combined. We now analyze our IRFs imposing a narrative sign restriction only on the 1932 monetary intervention which was the largest open market purchase undertaken by the Fed since its founding in 1913. Specifically, we now impose only Narrative Sign Restriction 5, requiring the 1932 open market operations pursued by the Fed to be an expansionary and dominant force of monetary policy shocks in 1932:M04 as described in Table 9. Section B.8 of the Internet Appendix presents impulse responses of this variation. As we can observe, the impulse responses are broadly similar to our baseline results.

— Place Table 9 About Here —

Robustness of Bounds for Conclusions. To address Baumeister and Hamilton's (2015) critique of set-identified SVARs, we report the robustness of the results by comparing the identified set with the posterior error bands. This allows us to check whether our conclusions are robust or simply driven by the prior over the rotations (see, e.g., Schorfheide (2017), Granziera et al. (2018), Watson (2019), and Baumeister and Hamilton (2020) for a detailed discussion). We present these bounds of the identified set as solid lines and our baseline impulse responses in shaded areas in Figure 13 (retail sales) and Figure 14 (building permits). As shown by both figures, we find the bounds of our reported posterior IRFs and the identified sets to be remarkably close. We do not find a pathological strong concentration of our reported posteriors within the identified set. Most importantly, our reported identified sets confirm the robustness of the heterogeneity we find across regions.

6 Concluding Remarks

What role did national and regional monetary policy play in the dramatic decline of the national money supply and the Great Depression? We address this question using a standard structural vector autoregression that uses Uhlig (2005) sign restrictions. The empirical analysis, as measured by the discount rate or the money supply, explains between 10 and 25 percent of the forecast error variance in retail sales for the twelve Federal Reserve districts. We find similar results for building permits. Contractionary monetary policy shocks by the New York Federal Reserve and our national monetary factor generally had a smaller impact on retail sales and building permits. A one-standard deviation shock to the discount rate only explains about 10 percent of the forecast error variance of the two measures of economic activity. The baseline results are robust to imposing the sign restrictions for as little as 1 quarter and to not imposing sign restrictions on real economic variables. Our results are also robust to a large battery of robustness checks that include augmenting the baseline specification with the share of failed bank deposits and the spread of each Fed district's discount rate with respect to the discount rate of the New York Fed. Our conclusions also remain unchanged when we impose minimal narrative sign restrictions to our baseline impulse-responses.

Overall, the results show that regional monetary policy shocks had large economic effects in all 12 Federal Reserve districts. The empirical analysis shows that regional monetary policy shocks had a larger effect on regional economic conditions than national monetary policy. This conclusion remains when national monetary policy is measured by a common factor taken from the discount rates of the 12 Federal Reserve banks or when we simply augment each regional VAR with the discount rate of the New York Fed. This suggests that the regional Federal Reserve banks were more responsible for the dramatic decline in the money supply that had real economic effects during the Great Depression than national monetary policy. Finally, our results are broadly consistent with Richardson and Troost (2009) and provide additional insights on the aggregate, dynamic responses of real economic activity to monetary policy shocks during the Depression. Our paper can be seen as a first exploration of the real effects of monetary policy using an ideal empirical setting of one country with 12 quasi-independent central banks through the lens of widely-used VAR models. Researchers could benefit from our empirical setting in future studies of how monetary policy affects other outcomes of interest.

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Tables

Table 1. Baseline Sign Restrictions Imposed for Identification. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	r_t
	$-$	$-$	$-$	$-$	x	$+$
$\mathcal{SR}$-Horizon	6 *month*					

Table 2. Variation: Common Monetary Policy FAVAR with Narrative Sign Restrictions on all four major monetary policy episodes and agnostic sign restrictions excluding constraints on output. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	r_t
	x	x	$-$	$-$	x	$+$
$\mathcal{SR}$-Horizon	6 *month*					
Narrative Sign Restriction	**Brief description of narrative**					**Date**
Narrative $\mathcal{SR}1 : (-)$	Antispeculative monetary policy tightening					1928:M04
Narrative $\mathcal{SR}2 : (-)$	Contractionary monetary policy tightening following Sterling crisis					1931:M10
Narrative $\mathcal{SR}3 : (+)$	Expansionary shock					1932:M04
Narrative $\mathcal{SR}4 : (-)$	Contractionary shock					1933:M01
Narrative $\mathcal{SR}5$: (strong)	Let Narrative $\mathcal{SR}3$ be dominant for r_t					

Table 3. Forecast Error Variance Decomposition for Regional-Specific VARs. Panel A shows the median FEVD relative to a monetary policy shock for each one of the twelve Federal Reserve districts. The first six columns refer to the horizon where $h = 0$ months, whereas columns 7 to 12 refer to the horizon $h = 60$ months. Panel B reports the respective maximum median FEVD and its corresponding horizon in brackets. The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

Panel A. Selected Horizons

	Horizon: Month 0						Horizon: Month 60					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	10%	9%	11%	12%	12%	18%	15%	17%	10%	8%	12%	14%
New York	11%	9%	12%	13%	11%	13%	12%	19%	6%	9%	13%	13%
Philadelphia	8%	8%	12%	12%	10%	9%	23%	18%	20%	14%	17%	15%
Cleveland	9%	11%	12%	16%	11%	14%	21%	16%	10%	15%	17%	16%
Richmond	14%	13%	11%	10%	9%	13%	20%	11%	8%	14%	16%	12%
Atlanta	12%	12%	11%	11%	10%	13%	24%	26%	13%	24%	17%	15%
Chicago	12%	10%	10%	12%	12%	17%	20%	13%	8%	14%	14%	11%
St. Louis	14%	14%	11%	11%	11%	10%	25%	18%	15%	11%	19%	16%
Minneapolis	12%	10%	10%	12%	14%	15%	15%	20%	17%	13%	12%	14%
Kansas City	11%	9%	14%	14%	15%	15%	18%	21%	10%	14%	17%	13%
Dallas	16%	13%	12%	8%	17%	11%	21%	24%	11%	24%	18%	14%
San Francisco	11%	12%	9%	11%	15%	12%	25%	21%	11%	18%	15%	15%

Panel B. Maximum Median FEVD Horizons

	Max median FEVD [at Horizon]					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	16% [20]	24% [13]	16% [7]	14% [6]	13% [5]	18% [2]
New York	14% [9]	29% [13]	12% [1]	16% [6]	18% [4]	16% [3]
Philadelphia	23% [48]	20% [27]	21% [32]	14% [60]	19% [8]	17% [5]
Cleveland	24% [22]	24% [13]	14% [6]	21% [11]	17% [8]	16% [60]
Richmond	21% [37]	18% [7]	13% [5]	15% [26]	17% [7]	13% [2]
Atlanta	24% [52]	30% [27]	14% [8]	27% [21]	17% [60]	15% [60]
Chicago	22% [25]	22% [12]	13% [4]	19% [10]	16% [4]	17% [0]
St. Louis	27% [37]	26% [14]	17% [24]	15% [9]	19% [59]	16% [60]
Minneapolis	17% [14]	24% [23]	17% [47]	18% [7]	14% [1]	18% [3]
Kansas City	21% [19]	39% [11]	19% [9]	24% [12]	18% [6]	16% [1]
Dallas	22% [41]	32% [18]	15% [4]	26% [30]	18% [60]	16% [3]
San Francisco	26% [33]	28% [16]	15% [10]	25% [14]	15% [60]	15% [60]

Table 4. Forecast Error Variance Decomposition for Factor-Augmented VAR: National Common Factor. Panel A shows the median FEVD relative to a shock to the national common factor of monetary policy for each one of the twelve Federal Reserve districts. The first six columns refer to the horizon where $h = 0$ months, whereas columns 7 to 12 refer to the horizon $h = 60$ months. Panel B reports the respective maximum median FEVD and its corresponding horizon in brackets. The variables included in the Factor-Augmented VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), Federal Reserve discount rate (r_t), the national common factor of discount rates ($\hat{f}_t$) and the regional (idiosyncratic) component of discount rates ($\hat{f}_{i,t}$).

Panel A. Selected Horizons

	Horizon: Month 0						**Horizon: Month 60**					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	9%	8%	9%	13%	12%	17%	13%	12%	7%	9%	11%	9%
New York	12%	9%	11%	12%	10%	16%	12%	14%	5%	7%	12%	10%
Philadelphia	10%	9%	11%	13%	10%	11%	18%	16%	11%	14%	15%	12%
Cleveland	9%	11%	11%	17%	10%	13%	16%	10%	6%	13%	14%	11%
Richmond	13%	11%	10%	11%	8%	11%	15%	9%	5%	13%	14%	9%
Atlanta	11%	11%	9%	11%	9%	14%	22%	22%	9%	21%	14%	14%
Chicago	10%	8%	8%	11%	11%	27%	18%	11%	6%	13%	13%	10%
St. Louis	12%	14%	9%	12%	11%	11%	21%	13%	11%	11%	17%	13%
Minneapolis	14%	11%	9%	9%	11%	15%	16%	19%	13%	12%	12%	10%
Kansas City	12%	8%	12%	12%	12%	18%	14%	14%	8%	12%	13%	11%
Dallas	16%	12%	10%	8%	16%	16%	18%	21%	7%	22%	17%	11%
San Francisco	11%	11%	9%	10%	14%	16%	17%	14%	7%	18%	14%	11%

Panel B. Maximum Median FEVD Horizons

	Max median FEVD [at Horizon]					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	13% [16]	20% [13]	11% [5]	13% [0]	14% [4]	17% [0]
New York	14% [10]	25% [13]	11% [0]	14% [6]	17% [4]	16% [0]
Philadelphia	18% [41]	18% [23]	13% [6]	14% [10]	18% [6]	16% [3]
Cleveland	19% [14]	20% [11]	12% [3]	20% [7]	17% [7]	13% [1]
Richmond	16% [35]	17% [8]	11% [3]	14% [20]	16% [7]	11% [1]
Atlanta	22% [60]	28% [17]	11% [7]	22% [18]	16% [8]	14% [0]
Chicago	20% [30]	19% [10]	10% [3]	16% [11]	17% [4]	27% [0]
St. Louis	23% [34]	21% [11]	12% [11]	15% [9]	19% [7]	13% [60]
Minneapolis	17% [10]	20% [19]	13% [59]	15% [10]	16% [4]	15% [0]
Kansas City	17% [11]	31% [10]	15% [6]	22% [10]	17% [7]	18% [1]
Dallas	18% [56]	29% [12]	13% [4]	24% [23]	17% [5]	16% [1]
San Francisco	17% [24]	21% [10]	10% [3]	25% [14]	15% [7]	16% [0]

Table 5. Forecast Error Variance Decomposition for Factor-Augmented VAR: Regional Factor. Panel A shows the median FEVD relative to a shock to the regional (idiosyncratic) factor of monetary policy for each one of the twelve Federal Reserve districts. The first six columns refer to the horizon where $h = 0$ months, whereas columns 7 to 12 refer to the horizon $h = 60$ months. Panel B reports the respective maximum median FEVD and its corresponding horizon in brackets. The variables included in the Factor-Augmented VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), Federal Reserve discount rate (r_t), the national common factor of discount rates ($\hat{f}_t$) and the regional (idiosyncratic) component of discount rates ($\hat{f}_{i,t}$).

Panel A. Selected Horizons

	Horizon: Month 0						**Horizon: Month 60**					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	10%	10%	11%	11%	14%	18%	19%	24%	16%	11%	13%	15%
New York	10%	9%	12%	14%	11%	14%	14%	23%	7%	10%	15%	15%
Philadelphia	7%	8%	12%	12%	11%	9%	27%	19%	22%	14%	14%	12%
Cleveland	9%	12%	12%	15%	11%	15%	27%	20%	14%	19%	18%	20%
Richmond	13%	16%	12%	10%	8%	14%	22%	11%	11%	13%	12%	9%
Atlanta	10%	14%	12%	11%	13%	10%	28%	21%	16%	25%	14%	14%
Chicago	12%	11%	10%	12%	14%	11%	23%	16%	11%	15%	13%	19%
St. Louis	14%	15%	11%	10%	10%	11%	29%	22%	18%	12%	17%	16%
Minneapolis	12%	10%	10%	14%	17%	7%	18%	25%	24%	13%	10%	14%
Kansas City	9%	10%	16%	13%	20%	11%	26%	26%	15%	16%	14%	15%
Dallas	14%	13%	14%	8%	19%	9%	30%	32%	17%	21%	17%	15%
San Francisco	11%	13%	10%	11%	15%	10%	33%	28%	18%	16%	16%	19%

Panel B. Maximum Median FEVD Horizons

	Max median FEVD [at Horizon]					
Fed District	rs_t	bp_t	p_t	m_t	cp_t	r_t
Boston	20% [30]	29% [21]	21% [12]	16% [7]	14% [0]	18% [0]
New York	15% [14]	31% [16]	12% [1]	17% [6]	18% [4]	16% [3]
Philadelphia	28% [52]	21% [26]	23% [37]	14% [60]	14% [60]	12% [60]
Cleveland	29% [30]	27% [14]	18% [13]	21% [20]	18% [60]	20% [60]
Richmond	22% [52]	16% [0]	17% [9]	13% [36]	12% [60]	14% [0]
Atlanta	28% [58]	22% [26]	16% [58]	26% [35]	14% [60]	14% [60]
Chicago	24% [32]	22% [15]	16% [8]	19% [9]	14% [0]	19% [60]
St. Louis	29% [43]	27% [18]	19% [30]	15% [10]	17% [60]	16% [60]
Minneapolis	18% [60]	25% [35]	24% [60]	15% [3]	17% [0]	15% [30]
Kansas City	27% [37]	33% [18]	25% [11]	21% [17]	20% [0]	15% [60]
Dallas	30% [59]	34% [32]	19% [18]	23% [30]	19% [0]	15% [60]
San Francisco	34% [49]	32% [28]	23% [21]	22% [13]	16% [60]	19% [14]

Table 6. Variation: Regional Monetary Policy FAVAR with Bank Failures. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	r_t	bf_t
	−	−	−	−	x	+	+
$\mathcal{SR}$-Horizon			6 *month*				

Table 7. Variation: Shorter Horizon Constraint. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	r_t
	−	−	−	−	x	+
$\mathcal{SR}$-Horizon			3 *month*			

Table 8. Variation: Regional VAR with Discount Rate Spread over New York Fed. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	$spread_t$
	−	−	−	−	x	+
$\mathcal{SR}$-Horizon			6 *month*			

Table 9. Variation: Common Monetary Policy FAVAR with Expansionary Narrative Sign Restriction of April 1932. This table details the sign restrictions imposed on the variables included in the VAR. Positive sign restrictions are denoted by "+", negative sign restrictions are denoted by "−", and variables left without sign restrictions are denoted by "x". The variables included in the VARs are the following: retail sales (rs_t), building permits (bp_t), food prices (p_t), money aggregate M1 (m_t), commercial paper rate (cp_t), and Federal Reserve discount rate (r_t).

$\mathcal{SR}$	rs_t	bp_t	p_t	m_t	cp_t	r_t
	−	−	−	−	x	+
$\mathcal{SR}$-Horizon			6 *month*			
Narrative $\mathcal{SR}$:	Expansionary shock 1932:M04 dominant for r_t					