Interest Rate Misalignments and Monetary Policy Effects: Evidence from U.S. States

Andriantomanga, Zo and Kishor, N. Kundan and Kumar, Labesh

University of Wisconsin Milwaukee, University of Wisconsin Milwaukee, University of Wisconsin Milwaukee

14 May 2025

Interest Rate Misalignments and Monetary Policy Effects: Evidence from U.S. States *

Zo Andriantomanga
University of Wisconsin-Milwaukee

Kundan Kishor
University of Wisconsin-Milwaukee

Labesh Kumar
University of Wisconsin-Milwaukee

May 14, 2025

Abstract

This paper examines whether a uniform monetary policy can effectively address diverse state-level economic conditions within the United States. Using quarterly data from 1989-2017 for 33 states, we construct state-level optimal interest rates based on a Taylor rule framework that incorporates local inflation and unemployment gaps. We document significant and persistent deviations between these state-implied rates and the actual federal funds rate, with hierarchical clustering analysis revealing systematic regional patterns in monetary policy misalignment. Using a local projection approach, we find that a one percentage point positive deviation shock reduces headline inflation by 0.6 percentage points and increases unemployment rates, with effects most pronounced for non-tradable sectors. Critically, responses to state-specific deviation shocks are substantially larger and more persistent than responses to aggregate deviation shocks, demonstrating that cross-sectional heterogeneity is essential for understanding monetary policy's regional impacts. Our findings remain robust to alternative specifications, including output gaps, interest rate smoothing, and accounting for unconventional monetary policy.

Keywords: Taylor rule, monetary policy, interest rates, regional business cycles

JEL classification: E43, E52, R11

*

1 Introduction

Whether a single monetary policy stance can effectively address heterogeneous regional economic conditions remains an open and critical question. Within the United States—a monetary union with a diverse economic landscape—this question has important implications for understanding how centralized policy decisions impact regional economies differently. State-level economic disparities, exemplified starkly during the Great Recession when unemployment rates ranged from just 4% in North Dakota to nearly 14% in Nevada, underscore the complexity of applying a ”one-size-fits-all” monetary approach. Such variations imply that a single federal funds rate might be overly restrictive in some states and excessively accommodative in others, potentially exacerbating local economic fluctuations rather than stabilizing them.

This paper examines this issue by constructing novel state-specific Taylor-rule-implied interest rates and evaluating their divergence from the actual federal funds rate—a measure we term the "policy rate gap." Specifically, we utilize quarterly data spanning from 1989 to 2017 for 33 U.S. states, generating optimal interest rates derived from state-level inflation and unemployment gaps. We further investigate whether the macroeconomic responses of inflation and unemployment differ depending on whether the policy rate gap is constructed using state-level versus national-level economic conditions.

First, we engage directly with an extensive literature examining monetary policy deviations from benchmark Taylor rules at the aggregate level. John Taylor's seminal work (Taylor (1993)) initiated an expansive literature emphasizing the benefits of rules-based monetary policy and the potential macroeconomic costs arising from significant policy deviations. Taylor (2007) has specifically argued that deviations from Taylor-rule benchmarks were pivotal in exacerbating the housing bubble and subsequent financial crisis. Building on Taylor's analysis, Nikolsko-Rzhevskyy and Papell (2012); Nikolsko-Rzhevskyy, Papell, and Prodan (2014); Papell and Prodan (2023); Papell and Prodan-Boul (2024); Taylor (2010, 2017) document historical deviations from Taylor-rule guidelines and explore their broader macroeconomic consequences. These studies collectively underscore the importance of adherence to rules-based benchmarks at the national level, but leave unexplored the critical implications of such deviations at the state level. Our paper fills this gap by explicitly quantifying the economic consequences of state-level deviations from Taylor-rule-implied policy benchmarks, extending these insights into the domain of regional economics. Despite this rich literature, applications of Taylor-rule frameworks to subnational economies remain limited. Moons and Van Poeck (2008) assess Taylor rule deviations in EMU member countries, while Coibion and Goldstein (2012) show that national-level Taylor rules can obscure important regional variation in policy needs. Our paper extends this literature by constructing implied interest rates for individual U.S. states based on localized inflation and labor market conditions, and by estimating the real effects of deviations from the federal funds rate. This allows us to quantify the cost of monetary policy mismatches and assess their persistence and macroeconomic consequences.

Second, we contribute to a growing literature on optimal currency areas (OCA), initiated by Mundell (1961), which emphasizes that the effectiveness of unified monetary policy declines sharply with increased regional economic diversity. Theoretical studies such as those of Aguiar, Amador, Farhi, and Gopinath (2015); O. Blanchard, Erceg, and Lindé (2017); Corsetti, Dedola, Jarociński, Maćkowiak, and Schmidt (2019); Gali and Monacelli (2008) predict welfare losses from uniform monetary policies in heterogeneous regions. Empirically, studies focused on the European Monetary Union by De Grauwe (2013), Ferrero (2009), and Lane (2012) underscore significant regional disparities in monetary policy effectiveness, further motivating our inquiry into similar phenomena within the U.S. [1]

Third, we build on foundational work documenting significant regional business cycle heterogeneity, as O. J. Blanchard, Katz, Hall, and Eichengreen (1992) show that U.S. states respond differently to economic shocks through unemployment and out-migration

[1]Within the European Monetary Union (EMU) context, empirical work by De Grauwe (2013) shows how a uniform interest rate exacerbates booms in already expanding regions and deepens recessions in struggling ones.Micossi (2015); Moons and Van Poeck (2008) find persistent asymmetries in monetary policy impact between core and peripheral EMU countries, with fiscal policy often insufficient to offset monetary misalignments. Within the U.S., Carlino and DeFina (1998) shows that regions differ in their sensitivity to monetary policy, with industrial structure and financial markets playing key roles. Owyang and Wall (2003, 2009) find structural breaks in regional policy transmission mechanisms, linked to differences in banking concentration and credit access. Beckworth (2010) explores the asymmetric effects of Fed policy across states, questioning whether the U.S. itself meets the criteria of an optimal currency area.

rather than wage adjustments, and Carlino and Sill (2001) highlight, using factor models, that cyclical innovations explain more variation in regional incomes than trend innovations. Owyang, Piger, and Wall (2005), employing Markov-switching models, show that states often enter and exit recessions asynchronously, further raising questions about the efficacy of uniform national policies.[2] Recent research also highlights how credit supply shocks and household leverage create divergent regional responses to national economic developments (Mian & Sufi, 2022; Mian, Sufi, & Verner, 2017). The question of regional economic heterogeneity and its implications for monetary policy effectiveness thus has deep roots in both macroeconomic theory and empirical research.

While existing work, notably by Coibion and Goldstein (2012) and Beckworth (2010), has begun to explore the monetary policy heterogeneity within the United States, our paper makes three distinct contributions. First, by explicitly constructing state-specific Taylor-rule benchmarks, we provide a quantifiable measure of state-level policy rate mismatch. Second, using local projections, we empirically identify the macroeconomic consequences of these mismatches, explicitly differentiating between aggregate and regional shocks. Third, we analyze how economic conditions across different sectors, particularly tradable versus non-tradable sectors, respond asymmetrically to policy mismatches, revealing that sectoral composition critically affects the regional transmission of monetary policy.

We find significant variation in policy gaps across states, demonstrating persistent and economically meaningful differences between actual monetary policy and what would be optimal for local conditions. The West Coast and parts of the Midwest generally exhibit negative median deviations, suggesting relatively looser monetary conditions during the period. Conversely, the Southeast, South Central/Plains, and parts of the Mountain West experienced positive deviations, indicating tighter-than-optimal monetary policies. Using a hierarchical clustering analysis, we also find that geographic proximity

[2] More recent research continues to identify regional asymmetries across various macroeconomic indicators. Baumeister, Leiva-León, and Sims (2024) develop high-frequency state-level economic indicators to track these differences, offering new tools to identify real-time disparities. Beraja, Hurst, and Ospina (2019) further show that regional business cycle asymmetries have aggregate implications, as shocks in highly cyclical regions can propagate through national aggregates, amplifying their effects. Mumtaz and Theodoridis (2018) find that uncertainty shocks disproportionately impact regions with higher share of manufacturing and construction industries, highlighting the role of industrial composition in economic vulnerability.

plays a significant role in cluster formation. States within the same region tend to experience similar deviations from the Federal Funds Rate, likely due to shared economic structures, labor markets, and industry compositions.

Using our constructed state-level interest rates, we systematically analyze the deviations between these state-specific optimal rates and the actual federal funds rate. Employing Jordà (2005)'s local projection methodology, we evaluate how these interest rate deviation shocks affect key economic indicators.[3] The results from our local projections show that state-level policy gaps matter. We find that a one-percentage-point positive deviation shock—where the federal funds rate exceeds the state-level Taylor-rule implied rate—results in a 0.6 percentage-point decrease in state-level headline inflation and a notable increase in the unemployment rate. These effects persist over time and are substantially stronger in non-tradable sectors—where the initial disinflationary impact is nearly three times larger than for tradables—highlighting how locally determined non-tradable prices intuitively amplify the effects of state-level policy mismatches. By contrast, when we apply the same exercise to the nationwide policy gap (the difference between the actual rate and the rate implied by the aggregate Taylor rule), inflation responses are not only much weaker but even counterintuitively turn positive—headline inflation briefly rises following a shock to the national policy gap. Crucially, this stark contrast shows that economic responses to state-specific gap shocks are both theoretically consistent and economically meaningful, whereas aggregate measures that do not take into account state-level heterogeneity mask—and can even invert—the true transmission of monetary policy.

These results contribute to a growing body of research that stresses the importance of regional heterogeneity in macroeconomic policy design. We provide empirical evidence that even within a currency union with fiscal transfers and labor mobility, such as the U.S., monetary policy can generate regionally unequal—and sectorally divergent—outcomes. This finding has implications not only for U.S. policy but also for other federations and

[3]Several studies treat deviations from Taylor rule prescriptions as proxies for discretionary or unanticipated monetary policy shocks. Coibion and Gorodnichenko (2012) argue that residuals from estimated Taylor rules capture persistent discretionary shocks and link them to macroeconomic fluctuations. **?** similarly interpret deviations from rule-based prescriptions as destabilizing forces in pre-Volcker monetary policy.

monetary unions, where addressing regional disparities may require integrating localized indicators into policy decisions, paying closer attention to nontradable inflation dynamics, improving communication about uneven effects, and reinforcing the role of subnational fiscal stabilization.

The robustness of our findings is examined across multiple alternative specifications, including variations in the Taylor-rule framework (such as different inflation and output gap measures), adjustments for interest rate smoothing, and considerations of unconventional monetary policy episodes. Across all these robustness checks, our core conclusions remain intact, emphasizing the reliability of our methodology and reinforcing the significance of our main results.

The remainder of the paper is organized as follows. Section 2 outlines the theoretical motivation, describes the data, and details the construction of state-specific Taylor-rule-implied interest rates. Section 3 presents economic and geographic stylized facts regarding the state-level policy rate gap. Section 4 describes our local projection estimation approach and reports the baseline results. Robustness checks are discussed in Section 5. Finally, Section 6 concludes with policy implications.

2 Measuring state-level policy rates gap

In this section, we outline the theoretical foundations of monetary policy misalignment, describe the data sources used to construct the relevant state-level variables, and detail the construction of our measure of state-level policy rate gaps.

2.1 Theoretical foundations

One of the most widely used frameworks for understanding and guiding central bank interest rate decisions is the Taylor Rule, introduced by Taylor (1993). The Taylor Rule provides a systematic method for setting the nominal interest rate based on deviations of inflation from its target and output from its potential level. It is commonly expressed as:

$$i_t^{TR} = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y^*) \tag{1}$$

where i_t is the FOMC's nominal Federal Funds Rate (FFR) target, π_t the inflation rate, r^* is the neutral interest rate, $\pi_t - \pi^*$ the deviation of inflation from the Fed's target, and $y_t - y^*$ is the output gap.

The Taylor Rule has been successful in explaining historical monetary policy decisions and is widely used as a benchmark for evaluating whether policy is too loose or too tight. However, the standard Taylor Rule is typically applied at the national level, implicitly assuming homogeneous economic conditions across all regions of the United States. In reality, economic conditions—such as inflation, output gaps — vary significantly across states due to differences in industrial composition, labor market dynamics, and demographic trends. A one-size-fits-all monetary policy may therefore lead to misalignments between the Federal Reserve's interest rate policy and the economic needs of individual states.

To account for these disparities, we extend the Taylor Rule framework to derive a state-specific implied interest rate. This allows us to analyze how closely the Federal Funds Rate aligns with the economic conditions of each state. The state-level Taylor Rule interest rate is defined as:

$$i_{it}^{TR} = r^* + \pi_{it} + \alpha(\pi_{it} - \pi^*) + \beta(y_{it} - y_i^*) \tag{2}$$

where i_{it}^{TR} is the implied interest rate for state i at time t, π_{it} represents the state-level inflation rate, and $y_{it} - y_i^*$ is the state-level output gap. r^* is the neutral rate of interest, π^* the Federal Reserve's inflation target.

To quantify state-level policy rate gap, or the extent of deviation between national monetary policy and state-level conditions, we define $D_{i,t}$ as the difference between the actual Federal Funds Rate and the Taylor Rule-implied state-level interest rate:

$$D_{i,t} \equiv i_t^{FFR} - i_{i,t}^{TR} \tag{3}$$

The deviation $D_{i,t}$ represents the difference between the actual federal interest rate set by the Federal Reserve and the implied state-level interest rate derived from a Taylor rule that considers each U.S. state's local inflation and local GDP. Therefore, $D_{i,t}$ measures the extent to which the Federal Reserve's national monetary policy deviates from what would be optimal for individual states based on their local economic conditions. A non-zero value of $D_{i,t}$ indicates a mismatch between the national monetary policy and a state's specific economic circumstances.

When $D_{i,t}$ is positive, it suggests that the actual federal interest rate is higher than the state-implied rate, indicating that monetary policy is tighter than what the state's economic conditions would warrant. Conversely, a negative $D_{i,t}$ value implies that the actual federal interest rate is lower than the state-implied rate, signaling that monetary policy is more accommodative than what the state's economic conditions would suggest. When $D_{i,t}$ is close to zero, it indicates that the actual federal interest rate aligns closely with the state-implied rate, suggesting that the national monetary policy is well-suited for the economic conditions of that particular state.

Theoretical sources of policy rate gaps. For illustration purposes, let us suppose that the Fed solely follows a Taylor rule, the variations in $D_{i,t}$ can be attributed to the discrepancy of national and state-level economic factors which become apparent when rearranging equations (1), (2), and (3)

$$D_{i,t}^{TR} = i_t^{TR} - i_{i,t}^{TR} \tag{4}$$

$$D_{i,t}^{TR} = (1+\alpha)(\pi_t - \pi_{i,t}) + \beta(y_t - y_{i,t}) \tag{5}$$

This equation highlights different sources of variations in interest rate misalignment, $D_{i,t}$, which stems from inflation differentials and economic growth disparity. Inflation differentials occur due to regional cost-of-living variations and economic factors, while disparities in state-level GDP growth compared to national output growth can result in different implied interest rates.

However, in practice, the Federal Reserve does not adhere strictly to the Taylor Rule and exercises discretion in setting monetary policy. $D_{i,t}$ is an endogenous variable that captures not only differences in state-level economic conditions but also the broader influences of discretionary monetary policy, economic heterogeneity, and data limitations. Understanding $D_{i,t}$ provides key insights into the extent of monetary policy misalignment across states and highlights the challenges of implementing a uniform interest rate policy in a diverse economy .

2.2 Data

The data consists of a panel of 33 US states for the period of January 1989 to December 2017 at a quarterly frequency. Table 1 presents the summary statistics for the baseline sample. Table A.1 lists the states included in the sample. Table A.2 reports data sources.

Our analysis incorporates three key measures of inflation obtained from Hazell, Herreno, Nakamura, and Steinsson (2022): headline, tradable, and non-tradable inflation. Annual inflation rates are calculated using disaggregated Consumer Price Index (CPI) components. Tradable inflation encompasses categories such as alcohol, clothing, transport, furnishings, and food, which are more susceptible to international market forces. Non-tradable inflation includes sectors like communication, health, housing, education, recreation, and restaurants, which are primarily influenced by domestic economic conditions. Headline inflation rate is the weighted average of tradable and non-tradable components. This distinction allows for a nuanced understanding of inflationary pressures, as tradable inflation may respond differently to global economic shifts, while non-tradable inflation tends to be more sensitive to domestic monetary policy. By examining these components separately, we gain deeper insights into the factors driving overall inflation.

We measure economic slack primarily using unemployment rates. We collect unemployment data for each state from the Federal Reserve Bank of St. Louis' FRED database. To calculate the unemployment gap, we use the difference between the current unemployment rate and its 5-year moving average. This approach allows us to capture cyclical fluctuations in labor market conditions while accounting for structural changes over time. We also consider the output gap as an alternative measure of economic slack following the original Taylor rule specification. We collect state-level GDP data from the Bureau of Economic Analysis (BEA). However, it's important to note that quarterly GDP data is only available from 2005 Q1 onwards, which limits our sample size. We compute the output gap using real-time quadratic detrending to estimate potential output. For nominal interest rates, we collect the federal funds rate from the FRED database and the effective federal funds rate using the shadow rate developed by Wu and Xia (2016).

The sample is determined by the joint availability of quarterly state-level observations for inflation and unemployment rates. The inflation dataset from Hazell et al. (2022) includes 33 states with data spanning from 1989 to 2017, providing a substantial timeframe and geographic coverage for the study. This sample represents a diverse mix of states in terms of economic size, population, and regional representation. Notably, these 33 states combined account for approximately 85% of the United States' total real GDP. The sample period of 1989 to 2017 encompasses several important economic phases, including the aftermath of the 1990s recession, the economic boom of the 2000s, the 2008 Global Financial Crisis, and the subsequent recovery. While our sample does not capture the post-COVID-19 inflation surge and the unprecedented policy responses, it offers a comprehensive view of various economic cycles.

Table 1 presents summary statistics for the main regional macroeconomic variables: headline, tradable, nontradable inflation, and unemployment rate. The average headline inflation rate across states is approximately 2.51%, with state-level averages ranging from 1.95% in Arkansas to 2.92% in California. This variation underscores persistent differences in inflationary pressures across regions. A decomposition of inflation into tradable and non-tradable components reveals further heterogeneity. Non-tradable inflation is higher on average (3.26%) and more stable, with state-level means ranging from 2.62% to 3.82%. This reflects the behavior of sticky prices in sectors such as housing and services. By contrast, tradable inflation is lower on average (1.27%) but exhibits greater dispersion across states, ranging from 0.97% to 1.91%. The higher volatility of tradable inflation is consistent with its exposure to global forces such as commodity price swings, exchange rates, and supply chain disruptions. State-level unemployment rates also vary significantly, averaging 6.03% but ranging from 4.34% in Utah to 7.91% in Michigan. These disparities in both inflation and labor market conditions suggest that states may operate under different macroeconomic regimes even within a common monetary framework.

From a policy perspective, these findings highlight the challenge of applying a uniform national monetary policy in the context of heterogeneous regional conditions. In particular, the divergence between tradable and non-tradable inflation implies that the pass-through of monetary policy may operate through different channels across regions. States where inflation is primarily driven by non-tradable components—such as housing or services—may respond differently to interest rate changes than those more exposed to tradable price volatility. Similarly, uneven labor market slack implies that real interest rate conditions and Phillips Curve dynamics may vary geographically. These considerations motivate the regional analysis undertaken in this paper, which aims to assess how the effects of monetary policy rate mismatches differ across U.S. states.

2.3 Implementation

Our goal is to construct the interest rate deviations $D_{i,t}$ specified in Equation 3. We start by constructing state-level interest rates following the Taylor rule to account for state-level economic conditions. The canonical Taylor rule formulation, as presented in Equation 2, relies on output gaps to measure economic slack. However, the limited availability of state-level GDP data, which only begins in 2005 Q1, constrains its applicability for our full-sample analysis.

Beyond data availability, there is strong empirical and theoretical support for using the unemployment gap in Taylor-rule-type specifications. A large literature shows that real-time output gap estimates are highly error-prone (Orphanides, 2001, 2003), whereas unemployment data are more reliable and timely. Moreover, using the unemployment gap aligns closely with the Federal Reserve's dual mandate and may serve as a sufficient proxy for cyclical slack (Ball, 1999; Clarida, Gali, & Gertler, 1999). Several papers provide additional evidence that Taylor rules based on the unemployment gap more accurately describe U.S. monetary policy post-1980 (Nikolsko-Rzhevskyy & Papell, 2012; Nikolsko-Rzhevskyy et al., 2014; Papell & Prodan-Boul, 2024).

To address this limitation, we employ an alternative specification that utilizes unemployment gaps as a proxy for economic slack. This substitution is grounded in Okun's Law, which empirically establishes a relationship between output and labor market dynamics (Okun, 1963). Specifically, Okun's Law suggests that a 2% increase in the output gap corresponds to a 1% decrease in the unemployment rate, and vice versa. We adapt the Taylor rule accordingly:

$$i_{i,t}^{TR} = r^* + \pi_{i,t} + \alpha(\pi_{i,t} - \pi^*) + \gamma(u_{i,t} - \bar{u}_{i,t}^{LR}) \quad (6)$$

where u_t represents the current unemployment rate, and $\bar{u}_{i,t}^{LR}$ denotes its 5-year moving average. This moving average serves to filter out structural trends in unemployment and provides a time-varying proxy for the natural rate of unemployment, allowing us to capture regional economic shifts.

We then compute $D_{i,t}$ following Equation 3 as the difference between the federal funds rate and the Taylor-rule implied state-level interest rates.

3 Stylized facts about state-level policy rates gap

In this section, we present an analysis of the state-level policy rates mismatch captured by the deviations $D_{i,t}$ following Equation 3. Understanding these deviations can provide valuable insights into the differential impacts of monetary policy across states and highlight potential regional economic disparities.

3.1 Empirical distribution

Figure 1 presents the density distribution of $D_{i,t}$ over different time periods: the full sample, 1989-2008, and 2009-2017. The distribution allows us to observe how the deviations have evolved over time, reflecting shifts in monetary policy's impact on different states.

[INSERT Figure 1 HERE]

- **Overall Distribution:** The full-sample density distribution suggests that while the majority of $D_{i,t}$ values cluster around zero, there is substantial variation, indicating that national monetary policy often deviates from state-specific conditions.

- **Pre-2008 Financial Crisis (1989-2008):** This period exhibits relatively moderate deviations, with a slight skewness suggesting that in some instances, national monetary policy was tighter than optimal for many states. This aligns with the conventional wisdom that the Federal Reserve followed a relatively rule-based policy approach during the Great Moderation.

- **Post-2008 Financial Crisis (2009-2017):** The distribution has become more concentrated around its center, indicating reduced dispersion in $D_{i,t}$, likely due to the zero lower bound constraint on interest rates. Additionally, there's a clear leftward shift in the distribution, with the median moving into negative territory, reflecting the Fed's implementation of looser monetary policy. The asymmetric shape of the distribution suggests that the Federal Reserve's accommodative stance post-crisis had varying impacts across states. While some states may have experienced appropriate or even excessive stimulus, others potentially faced policy mismatches, highlighting the challenges of implementing a uniform monetary policy across diverse regional economies.

3.2 Geographical distribution

To further analyze the impact of monetary policy across states, Figure 2 presents the median deviation for each state over the sample period from 1989 to 2017. This geographical distribution reveals significant heterogeneity: some states experienced persistently tighter monetary conditions, while others benefited from more accommodative policies. Table A.3 presents the summary statistics for $D_{i,t}$ for each state.

The map reveals a distinct regional pattern. The West Coast and parts of the Midwest generally exhibit negative median deviations, suggesting relatively looser monetary conditions during the period. Conversely, the Southeast, South Central/Plains, and parts of the Mountain West experienced positive deviations, indicating tighter-than-optimal monetary policies.

[INSERT Figure 2 HERE]

- **States with Positive Deviations:** Virginia and North Carolina exhibit the most positive median deviations, suggesting prolonged periods of tighter-than-optimal monetary policy, potentially constraining economic growth. Similar trends are observed in the Southeast (Florida, Alabama, Mississippi, Louisiana, and Arkansas), South Central/Plains (Oklahoma and Kansas), and Mountain West (Colorado and Utah).

- **States with Negative Deviations:** Oregon and Washington display the largest negative median deviations, indicating more accommodative monetary policy relative to their economic conditions. Other regions with negative deviations include the West Coast (California), the Midwest (Minnesota, Iowa, and Michigan), and the Southeast (Tennessee and Georgia). This may have contributed to lower borrowing costs and increased growth potential in these regions.

The geographical distribution underscores that monetary policy effects are not uniform across the United States. The heterogeneity in D_{it} suggests that some states may be consistently disadvantaged or favored by a uniform federal funds rate.

3.3 Clustering analysis

While visualizing the geographical distribution of $D_{i,t}$ provides an intuitive understanding of regional differences, it does not formally classify states based on their similarity in interest rate deviations. A clustering analysis allows for a data-driven approach to identifying groups of states that share common patterns.

We implement a hierarchical clustering on the deviations. This is an unsupervised machine learning technique used to group similar data points into clusters based on their proximity in a given metric space. In this case, we apply hierarchical clustering to state-level deviations $D_{i,t}$ to uncover natural groupings of states that experience similar monetary policy looseness or tightness relative to the Federal Funds Rate.

Unlike other clustering methods, such as k-means, hierarchical clustering builds a nested hierarchy of clusters without requiring a pre-specified number of groups. It does so iteratively by merging the closest data points, or clusters, based on a distance metric until all data points form a single hierarchy. In our case, we use the correlation distance metric following the broad literature. The resulting dendrogram visually represents this process, with the height of each branch indicating the level of dissimilarity between clusters.

[INSERT Figure 3 HERE]

The dendrogram in Figure 3 reveals three primary clusters of states based on their interest rate deviations. Cluster 1 includes states such as New York, Pennsylvania, and Connecticut, as well as Alabama and Florida, which suggests regional similarities in their monetary policy deviations. Cluster 2 consists of states like Mississippi and Tennessee, indicating a distinct pattern in their deviations. Cluster 3 groups together California, Oregon, and Washington, as well as Midwestern states such as Illinois, Michigan, Minnesota, and Wisconsin. This suggests that states within this cluster have shared economic characteristics that influence their response to national monetary policy.

The main takeaway is that geographic proximity plays a significant role in cluster formation. States within the same region tend to experience similar deviations from the Federal Funds Rate, likely due to three underlying economic mechanisms: (1) Shared industrial composition (e.g. energy-dependent states responding similarly to commodity price shocks), (2) labor market linkages through interstate migration and commuting patterns, and (3) financial integration through regional banking networks. For instance, Cluster1's Northeastern states share financial services concentration; while Cluster 3's combination of West Coast and Midwestern states reflects their common exposure to manufacturing cycles and technology sector dynamics[4].

4 The Macroeconomic impact

In this section, we assess the macroeconomic effects of monetary policy misalignments by estimating the dynamic responses of key economic variables to policy rate gaps. To distinguish between localized and aggregate effects, we separately analyze shocks to the state-level deviation (D_{it}) and the aggregate nationwide deviation (D_t). This distinction is critical: while D_{it} captures state-specific monetary mismatches that account for local inflation and unemployment conditions, D_t reflects the aggregate stance of monetary policy relative to national fundamentals. Comparing the two allows us to evaluate whether national-level measures adequately capture the macroeconomic consequences of

[4]Carlino and DeFina (1998)'s finding that manufacturing-intensive states show higher interest rate sensitivity, helping explain cluster 3's composition

monetary policy deviations, or whether important heterogeneity is masked when cross-sectional variation is ignored.

4.1 Macroeconomic impact of state-level policy rate gap D_{it}

To assess the real effects of policy rate gaps across U.S. states, we estimate the dynamic responses of key macroeconomic variables to shocks in state-level policy rate gaps $D_{i,t}$. In doing so, we are following studies that treat deviations from Taylor rule prescriptions as proxies for discretionary or unanticipated monetary policy shocks. For details, see Coibion and Gorodnichenko (2012); **?**. Given the potential for rich and flexible dynamics in regional responses, we adopt a local projection approach à la Jordà (2005). This method allows us to trace out impulse response functions (IRFs) without imposing strong assumptions on the underlying data-generating process and is well-suited for accommodating heterogeneity across states and over time. This approach involves estimating the following series of regressions, one for each horizon $h = 0, \ldots, 12$:

$$y_{i,t+h} = \alpha_i^h + \sum_{j=0}^{J} \beta_{hj} D_{i,t-j} + \sum_{j=0}^{J} \theta_{hj} x_{t-j} + \sum_{j=1}^{J} \gamma_{hj} y_{it-j} + \epsilon_{it+h} \tag{7}$$

where $y_{i,t+h}$ is either headline, tradable, non-tradable inflation or the unemployment rate. $D_{i,t}$ is the deviation shock and β_h is the dynamic impact of interest at horizon h. We refer to the dynamic effects up to horizon h as the Impulse Response Function (IRF). $\mathbf{x}_{it}$ is a vector of controls that account for global factors like the US national unemployment rate, and the US inflation rate. α_i^h represents the state-level fixed effects.

We estimate the local projections for a shock in the policy rate gap $D_{i,t}$ across $h = 0, \ldots, H$ quarterly horizons, with $H = 12$, using the ordinary least squares estimator. In our baseline specification, the number of lags j is set to 4 to control for potential seasonality in the price series. Standard errors are clustered at the state level to account for potential serial correlation and heteroskedasticity within states. We also construct the 90 percent confidence intervals for the IRFs using the standard errors of the β_{hj} coefficients estimated for each horizon.

[INSERT Figure 4 HERE]

Figure 4 plots the impact of a 1 percentage point increase in $D_{i,t}$ on headline, tradable, non-tradable inflation and the unemployment rate. For each variable of interest, we report the impulse response function while controlling for the US national levels of inflation and unemployment rate. The main finding is that a $D_{i,t}$ shock leads to a slowdown in economic activity, as evidenced by a rise in the unemployment rate and a decline in the inflation rate, that is mainly driven by the heightened sensitivity of nontradable goods and services.

We find that $D_{i,t}$ shocks have a negative, sizeable and statistically significant, impact on inflation. Following a 1pp increase in $D_{i,t}$, headline inflation instantaneously declines by about 0.6 percentage points. The impact is persistent as headline remains depressed in the subsequent months to finally revert to 0 four months after the initial shock. The response of tradable is similar to headline, with however a more muted decline of 0.2 pp at the time of the initial shock to reverting over the next four months. For nontradable inflation, a 1 pp $D_{i,t}$ shock leads to an initial decrease of about 0.7 percentage points to revert to zero in the subsequent four months. The magnitude of the impact is most sizeable on nontradable inflation, reflecting the heightened sensitivity of locally traded goods and services to an increase in the national and regional interest rate mismatch. Finally, A 1pp shock in $D_{i,t}$ leads to a persistent increase in unemployment rate which peaks 2 months after the initial shock to gradually decline in the subsequent months.

The results presented here complement the recent literature on the regional impact of monetary policy. Hauptmeier, Holm-Hadulla, and Nikalexi (2020) have documented how monetary policy can aggravate regional inequality, with tightening shocks increasing disparities and easing shocks mitigating them. Recent literature provides microfoundations to explain this heterogeneity. Beraja, Fuster, Hurst, and Vavra (2019) identify the refinancing channel as a key mechanism for regional heterogeneity in monetary transmission, finding that regions with high mortgage debt and refinancing capacity benefit more from lower interest rates.[5]

4.2 Macroeconomic impact of aggregate nationwide policy rate gap D_t

In this section, we examine the macroeconomic consequences of monetary policy deviations measured at the national level. The underlying idea is to examine the impact of deviation in policy rate at the national level that ignores state-level heterogeneity. Specifically, we define the nationwide deviation as

$$D_t = i_t^{FFR} - i_t^{TR}$$

where i_t^{TR} is the U.S. interest rate implied by a Taylor rule using national inflation and economic slack. This specification abstracts from cross-sectional heterogeneity and captures the aggregate stance of monetary policy relative to national fundamentals. We estimate the following panel regression to compare the effects of the nationwide gap D_t with those of the heterogeneous, state-specific gap D_{it}:

$$y_{i,t+h} = \alpha_i^h + \sum_{j=0}^{J} \beta_{hj} D_{t-j} + \sum_{j=0}^{J} \theta_{hj} x_{t-j} + \sum_{j=1}^{J} \gamma_{hj} y_{it-j} + \epsilon_{it+h} \quad (8)$$

[INSERT Figure 5 HERE]

Figure 5 compares the impulse responses of macroeconomic variables to shocks in the nationwide mismatch D_t versus the state-level mismatch D_{it}. Across all variables, the regional mismatch shocks (D_{it}) generate not only quantitatively larger and more persistent effects compared to their national counterparts, but also responses that are consistent with economic theory. A positive regional mismatch shock—implying a tighter-than-warranted local policy stance—leads to a significant and persistent increase in the unemployment rate, peaking around eight quarters after the shock. Headline inflation also

[5] The housing market has emerged as a crucial channel in monetary policy transmission research. Albuquerque, Iseringhausen, and Opitz (2024) demonstrate sizeable heterogeneity in US state responses to monetary policy shocks based on differences in housing supply elasticities, household debt levels, and housing wealth. Charles, Hurst, and Schwartz (2019) examine how durable goods consumption varies across households and regions in response to interest rate changes, highlighting differential spending patterns. Auerbach, Gorodnichenko, McCrory, and Murphy (2022) demonstrate that the effectiveness of fiscal transfers as countercyclical tools also varies significantly across regions, depending on income composition, automatic stabilizers, and local multipliers.

declines more sharply and persistently in response to D_{it} shocks, consistent with contractionary monetary policy effects. The disinflationary response is particularly pronounced in the nontradable sector, highlighting the heightened sensitivity of locally determined prices to regional monetary conditions. By contrast, tradable inflation responses are muted and short-lived, suggesting a dominant role for national or global forces in price-setting.

While D_t shocks also lead to modest increases in unemployment, their effects on inflation are weaker and, in some cases, even exhibit the opposite sign—showing slight increases in inflation rather than declines. This divergence underscores the limited informational content of aggregate mismatch measures, which capture only a fraction of the transmission mechanism operating through localized policy misalignments.[6] Overall, these findings underscore the importance of accounting for regional heterogeneity in the transmission of monetary policy. Analyses based solely on the aggregate stance—captured by D_t—may mask substantial variation in localized policy misalignment and its macroeconomic consequences.

5 Robustness checks

In this section, we conduct a thorough examination of the robustness of our baseline results under alternative specifications of our measure of policy rate gaps. We focus on three key dimensions. First, we replace the unemployment gap with the output gap as the measure of economic slack, aligning more closely with the original Taylor rule formulation. Second, we augment the Taylor rule specification to incorporate interest rate smoothing, reflecting the gradual adjustment behavior typically observed in central bank policy setting. Third, we assess the stability of our findings when accounting for unconventional monetary policy measures, particularly during the post-Global Financial Crisis period.

[6] In the appendix, we present two alternative definitions of the nationwide policy rate gap. The first is a simple average across states, defined as $D_t^{\text{avg}} = \frac{1}{N}\sum_{i=1}^{N} D_{it}$, where D_{it} is the policy rate gap in state i at time t. The second is a population-weighted average, defined as $D_t^{\text{w}} = \sum_{i=1}^{N} \omega_{it} D_{it}$, where ω_{it} is the population share of state i at time t, such that $\sum_{i=1}^{N} \omega_{it} = 1$ for each t. Results based on these alternative specifications are consistent with our baseline findings and reinforce the conclusion that aggregate mismatch measures mask substantial regional variation in monetary policy transmission.

5.1 Alternative measure of economic slack

While our baseline specification calculates state-level interest rates using the unemployment rate (see Equation 6), the original Taylor rule formulation employs the output gap—the difference between actual and potential GDP. To assess the robustness of our results, we explore an alternative specification based on the output gap. This approach necessitates the use of state-level GDP data from the Bureau of Economic Analysis (BEA). However, the availability of quarterly state-level GDP data only from 2005 onwards constrains our sample period. We compute the output gap using the real time quadratic detrending. Subsequently, we update our calculations for $i_{i,t}^{TR}$ and the deviations $D_{i,t}$. Then, we re-estimate our baseline model for the period spanning 2005 Q1 to 2017 Q4. These alternative measures of economic slack are complementary; unemployment gaps better capture labor market conditions in real time, while output gaps alignn with Taylor rule's theoretical foundations and may better reflect overall economic activity. We examine both because state-level business cycles may manifest differently in labor markets compared to production measures, particularly in states with high labor force participation volatility or large informal sectors.

[INSERT Figure 6 HERE]

The results presented in Figure 6 demonstrate strong consistency with our baseline findings. A 1 percentage point shock to D_{it} induces a significant slowdown in economic activity, characterized by a persistent decline in real GDP and a reduction in inflation rates, primarily driven by nontradable inflation. These results reinforce the importance of accounting for cross-sectional variation in deviation shocks: when only the nationwide deviation D_t is considered, the macroeconomic responses are markedly weaker, with real activity effects fading quickly and inflation responses often exhibiting the wrong sign.

Examining the inflation dynamics further confirms the robustness of our baseline results. A 1 percentage point shock to D_{it} initially suppresses headline inflation by approximately 0.6 percentage points, with the effects persisting for several quarters before gradually dissipating. Nontradable inflation exhibits the highest sensitivity, consistently driving the overall decline, while the response of tradable inflation remains muted. In contrast, inflation responses to D_t shocks are not only smaller in magnitude and shorter-lived, but in some cases move in the opposite direction—suggesting that nationwide mismatch measures may substantially understate the contractionary effects of policy misalignment.

The effects on real economic activity also mirror the baseline. A 1 percentage point shock to D_{it} leads to a peak decline in real GDP growth of about 3 percentage points before gradually reverting toward zero over a year. Conversely, when considering D_t, the real GDP response is minimal and fades rapidly. Overall, these findings confirm that regional mismatch shocks (D_{it}) are critical drivers of macroeconomic dynamics, and that their effects remain robust to alternative measures of economic slack.

5.2 Alternative Taylor Rule specification

There are several versions of the Taylor Rule, each with different assumptions regarding how central banks respond to economic conditions. One modification is the inclusion of a smoothing parameter to reflect the idea that central banks do not adjust interest rates instantaneously in response to changes in economic conditions. This smoothing allows for gradual adjustments, which aligns more closely with real-world central banking behavior. In this version, the nominal interest rate is expressed as:

$$i_t^{TR} = \rho i_{t-1} + (1-\rho)\{r^* + \pi_t + \alpha(\pi_t - \pi^*) + \gamma(u_t - \bar{u}_{t,20})\} \quad (9)$$

The inclusion of the lagged interest rate, i_{t-1}, captures the persistence of interest rate changes, reflecting the gradual adjustment that central banks typically make rather than abrupt shifts. We set the parameter ρ to 0.5, to recognize the trade-offs faced by central banks between stabilizing inflation, output, and avoiding excessive volatility in interest rates.

[INSERT Figure 7 HERE]

This version of the Taylor Rule is particularly useful in capturing the gradual nature of monetary policy adjustments and the role of expectations in shaping policy responses. It aligns with the findings of many empirical studies, which suggest that interest rate smoothing is a key feature of actual central bank behavior. For instance, **?** and Orphanides (2002) argue that interest rate smoothing reflects both the economic costs of adjusting policy rates frequently and the central bank's preference for minimizing volatility. Furthermore, Woodford and Walsh (2005) highlights the importance of forward-looking policy rules in incorporating expectations about future economic conditions, which is essential for maintaining credibility and achieving long-term economic stability.

Figure 7 presents the impulse responses using deviations constructed from a Taylor Rule with a smoothing parameter. The results closely mirror our baseline findings. A 1 percentage point shock to D_{it} generates a persistent rise in unemployment and a sustained decline in headline inflation, primarily driven by nontradable inflation, while tradable inflation remains relatively unaffected. By contrast, shocks to the nationwide mismatch D_t produce substantially smaller effects across all variables, with inflation responses often exhibiting the wrong sign—showing little to no disinflation and, in some cases, slight increases following a positive gap shock. These findings confirm that the importance of regional interest rate mismatches is robust to alternative Taylor Rule specifications. Incorporating interest rate smoothing does not materially alter the conclusion that cross-sectional heterogeneity plays a critical role in the transmission of monetary policy shocks.

5.3 Accounting for unconventional monetary policy

In our baseline, we compute D_{it} as the deviation of the federal funds rate from the state-level interest rate. However, the aftermath of the Global Financial Crisis (GFC) ushered in an unprecedented period of low interest rates, with rates approaching the zero lower bound. The Federal Reserve implemented additional expansionary measures, such as quantitative easing and forward guidance, to stimulate economic recovery. Consequently, the near-zero federal funds rate may not accurately reflect the effective stance of monetary policy, implying that our variable D_{it} may not capture true policy deviations.

To address this limitation, we employ the shadow federal funds rate developed by Wu and Xia (2016). The shadow rate provides a more comprehensive measure of monetary policy stance, particularly during periods when conventional policy tools are constrained by the zero lower bound. It incorporates the effects of unconventional monetary policy actions, offering a continuous and unrestricted metric that can take on negative values to reflect accommodative policy beyond what nominal rates alone can convey.

Using this alternative measure, we revise Equation 3 as follows:

$$D_{i,t} \equiv i_t^{EFR} - i_{i,t}^{TR} \tag{10}$$

where i_t^{EFR} represents the effective federal funds rate combining the federal funds rate (1989-2008) and Wu-Xia shadow federal funds rate (2009-2017) (see Nikolsko-Rzhevskyy et al., 2014). This modification allows us to capture a more nuanced picture of monetary policy deviations, especially during periods of unconventional policy implementation.

[INSERT Figure 9 HERE]

The results presented in Figure 9 demonstrate that our main findings remain robust when accounting for unconventional monetary policy. A 1 percentage point shock to D_{it} induces a significant and persistent increase in the unemployment rate, peaking around two quarters after the shock and gradually declining thereafter. In contrast, shocks to the nationwide mismatch D_t lead to a much smaller and less persistent increase in unemployment.

Inflation dynamics exhibit a similar divergence. A shock to D_{it} results in a notable and sustained decline in headline inflation, driven primarily by a pronounced fall in nontradable inflation, while tradable inflation remains muted. By contrast, inflation responses to D_t shocks are not only smaller and more short-lived, but in some cases exhibit the wrong sign, showing flat or slightly positive responses rather than the expected disinflation. This further highlights the limited information content of nationwide mismatch measures when unconventional policies are in place. Overall, these results confirm that the importance of regional monetary policy mismatches persists even after accounting for unconventional monetary policy measures. Even when incorporating tools such as quantitative easing and forward guidance, localized deviations in monetary stance remain critical drivers of macroeconomic outcomes.

6 Conclusions

This paper investigates the extent and macroeconomic implications of state-level monetary policy deviations within the United States. Given the Federal Reserve's practice of setting a uniform national policy rate, we construct a measure of "policy rate gap" at the state level using Taylor-rule-implied interest rates derived from state-specific inflation and unemployment conditions. Our analysis spans nearly three decades (1989-2017) and covers 33 states, capturing a broad range of economic cycles and regional experiences.

Our empirical findings underscore the substantial heterogeneity in policy gaps across states, showing persistent and economically significant divergences between actual monetary policy and optimal local conditions. Notably, we document clear geographic and economic clustering, highlighting that gaps are not random but systematically aligned with state-level economic structures and sectoral compositions. Such patterns are particularly pronounced when distinguishing between tradable and non-tradable sectors, with non-tradable sectors being disproportionately sensitive to policy rate gaps.

Using a local projection framework, we quantify the dynamic effects of these gaps. Our estimates indicate that a positive gap shock—where the federal funds rate is higher than the state-specific Taylor-rule implied rate—results in a persistent decline in local inflation and a measurable increase in unemployment rates. Importantly, these negative effects are significantly stronger at the state level than comparable aggregate responses to national policy gaps, suggesting that state-level monetary imbalances carry distinct welfare costs. In fact, in the case of inflation, the national level policy rate gap yields the opposite response to the state-level.

The robustness of our results is confirmed through extensive sensitivity analyses, including alternative Taylor-rule specifications, variations in the inflation and unemployment gaps, adjustments for interest rate smoothing, and controlling for unconventional monetary policy episodes. The persistence of our core findings across these checks shows their reliability and strengthens our primary conclusion that monetary policy deviations represent a non-negligible challenge within monetary unions characterized by substantial regional heterogeneity.

From a policy perspective, our findings have meaningful implications. First, they highlight the limitations of a uniform monetary policy in addressing the diverse economic conditions faced by individual states. While aggregate stabilization remains critical, policymakers should be mindful of the uneven distributional consequences of monetary policy. This suggests a potential role for greater inclusion of regional economic indicators in policy deliberations, providing policymakers a more comprehensive picture of monetary policy's heterogeneous impacts.

Second, the differential responses between nontradable and tradable inflation point to a critical channel through which regional disparities manifest. Nontradable inflation, which is more sensitive to local economic conditions, exhibits substantially stronger and more persistent responses to monetary policy mismatches than tradable inflation. This suggests that focusing exclusively on aggregate inflation measures—dominated by tradable goods prices—may obscure important localized inflationary pressures. Greater attention to regional nontradable inflation dynamics could enhance the effectiveness of monetary policy by allowing for better detection of underlying regional overheating or slack.

Third, persistent state-level mismatches could undermine the credibility and effectiveness of monetary policy if local populations perceive monetary policy as systematically favoring certain regions over others. Strengthening communication strategies to acknowledge regional disparities, while emphasizing the overall national stabilization objectives, could help maintain public trust in centralized monetary frameworks.

Finally, our findings imply a complementary role for fiscal policy at both the state and national levels. At the federal level, robust automatic stabilizers such as unemployment insurance and transfer programs should be maintained and, where feasible, strengthened to smooth aggregate demand across the business cycle. At the state level, by contrast, more active, discretionary fiscal interventions are warranted to address localized shocks and structural rigidities. In particular, targeted measures such as reducing labor market frictions through enhanced workforce training and mobility programs, streamlining occupational licensing, and investing in region-specific infrastructure can help states adapt to divergent monetary conditions. Coupling these state-level fiscal reforms with strong federal stabilizers will bolster overall economic resilience and mitigate regional disparities within a unified monetary framework.

References

Aguiar, M., Amador, M., Farhi, E., & Gopinath, G. (2015). Coordination and crisis in monetary unions. *The Quarterly Journal of Economics*, *130*(4), 1727–1779.

Albuquerque, B., Iseringhausen, M., & Opitz, F. (2024). *The housing supply channel of monetary policy*. International Monetary Fund.

Auerbach, A., Gorodnichenko, Y., McCrory, P. B., & Murphy, D. (2022). Fiscal multipliers in the COVID-19 recession. *Journal of International Money and Finance*, *126*, 102669.

Ball, L. (1999). Policy rules for open economies. In *Monetary policy rules* (pp. 127–156). University of Chicago Press.

Baumeister, C., Leiva-León, D., & Sims, E. (2024). Tracking weekly state-level economic conditions. *Review of Economics and Statistics*, *106*(2), 483–504.

Beckworth, D. (2010). One nation under the fed? The asymmetric effects of us monetary policy and its implications for the united states as an optimal currency area. *Journal of Macroeconomics*, *32*(3), 732–746.

Beraja, M., Fuster, A., Hurst, E., & Vavra, J. (2019). Regional heterogeneity and the refinancing channel of monetary policy. *The Quarterly Journal of Economics*, *134*(1), 109–183.

Beraja, M., Hurst, E., & Ospina, J. (2019). The aggregate implications of regional business cycles. *Econometrica*, *87*(6), 1789–1833.

Blanchard, O., Erceg, C. J., & Lindé, J. (2017). Jump-starting the euro-area recovery: would a rise in core fiscal spending help the periphery? *NBER macroeconomics annual*, *31*(1), 103–182.

Blanchard, O. J., Katz, L. F., Hall, R. E., & Eichengreen, B. (1992). Regional evolutions. *Brookings papers on economic activity*, *1992*(1), 1–75.

Carlino, G., & DeFina, R. (1998). The differential regional effects of monetary policy. *Review of economics and statistics*, *80*(4), 572–587.

Carlino, G., & Sill, K. (2001). Regional income fluctuations: Common trends and common cycles. *Review of Economics and Statistics*, *83*(3), 446–456.

Charles, K. K., Hurst, E., & Schwartz, M. (2019). The transformation of manufacturing and the decline in US employment. *NBER Macroeconomics Annual*, *33*(1), 307–372.

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A New-Keynesian perspective. *Journal of Economic Literature*, *37*(4), 1661–1707.

Coibion, O., & Goldstein, D. (2012). One for some or one for all? Taylor rules and interregional heterogeneity. *Journal of Money, Credit and Banking*, *44*(2-3), 401–431.

Coibion, O., & Gorodnichenko, Y. (2012). Why are target interest rate changes so persistent? *American Economic Journal: Macroeconomics*, *4*(4), 126–162.

Corsetti, G., Dedola, L., Jarociński, M., Maćkowiak, B., & Schmidt, S. (2019). Macroeconomic stabilization, monetary-fiscal interactions, and Europe's monetary union. *European Journal of Political Economy*, *57*, 22–33.

De Grauwe, P. (2013). Design failures in the Eurozone: Can they be fixed? *Euroforum policy paper 1*, 1–24.

Ferrero, A. (2009). Fiscal and monetary rules for a currency union. *Journal of international Economics*, *77*(1), 1–10.

Gali, J., & Monacelli, T. (2008). Optimal monetary and fiscal policy in a currency union. *Journal of international economics*, *76*(1), 116–132.

Hauptmeier, S., Holm-Hadulla, F., & Nikalexi, K. (2020). *Monetary policy and regional inequality* (No. 2385). ECB Working Paper.

Hazell, J., Herreno, J., Nakamura, E., & Steinsson, J. (2022). The slope of the phillips curve: Evidence from US states. *The Quarterly Journal of Economics*, *137*(3), 1299–1344.

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

Lane, P. R. (2012). The European sovereign debt crisis. *Journal of economic perspectives*,

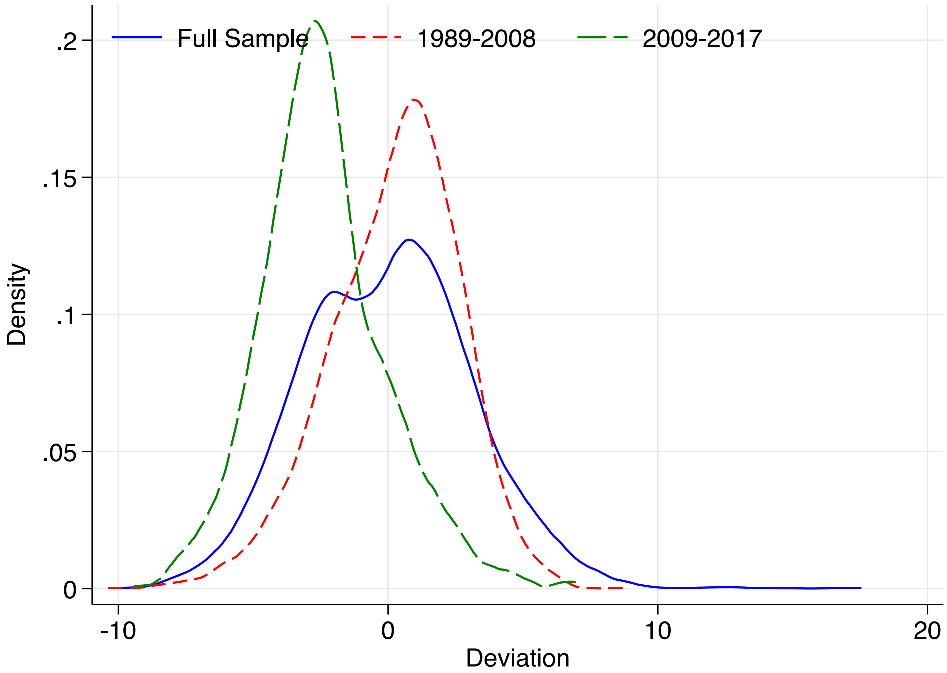
26(3), 49–68.
Mian, A., & Sufi, A. (2022). Credit supply and housing speculation. *The Review of Financial Studies*, *35*(2), 680–719.
Mian, A., Sufi, A., & Verner, E. (2017). How do credit supply shocks affect the real economy? Evidence from the united states in the 1980s. (National Bureau of Economic Research working paper)
Micossi, S. (2015). *The monetary policy of the European Central Bank (2002-2015). ceps special report no. 109/may 2015*.
Moons, C., & Van Poeck, A. (2008). Does one size fit all? a taylor-rule based analysis of monetary policy for current and future EMU members. *Applied economics*, *40*(2), 193–199.
Mumtaz, H., & Theodoridis, K. (2018). The changing transmission of uncertainty shocks in the us. *Journal of Business & Economic Statistics*, *36*(2), 239–252.
Mundell, R. A. (1961). A theory of optimum currency areas. *The American economic review*, *51*(4), 657–665.
Nikolsko-Rzhevskyy, A., & Papell, D. H. (2012). Taylor rules and the great inflation. *Journal of Macroeconomics*, *34*(4), 903–918.
Nikolsko-Rzhevskyy, A., Papell, D. H., & Prodan, R. (2014). Deviations from rules-based policy and their effects. *Journal of Economic Dynamics and Control*, *49*, 4–17.
Okun, A. M. (1963). *Potential gnp: its measurement and significance*. Cowles Foundation for Research in Economics at Yale University.
Orphanides, A. (2001). Monetary policy rules based on real-time data. *American Economic Review*, *91*(4), 964–985.
Orphanides, A. (2002). Monetary-policy rules and the great inflation. *American economic review*, *92*(2), 115–120.
Orphanides, A. (2003). The quest for prosperity without inflation. *Journal of Monetary Economics*, *50*(3), 633–663.
Owyang, M. T., Piger, J., & Wall, H. J. (2005). Business cycle phases in US states. *Review of Economics and Statistics*, *87*(4), 604–616.
Owyang, M. T., & Wall, H. J. (2003). Structural breaks and regional disparities in the transmission of monetary policy. *FRB of St. Louis Working Paper*.
Owyang, M. T., & Wall, H. J. (2009). Regional VARs and the channels of monetary policy. *Applied Economics Letters*, *16*(12), 1191–1194.
Papell, D. H., & Prodan, R. (2023). Policy rules consistent with the fomc's longer-run goals and monetary policy strategy. *The Economists' Voice*, *19*(2), 147–160.
Papell, D. H., & Prodan-Boul, R. (2024). Policy rules and forward guidance following the Covid-19 recession. *Journal of Financial Stability*, *74*, 101321.
Taylor, J. B. (1993). Discretion versus policy rules in practice. In *Carnegie-rochester conference series on public policy* (Vol. 39, pp. 195–214).
Taylor, J. B. (2007). *Housing and monetary policy.* (National Bureau of Economic Research working paper)
Taylor, J. B. (2010). Getting back on track: macroeconomic policy lessons from the financial crisis. *Federal Reserve Bank of St. Louis Review*, *92*(3), 165–176.
Taylor, J. B. (2017). *Rules versus discretion: assessing the debate over the conduct of monetary policy.* (National Bureau of Economic Research working paper)
Woodford, M., & Walsh, C. E. (2005). Interest and prices: Foundations of a theory of monetary policy. *Macroeconomic Dynamics*, *9*(3), 462–468.
Wu, J. C., & Xia, F. D. (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking*, *48*(2-3), 253–291.

Table 1: Summary statistics

State	Inflation	Tradable Inflation	Non-Tradable Inflation	Unemployment Rate
Alabama	2.28 [-0.95, 5.62]	1.45 [-4.01, 5.63]	2.85 [-1.15, 6.66]	6.25 [3.83, 10.97]
Alaska	2.54 [-1.32, 5.99]	1.56 [-6.0, 7.71]	3.15 [-0.34, 8.03]	7.62 [6.1, 11.27]
Arkansas	1.95 [-2.98, 5.32]	1.05 [-3.43, 5.21]	2.62 [-5.09, 8.88]	5.78 [3.7, 8.0]
California	2.92 [0.2, 11.64]	1.26 [-2.24, 8.29]	3.82 [0.21, 14.16]	7.44 [4.53, 12.4]
Colorado	2.69 [-1.98, 6.8]	1.67 [-2.46, 6.91]	3.31 [-2.0, 8.06]	5.05 [2.43, 9.37]
Connecticut	1.97 [-3.74, 6.11]	1.02 [-4.84, 8.04]	2.91 [-4.91, 13.14]	5.49 [2.1, 9.53]
Florida	2.51 [-1.21, 7.74]	0.97 [-4.88, 7.71]	3.49 [1.06, 11.71]	6.25 [3.23, 11.4]
Georgia	2.47 [-0.68, 10.12]	1.04 [-3.23, 9.35]	3.34 [0.74, 11.42]	5.99 [3.4, 10.53]
Hawaii	2.55 [-1.53, 7.5]	1.45 [-2.8, 6.41]	3.22 [-2.1, 9.67]	4.5 [2.0, 6.87]
Illinois	2.33 [-0.99, 7.95]	1.14 [-2.59, 5.7]	3.0 [-0.6, 9.61]	7.06 [4.2, 12.83]
Indiana	2.3 [-1.41, 5.47]	1.04 [-4.72, 5.06]	3.08 [-0.08, 5.67]	5.39 [2.8, 10.47]
Kansas	2.19 [-3.32, 5.58]	1.68 [-3.67, 6.29]	2.51 [-4.36, 6.81]	4.72 [3.4, 7.4]
Louisiana	2.29 [-2.15, 4.86]	1.33 [-2.39, 6.25]	2.94 [-2.83, 7.16]	6.23 [4.0, 9.83]
Maryland	2.68 [-1.6, 9.99]	1.3 [-4.81, 11.5]	3.48 [-1.07, 9.49]	5.23 [3.23, 8.27]
Massachusetts	2.57 [-2.63, 8.64]	1.23 [-10.38, 8.52]	3.41 [-2.26, 8.94]	5.54 [2.7, 9.1]
Michigan	2.63 [-0.58, 9.78]	0.95 [-3.52, 10.22]	3.54 [0.24, 10.43]	7.91 [3.27, 16.37]
Minnesota	2.44 [-3.12, 7.31]	1.05 [-4.29, 5.63]	3.13 [-1.94, 9.73]	4.88 [2.57, 8.87]
Mississippi	2.58 [-1.14, 6.41]	1.83 [-1.62, 6.95]	3.15 [-1.48, 7.61]	6.93 [4.9, 10.5]
Missouri	2.82 [-0.51, 11.41]	1.33 [-3.22, 9.33]	3.63 [0.56, 13.16]	6.03 [3.03, 10.47]
New Jersey	2.58 [-1.03, 9.78]	1.19 [-2.95, 8.81]	3.33 [-1.4, 11.21]	6.24 [3.53, 9.97]
New York	2.7 [-0.86, 9.67]	1.44 [-3.61, 8.25]	3.4 [-0.01, 11.3]	6.47 [4.2, 9.6]
North Carolina	2.01 [-1.28, 5.9]	1.09 [-3.78, 4.98]	2.82 [-2.24, 8.72]	5.78 [3.2, 11.2]
Ohio	2.87 [-0.36, 11.87]	1.32 [-2.36, 8.95]	3.79 [0.51, 14.28]	6.78 [3.9, 13.83]
Oklahoma	2.61 [-0.9, 8.72]	0.71 [-5.63, 4.97]	3.18 [-0.42, 8.1]	4.72 [2.9, 6.9]
Oregon	3.18 [1.0, 7.91]	2.25 [-1.55, 7.25]	3.8 [1.27, 10.24]	7.06 [3.97, 11.83]
Pennsylvania	2.56 [-0.58, 9.71]	0.91 [-5.85, 7.33]	3.55 [0.28, 11.93]	6.39 [4.13, 12.23]
South Carolina	2.15 [-2.52, 6.38]	1.29 [-3.76, 6.22]	2.75 [-1.72, 6.7]	6.32 [3.33, 11.67]
Tennessee	2.97 [-0.8, 14.68]	1.91 [-2.79, 20.19]	3.55 [-1.12, 14.37]	6.48 [3.43, 12.77]
Texas	2.52 [-1.39, 9.41]	1.2 [-2.49, 8.64]	3.28 [-0.63, 9.29]	6.12 [4.1, 9.3]
Utah	1.95 [-4.03, 5.31]	0.85 [-2.66, 6.43]	2.76 [-4.05, 7.8]	4.34 [2.4, 8.4]
Virginia	2.21 [-1.7, 6.24]	1.13 [-4.33, 6.02]	3.13 [-1.22, 8.28]	4.39 [2.2, 7.07]
Washington	2.56 [-2.25, 7.76]	0.93 [-11.54, 8.16]	3.53 [0.18, 8.71]	6.85 [4.5, 12.1]
Wisconsin	2.64 [-0.68, 9.41]	1.29 [-2.97, 8.34]	3.47 [0.18, 10.36]	5.52 [3.0, 11.3]

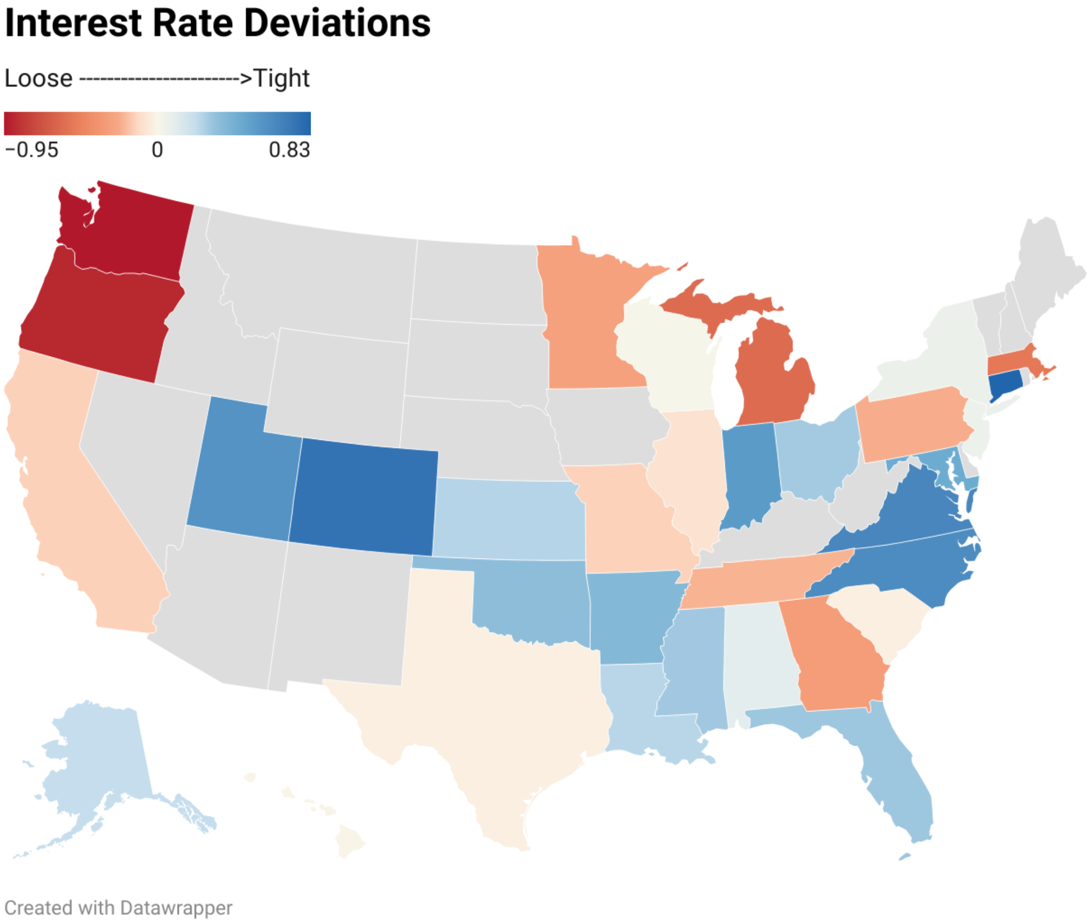
Note: This table presents the summary statistics in our sample of 33 US states from 1989 to 2017.
Each cell displays the average value followed by the range [minimum, maximum] in square brackets.
inflation rates are calculated as the year-over-year percent change of the price index.

Figure 1: Density distribution of policy rate gaps $D_{i,t}$ over different time periods



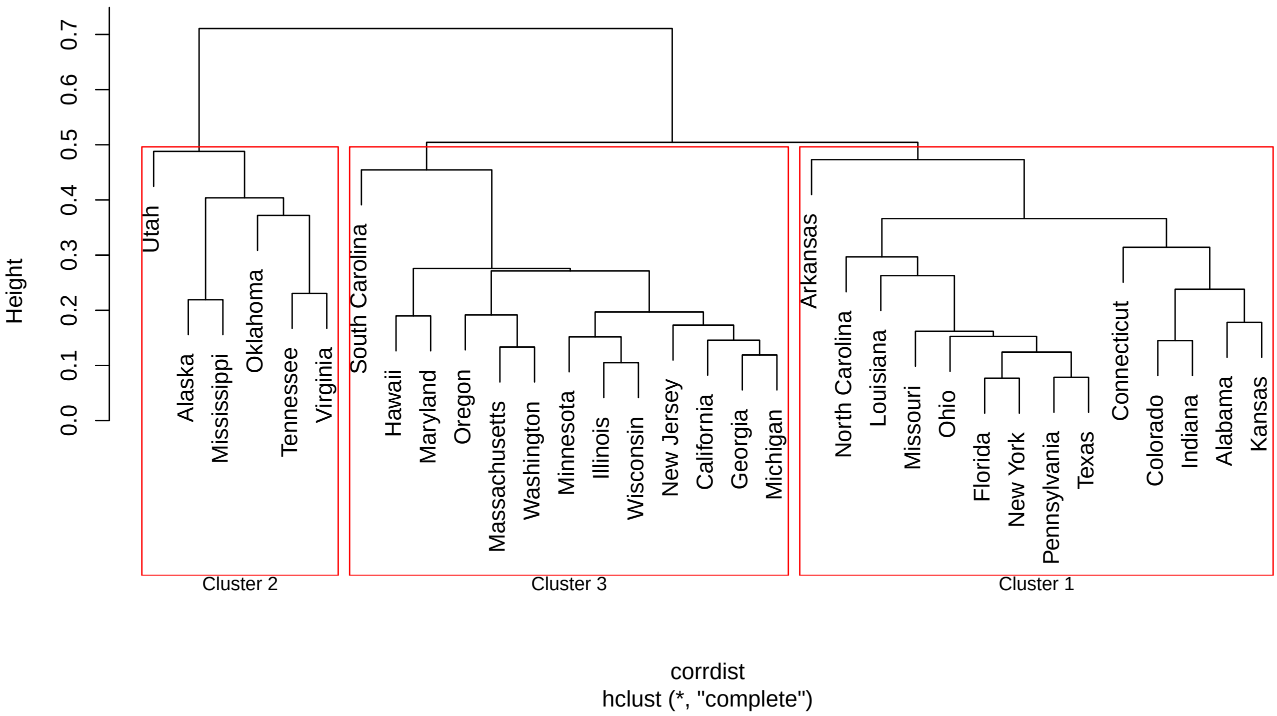
Notes: This figure illustrates the distribution of deviations $D_{i,t}$ across three distinct time periods. The solid blue line represents the full sample distribution. The red dashed line depicts the distribution for the pre-Global Financial Crisis period (1989-2008), while the green line shows the post-Global Financial Crisis period (2009-2017).

Figure 2: Geographical Distribution of policy rate gaps D_{it}



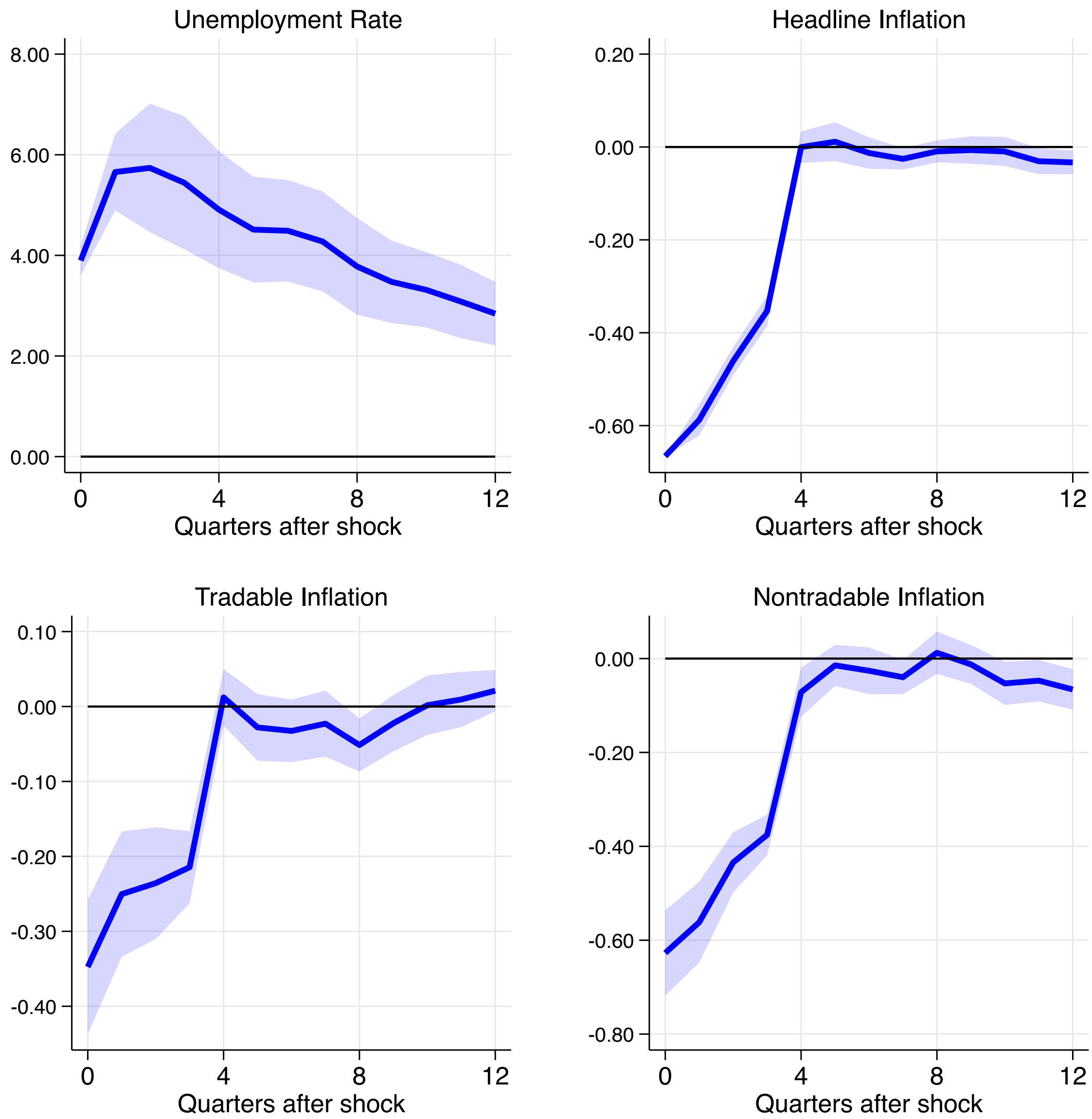
Notes: This figure shows the sample median of deviations (D_{it}) from 1989-2017 for 33 U.S. states. Positive deviations are represented by increasingly blue hues, indicating that monetary policy is tighter than implied by the state's economic conditions, while negative deviations are represented by increasingly red hues, indicating that monetary policy is looser than what the state's economic conditions would warrant. Dark grey areas represent states with missing data.

Figure 3: Dendrogram - Hierarchical clustering of policy rate gaps D_{it}



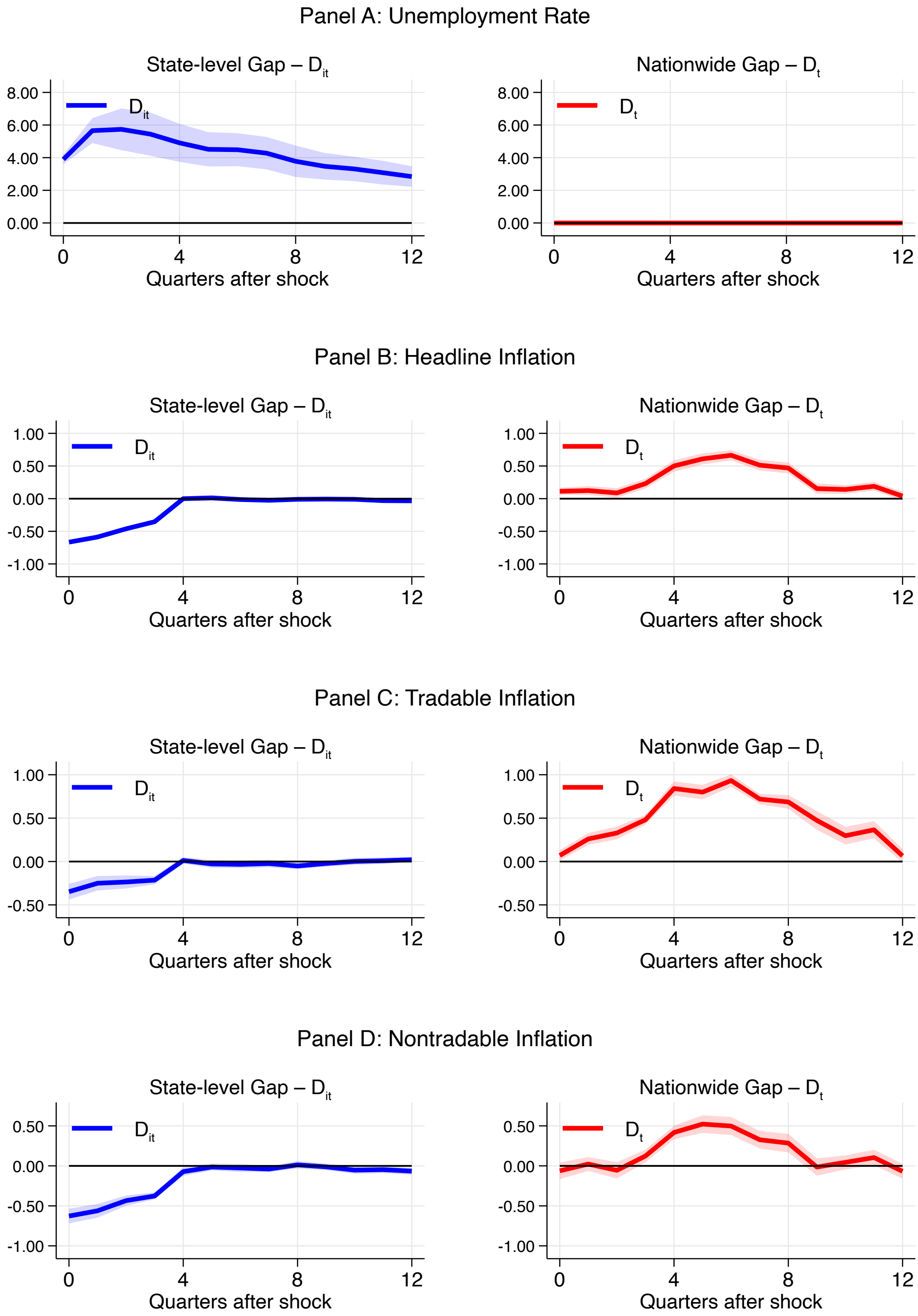
The figure presents a hierarchical clustering dendrogram of each state's policy rate gaps $D_{i,t}$ constructed using a complete-linkage clustering and a correlation distance metric. The horizontal axis lists U.S. states, while the vertical axis represents the height at which clusters merge, indicating the relative similarity of states in our sample.

Figure 4: Impact of a 1pp shock to state-level policy rate gap D_{it}



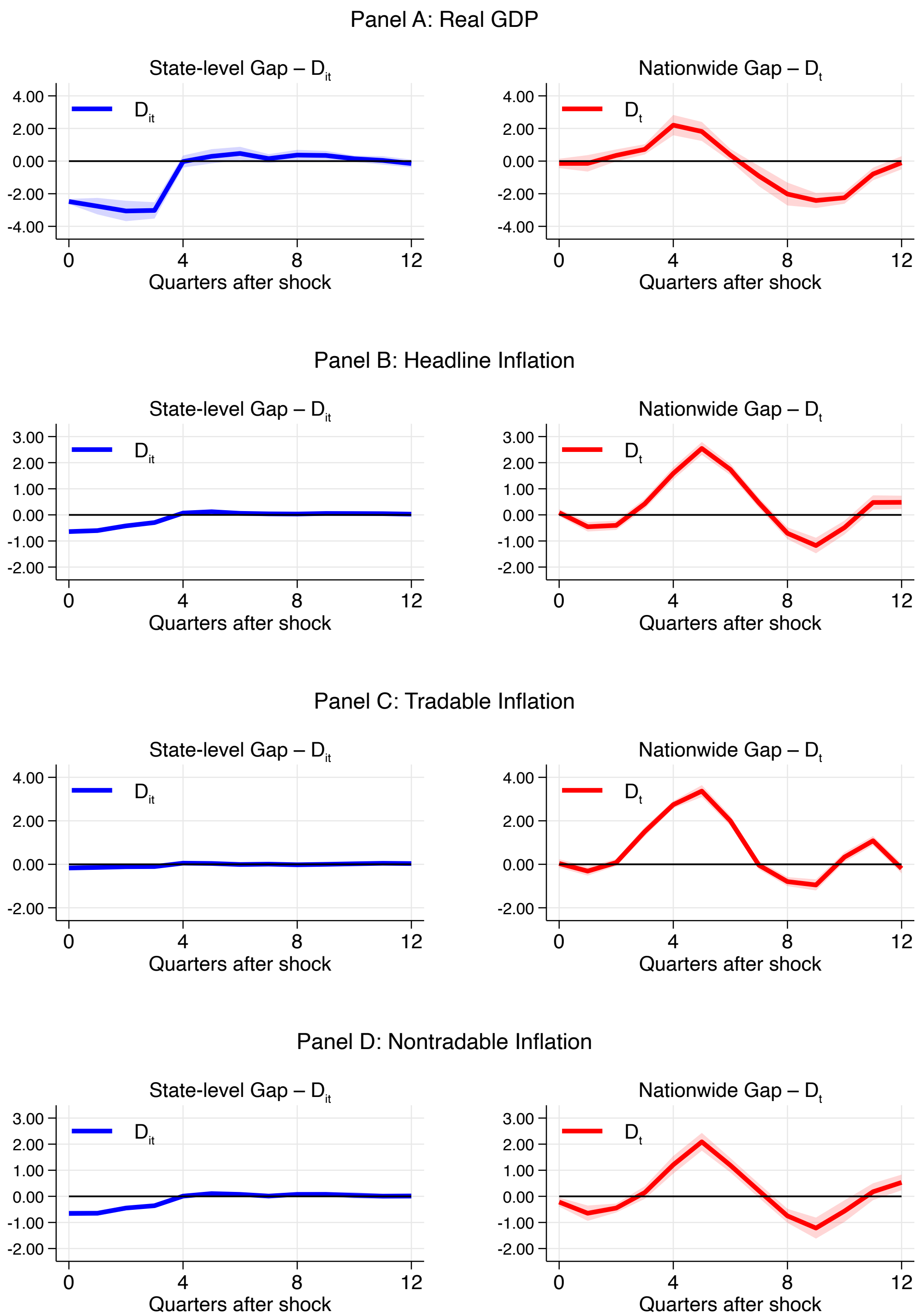
Notes: The figure plots the impact of a 1pp shock to policy rate mismatch D_{it} on the unemployment rate, headline, tradable and non-tradable inflation from 1989Q1 to 2017Q4. The solid blue line is the impulse response function (IRF); the shaded region represents the 90 percent confidence band. t=0 indicates the quarter of the shock.

Figure 5: Baseline comparison of state-level and nationwide policy rate gap impacts



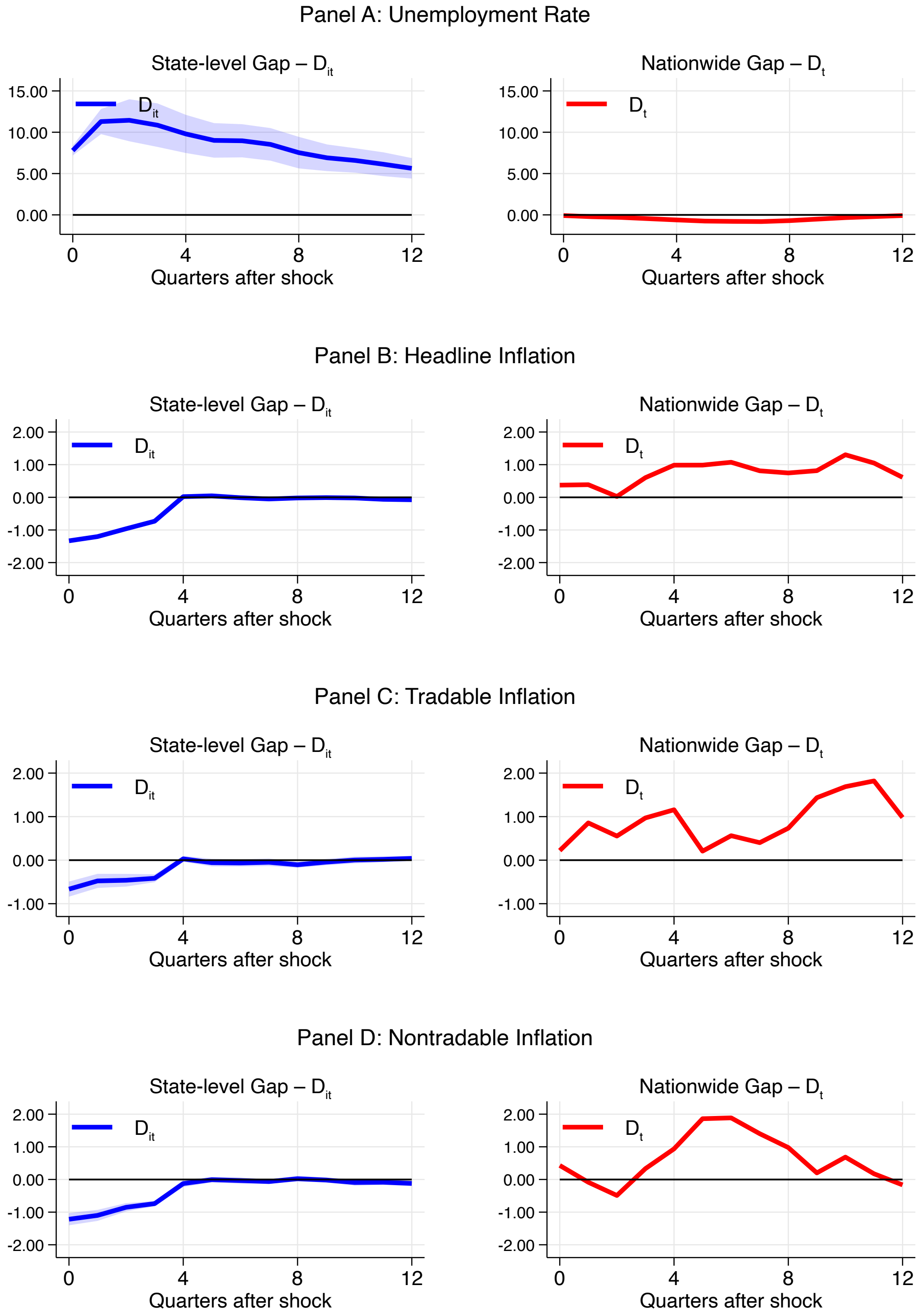
Notes: This figure illustrates the responses of unemployment, headline, tradable, and non-tradable inflation to a 1 percentage point shock in the policy rate mismatch. The blue solid line corresponds to the state-level gap (D_{it}), and the red solid line to the nationwide gap (D_t), covering the period from 1989 Q1 to 2017 Q4. The shaded regions indicate 90 percent confidence intervals. t=0 denotes the quarter in which the shock occurs.

Figure 6: Comparison of state-level and nationwide policy rate gap impacts, with output gaps as an alternative measure of economic slack



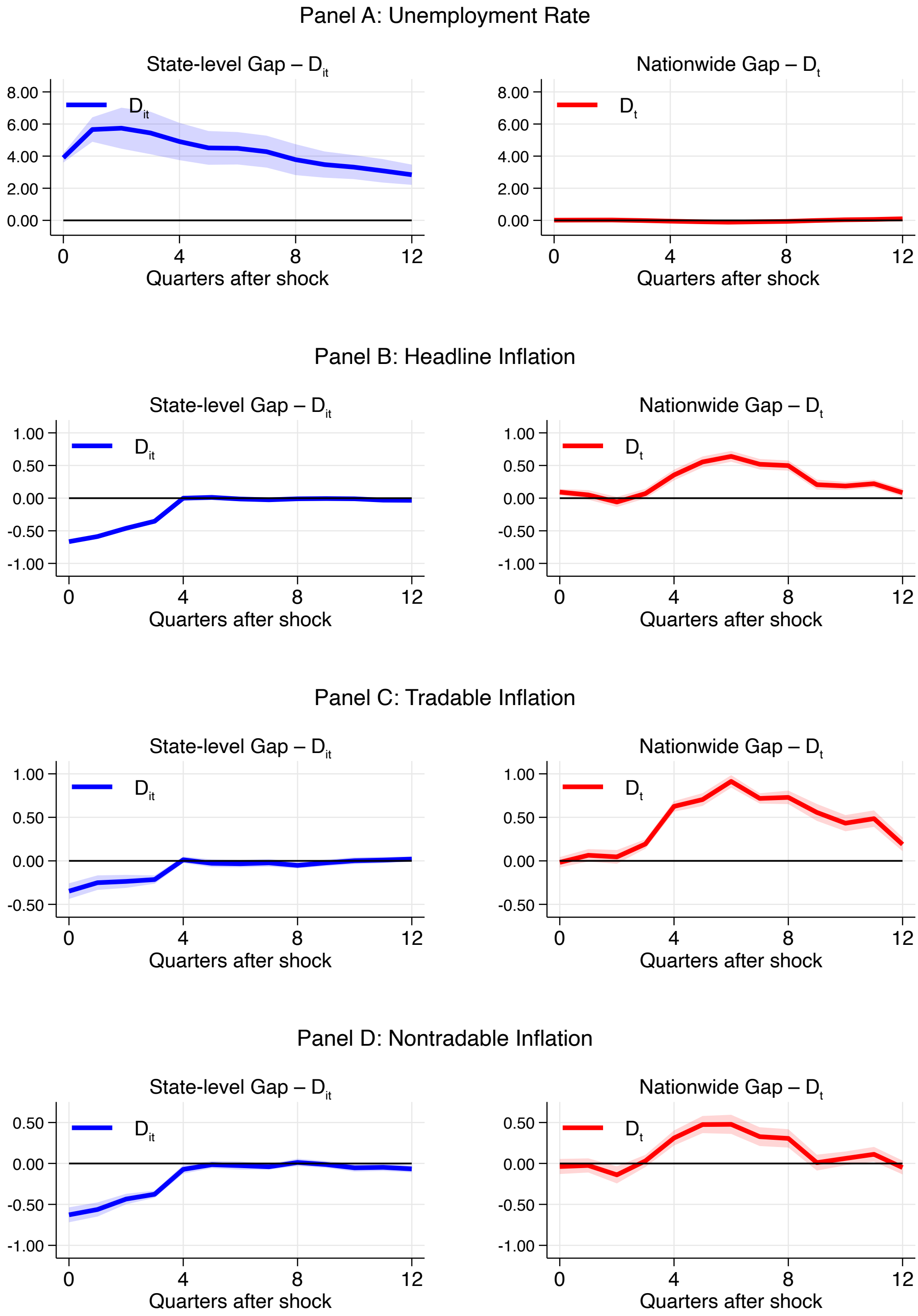
Notes: This figure illustrates the responses of real GDP growth, headline, tradable, and non-tradable inflation to a 1 percentage point shock in the policy rate mismatch. The blue solid line corresponds to the state-level gap (D_{it}), and the red solid line to the nationwide gap (D_t), covering the period from 2005 Q1 to 2017 Q4. Deviation shocks are calculated using state-level interest rates derived from a Taylor rule incorporating output gaps, in contrast to our baseline specification based on unemployment gaps. The shaded regions indicate 90 percent confidence intervals. t=0 denotes the quarter in which the shock occurs.

Figure 7: Comparison of state-level and nationwide policy rate gap impacts, under an interest-smoothing Taylor rule specification



Notes: This figure illustrates the responses of unemployment, headline, tradable, and non-tradable inflation to a 1 percentage point shock in the policy rate mismatch. The blue solid line corresponds to the state-level gap (D_{it}), and the red solid line to the nationwide gap (D_t), covering the period from 1989 Q1 to 2017 Q4. Deviation shocks are calculated using state-level interest rates derived from an alternative Taylor rule specification incorporating a smoothing parameter. The shaded regions indicate 90 percent confidence intervals. t=0 denotes the quarter in which the shock occurs.

Figure 8: Comparison of state-level and nationwide policy rate gap impacts, when accounting for unconventional monetary policy



Notes: This figure illustrates the responses of unemployment, headline, tradable, and non-tradable inflation to a 1 percentage point shock in the policy rate mismatch. The blue solid line corresponds to the state-level gap (D_{it}), and the red solid line to the nationwide gap (D_t), covering the period from 1989 Q1 to 2017 Q4. Deviation shocks are calculated as the difference between the effective federal funds rate and the state-level rate, rather than the federal funds rate and the state-level rate as in the baseline. The shaded regions indicate 90 percent confidence intervals. t=0 denotes the quarter in which the shock occurs.

Appendix

A Appendix Tables

Table A.1: List of US States

State	N	Start	End	State	N	Start	End
Alabama	116	1989 Q1	2017 Q4	Mississippi	116	1989 Q1	2017 Q4
Alaska	116	1989 Q1	2017 Q4	Missouri	116	1989 Q1	2017 Q4
Arkansas	116	1989 Q1	2017 Q4	New Jersey	116	1989 Q1	2017 Q4
California	116	1989 Q1	2017 Q4	New York	116	1989 Q1	2017 Q4
Colorado	116	1989 Q1	2017 Q4	North Carolina	116	1989 Q1	2017 Q4
Connecticut	116	1989 Q1	2017 Q4	Ohio	116	1989 Q1	2017 Q4
Florida	116	1989 Q1	2017 Q4	Oklahoma	115	1989 Q2	2017 Q4
Georgia	116	1989 Q1	2017 Q4	Oregon	116	1989 Q1	2017 Q4
Hawaii	116	1989 Q1	2017 Q4	Pennsylvania	116	1989 Q1	2017 Q4
Illinois	116	1989 Q1	2017 Q4	South Carolina	116	1989 Q1	2017 Q4
Indiana	116	1989 Q1	2017 Q4	Tennessee	116	1989 Q1	2017 Q4
Kansas	116	1989 Q1	2017 Q4	Texas	116	1989 Q1	2017 Q4
Louisiana	116	1989 Q1	2017 Q4	Utah	116	1989 Q1	2017 Q4
Maryland	116	1989 Q1	2017 Q4	Virginia	116	1989 Q1	2017 Q4
Massachusetts	116	1989 Q1	2017 Q4	Washington	116	1989 Q1	2017 Q4
Michigan	116	1989 Q1	2017 Q4	Wisconsin	116	1989 Q1	2017 Q4
Minnesota	116	1989 Q1	2017 Q4				

Total = 33 States

Table A.2: Data Sources

Data ID	Description	Source
FEDFUNDS	Federal Funds Effective Rate	FRED Database (Federal Reserve Bank of St. Louis)
GDP	GDP by State	Bureau of Economic Analysis
pi	Headline Inflation	Hazell et al. (2022) - State-Level Inflation Rates
pi_nt	Non-tradable Inflation	Hazell et al. (2022) - State-Level Inflation Rates
pi_t	Tradable Inflation	Hazell et al. (2022) - State-Level Inflation Rates
Wu-Xia	Wu-Xia Shadow Federal Funds Rate	Wu and Xia (2016) and Federal Reserve Bank of Atlanta
XXUR	State Level Unemployment Rate - Where XX refers to two letter state codes from: AK, AL, AR, CA, CO, CT, FL, GA, HI, IL, IN, KS, LA, MA, MD, MI, MN, MO, MS, NC, NJ, NY, OH, OK, OR, PA, SC, TN, TX, UT, VA, WA and WI	FRED Database (Federal Reserve Bank of St. Louis)

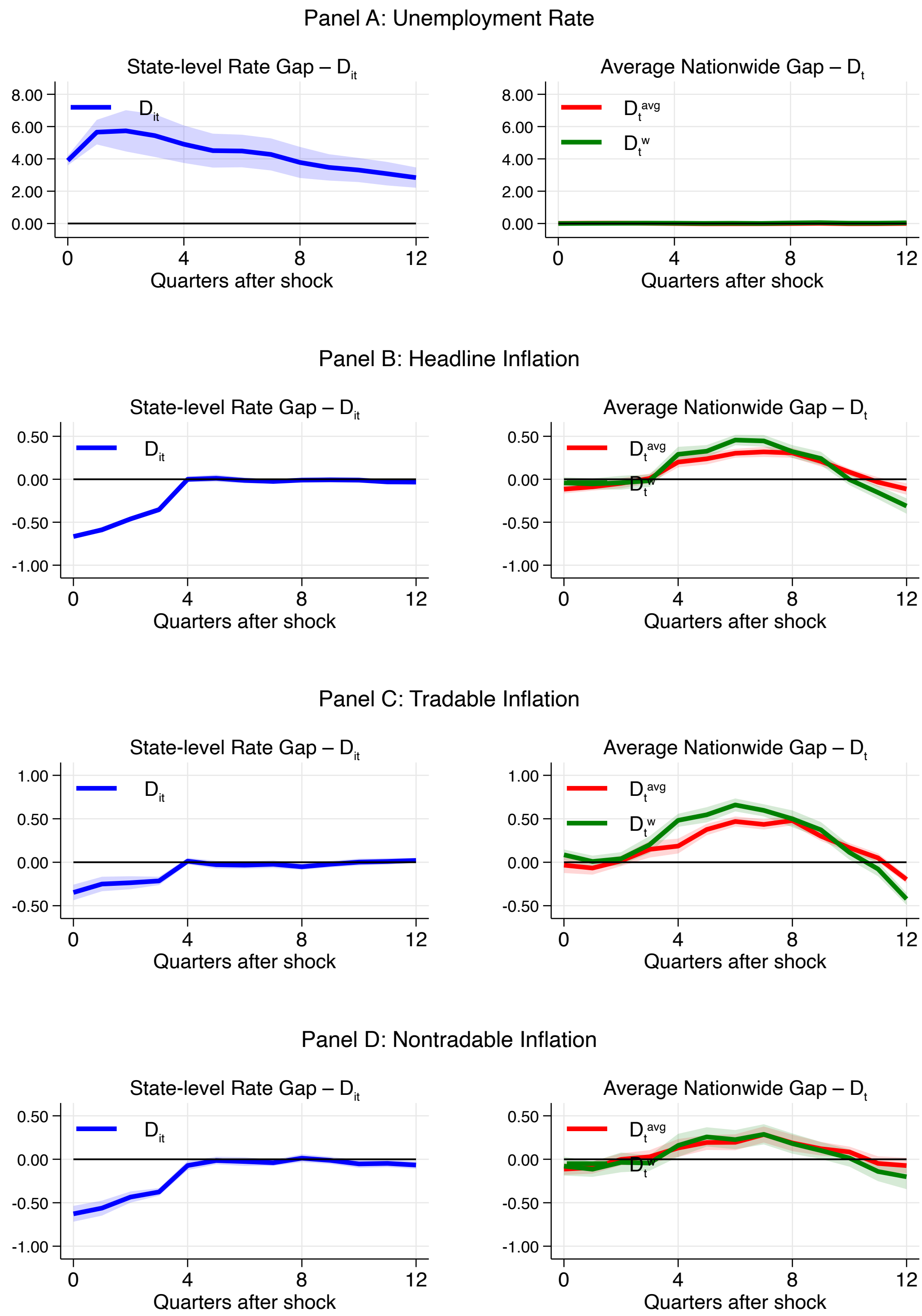
Table A.3: Summary statistics for policy rate deviations $D_{i,t}$ by state

State	Mean	Std.Dev.	Median	Min	Max
Alabama	0.13	2.59	0.09	-7.01	5.50
Alaska	-0.04	3.79	0.21	-7.80	9.38
Arkansas	0.27	2.68	0.37	-7.02	6.02
California	-0.19	2.62	-0.13	-4.61	5.04
Colorado	-0.09	2.97	0.76	-8.13	4.71
Connecticut	0.38	3.09	0.83	-9.42	6.69
Florida	0.00	3.15	0.28	-6.53	7.17
Georgia	0.03	2.98	-0.32	-6.13	8.50
Hawaii	-0.04	3.67	-0.01	-8.75	6.41
Illinois	0.12	3.13	-0.09	-5.67	8.05
Indiana	0.14	2.65	0.54	-6.19	5.59
Kansas	0.21	3.07	0.24	-7.89	8.91
Louisiana	0.07	2.85	0.23	-5.59	6.22
Maryland	-0.08	3.27	0.44	-10.38	8.67
Massachusetts	-0.03	3.90	-0.53	-7.98	16.73
Michigan	-0.07	3.43	-0.60	-6.34	8.50
Minnesota	0.05	3.53	-0.29	-7.47	8.57
Mississippi	-0.04	2.87	0.27	-6.86	5.31
Missouri	-0.14	2.62	-0.13	-5.77	6.24
New Jersey	-0.03	3.66	0.05	-7.78	8.13
New York	-0.10	2.78	0.06	-5.95	6.56
North Carolina	0.33	2.26	0.62	-4.87	6.26
Ohio	-0.16	2.52	0.27	-5.85	4.68
Oklahoma	-0.03	2.94	0.34	-8.02	6.18
Oregon	-0.32	3.36	-0.90	-6.18	10.01
Pennsylvania	-0.01	3.01	-0.21	-6.98	7.08
South Carolina	0.24	2.16	-0.03	-4.68	4.60
Tennessee	-0.21	3.34	-0.18	-7.95	6.63
Texas	-0.00	3.16	-0.03	-7.09	7.08
Utah	0.30	2.88	0.58	-7.42	6.96
Virginia	0.22	2.57	0.65	-7.37	5.27
Washington	-0.02	4.07	-0.95	-6.60	17.55
Wisconsin	-0.05	3.19	0.01	-6.28	8.74

Note: This table presents the summary statistics for the policy rate deviations $D_{i,t}$ by State.

B Appendix Graphs

Figure 9: Comparison of state-level and cross-sectional average policy rate gap impacts



Notes: This figure illustrates the responses of unemployment, headline, tradable, and non-tradable inflation to a 1 percentage point shock in the policy rate mismatch. The blue solid line corresponds to the state-level gap (D_{it}), the red solid line to the nationwide average gap (D_t^{avg}) defined as $D_t^{\text{avg}} = \frac{1}{n}\sum_{i=1}^{N} Dit$, and the green solid line to population-weighted average, defined as $D_t^{\text{w}} = \sum_{i=1}^{N} \omega_{it} D_{it}$, where ω_{it} is the population share of state i at time t, covering the period from 1989 Q1 to 2017 Q4. The shaded regions indicate 90 percent confidence intervals. t=0 denotes the quarter in which the shock occurs.