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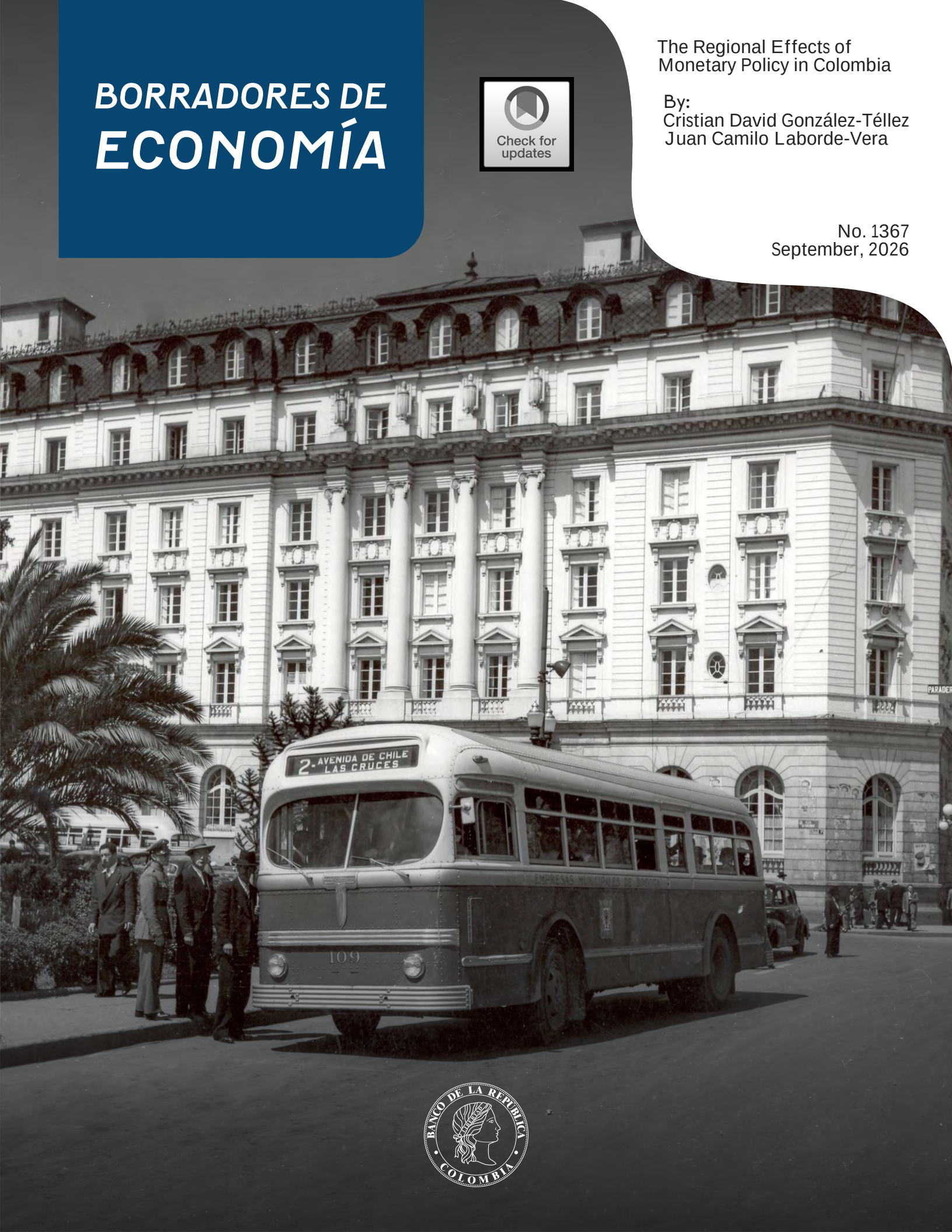

BANCO DE LA REPÚBLICA
COLOMBIA

The Regional Effects of Monetary Policy in Colombia*

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Abstract

We estimate the regional effects of monetary policy in Colombia using exogenous monetary shocks and local projections. Contractionary shocks reduce inflation, economic activity, and employment across regions, but with substantial regional heterogeneity in the magnitude of these effects. We find a positive cross-sectional covariance between price and activity responses, which indicates that these differences primarily reflect variation in the sensitivity of local demand to monetary shocks rather than heterogeneity in regional supply elasticities. We find that the regional transmission of monetary policy is amplified by a greater financial leverage, trade openness, labor-market informality and sectoral specialization in mining. Our results show that a common monetary policy shock generates systematically unequal regional outcomes because differences in local economic structure shape the strength of monetary transmission.

JEL Classification: E24, E43, E44, E52, E58, F41, F45, R11, R12

Keywords: Monetary Policy, Regional Heterogeneity, Heterogeneous Effects of Monetary Policy, Local Projections, Monetary Policy Shocks

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Los Efectos Regionales de la Política Monetaria en Colombia*

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Resumen

Estimamos los efectos regionales de la política monetaria en Colombia utilizando choques monetarios exógenos y proyecciones locales. Los choques contractivos reducen la inflación, la actividad económica y el empleo a lo largo de las regiones del país, aunque con una heterogeneidad regional considerable en la magnitud de estos efectos. Encontramos una covarianza transversal positiva entre las respuestas de los precios y de la actividad, lo que indica que estas diferencias reflejan principalmente variaciones en la sensibilidad de la demanda regional a los choques monetarios, más que elasticidades de la oferta diferentes por región. Encontramos que la transmisión regional de la política monetaria se amplifica en regiones con mayor apalancamiento financiero, mayor apertura comercial, mayor informalidad laboral y una especialización sectorial más marcada en la minería. Nuestros resultados muestran que un choque común de política monetaria genera resultados regionales sistemáticamente desiguales, debido a que las diferencias en la estructura económica local moldean la intensidad de la transmisión monetaria.

Clasificación JEL: E24, E43, E44, E52, E58, F41, F45, R11, R12

Palabras clave: Política monetaria, heterogeneidad regional, efectos heterogéneos de la política monetaria, proyecciones locales, choques de política monetaria.

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1 Introduction

This paper estimates how the effects of monetary policy shocks vary across space in Colombia and evaluates potential sources of economic heterogeneity that may account for these differences. After a monetary tightening shock, inflation, economic activity and employment decline in Colombia, but do so at different rates across cities and departments.[1] Notably, regions with larger inflation declines also experience stronger contractions in employment and economic activity. This comovement is consistent with spatial heterogeneity in local demand sensitivity to monetary policy shocks playing a dominant role relative to heterogeneity in local supply elasticities.

The magnitude of the downturn is increasing in the sensitivity of the region's dominant sector to monetary policy. Regions specialized in capital-intensive industries display a weaker link between activity and employment, consistent with a partial disconnect of output and labor market adjustment.

We find that regions with greater trade openness experience larger contractions in economic activity and inflation following a monetary tightening. To illustrate the mechanism, a concrete example is useful. La Guajira is a department whose production structure is heavily concentrated in mining. In response to the tightening shock, we show that aggregate oil and coal exports decline.[2] This reduction in exports amplifies the negative effects of monetary policy on local real activity and employment, as well as on inflation with a lag.

Beyond the sectoral and external channels, we document a financial amplification mechanism operating through the local stock of bank credit. Departments with above-trend outstanding credit balances experience larger contractions in both economic activity and inflation in response to a monetary tightening shock. This pattern might be consistent with a debt-service channel whereby a higher volume of interest-sensitive liabilities raises the sensitivity of local demand to changes in the policy rate. The cross-sectional relationship between the minimum responses of credit and economic activity is positive and robust across identification strategies, indicating that the contraction in real activity and credit reinforce each other.

We also provide evidence of an informality amplification mechanism operating through local labor markets. Departments in which informal employment is above its own historical average experience larger declines in employment and economic activity after a monetary tightening, together with stronger disinflation. This pattern suggests that informality increases the sensitivity of local demand to monetary policy. Informal workers typically face more unstable income streams, weaker access to formal credit, and lower coverage by social insurance mechanisms, which reduces their ability to smooth consumption when they face a negative labor income shock. As a result, monetary contractions may translate more directly into lower household spending in regions where informality is elevated. This stronger contraction in demand might then feed into a stronger

[1] We use the term *cities* when referring to inflation and employment, since these variables are observed at the city level. We use the term *departments* when discussing economic activity, as this variable is measured at the department level. We refer to *regions* when discussing outcomes for both spatial units or when mapping city to department outcomes.

[2] This pattern is consistent with either an *expenditure-switching* channel, which operates through a reduction in export supply in response to an exchange rate appreciation (McLeay and Tenreyro, 2026) or a *trade-credit* channel whereby tighter financial conditions restrict the availability and increase the cost of working capital for exporting firms (Bruno and Shin, 2023).

disinflationary response.

As Herreño and Pedemonte (2025) highlight, the covariance between the price and activity effects of monetary policy is a sufficient statistic to assess whether the differential effects of monetary policy across regions are due to heterogeneity in supply or demand. In particular, if the source of heterogeneity is the slope of the Phillips Curve across regions, the cross-sectional covariance between price and quantity responses will be negative. In this case, the negative shift in demand caused by a monetary contraction will reduce prices by less and quantities by more in regions with flatter supply curves. By contrast, if the source of heterogeneity is the sensitivity of regional demand curves to monetary shocks, the correlation between the price and quantity effects of monetary policy will be positive. In this case, regions with more policy-sensitive demand curves will exhibit larger changes in real marginal costs, which through a common slope of the Phillips curve, induces larger price effects. The sectoral, financial, external, and informality channels we document are precisely the mechanisms through which local demand sensitivity varies across Colombian regions, rationalizing why the cross-sectional covariance between price and activity responses has a positive sign.

To find our results, we use exogenous variation in the stance of monetary policy for 2008-2025, using the three sources of state-of-the-art monetary policy shocks identified by López et al. (2020), Romero et al. (2021) and Laborde (2026). We use these shocks to estimate impulse response functions in panel and individual settings using local projections. Our analysis uses regionally disaggregated data for economic activity, employment, informality, and consumer prices in Colombia at a monthly frequency. For economic activity we use the *Indicador Trimestral de Actividad Económica Departamental* (ITAED) for 13 departments for March 2015-April 2025. For prices we use the Consumer Price Index (CPI) data for 22 cities for December 2008-April 2025 and for employment we use the *Gran Encuesta Integrada de Hogares* (GEIH) for 22 cities for March 2010-April 2025.

We additionally construct several monthly department-level measures of labor-market informality from GEIH microdata, including definitions based on pension contributions, firm size, business registration, accounting practices, occupational risk insurance affiliation, health insurance regime, and a composite indicator. To investigate the financial channel, we additionally draw on monthly departmental data on outstanding bank credit, and to characterize external market integration we use the TAM-2 subcomponent of the *Índice de Desempeño de Comercio Exterior* (IDC), which ranks all 33 Colombian departments by their trade openness.

We also build a dataset of financial and macroeconomic variables for Colombia as a whole for the period December 2008-April 2025 and estimate impulse response functions for aggregate variables using local projections, finding responses broadly in line with the conventional view on the macroeconomic consequences of exogenous monetary shocks. In the panel and most individual-region estimations all shocks eliminate any signs of price and activity puzzles.

Our results raise an important normative question: should monetary policy assign different weights on economic conditions across regions? We argue that monetary policy is, to a large extent, constrained by the fact that it relies on a single national instrument and therefore cannot tailor its response to developments in each

region independently. On the other hand, fiscal policy can be designed according to the prevailing regional economic conditions and therefore can be used as an instrument to reduce regional disparities induced by monetary policy actions. This is particularly relevant in economies such as Colombia, where regional differences in productive structure, financial depth, trade exposure, and labor-market informality imply that the real costs of a common monetary tightening are unevenly distributed across space.

2 Related Literature

We contribute to the literature that has studied the spatial heterogeneity in the effects of monetary policy. A growing body of evidence shows that a common aggregate monetary shock might generate markedly different responses in output, employment, credit, and inflation across subnational regions. These differences have been linked to heterogeneity in sectoral composition, financial depth, household and firm balance-sheet exposure, demographic structure, and factor mobility (Domínguez-Torres and Hierro, 2019).

Seminal evidence for the United States established early the importance of regional heterogeneity in monetary transmission. Carlino and DeFina (1998) showed that regions with a larger manufacturing share experienced significantly stronger contractions following monetary tightenings, whereas regions more specialized in services exhibited more muted responses. In line with these results, Datsenko and Fleck (2024b) use the Romer and Romer (2004) shocks and show in a local projections setting that metropolitan areas specialized in manufacturing experience stronger employment declines following increases in the Federal Reserve's policy rate. Similarly, our results indicate that the strength of monetary transmission in Colombia is mediated by the sectoral composition of local economies. In particular, Colombian regions specializing in mining exhibit more pronounced economic contractions in response to a monetary tightening shock relative to agricultural or diversified regions.

More recent work has broadened this interpretation by incorporating financial and distributive mechanisms. Di Maggio et al. (2017a) show that areas with a higher prevalence of adjustable-rate mortgages are more sensitive to monetary policy, highlighting that regional sensitivity depends not only on productive structure but also on the composition of household and firm balance sheets. In line with these results, we find that Colombian regions with higher levels of financial leverage experience stronger effects of monetary policy on output and inflation.

Herreño and Pedemonte (2025) study the local employment and inflation responses to monetary policy in U.S. metropolitan areas. Using alternative identification strategies, including Romer and Romer (2004) and Miranda-Agrippino and Ricco (2021), they show that the cross-sectional covariance between price and quantity responses constitutes a sufficient statistic for distinguishing between alternative sources of regional heterogeneity. A positive covariance between inflation and output responses is consistent with differences in regional demand sensitivities, whereas a negative covariance points to variation in regional supply elasticities. They

find a positive covariance and, in order to rationalize these findings, they develop a monetary-union model with heterogeneous agents in which regional variation in the share of hand-to-mouth households generates the observed patterns. Their framework represents an important advance insofar as it moves beyond documenting heterogeneous responses and instead identifies the underlying economic mechanisms that produce them. We adopt their empirical methodology and find that in Colombia the covariance between price and quantity responses is also positive. We also find that some of the drivers of the regional heterogeneity in demand sensitivity to monetary policy shocks are sectoral composition, financial leverage, trade openness and labor informality.

The importance of these mechanisms has been particularly emphasized in economically integrated areas characterized by substantial regional heterogeneity. In Europe, the implementation of a common monetary policy under the European Central Bank generated a large literature on the territorial consequences of a single interest rate. Hauptmeier et al. (2020) find that lower-income regions exhibit more persistent and contractionary responses to monetary tightenings, including evidence of hysteresis effects on employment and productivity. More generally, Winkler et al. (2004) argue that differences in trade openness, industrial structure, and financial development generate persistent regional asymmetries in monetary transmission within the Euro Area. Using a local projections framework and high-frequency monetary policy shocks constructed by Jarociński and Karadi (2020), Datsenko and Fleck (2024a) show that economies with a larger manufacturing share experience significantly stronger declines in real GDP following a monetary tightening, whereas service-oriented economies are comparatively insulated.

This discussion naturally connects to the literature on Optimum Currency Areas (OCA), initiated by Mundell (1961). A monetary union entails a trade-off between the benefits of sharing a common currency and the loss of the ability to tailor monetary policy to local economic conditions. Kenen (1969) emphasized the role of productive diversification as a buffer against asymmetric shocks, while Frankel and Rose (1998) argued that economic integration may endogenously increase business-cycle synchronization. Although originally developed in an international context, the logic of the OCA framework applies equally well to subnational economies. Colombia can be viewed as a monetary union composed of regions with substantial differences in productive structure, sectoral specialization, trade integration, and financial development. From this perspective, and as highlighted by Bellifemine et al. (2025), studying regional heterogeneity in monetary transmission provides valuable insights into aggregate monetary policy, since spatial asymmetries may fundamentally alter the nationwide implications of a common shock.

Evidence for emerging economies further suggests that regional asymmetries may be particularly pronounced in contexts characterized by large structural and financial disparities. For South Korea, Joo et al. (2024) find that regions with lower income, older populations, and higher household indebtedness exhibit stronger contractions in output and employment following monetary tightenings. For Indonesia, Ridhwan et al. (2021) show that regional sensitivity depends on the relative importance of manufacturing, mining, bank credit, and trade integration, while Ridhwan et al. (2014) identify sectoral composition as the primary driver of regional heterogeneity.

Similar findings are reported by Kapuściński and Stanisławska (2019) for Poland, where regional differences in monetary transmission are closely linked to industrial structure and demographic characteristics.

Evidence for Latin America remains comparatively limited, although the existing studies point in a similar direction. For Argentina, Baumann and Galiani (2019) document asymmetric regional effects associated with financial integration and provincial productive structure. For Colombia, the available evidence also suggests the existence of regional heterogeneity, although disagreement persists regarding its magnitude and persistence. Quintero Otero (2019) show that departments with a greater concentration of financially dependent sectors experience stronger contractions following unexpected increases in policy rates. Romero Prieto (2008) find partial evidence of regional heterogeneity and spatial diffusion across departments, although with relatively short-lived effects. In contrast, Zuccardi Huertas (2002) concludes that regional differences are not statistically significant at the aggregate level. Taken together, the existing evidence suggests that the extent and sources of regional heterogeneity in Colombia remain an open empirical question, particularly given differences in identification strategies, temporal coverage, and regional aggregation.

Additionally, given its large prevalence across developing countries, a growing literature has examined how labor market informality shapes business cycle dynamics and the propagation of macroeconomic shocks. This literature delivers contrasting predictions regarding whether informality dampens or amplifies aggregate fluctuations and, more specifically, whether it attenuates or strengthens the transmission of monetary policy.

The macroeconomic literature has long emphasized that labor-market informality can act as a shock absorber over the business cycle. Informal employment tends to expand when formal employment contracts, cushioning downturns by reallocating displaced workers into relatively unregulated activities. Fernández and Meza (2015) document this mechanism for Mexico, showing that informal employment is countercyclical, lags the business cycle, and is negatively correlated with formal employment. As a result, aggregate employment in emerging economies is substantially less volatile and less procyclical than in advanced economies. Leyva and Urrutia (2020) reach a complementary conclusion in a small open economy model with frictional labor markets. In their framework, interest-rate shocks primarily affect job creation in the formal sector, generating a countercyclical informality rate, while the informal sector provides a margin of adjustment that mitigates the effects of labor-market frictions on aggregate employment and consumption. Extending the analysis to a broad panel of advanced and emerging economies, Horvath and Yang (2022) show that larger informal sectors dampen the volatility and countercyclicality of unemployment by absorbing part of the labor market adjustment that would otherwise occur through joblessness.

A more recent strand of the literature argues instead that informality may amplify aggregate volatility once demand-side and financial channels are taken into account. Ávila-Montealegre et al. (2026) develop a DSGE model calibrated to Colombia in which low-skilled households supply both formal and informal labor but face binding borrowing constraints. Since formal wages are downwardly rigid while informal wages remain flexible, productivity and demand shocks are absorbed disproportionately through informal employment and wages.

Informal workers, who are effectively hand-to-mouth consumers, possess little capacity to smooth consumption intertemporally, whereas higher-income households adjust mainly through savings and investment. The interaction between formal-sector wage rigidity and the limited consumption-smoothing capacity of informal workers generates a mechanism through which higher informality increases the relative volatility of consumption and investment. The authors show that this mechanism accounts for a substantial fraction of the positive cross-country relationship between informality and macroeconomic volatility observed across sixty economies between 1990 and 2020.

These contrasting views become particularly relevant in the context of monetary policy transmission. Alberola and Urrutia (2020) build a New Keynesian model with labor and financial frictions calibrated to Mexico in which only formal firms have access to external finance. In their framework, the informal sector acts as a buffer that flattens the Phillips curve, dampens the inflationary effects of demand and financial shocks, and makes disinflation more costly. Consequently, a contractionary monetary policy shock generates a larger sacrifice ratio and a deeper decline in output and employment when an informal sector is present than in an otherwise identical economy without informality. By contrast, Yépez (2025) obtain the opposite result in a two-sector New Keynesian model with endogenous firm entry. Under a plausible calibration, the flexibility of the informal sector reduces the sacrifice ratio associated with monetary tightenings because informal firms absorb part of the reallocation that would otherwise manifest itself as a larger contraction in formal activity. Using a structural VAR for Mexico, they further show that informality rises following contractionary monetary policy shocks, consistent with countercyclical reallocation toward informal employment as financing conditions tighten.

For Colombia, Otero-Cortés et al. (2025) develop a general-equilibrium model featuring high- and low-skilled households, a downwardly rigid minimum wage, and nominal price rigidities. They find that contractionary monetary policy shocks have stronger effects on both consumption and inflation in economies with higher informality. As the share of informal employment increases, a smaller fraction of labor input is tied to the minimum wage, labor costs become more flexible, and monetary policy is transmitted more effectively through labor-market adjustment. Although this mechanism enhances the effectiveness of monetary policy, it simultaneously increases aggregate volatility.

Taken together, this literature suggests that whether informality amplifies or dampens monetary transmission is ultimately an empirical question. The answer depends on which margin dominates: the buffering of unemployment and inflation emphasized by Fernández and Meza (2015), Leyva and Urrutia (2020), Horvath and Yang (2022), and Alberola and Urrutia (2020), or the amplification of household demand and labor-cost flexibility emphasized by Ávila-Montealegre et al. (2026), Yépez (2025), and Otero-Cortés et al. (2025). Importantly, most existing evidence originates either from cross-country studies or from representative-agent models calibrated to a single national economy. Consequently, we know considerably less about how informality shapes monetary transmission within a country across regions that face the same monetary policy but differ persistently in labor-market structure. This gap is particularly relevant for Colombia, where informality varies substantially

across departments and represents one of the most salient dimensions of regional economic heterogeneity. By exploiting subnational variation in informality within a common monetary regime, our analysis provides direct evidence on this channel. We find that higher levels of informality amplify the effects of monetary policy on employment, activity and inflation.

From a methodological standpoint, the recent literature has increasingly converged toward the use of the local projections technique proposed by Jordà (2005) as the standard framework for estimating impulse responses in heterogeneous environments. Relative to traditional VAR models, local projections offer greater flexibility in modeling cross-sectional heterogeneity, nonlinearities, and horizon-dependent dynamics, features that are particularly valuable in regional panel settings. At the same time, the identification of monetary shocks has evolved toward more robust approaches based on external instruments, high-frequency surprises, and narrative measures, thereby reducing reliance on restrictive structural assumptions (Ramey, 2016; Nakamura and Steinsson, 2018). We follow this recent literature in using narrative and high-frequency methods for identifying exogenous monetary policy shocks and local projections to estimate impulse response functions.

Overall, this paper contributes to the literature along several dimensions. First, we provide new evidence on the regional effects of monetary policy in Colombia using subnational data on economic activity, employment, and inflation over the period 2008–2025. Second, we employ three contemporary measures of exogenous monetary policy shocks developed for Colombia and consistent with state-of-the-art identification strategies in the international literature. Third, we show that labor-market informality constitutes a central source of regional heterogeneity in monetary transmission, significantly affecting the responses of local economic activity, labor-market outcomes, and prices to a common monetary shock. Fourth, we relate these differences to broader dimensions of regional economic structure, including sectoral specialization, financial depth, and trade openness. Finally, we connect the regional monetary transmission and Optimum Currency Area literatures by showing how persistent differences in labor-market institutions shape the propagation of a common monetary policy across territorially heterogeneous economies.

3 Data and Empirical Specification

3.1 Data

This section presents the data, empirical specification and monetary policy shocks we use in our analysis. We first show the time series of the macroeconomic variables at the subnational level in Colombia (inflation, economic activity and employment) we will use. While the region-level employment, inflation, and real activity growth series comove over time, they display substantial and persistent cross-sectional heterogeneity in both levels and volatility.

First, we use monthly Consumer Price Index (CPI) data for 22 cities. Second, we employ the Indicador Trimestral de Actividad Económica Departamental (ITAED), which captures economic activity at the depart-

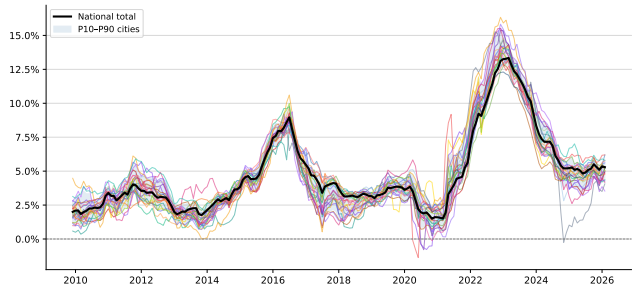
mental level. Our specification uses monthly monetary shocks, so we interpolate the series of ITAED using shape-preserving piecewise cubic interpolation, following Miranda-Agrippino and Rey (2020).[3] Finally, we use the level of employment from the Gran Encuesta Integrada de Hogares (GEIH), which allow us to characterize labor market dynamics across 22 cities. Taken together, these variables allow us to jointly analyze the evolution of prices, quantities, and labor market outcomes at the regional level in response to aggregate monetary policy shocks.

Figure 1 plots the evolution of annual inflation across cities. Panel (a) reveals a pronounced common component, driven by well-identified macroeconomic episodes, including the 2014–2016 inflation surge, associated with the sharp decline in oil prices[4] and the consequent currency depreciation, the El Niño phenomenon, and the nationwide truckers' strike, as well as the disinflation observed at the onset of the COVID-19 pandemic and the subsequent post-pandemic inflation surge. Conditional on this aggregate component, however, city-level inflation paths display systematic heterogeneity in both levels and volatility.

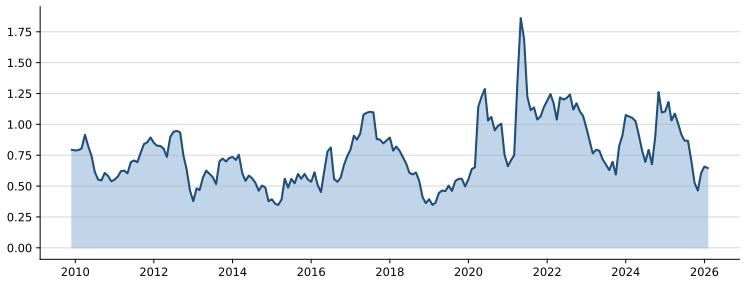
Panel (b) shows the cross-sectional standard deviation of inflation across cities. There seems to be a pattern of low dispersion in tranquil periods and high dispersion during macroeconomic stress, which suggests that aggregate shocks affect not only the level of inflation but also its spatial distribution. Inflation is therefore not a spatially uniform phenomenon, and its heterogeneity emerges endogenously over the cycle.

Figure 1: Annual inflation by City

(a) Historical inflation by city



(b) Cross-section standard deviation



Note: This figure displays the time series of the year-on-year change in CPI inflation across cities in Colombia (Panel a) and the cross-sectional standard deviation (Panel b), covering the period 2008–2025.

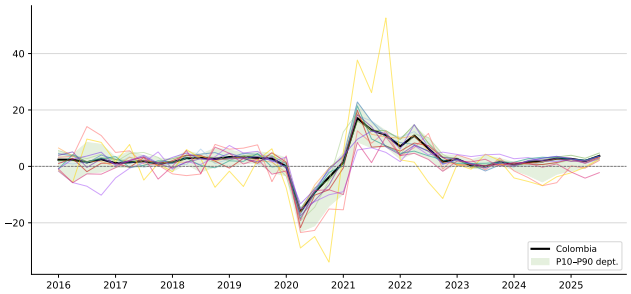
Figure 2 presents annual growth in the ITAED across departments. Panel (a) reveals that regional economies are highly synchronized in direction but not in magnitude. These differences are particularly pronounced during the recovery phase of the pandemic. While some departments exhibit extremely high growth rates-exceeding 40 percent in some cases-others display much more muted or uneven recoveries. This heterogeneity

[3]This transformation may induce serial correlation at the monthly frequency and, consequently, yield impulse responses that are smoother than those that would be obtained when using the original quarterly data as the dependent variable. The sign of the associated bias is not ex ante clear, as interpolation can attenuate or amplify the estimated responses. For this reason, we interpret the responses of interpolated variables as describing the monthly distribution of quarterly movements, rather than as exploiting independent monthly variation in the outcome.

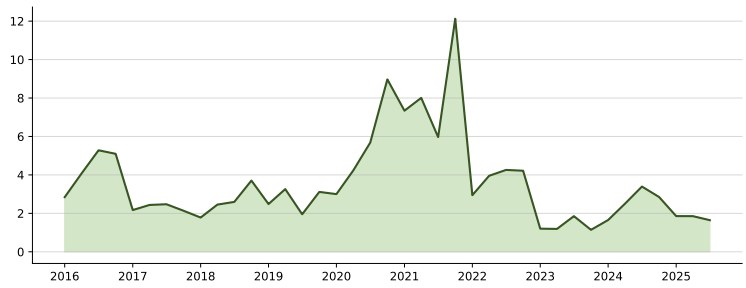
[4]During this period, the price of oil fell by approximately 70%, from USD 111.8 per barrel in June 2014 to USD 32.18 per barrel in February 2016.

Figure 2: Annual Growth of ITAED by Department

(a) Historical growth of the ITAED by department



(b) Cross-section standard deviation



Note: This figure displays the time series of the year-on-year change in the ITAED across departments in Colombia (Panel a) and the cross-sectional standard deviation (Panel b), covering the period 2015–2025.

is not a second-order feature but a dominant aspect of the adjustment to aggregate shocks.

Panel (b) confirms this observation. Cross-sectional dispersion rises sharply during 2020–2022, reaching levels multiple times larger than those observed in normal periods. Aggregate shocks thus generate both synchronization and divergence: regions move together, but by very different amounts.

Figure 3 reports employment rates across cities. Panel (a) shows a mild but steady increase in employment rates during the past decade, and a sharp aggregate drop during 2020, followed by a gradual recovery. However, labor market dynamics are markedly heterogeneous in the cross section. Some cities exhibit persistently lower employment rates relative to the national rate, while others exhibit higher levels. Notably, some cities respond more to crisis such as the pandemic and the recovery is uneven: in several cities, employment remains depressed for a prolonged period, while in others it converges back more quickly.

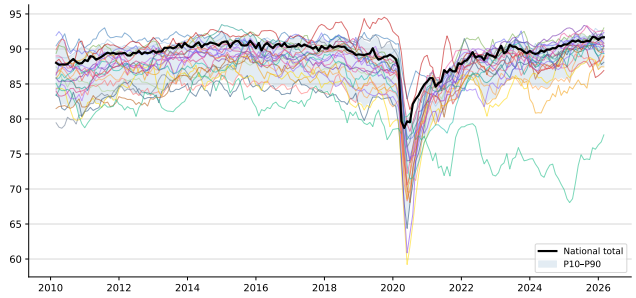
Panel (b) shows that cross-sectional dispersion in employment is relatively constant excluding the pandemic crisis. During the COVID crisis it increased significantly and remained elevated during the recovery. In contrast to inflation, where dispersion tends to decline after peak episodes, labor market disparities exhibit greater persistence. This evidence suggests that regional labor markets differ not only in their sensitivity to shocks but also in the speed of adjustment, introducing an additional margin of asymmetry in the propagation of aggregate disturbances.

A consistent message emerges from the data: regional economies in Colombia are exposed to common shocks but do not experience them uniformly. Heterogeneity is persistent and it arises simultaneously in prices, economic activity, and labor markets, and intensifies precisely when macroeconomic conditions tighten.

Hence, monetary policy, which is implemented through a single national interest rate, might generate heterogeneous regional effects. Moreover, the joint behavior of inflation, activity, and employment suggests that these differences are not independent, but rather reflect common underlying transmission mechanisms. A natural implication is that monetary transmission cannot be fully understood through aggregate relationships alone. Instead, it requires an explicit regional perspective that accounts for cross-sectional variation and identifies its structural determinants.

Figure 3: Employment Rate by City

(a) Historical Employment by city



(b) Cross-section standard deviation

Note: This figure displays the time series of the employment rate across regions in Colombia (Panel a) and the cross-sectional standard deviation (Panel b), covering the period 2010–2025.

Against this background, the empirical analysis of this paper addresses two central questions. First, how heterogeneous are the effects of monetary policy shocks across regions? Second, which economic characteristics-particularly those related to the sensitivity of regional demand-account for these differences? The following sections formalize and quantify these channels.

3.2 Empirical Specification

To quantify the dynamic effects of monetary policy on regional inflation, economic activity, and employment we estimate impulse responses using the local projections (LP) framework of Jordà (2005). Relative to vector autoregressions, local projections directly estimate horizon-specific responses and are therefore well suited to environments with potential model misspecification, heterogeneous dynamics, and horizon-dependent effects-features that are central in our regional setting.

Our objective is to trace the causal effect of an exogenous monetary policy shock on regional outcomes, relative to a counterfactual path without such intervention. We proceed in two steps. First, we estimate panel local projections with region fixed effects to recover the average response across regions. Second, we estimate individual-region specifications to characterize cross-sectional heterogeneity in monetary transmission.

Let $y_{i,t}$ denote the outcome of interest in region i at time t, and let s_t denote the aggregate monetary policy shock. The baseline panel local projection is given by:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h s_t + \sum_{j=1}^{12} \phi_{h,j} \Delta y_{i,t-j} + \varepsilon_{i,t+h}, \quad h = 0, 1, \ldots, H, \tag{1}$$

where $y_{i,t+h} - y_{i,t-1}$ denotes the cumulative change in the outcome variable between $t-1$ and $t+h$, $\alpha_{i,h}$ are region fixed effects, γ_h is a constant. Let $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$. The specification includes $p = 12$ lags of the monthly change, i.e., $\{\Delta y_{i,t-1}, \ldots, \Delta y_{i,t-12}\}$, as controls. The coefficient β_h traces the cumulative impulse response of the dependent variable to a one percentage point monetary policy shock at horizon h.

Identification relies on the exogeneity condition $\mathbb{E}(s_t \varepsilon_{i,t+h}) = 0$, which requires monetary policy shocks

to be orthogonal to contemporaneous and future regional innovations. Since s_t is common across regions, identification in the panel arises from differences in the magnitude and persistence of regional responses to the same aggregate shock.

To obtain heterogeneous responses, we estimate the following local projection separately for each region:

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h s_t + \sum_{j=1}^{12} \phi_{h,j} \Delta y_{t-j} + \nu_{t+h}, \quad h = 0, 1, \ldots, H, \tag{2}$$

where β_h captures the region-specific impulse response at horizon h, and $\Delta y_t = y_t - y_{t-1}$ so the specification includes $p = 12$ lags of the monthly change, i.e., $\{\Delta y_{t-1}, \ldots, \Delta y_{t-12}\}$, as controls. Estimating equation (2) separately allows us to recover the full cross-sectional distribution of impulse responses and relate it to observable regional characteristics.

The maximum horizon H varies with data frequency. In the baseline specification, we estimate responses up to 24-36 months for inflation, employment, and activity indicators. All specifications include 12 lags of the dependent variable, which is standard in the monetary policy literature and sufficient to capture persistence in regional macroeconomic series. We also tested for the inclusion of 0, 1, 2, 3 and 4 lags of the shocks and found that the results remain virtually the same.

Inference accounts for the serial correlation induced by overlapping forecast horizons. Specifically, standard errors are computed using Newey-West heteroskedasticity and autocorrelation consistent (HAC) estimators with horizon-dependent truncation. This correction is required because the regression error $\varepsilon_{i,t+h}$ follows a moving-average process of order h.

The LP framework is particularly well suited to our application for two reasons. First, it allows for fully flexible dynamics across horizons without imposing the cross-equation restrictions inherent in VAR models. Second, it provides a transparent way to accommodate heterogeneous responses across regions. Taken together, these features allow us to characterize both the average and the cross-sectional distribution of regional responses to a common monetary policy shock, directly linking the empirical design to the central question of the paper.

3.3 Monetary policy shocks

Identifying the causal effects of monetary policy requires isolating variation in the Banco de la República's policy rate that is orthogonal to contemporaneous macroeconomic conditions. To this end, we employ three alternative measures of exogenous monetary policy shocks. Comparing results across identification strategies allows us to assess the robustness of the estimated regional responses to different assumptions regarding the information set of the central bank and financial market participants.

Our first identification strategy exploits forecast errors constructed from Bloomberg surveys of financial analysts. The baseline monetary shock is defined as the difference between the realized policy rate decision of the Banco de la República and the consensus expectation of market analysts immediately prior to each monetary

policy meeting, measured as the average forecast[5]. Following Laborde (2026) (who builds on the approaches of Checo et al. (2024) and Bauer and Swanson (2023)) we orthogonalize these forecast errors with respect to a broad set of macroeconomic and financial variables for the period 2008m12-2025m4 and as a robustness test we include the full sample data and policy surprises from 2002m3-2025m4[6].

In particular, we estimate the following regression model:

$$FE_t = \alpha + \beta X_t + \varepsilon_t \tag{3}$$

where FE_t is the set of policy surprises (average forecast errors) at month t and X_t is a vector that includes all the nominal, real and financial variables outlined in footnote 3. All variables are expressed in levels. The algorithm we follow is to first run the policy surprises against all the independent variables and then sequentially remove the variables with the highest p-value until there only remain statistically significant regressors at a level of at least 10%.

The residual from this projection captures the component of monetary policy surprises that remains unexplained even conditional on the observable state of the economy. This approach therefore seeks to isolate exogenous monetary innovations purged of systematic policy responses to publicly available macroeconomic information.

Our second measure corresponds to the high-frequency monetary policy shock series constructed by Romero et al. (2021) for Colombia. This strategy exploits narrow-window movements in short-term interest rate instruments (particularly overnight interest rate swaps, OIS) around monetary policy announcements by the Banco de la República. By focusing on asset price changes within tight event windows, the approach isolates revisions in market expectations induced by monetary policy announcements while minimizing contamination from other macroeconomic news. We use the updated version of the series available through January 2025, covering the period 2008m1-2025m1. Because the measure is derived from real-time financial market prices, it captures the surprise component of monetary policy as perceived by market participants at the time of each announcement.

Our third identification strategy employs the narrative monetary policy shocks for Colombia constructed by López et al. (2020), following the methodology pioneered by Romer and Romer (2004). The procedure regresses discretionary changes in the policy rate on the central bank's internal macroeconomic forecasts available at the time of each policy decision, including projections for inflation, output growth, and the output gap. The

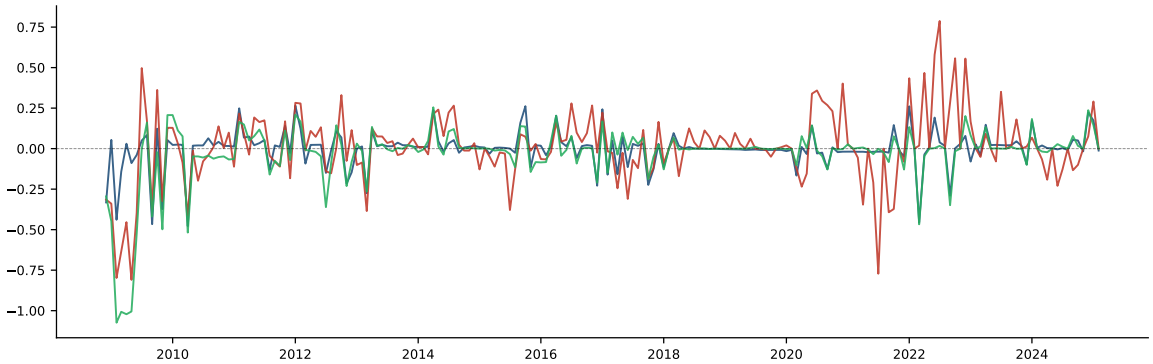
[5]Using the median forecast yields less variation in the policy surprises, so we use the average forecast error for our baseline results. However, the results are robust to using the median forecast error for most variables.

[6]We include the MSCI Share Price Index ex Div in local currency (Haver code: N233KML), the peso/US exchange rate (Haver code: N233XUSV), the central government primary balance (seasonally adjusted) (Haver code: N233FGBM), the consumer price index (CPI) seasonally adjusted (Haver code: H233PC), the producer price index (PPI) seasonally adjusted (Haver code: H233PP), the terms of trade (Haver code: N233PFTT), the manufacturing industrial production index seasonally adjusted (Haver code: H233DM), the employed working-age population total (thousands of persons, seasonally adjusted) (Haver code: S233ELE), the unemployment rate total (seasonally adjusted) (Haver code: S233ELUR), imports of goods (fob) (Haver code: H233IMFD), exports of goods (fob) (Haver code: H233IXD), the economic activity index (ISE) seasonally adjusted (Haver code: S233GVI), expected inflation over the next 12 months, Average (Haver code: N233VCPY), the 5-year sovereign CDS (Bloomberg), the retail trade nominal salary per capita (Haver code: H233E8), the retail trade real salary per capita (Haver code: H233E9), the expected reference exchange rate over the next 12 months (TRM), average (Haver code: N233VXY), and the trade balance (fob), seasonally adjusted (Haver code: H233IBD).

residual from this regression captures the component of monetary policy decisions that cannot be explained by the systematic reaction of the central bank to its own economic forecasts. In our sample, the series spans the period 2002m3-2025m3. Relative to high-frequency identification approaches, narrative shocks have the advantage of explicitly conditioning on the central bank's internal information set, thereby mitigating concerns related both to contemporaneous endogeneity and to the so-called central bank information effect. However, they do not fully control for the complete information set of the central bank and hence might classify systematic variation in the policy rate as exogenous shocks.[7]

All three shock series are available at monthly frequency and are normalized such that a positive realization corresponds to an unexpected one percentage point monetary tightening on impact. Examining the consistency of the results across these alternative measures allows us to distinguish which dimensions of regional heterogeneity are robust to the identification strategy and which depend more sensitively on the assumptions underlying each shock measure.

Figure 4: Monetary policy shocks



Note: The figure displays the time evolution of the three monetary policy shocks employed in the local projections, covering the period 2008–2025. The Bloomberg shock by Laborde (2026) is the solid blue line. The Romer & Romer shocks estimated by López et al. (2020) are the red line and the high-frequency OIS Romero et al. (2021) shocks are displayed by the green line.

Figure 4 plots the three monetary policy shocks over 2008–2025. The high-frequency shocks, OIS and Bloomberg, are highly correlated and fluctuate around zero, consistent with their interpretation as monetary policy surprises relative to market expectations. In contrast, the Romer and Romer shock is more persistent and appears to track the phases of the monetary policy cycle. Table 1 confirms that the strongest pairwise correlation is between Bloomberg and OIS (r=0.660), followed by Romer and Romer and OIS (r=0.592), and Bloomberg

[7]The narrative shock is an aggregate monetary policy innovation by construction. It is obtained after removing the component of policy rate changes that is predictable from the central bank's aggregate forecasts, rather than from region-specific forecasts. This is consistent with the institutional setting being studied: Colombia has a single policy rate and a single monetary policy stance, so the systematic component of policy is naturally defined with respect to national, not regional, macroeconomic conditions. The methodology therefore does not require the shock to be constructed separately for each region. Instead, it requires that, conditional on the aggregate information set used in the shock construction, the remaining variation represents unexpected movements in the national policy stance. Regional outcomes are then used to study heterogeneous transmission of this common aggregate shock. We nevertheless acknowledge that the residual may not be orthogonal to all regional information if such information was part of the central bank's broader assessment or correlated with omitted aggregate variables.

Table 1: Correlation between monetary policy shocks

	(1)	(2)	(3)
(1) Bloomberg	1.000		
(2) Romer & Romer	0.459	1.000	
(3) OIS	0.660	0.592	1.000

Pearson correlations. N = 195 monthly observations.

and Romer and Romer (r=0.459). These moderate positive correlations suggest that the three measures capture a common monetary policy component while retaining substantial independent variation.

The differences are particularly pronounced in 2022, when the Romer and Romer shock is unusually volatile and often has the opposite sign to the other two measures. Its annual mean reaches 0.285, compared with 0.044 over 2018-2024, and all its nonzero observations are positive. By contrast, the OIS and Bloomberg shocks alternate in sign and register large negative surprises during 2022. This pattern suggests that OIS and Bloomberg primarily capture unexpected policy changes, whereas the narrative shocks may also reflect the endogenous response of monetary policy to the volatile and unusual macroeconomic conditions of this year.

In particular, during 2022, the Romer and Romer shock measure may not have adequately disentangled exogenous monetary policy innovations from Banco de la República's endogenous response to multiple concurrent inflationary pressures. These pressures included strong aggregate demand following the reopening of the economy and the release of pent-up demand, a historically large fiscal impulse, currency depreciation, heightened risk premia amid increased political uncertainty, domestic supply disruptions related to the 2021 blockades, and external supply shocks stemming from Russia's invasion of Ukraine and the ensuing surge in energy and fertilizer prices. Consequently, local projections using the Romer and Romer shocks may attribute the contemporaneous increases in inflation, activity, and employment to monetary tightening, even though the underlying causality may run in the opposite direction: deteriorating inflationary pressures and stronger economic activity prompted the policy-rate increases. Given the exceptional conditions prevailing in 2022 and the marked divergence across shock measures, some individual-city specifications include dummy variables to control for this period when using the Romer and Romer shocks.

4 Revisiting the Domestic Effects of Monetary Policy Shocks in Colombia

Before turning to regional heterogeneity, we establish that our identification strategies recover aggregate impulse responses consistent with conventional monetary theory. This exercise serves two purposes. First, it validates our shock measures against the prior literature on monetary transmission in Colombia. Second, it provides a natural aggregate benchmark against which to assess whether regional responses are systematically larger, smaller, or structurally different from the economy-wide responses.

Figure 5 reports cumulative impulse responses of twenty macroeconomic and financial variables to a one-

percentage-point contractionary monetary shock, estimated via local projections as described in Section 3. We display results for all three identification strategies simultaneously (the high-frequency Bloomberg shocks by Laborde (2026) in blue solid, the narrative Romer & Romer shocks by López et al. (2020) in red dashed, and the high-frequency OIS shocks by Romero et al. (2021) in green long dash and three points) with shaded bands representing 68% confidence intervals.

Financial markets. The monetary shock transmits rapidly and powerfully across the yield curve. The policy rate responds on impact, validating the internal consistency of the identification. One-year yields rise on impact and revert toward baseline over the subsequent 12-15 months, a pattern consistent with transitory monetary tightening being progressively priced out by markets as the shock dissipates. Five- and ten-year yields display a more muted and front-loaded response. They increase modestly at short horizons but converge back to zero well before the end of the estimation window, indicating that the shock has limited pass-through to long-term rates. As a result, the yield curve slope falls on impact before gradually reverting. This inversion of the slope is a classic sign of monetary tightening and is consistent with market expectations of a subsequent easing once the inflation objective is restored. The 90-day deposit rate mirrors the policy rate response closely, confirming that the shock propagates to retail financial conditions with minimal attenuation. The nominal exchange rate appreciates on impact across all three identification strategies, consistent with uncovered interest parity. However, only the Bloomberg shock exhibits a statistically significant point estimate. Equity prices display a consistent and persistent decline across all three measures, with the impulse deepening over the first 12-15 months before stabilizing at a lower level, consistent with a higher discounting of future cash flows under higher interest rates.

Real activity. Monetary tightening generates a meaningful and persistent contraction in real economic activity. Industrial production contracts in the periods following the shock and recovers gradually. The Economic Activity Index (ISE) displays a broadly similar pattern. Employment falls significantly, consistent with firms shedding labor in response to higher financing costs and reduced demand, while the unemployment rate rises correspondingly. These labor market dynamics suggest that the contractionary effects of monetary policy extend beyond the intensive margin of hours worked to include separations and hiring freezes along the extensive margin. Across all three identification strategies, the signs, timing, and approximate magnitudes of the real-sector responses are qualitatively consistent, reinforcing the robustness of our findings.

Prices. Consumer prices decline with a lag following the contractionary shock. Producer prices respond more rapidly and more forcefully than consumer prices, reflecting the greater exposure of upstream prices to exchange rate movements and global demand conditions.

External sector. Both exports and imports contract following the tightening. The decline in exports is consistent with an expenditure-switching effect operating through the exchange rate appreciation, as well as a tightening of trade credit conditions that raises the cost of financing export activity. Imports also fall, reflecting the broader compression of domestic demand. Oil and coal exports decline persistently after the monetary

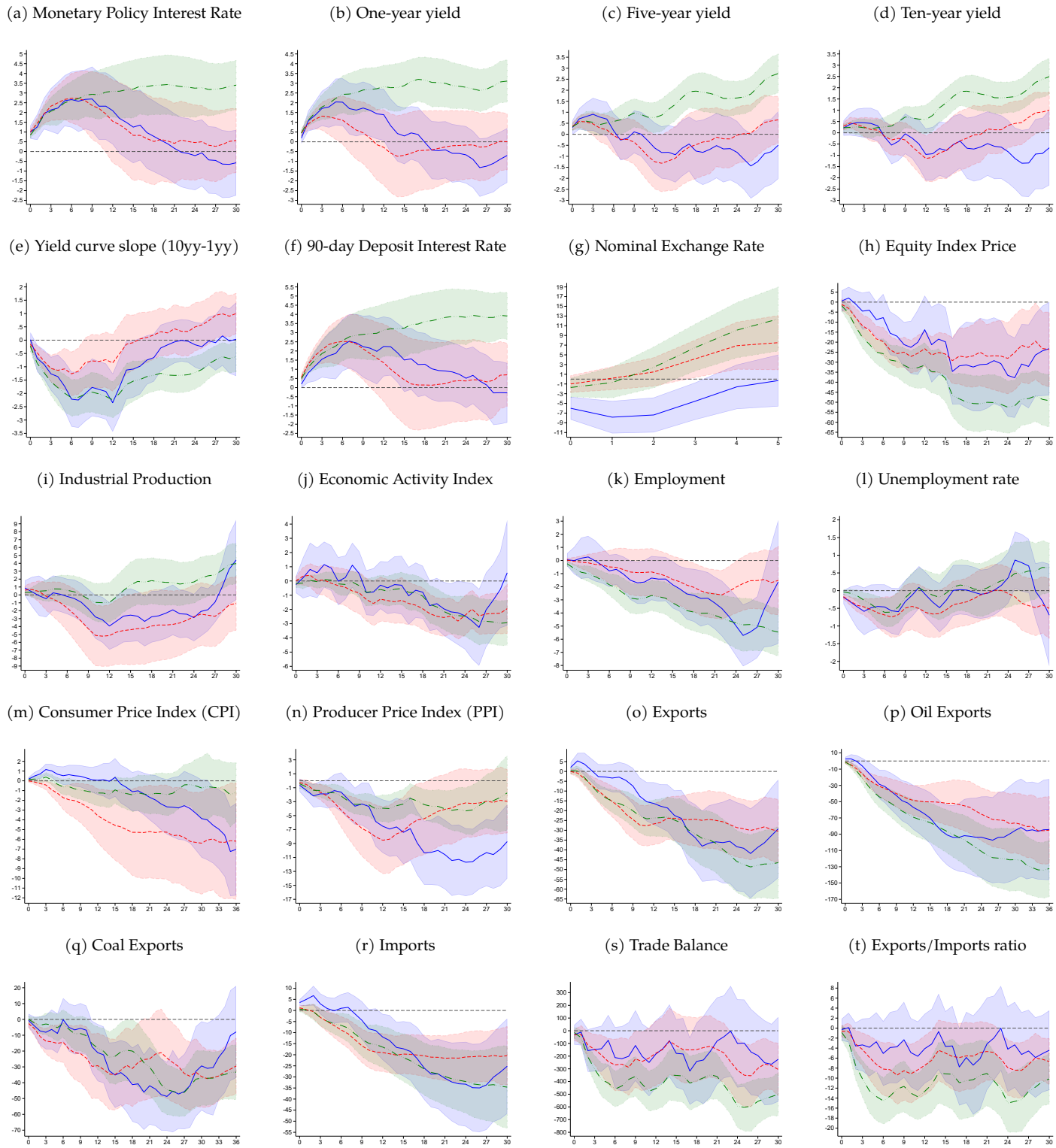
shock, consistent with the findings of McLeay and Tenreyro (2026) and Laborde (2026).[8] The trade balance and the exports-to-imports ratio deteriorate and recover only gradually. These dynamics are particularly relevant for the regional analysis that follows, as departments whose production structure is concentrated in tradable and commodity-linked sectors will be exposed to this channel of monetary transmission.

A central finding of this section is the degree of agreement across the three shock measures. Despite relying on fundamentally different identifying assumptions (forecast errors from Bloomberg surveys, high-frequency movements in interest rate swaps, and narrative residuals from central bank projections) all three strategies yield qualitatively consistent impulse responses for financial variables, real activity, and inflation. The sample period of our baseline results is 2008m12-2025m4. The results are robust to extending the sample period backward to 2002m3-2025m4, as shown in Figure A1 of the appendix.

Taken together, the aggregate responses documented here are broadly in line with the predictions of conventional monetary theory and consistent with estimates from the broader international literature. Following a one-percentage-point monetary tightening shock, financial conditions tighten, real economic activity contracts, employment falls, and prices eventually decline. These aggregate dynamics establish the plausibility of our framework and motivate the subsequent regional analysis. The key question is whether this aggregate response masks substantial cross-sectional heterogeneity, and if so, through which structural channels this heterogeneity is mediated.

[8] The results are robust to controlling for oil and coal prices.

Figure 5: Aggregate Effects of Monetary Policy in Colombia



Note: This figure plots the monthly response of 20 Colombian variables upon three identified exogenous monetary shocks for the sample 2008m1-2025m4 (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). These are our estimates of β_h in Equation 2 where the unit of analysis is Colombia as a whole. For interest rates, trade balance and unemployment the dependent variable is the h+1-period change in the level of the variable. For the rest of the variables, the dependent variable is the h+1-period change in the natural logarithm of the variable. The specification has 12 lags of the dependent variable except for interest rates, where the specification has no lags. The time series of industrial production, economic activity index (ISE), employment, unemployment, exports, imports, and trade balance are smoothed using one month moving averages. The specification for CPI with the Romer and Romer shocks uses dummy variables to control for 2022. The shaded areas show a 68% confidence interval.

5 New Evidence on the Regional Effects of Monetary Policy in Colombia

5.1 Prices

We begin by documenting the effects of monetary policy on consumer prices at the city level. Figure 6 reports the cumulative impulse responses of CPI inflation for 22 Colombian cities, alongside the panel estimate pooling all cities with region fixed effects and the aggregate national response. Panel w of Figure 6 shows the panel fixed-effects estimates under each of the three identification strategies. We also plot the result of using the high-frequency Bloomberg-based shocks estimated by Laborde (2026) but orthogonalizing them with respect to the yearly changes of the variables, instead of the level. Panel x shows the aggregate response, also shown in Panel m of Figure 5, which is plotted for convenience.

The panel fixed-effects estimates, which recover the average city-level response to a monetary tightening, point to a negative and persistent decline in consumer prices across all three identification strategies. The response is initially muted, consistent with the well-known and documented "long and variable lags" of monetary policy; that is, the sluggishness of consumer price adjustment in response to a monetary policy shock. The response to the Bloomberg shocks is null until around month 9–12, when it turns negative, while the OIS shocks induce a modest negative response after about 3 months. The responses show there is no evidence of a price puzzle in any of the specifications. The Romer and Romer shock turns negative almost immediately and produces the largest and most persistent response over most of the horizon, while the OIS shocks yield the most attenuated path. The Bloomberg shocks occupy an intermediate position for most of the horizon, although in several cities they widen sharply toward the end of the three-year window.

Interestingly, the OIS shocks remain closest to their initial level throughout the horizon, while the Romer & Romer and Bloomberg shocks drift down throughout the horizon and, by the end of the forecast horizon, have not returned to their initial level. That all three strategies agree in sign and general shape across the full 36-month window provides confidence that the result is not an artifact of a particular identification approach.

Despite the common downward trend recovered at the panel level, city-specific estimates reveal substantial cross-sectional heterogeneity in the magnitude, speed, and robustness of the price response conditional on the shock. The following broad patterns emerge from the individual impulse responses.

The Bloomberg shock produces the most delayed yet pervasive disinflation across cities. During the first 3–15 months, estimated responses remain close to zero or slightly positive, with no city exhibiting an immediate decline in inflation. Thereafter, inflation falls steadily, becoming negative and statistically significant across virtually all cities. By months 30–36, all 22 cities display significant disinflation, with little evidence of mean reversion over the three-year horizon. Instead, responses continue to drift downward, consistent with the view that monetary policy affects consumer prices only after long and variable lags.

The Romer and Romer shocks yield earlier and more systematic disinflation. Inflation begins to decline within 3–6 months in most cities and continues to fall thereafter, with 68% confidence intervals excluding zero

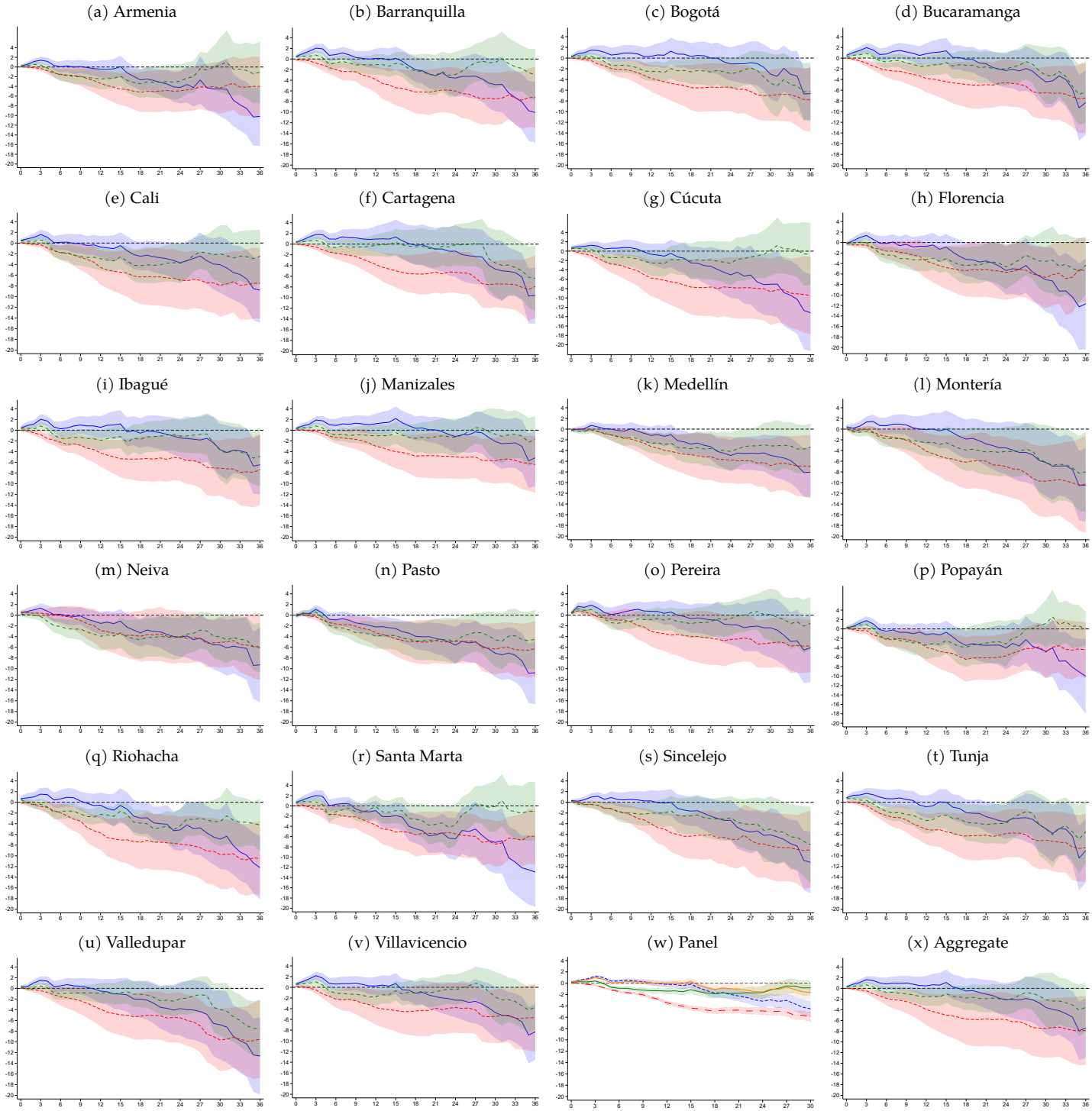
over much of the horizon in the majority of cases. Mean reversion is again largely absent. Overall, narrative shocks generate a remarkably homogeneous pattern of disinflation across cities, with effects that are generally earlier and larger than those associated with OIS and Bloomberg-based identification.

By contrast, the OIS shocks produce the weakest disinflationary responses. Estimated effects remain close to zero or only modestly negative throughout the horizon, and statistical significance is limited. Although a small number of cities (notably Neiva and Pasto) display responses comparable to those obtained under the Romer and Romer identification, these are exceptions rather than the rule. Overall, the city-level evidence suggests that OIS-based shocks are transmitted less strongly and less precisely than narrative monetary policy shocks.

The panel estimates, which benefit from a substantially larger number of observations, are more precise and point to a lagged disinflationary effect of contractionary monetary policy shocks across all identification strategies. This finding stands in contrast to the aggregate-inflation specification, where the impulse response displays a small initial increase. Hence, the average response across regions need not coincide with the response of aggregate inflation. A plausible interpretation is that general-equilibrium forces operating at the aggregate level attenuate the regional inflation responses, or that some regions have a greater weight on the aggregate response because they are larger.

Importantly, the city-level responses are qualitatively consistent with the aggregate results documented previously. A monetary tightening reduces consumer prices across the distribution of Colombian cities, with the decline building gradually and persisting well beyond the first year. The heterogeneity lies not in the direction of the response, which is negative across cities, but in its timing and intensity. However, the responses are also heterogeneous conditional on the monetary shock. There are early and comparatively strong effects according to Romer and Romer shocks, weak and attenuated OIS-based shock responses, and delayed but ultimately large Bloomberg-based shocks disinflation. This pattern is the central fact that the subsequent analysis seeks to explain.

Figure 6: Effects of Monetary Policy on CPI Inflation by City



Note: This figure plots the monthly response of CPI inflation for 22 cities, the "average" city (Panel w) and Colombia (Panel x) upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). We also report in Panel w the shock that results from orthogonalizing the Laborde (2026) shocks with respect to the yearly change of the variables instead of the level (yellow, dots). These are our estimates of β_h in Equations 2 for Panels a-v and Panel x, and 1 for Panel w. The dependent variable is the h+1-period change in the level of CPI. The specification has 12 lags of the dependent variable. The specification with the Romer and Romer shocks uses dummy variables to control for the pandemic period. The shaded areas show a 68% confidence interval.

5.2 Activity

We now turn to the effects of monetary policy on real economic activity at the departmental level. Figure 7 presents the corresponding department-specific estimates for the thirteen departments for which ITAED data are available. Panel r reports the panel fixed-effects impulse responses.

The panel fixed-effects estimates reveal a negative and persistent decline in economic activity following a contractionary monetary policy shock under all three identification strategies. The response builds gradually over the estimation horizon and only recovers toward the end of the 30-month window, consistent with the presence of persistent real effects of monetary policy. The Romer and Romer shocks tend to generate the deepest peak contraction, both in the panel estimate and across most individual departments, whereas the Bloomberg-based shock produces the most attenuated average trajectory and recovers earliest in the panel estimate. The OIS-based shock occupies an intermediate position, though in a few departments (e.g., Bolívar, Cesar) it approaches the depth of the Romer and Romer response. The substantial agreement across identification strategies in both sign and dynamic profile reinforces the interpretation that monetary tightening induces a contraction in real activity across Colombian departments.

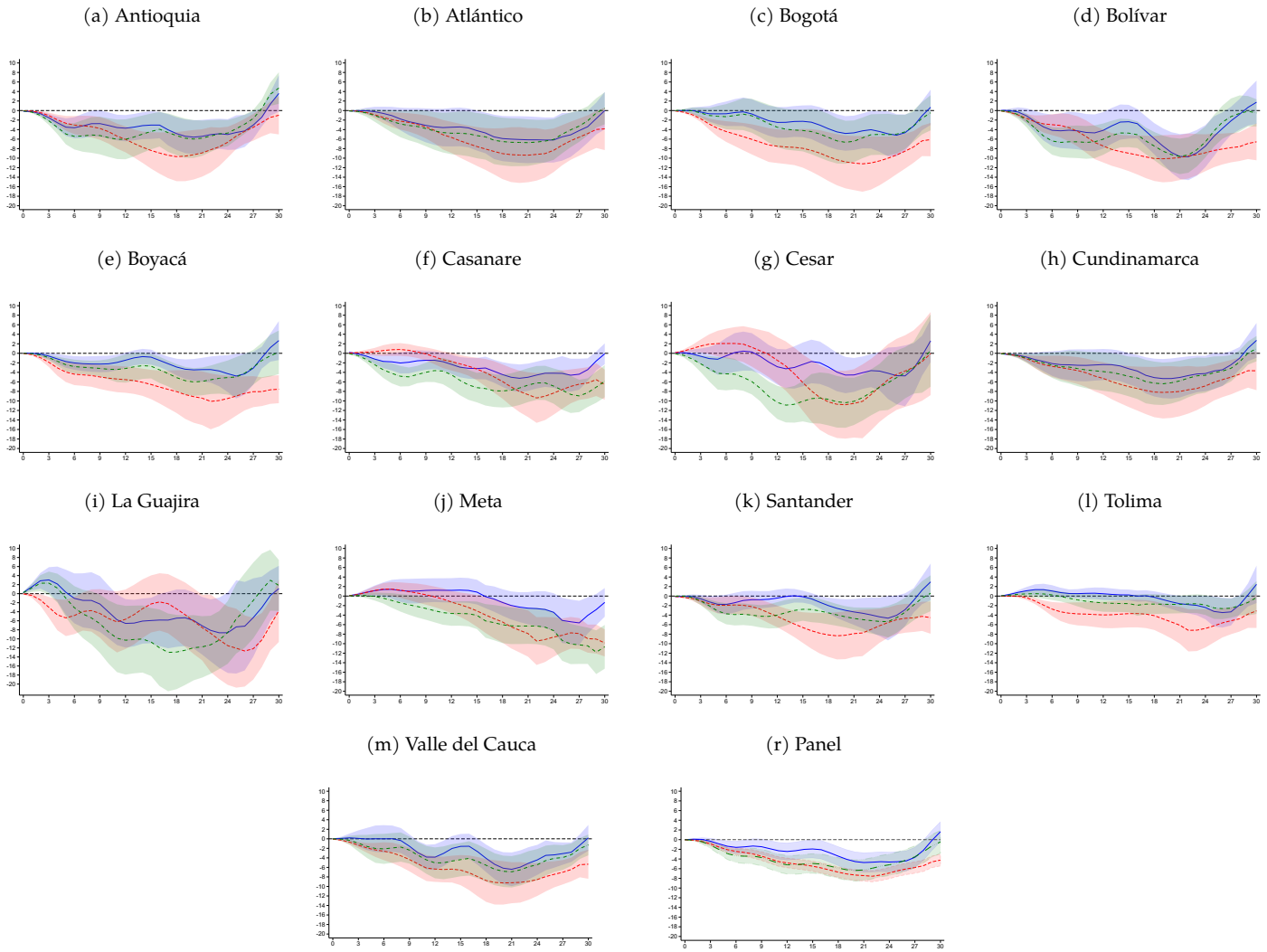
The department-level estimates reveal substantial heterogeneity in both the magnitude and timing of the response of economic activity, with a relatively stable cross-department ranking across identification strategies. At one end of the distribution, La Guajira, Meta, and Bolívar exhibit the largest contractions, with peak cumulative declines substantially exceeding those of the average department. These departments share a productive structure heavily concentrated in mining and extractive industries-sectors particularly sensitive to the credit and external-demand channels of monetary transmission, as will be shown in the next section. Cesar also displays a pronounced response, consistent with its strong dependence on coal extraction and its resulting exposure to commercial credit conditions and commodity-price dynamics.

At the opposite end, Tolima exhibits the most muted response under all three identification strategies, with a mild and gradual contraction that remains well below the panel average throughout the estimation horizon. Santander likewise displays a more moderate decline despite accounting for a significant share of Colombia's industrial and refining activity, suggesting that the diversification of its productive structure may partially cushion the aggregate contractionary impulse. These two departments therefore represent cases in which local structural characteristics appear to mitigate, rather than amplify, the transmission of monetary policy to real activity.

The remaining departments, Antioquia, Atlántico, Bogotá, Boyacá, Casanare, Cundinamarca, and Valle del Cauca, occupy intermediate positions, exhibiting broadly negative responses whose magnitude and persistence vary across identification strategies. Notably, Meta and Casanare display the largest divergence across shock measures during the first year: the Romer and Romer shock is initially close to zero, and in Casanare even mildly positive through month 9–12, whereas the OIS and Bloomberg shock measures point to contractions from an earlier horizon. However, this divergence is transient rather than persistent: by the end of the three-year horizon the Romer and Romer response converges toward a contraction of similar or greater magnitude than the other

two measures in both departments, consistent with the delayed but ultimately pronounced pattern of the Romer and Romer shock documented at the panel level.

Figure 7: Effects of Monetary Policy on ITAED by Department



Note: This figure plots the monthly response of ITAED for 13 departments and the "average" department (Panel r) upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). These are our estimates of β_h in Equations 2 and 1. The dependent variable is the h+1-period change in the natural logarithm of ITAED. The specification has 12 lags of the dependent variable. The time series are smoothed using one month moving averages. The specification with the Romer and Romer shocks uses dummy variables to control for 2022. The shaded areas show a 68% confidence interval.

5.3 Employment

Figure 8 presents the impulse response functions of employment following a contractionary monetary policy shock across cities. Consistent with the aggregate evidence documented in previous sections, employment declines after a monetary tightening. However, the magnitude, timing, and persistence of this response exhibit substantial heterogeneity across cities.

On average, employment responds with a slight lag relative to economic activity, which might reflect labor

market rigidities and adjustment costs. The contraction becomes statistically significant after a few periods and remains negative over the medium term, indicating that monetary policy shocks have persistent effects on labor market outcomes. This pattern is consistent with the gradual adjustment of firms' labor demand in response to weakening economic conditions.

Importantly, the figures reveal marked cross-regional dispersion in employment responses. There are notable differences in persistence. While some regions display short-lived employment responses with partial reversals after a few periods, others exhibit highly persistent declines. These differences likely reflect variation in labor market flexibility, sectoral composition, and exposure to financial conditions.

The Romer and Romer shock (red) yields the most systematic and immediate contractionary employment response across cities: in the panel estimate and in many individual cities (e.g., Barranquilla, Cali, Cartagena, Cúcuta, Florencia, Santa Marta, Sincelejo, Valledupar, Villavicencio) the point estimate turns negative almost immediately, deepens steadily at intermediate horizons, and shows comparatively little mean reversion by the end of the three-year window.

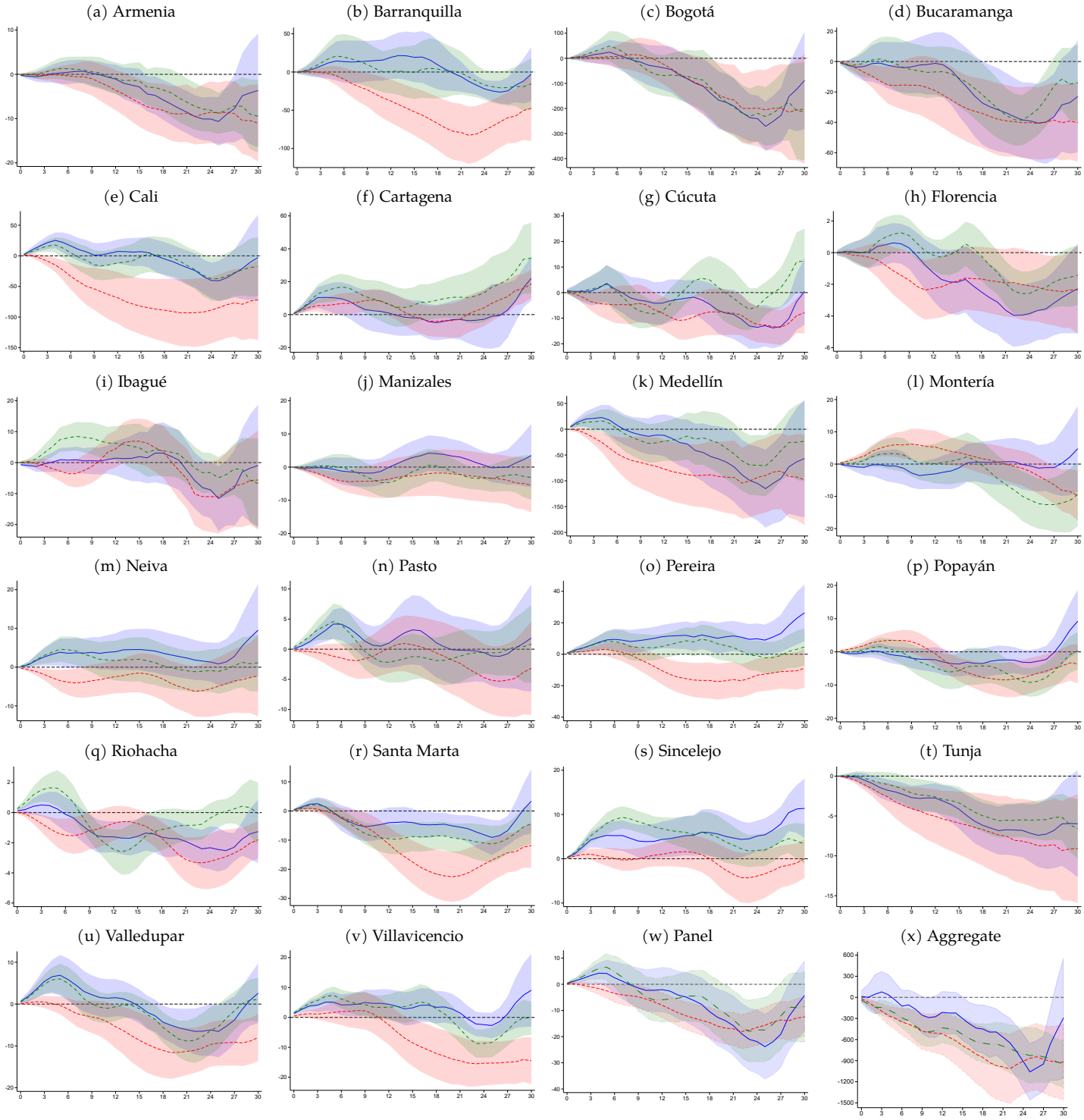
The Bloomberg and OIS shocks (blue and green), by contrast, produce more heterogeneous responses: in several cities, and in the panel estimate, both display a mild positive impact during the first 3–6 months before turning negative at intermediate horizons, and confidence bands widen substantially at longer horizons, with several cities showing partial reversals toward the end of the horizon, in line with declining precision and a more mixed adjustment pattern.

The results for employment reveal that aggregation does not generate a substantial gap between individual and aggregate responses. For all three identification strategies, the panel (average-city) point estimate is similar to the aggregate response and to the average individual-city responses when the dependent variable is the natural logarithm of employment (not shown), except for the OIS shocks, which exhibit more negative aggregate responses. The responses shown are the result of using the level of employment as the dependent variable, so the aggregate response shows a larger decline in employment relative to the panel response.

Additionally, the elasticity of employment with respect to economic activity varies systematically across regions. In particular, regions with a higher concentration of capital-intensive sectors (such as mining and energy) tend to exhibit more muted employment responses relative to the decline in output. This pattern suggests a partial decoupling between production and labor demand in these regions, where firms can adjust utilization rates or capital intensity with limited changes in employment. By contrast, regions with a larger share of labor-intensive activities display stronger employment contractions, reflecting a tighter link between output fluctuations and labor demand.

Taken together, these findings suggest that the transmission of monetary policy to employment operates primarily through local demand channels, but is significantly shaped by regional structural characteristics. The evidence supports the view that differences in sectoral composition are a key determinant of how labor markets adjust to common monetary shocks.

Figure 8: Effects of Monetary Policy on Employment by City



Note: This figure plots the monthly response of employment for 22 cities, the "average" department (Panel w) and the aggregate effect (Panel x) upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). These are our estimates of β_h in Equations 2 and 1. The dependent variable is the h+1-period change in the level of employment. The specification has 12 lags of the dependent variable. The time series are smoothed using one month moving averages. The specification with the Romer and Romer shocks uses dummy variables to control for 2022. The shaded areas show a 68% confidence interval.

6 Inspecting the causal mechanisms

6.1 Cross-Sectional Evidence on Demand vs. Supply Mechanisms

This section provides a unified interpretation of the regional heterogeneity documented in the previous sections by jointly analyzing the responses of prices, employment and economic activity. Building on the framework of Herreño and Pedemonte (2025) outlined in the introduction, we assess whether cross-regional differences in the effects of monetary policy are driven primarily by heterogeneity in supply slopes or in the sensitivity of local demand.

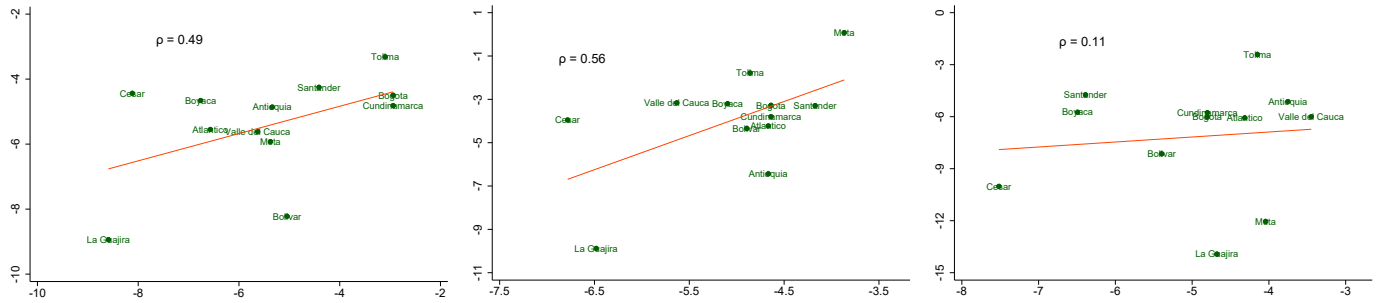
In this setting, the sign of the cross-sectional covariance between price and quantity responses serves as a sufficient statistic to distinguish between alternative sources of regional heterogeneity. If heterogeneity arises from differences in supply conditions, such as variation in the slope of regional Phillips curves, the relationship between price and activity (or employment) responses should be negative. In this case, regions where inflation declines more would tend to exhibit smaller contractions in real activity. By contrast, if heterogeneity is driven by differences in the sensitivity of local demand, the relationship should be positive: regions experiencing larger declines in activity or employment would also display larger reductions in inflation.

Figure 9 summarizes this relationship using a cross-sectional representation of the impulse responses. For each region, the horizontal axis reports the minimum response of economic activity, measured as the minimum of the estimated activity coefficients across horizons for each region, while the vertical axis reports the corresponding minimum response of prices. Each panel corresponds to a different identification of monetary policy shocks, allowing for a direct comparison across alternative measures.

In the case of Bloomberg shocks (Panel a), the slope of the relationship is positive, indicating that regions with stronger contractions in activity also exhibit larger declines in prices. A similar pattern emerges for the Romer and Romer shocks (Panel b), although the relationship appears stronger than in the Bloomberg case. In both cases, the positive association is consistent with heterogeneity primarily driven by differences in the sensitivity of regional demand to monetary policy. The OIS-based shocks (Panel c) display a positive but weak relationship between price and activity responses.

Figure 9: Inflation and Economic Activity Responses by Department

(a) Bloomberg (b) Romer & Romer (b) OIS



Note: This figure shows a scatterplot of the minimum inflation response (y-axis) and the minimum ITAED response (x-axis) for each city to a contractionary monetary shock. A linear fit is also plotted. The sample period for the estimation is 2010m3-2025m4 for inflation and 2015m3-2025m4 for ITAED.

Figure 10 complements this analysis by moving from the departmental level to the city level and replacing economic activity with employment. For each of the cities in the sample, the horizontal axis reports the minimum response of employment to a contractionary monetary policy shock, while the vertical axis reports the minimum response of inflation. As in Figure 9, each panel corresponds to a different shock identification, allowing us to assess whether the cross-sectional covariance between prices and quantities is robust to both the measure of real activity and the level of aggregation.

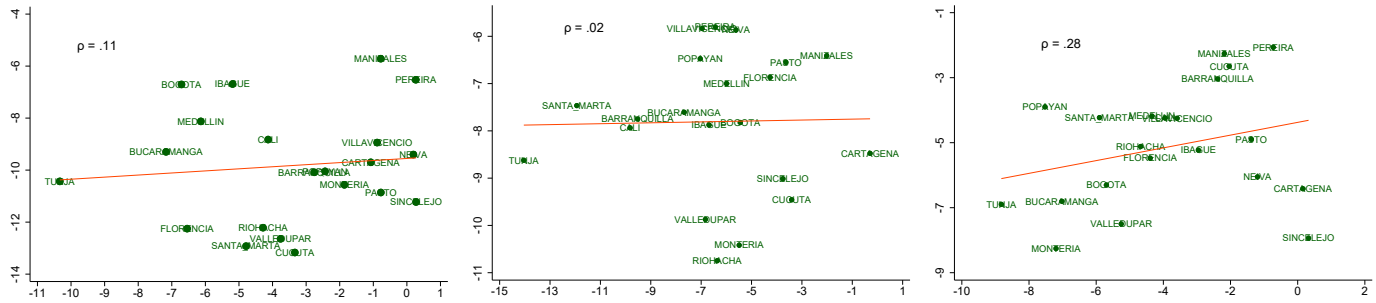
Panel a, corresponding to Bloomberg shocks, shows a mildly positive relationship between inflation and employment responses, with a correlation of 0.11. Panel b, corresponding to Romer and Romer shocks, displays a null relationship between the minimum responses of employment and inflation. This might suggest that supply side heterogeneity might also be playing a role under this identification scheme. Panel c, based on OIS shocks, also shows a positive relationship, although stronger than in Panel b.

Taken together, the predominance of a positive relationship across specifications provides stronger support for the interpretation that regional heterogeneity is primarily driven by differences in the sensitivity of local demand to monetary policy. Regions that experience larger contractions in real activity, whether measured by output or employment, also tend to exhibit larger declines in inflation, consistent with heterogeneity in the sensitivity of local demand.

Overall, while the exact magnitude and slope of the cross-sectional relationship are not invariant to the identification strategy or the choice of real variable, the balance of the evidence points toward demand-side mechanisms as the dominant driver of regional heterogeneity in the transmission of monetary policy.

Figure 10: Inflation and Employment Responses by City

(a) Bloomberg (b) Romer & Romer (b) OIS



Note: This figure shows the scatterplot of the minimum inflation response (y-axis) and the minimum employment response (x-axis) for each city to a contractionary monetary shock. A linear fit is also plotted. The sample period for the estimation is 2010m3-2025m4.

6.2 Sectoral Channel

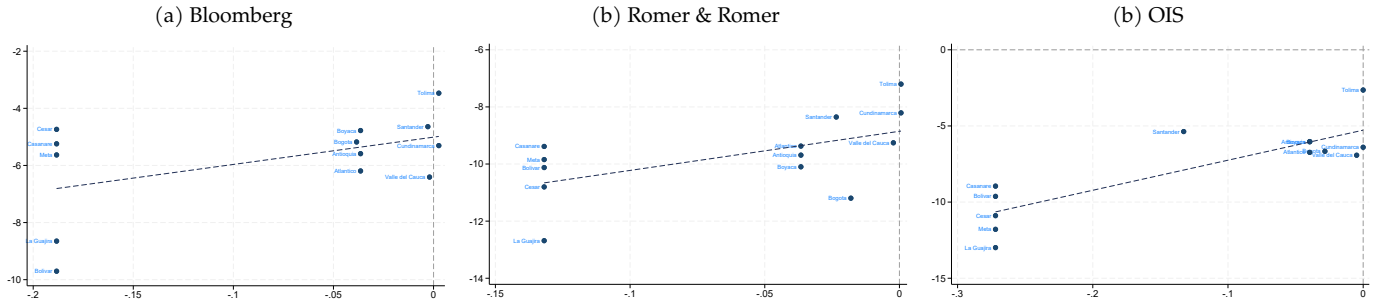
The interpretation based on the cross-covariance between prices and quantities, developed in the previous subsection, suggests that regional heterogeneity in the transmission of monetary policy operates primarily through differences in the sensitivity of local demand. A natural question, however, is which structural characteristics of each regional economy determine that sensitivity. This subsection addresses this question by focusing on a specific channel: the sectoral composition of departmental economies. The motivating hypothesis is straightforward. If Colombian departments specialize in sectors that differ in their exposure to monetary policy , whether due to their credit intensity, export orientation, or sensitivity to the aggregate demand cycle, then the response of departmental aggregates to a monetary shock should inherit the sensitivity of the sector that accounts for the largest share of their value added.

To operationalize this hypothesis, we identify, for each of the thirteen departments with available ITAED data, the sector with the largest average share in departmental GDP over the 2005-2024 period. This procedure yields a natural grouping: La Guajira, Meta, Casanare, Cesar, and Bolívar are classified as mining-intensive departments, Tolima and Cundinamarca are predominantly agricultural, Antioquia, Atlántico, and Boyacá are dominated by utilities, Bogotá is concentrated in financial services, Santander in construction and Valle del Cauca in real estate activities. This classification allows us to associate each department with the estimated response of its dominant sector's GDP to a contractionary monetary policy shock, obtained using local projections with the same specification employed in previous sections.

Figure 11 presents the results in the form of a scatter plot. The horizontal axis reports the trough response of the dominant sector's GDP to the monetary shock, while the vertical axis reports the corresponding trough response of departmental ITAED. Each panel corresponds to a different identification strategy. Under all three identifications, the relationship between the two variables is clearly positive, as departments whose dominant sector experiences the largest contractions are also those in which ITAED declines more sharply. In particular, mining departments (La Guajira, Meta, Casanare, Cesar, and Bolívar) are consistently located in the lower-left

quadrant of the diagram, whereas departments whose dominant sectors are less sensitive to monetary policy, such as Tolima and Cundinamarca (agriculture), appear in the upper-right region, with considerably more moderate declines in aggregate activity. This pattern is consistent with the evidence presented in Section 5.2 and with the observation that oil and coal exports contract markedly following a monetary tightening, thereby linking the sectoral channel with the external channel discussed in the introduction. The slope and overall fit of the relationship are broadly similar across the three identification strategies, reinforcing the interpretation that the sectoral channel operates independently of the specific measure of the monetary shock used.

Figure 11: Activity versus Dominant Sector by Department



Note: This figure plots the minimum response of the ITAED economic activity index (Y-axis) and the minimum response of the most influential sector (X-axis).

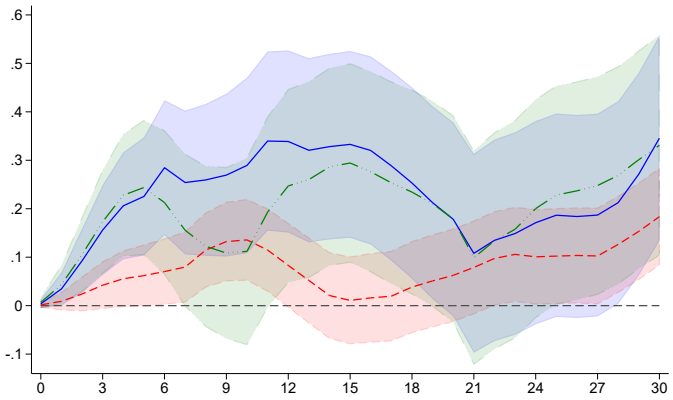
To quantify this channel, we complement the cross-sectional evidence with a panel local projections estimation that incorporates an interaction term between the monetary shock and the cyclical position of the dominant sector. Specifically, we estimate:

$$\log \text{ITAED}_{i,t+h} - \log \text{ITAED}_{i,t-1} = \alpha_{i,h} + \beta_h s_t + c_h \left(s_t \times Z_{i,t}\right) + d_h Z_{i,t} + \sum_{j=1}^{12} \phi_{h,j} \Delta \log \text{ITAED}_{i,t-j} + \varepsilon_{i,t+h}, \quad (4)$$

where $Z_{i,t}$ is the (demeaned) log of monthly GDP in the dominant sector of department i. The coefficient of interest is c_h, which measures how the effect of the shock on departmental activity varies with the cyclical state of the dominant sector. Figure 12 reports the estimated path of c_h under the three identification strategies.

Three main findings emerge. First, c_h is positive under all identification strategies. The Bloomberg and OIS shocks yield very similar trajectories, while the Romer and Romer approach produces a qualitatively similar but smaller pattern. Second, the positive sign of c_h can be interpreted as follows. When the dominant sector of a department is above trend ($Z > 0$) at the time of monetary tightening, the contractionary effect on departmental ITAED is mitigated; that is, the dominant sector acts as a cyclical buffer that dampens the transmission of the shock. Conversely, when the dominant sector is in a weak phase ($Z < 0$), monetary tightening propagates more strongly to aggregate departmental activity. This result is consistent with the view that the idiosyncratic strength of the sector anchoring the departmental economy, whether mining, agriculture, financial services, or

Figure 12: Effects of Monetary Policy through the Sectoral Channel



Note: This figure plots our estimates of c_h in Equation 4 upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). The dependent variable is the h+1-period change in the natural logarithm of ITAED. The specification has 12 lags of the dependent variable. The time series is smoothed using moving averages. The shaded areas show a 68% confidence interval.

construction, modulates the sensitivity of the regional aggregate to national monetary policy. Third, the fact that all identification strategies yield consistent signs and dynamics, and that the magnitude of the coefficient increases over the horizon, suggests that the cyclical position of the dominant sector conditions the departmental response over the entire horizon during which the monetary shock affects real activity.

Taken together, Figures 11 and 12 provide two complementary pieces of evidence on the sectoral channel. The first shows, in the cross-section, that the magnitude of the contraction in departmental ITAED following a monetary tightening is closely linked to the sensitivity of the dominant sector to monetary policy, consistently across all three identification strategies. The second shows, through a dynamic panel exercise, that the cyclical position of the dominant sector modulates the transmission of the shock to departmental aggregates. Jointly, these results support the interpretation that sectoral composition is a key structural determinant of the regional heterogeneity documented previously, and provide a concrete mechanism underpinning the broader notion of 'local demand sensitivity' introduced in the previous subsection.

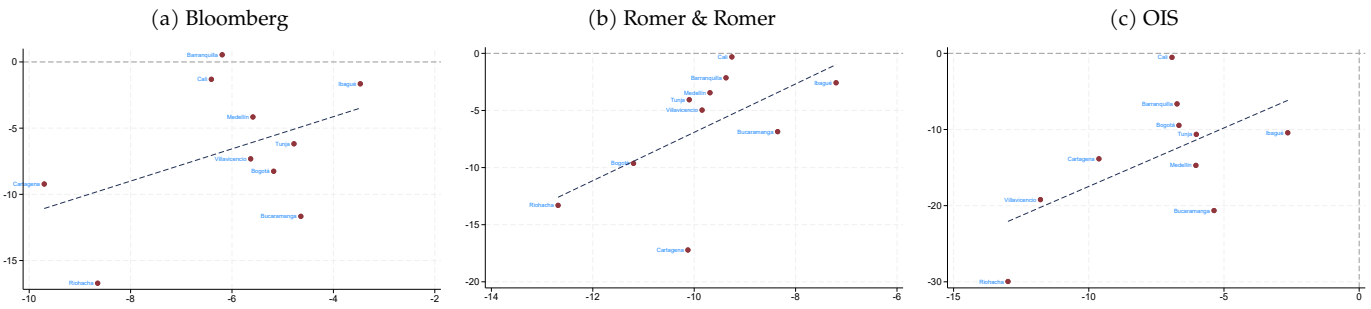
6.3 Financial Channel

The sectoral channel analyzed in the previous subsection captures one structural dimension along which Colombian departments differ in their exposure to monetary policy, but it is not exhaustive. A long-standing strand of the literature on monetary transmission, going back to Bernanke and Gertler (1995) and reinforced more recently by Di Maggio et al. (2017b), emphasizes that the depth of credit intermediation at the local level is itself a key determinant of how monetary policy propagates to real activity. Regions with a larger stock of outstanding bank credit are more directly exposed to changes in the policy rate, both because the debt-service burden on households and firms rises with the volume of outstanding variable-rate loans and because tighter credit conditions reduce the availability of new financing for investment and consumption. This subsection investi-

gates that channel directly, by documenting a positive cross-sectional relationship between the response of bank credit and the response of real activity to a monetary tightening, and by examining whether the cyclical position of departmental credit modulates the transmission of monetary shocks to regional outcomes.

Figure 13 presents the cross-sectional evidence. For each city in the sample, the horizontal axis reports the minimum cumulative response of ITAED to a contractionary monetary policy shock, while the vertical axis reports the corresponding minimum cumulative response of total outstanding bank credit. Each panel corresponds to a different identification strategy. Across all three measures, the relationship between the two variables is clearly positive, cities that experience sharper contractions in real activity also exhibit larger declines in total credit. Riohacha stands out as a clear outlier in the lower-left quadrant under all three identifications, combining the deepest contraction in ITAED with the largest decline in credit. At the other extreme, Barranquilla and Ibagué display comparatively moderate contractions in both variables. This pattern is consistent with a credit channel of monetary transmission whereby tighter monetary conditions reduce both local demand and the flow of new credit, and the two channels reinforce each other as firms and households cut spending in response to rising borrowing costs and tightening credit supply.

Figure 13: Activity versus total portfolio



Note: The figure shows the minimum response of the ITAED economic activity (y-axis) and the minimum response of the total portfolio (x-axis).

To quantify this channel, we complement the cross-sectional evidence with a panel local projection that incorporates an interaction between the monetary shock and the cyclical position of departmental bank credit. Specifically, we estimate:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h s_t + c_h \left(s_t \times Z^{\text{cred}}_{i,t} \right) + d_h Z^{\text{cred}}_{i,t} + \sum_{j=1}^{12} \phi_{h,j} \Delta y_{i,t-j} + \varepsilon_{i,t+h}, \tag{5}$$

where $y_{i,t}$ is, alternatively, departmental ITAED (Panel a of Figure 14) or departmental CPI inflation (Panel b), and $Z^{\text{cred}}_{i,t}$ is the log of total outstanding bank credit in department i, demeaned within department so as to isolate cyclical deviations from each department's own historical level. Positive values of $Z^{\text{cred}}_{i,t}$ correspond to episodes of above-trend credit expansion; negative values to episodes in which the local credit stock is relatively compressed. The coefficient of interest, c_h, measures how the effect of a monetary tightening on real activity

and prices varies with the cyclical state of local credit intermediation.

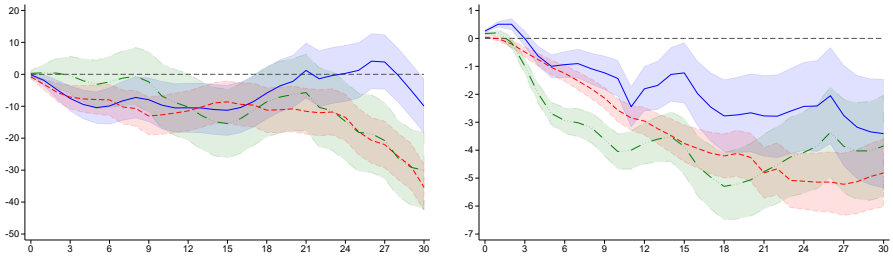
Figure 14 reports the estimated trajectory of c_h under the three identification strategies. c_h is negative and deepens progressively over the estimation horizon for both activity and inflation. This implies that departments entering a tightening cycle with above-trend credit balances experience amplified contractions and disinflations relative to departments where credit is depressed. Overall, our estimates suggest that the financial channel of monetary policy is present and a higher stock of credit amplifies the negative effects of a monetary tightening shock on inflation and economic activity.

Although we do not have a structural model to interpret our results, this result might suggest that departments with above-trend credit at the time of a tightening carry a larger stock of interest-sensitive liabilities, so a given increase in the policy rate generates a proportionally larger compression of cash flows for households and firms. This debt-service channel strengthens with the volume of variable-rate contracts outstanding in the local economy. Additionally, above-trend credit growth typically coincides with higher asset valuations and more leveraged balance sheets, making local economies more vulnerable to a sudden tightening of financial conditions and amplifying the transmission of the shock to investment and consumption decisions.

Taken together, the evidence in Figures 13 and 14 contributes a second structural determinant of regional heterogeneity, complementing the sectoral mechanism documented in Section 6.2. The coexistence of both channels rationalizes why the cross-sectional covariance between price and activity responses documented in Section 6.1 has predominantly a positive sign. The credit channel, by amplifying the debt-service burden and financial vulnerability of households and firms in more leveraged departments, is one of the mechanisms through which the sufficient statistic of Herreño and Pedemonte (2025) favors a demand-driven interpretation of regional heterogeneity in the Colombian case.

Figure 14: Financial Channel of Monetary Policy

(a) Activity (b) Inflation



Note: This figure plots our estimates of c_h in Equation 5 upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). The dependent variable is the h+1-period change in the natural logarithm of ITAED and CPI. The specification has 12 lags of the dependent variable. The shaded areas show a 68% confidence interval.

6.4 International Trade Channel

An additional mechanism may be at work for departments whose productive structure is oriented toward international markets. As discussed in Section 4, monetary tightening leads to an appreciation of the nominal exchange rate, which in turn reduces the domestic-currency revenues of exporting firms. The tightening of local financial conditions might also reduce the availability of trade credit for firms engaged in cross-border transactions.[9] The appreciation also reduces their costs denominated in foreign currency, so the net effect depends on the balance sheet structure of each firm. Departments that are more deeply integrated into external markets are more exposed to these international trade channels, and their aggregate activity could contract by more following a monetary tightening. This subsection investigates this hypothesis by examining whether the degree of external market integration of each department predicts the magnitude of its ITAED response to a contractionary shock.

To measure external market integration, we draw on the TAM-2 subcomponent of the *Índice de Desempeño de Comercio Exterior* (IDC), constructed annually by Consejo Privado de Competitividad for all 33 Colombian departments and ranked from 1 (best performance) to 33 (worst). For each department, we compute the time-average of the annual ranking over the available sample as a measure of structural trade openness. Among the thirteen departments in our sample, La Guajira (TAM-2 $= 1.7$) and Cesar (2.6) occupy the top positions, driven by their dominant role in coal and mineral exports, followed by Bolívar (3.7) and Bogotá (3.6). At the opposite end, Tolima (25.0), Meta (20.1), and Santander (19.1) display the weakest external market performance, reflecting their more domestically oriented productive structures.

Figure 15 presents the cross-sectional evidence. For each department, the horizontal axis reports the average TAM-2 ranking and the vertical axis reports the minimum cumulative response of ITAED to a contractionary monetary policy shock, with each panel corresponding to a different identification strategy. The relationship is positive and consistent across all three measures. The positive slope implies that departments with better external market rankings, those more deeply integrated into international trade, experience larger contractions in economic activity following a monetary tightening. La Guajira and Bolívar consistently appear in the lower-left region of the diagram, combining top trade rankings with the sharpest ITAED contractions, while Tolima anchors the upper-right corner with a weak trade ranking and a comparatively mild response.

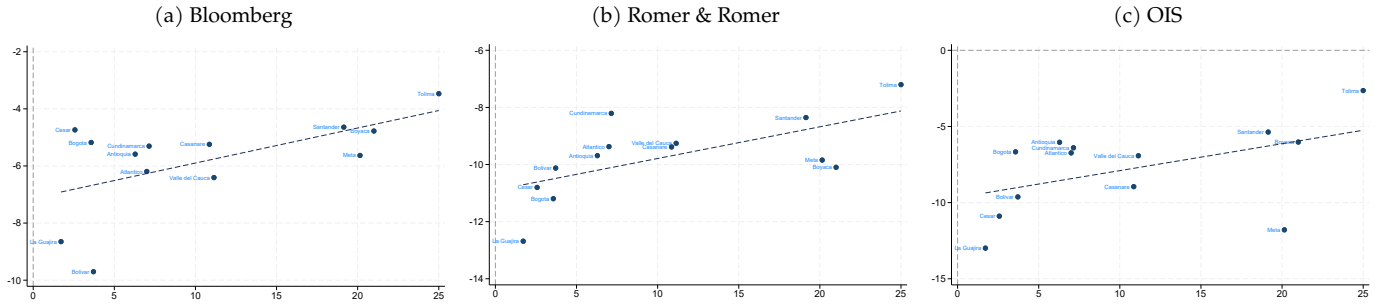
Two mechanisms rationalize this finding. The first is an expenditure-switching channel: monetary tightening appreciates the peso, reducing export competitiveness and depressing revenues of firms in trade-oriented departments, particularly commodity exporters such as La Guajira and Cesar. The second is a trade-credit channel, tighter financial conditions raise the cost of working capital for exporting and importing firms, reducing cross-border transaction volumes and propagating the contractionary impulse to local activity. As documented in Section 4, both oil and coal exports contract markedly following monetary tightening at the aggregate level,

[9] A point might be made according to which firms engaging in international transactions and demanding trade-credit do so at the dollar-interest rate and hence local financial conditions do not affect these firms. Further research must be done in order to determine the strength and direction of the trade-credit channel of domestic monetary policy in Colombia.

and the cross-sectional evidence here suggests that the departments most exposed to this external transmission bear a disproportionate share of the resulting contraction.

Taken together, the external sector channel provides a third structural determinant of regional heterogeneity in monetary transmission, complementing the sectoral and financial mechanisms documented in Sections 6.2 and 6.3. Departments more tightly integrated into international markets face a larger monetary policy multiplier, as the exchange rate appreciation triggered by a tightening reinforces the domestic demand compression through an additional reduction in export revenues and trade finance availability.

Figure 15: Activity versus Trade Openness



Note: The figure shows the minimum response of the ITAED economic activity index (y-axis) and the average of the external sector size ranking carried out by Consejo Privado de Competitividad (x-axis).

6.5 Informality Channel

Labor-market informality can affect monetary transmission through several margins. First, it reflects the degree of contractual flexibility with which firms can adjust employment in response to changing economic conditions. In Colombia, informal jobs are generally characterized by lower firing costs, weaker employment protection, and fewer institutional rigidities than formal employment, consistent with the flexibility margin documented by Leyva and Urrutia (2020) and Otero-Cortés et al. (2025). As a result, monetary contractions may translate into faster and larger formal employment adjustments and lower informal jobs adjustments. Second, informal workers typically face more unstable income streams, weaker access to formal credit, and lower coverage by social insurance mechanisms. These features reduce their ability to smooth consumption when labor income falls, mirroring the hand-to-mouth mechanism formalized by Herreño and Pedemonte (2025) and Ávila-Montealegre et al. (2026). Consequently, a given employment or earnings shock is more likely to translate into an immediate contraction in household spending in regions where informality is high. The associated decline in labor income and consumption is then expected to reinforce the contraction in local demand, producing larger responses of employment, economic activity, and ultimately inflation through a larger decline in marginal costs.

Under this interpretation, informality acts as a specific labor-market amplifier of local demand sensitivity. Its distinctive mechanism is that it changes how quickly and strongly labor income, household spending, and local activity respond to tighter financial conditions. In this sense, informality amplifies the same demand-side transmission mechanism identified in the previous subsections, but it does so through a different margin:

the combination of flexible labor adjustment, limited consumption smoothing, and weaker formal protection among informal workers. We examine this hypothesis by interacting monetary policy shocks with the cyclical component of departmental informality. Since informality can be measured using several closely related definitions, we begin by comparing the available measures before selecting a baseline indicator for the interaction analysis.

Table 2: Correlation matrix of informality measures

	Pension	Firm size	Firm size (excl. skilled)	Registration	Accounting	ARL	Health	Composite
Pension	1.000	0.951	0.945	0.776	0.735	0.953	0.858	0.951
Firm size		1.000	0.992	0.757	0.706	0.918	0.805	0.928
Firm size (excl. skilled)			1.000	0.774	0.751	0.910	0.801	0.926
Registration				1.000	0.792	0.741	0.711	0.813
Accounting					1.000	0.714	0.598	0.755
ARL						1.000	0.791	0.905
Health							1.000	0.879
Composite								1.000

Notes: All measures are dummy indicators of informal employment constructed from GEIH microdata and aggregated to monthly department-level rates. **Pension**: worker does not contribute to a pension fund. **Firm size**: worker is self-employed, an employer, a wage earner, or unpaid at a firm with five or fewer employees (standard DANE size-based definition); domestic, family, and day workers are always classified as informal, public employees as always formal. **Firm size (excl. skilled)**: identical to Firm size, except self-employed workers in professional or technical occupations are reclassified as formal. **Registration**: self-employed workers and employers whose business lacks legal registration (RUT, Chamber of Commerce, or commercial registry); wage earners are proxied by pension-contribution status. **Accounting**: self-employed workers and employers whose business keeps no formal accounting records. **ARL**: worker is not affiliated with an occupational risk insurer (Aseguradora de Riesgos Laborales). **Health**: worker is not enrolled in the contributory health regime (i.e., uninsured or in the subsidized regime). **Composite**: union of the Pension, Health, and Registration definitions, the broadest measure of informality.

Table 2 shows that the eight alternative measures of informality are highly correlated with one another. Pairwise correlations exceed 0.90 in eleven of the twenty-eight pairs and fall below 0.80 only for pairs involving Accounting and, to a lesser extent, Registration. In particular, the ARL measure exhibits correlations above 0.90 with Pension, Firm Size, Firm Size excluding skilled workers, and the Composite index, and correlations between 0.71 and 0.79 with Registration, Accounting, and Health. This substantial overlap indicates that the alternative definitions largely capture the same underlying dimension of labor-market informality, consistent with the use of a single baseline informality indicator in related structural work (Ávila-Montealegre et al., 2026; Otero-Cortés et al., 2025). Estimating the interaction channel separately for all eight measures would therefore generate considerable duplication with little additional information while substantially expanding the parameter space. We consequently adopt ARL as our baseline measure of departmental informality. Among the available proxies, ARL offers a clear economic interpretation because affiliation with an occupational risk insurer is a legal requirement of formal employment and is therefore closely tied to formal labor-market attachment.

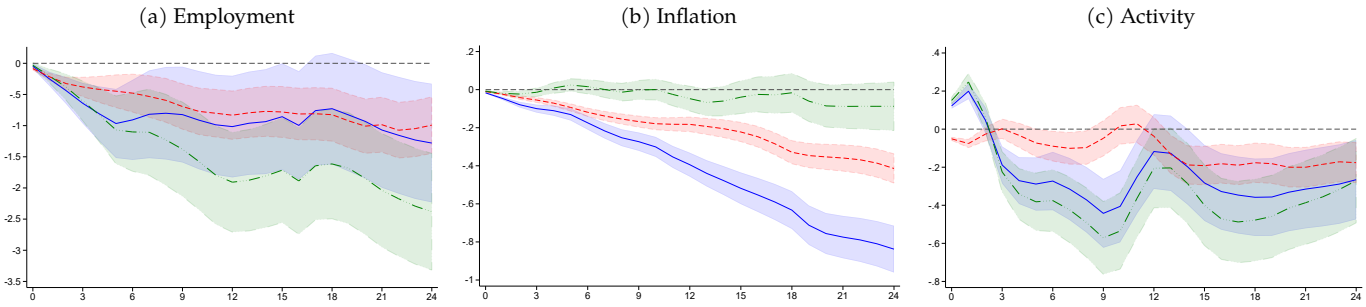
To estimate the informality channel, we augment the department-level local projection with an interaction between the monetary policy shock and the cyclical component of departmental ARL-based informality:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h s_t + c_h\, s_t \times Z_{i,t}^{ARL} + d_h Z_{i,t}^{ARL} + \sum_k \gamma_{k,h}\,(dep_k \times post2021_t) + \delta_h D_t^{covid} + \sum_{j=1}^{12} \phi_{h,j} \Delta y_{i,t-j} + \varepsilon_{i,t+h}, \tag{6}$$

where y_i denotes the regional outcome of interest, departmental employment, departmental economic activity, or city-level inflation, depending on the specification. $Z_{i,t}^{ARL}$ denotes the monthly ARL informality rate demeaned within each department. Consequently, $Z_{i,t}^{ARL} > 0$ identifies periods in which a department experiences temporarily higher informality than its own historical average. The department $\times$ post-2021 fixed effects absorb the change in the GEIH sampling frame and in our informality-imputation procedure introduced in 2021m1, while D^{covid} is a common dummy for 2020m3–2020m4 that captures the disruption to survey fieldwork during the strictest phase of the COVID-19 lockdowns. The informality panel extends the departmental GEIH series back to 2010m1 through a Chow–Lin temporal disaggregation of DANE's annual departmental expansion factors, allowing us to estimate the specification over a substantially longer sample than the department-level ITAED regressions presented in Section 5.2.

The interaction coefficient, c_h, captures whether the response of a given regional outcome to a monetary tightening depends on the cyclical position of departmental informality. Because informality is demeaned within departments, identification comes entirely from within-department variation over time rather than from permanent cross-sectional differences across departments—in contrast to the cross-country, between-economy comparisons that identify the informality channel in Horvath and Yang (2022), Alberola and Urrutia (2020), and Ávila-Montealegre et al. (2026). The coefficient therefore asks whether the same department becomes more or less sensitive to monetary policy when informality is temporarily above its own long-run average, an identification strategy closer in spirit to the time-varying informality response documented for Mexico by Yépez (2025). A negative value of c_h implies that above-trend informality amplifies the contractionary effects of monetary policy, whereas a positive value indicates that it attenuates them.

Figure 16: Informality channel



Note: This figure plots our estimates of c_h in Equation 6 upon three identified exogenous monetary shocks (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). The dependent variable is the $h+1$-period change of ITAED, CPI, and employment. The specification includes 12 lags of the dependent variable. The shaded areas show a 68% confidence interval.

Figure 16 reports the estimated path of c_h for employment, inflation, and economic activity under the three monetary-shock identification strategies. Three regularities emerge.

First, departments experiencing temporarily elevated informality exhibit systematically larger employment losses following a monetary tightening. Rather than dissipating over the forecast horizon, the employment contraction continues to deepen. Second, departments with above-trend informality experience a substantially deeper decline in ITAED during the first year after the shock, followed by only a partial recovery. This pattern might suggest that informality amplifies the effects of monetary policy on local demand, as workers with weaker formal attachment may have lower access to formal credit, fewer insurance mechanisms, and less capacity to smooth consumption when income falls, the same hand-to-mouth mechanism that Ávila-Montealegre et al. (2026) show amplifies consumption and investment volatility in a DSGE model.

Third, the inflation response generally points in the same direction. Under both the Bloomberg-surprise and Romer and Romer shocks, departments with temporarily elevated informality experience greater disinflation following a monetary tightening. This result is consistent with the interpretation that informality amplifies the contraction in local demand rather than merely changing the composition of employment. It is worth noting that this finding departs from the dampened-inflation prediction of Alberola and Urrutia (2020), whose Mexican-calibrated model implies that an informal sector should flatten the Phillips curve and mute the inflation response to a monetary contraction. Our regional evidence instead aligns more closely with Otero-Cortés et al. (2025), who find that in a model calibrated to Colombia, greater informality, by reducing the share of hours tied to a downwardly rigid minimum wage, makes labor costs more flexible and therefore *increases* the sensitivity of both consumption and inflation to a monetary tightening.

The joint behavior of employment, activity, and inflation is particularly informative for understanding the underlying transmission mechanism. Section 6.1 showed that the cross-sectional covariance between price and activity responses provides a sufficient statistic for distinguishing demand-driven from supply-driven regional heterogeneity. A positive covariance indicates differences in the sensitivity of local demand, whereas a negative covariance is consistent with heterogeneous local supply elasticities. The informality mechanism reproduces the same positive comovement identified for the sectoral, financial, and external channels: departments experiencing temporarily higher informality exhibit larger declines in employment, economic activity, and inflation following a monetary tightening.

This joint pattern points to a demand-side amplification mechanism rather than a supply-side one. Greater labor-market informality increases the flexibility with which firms adjust employment in response to tighter financial conditions, producing a larger decline in labor income. At the same time, informal workers' weaker attachment to formal credit and social insurance systems may limit their ability to smooth consumption after income losses. These two margins reinforce each other: employment adjusts more rapidly, and the resulting income losses translate more directly into lower household spending, which then generates both a deeper decline in economic activity and greater disinflation.

7 Conclusion

This paper has examined the regional effects of monetary policy in Colombia, providing new evidence on the magnitude, heterogeneity, and structural determinants of monetary transmission across departments and cities. Using three state-of-the-art identification strategies for exogenous monetary policy shocks and local projections estimated at both panel and individual levels, we have documented a set of facts that advance our understanding of how a single national interest rate propagates through a spatially heterogeneous economy.

Our aggregate results confirm that contractionary monetary policy shocks generate responses broadly consistent with conventional monetary theory: financial conditions tighten, real economic activity declines, employment falls and unemployment increases, consumer and producer prices decline, exports and imports contract and the trade balance deteriorates.

At the regional level, we document substantial heterogeneity in the responses of inflation, economic activity, and employment across Colombian cities and departments. The direction of these responses is broadly consistent across regions: monetary tightening reduces prices and activity throughout the distribution, but their magnitude, timing, and persistence differ markedly.

Applying the framework of Herreño and Pedemonte (2025), we find that the cross-sectional covariance between price and activity responses is predominantly positive, pointing to differences in the sensitivity of local demand, rather than differences in regional supply elasticities, as the primary source of heterogeneity in monetary transmission across Colombian regions.

Four structural mechanisms account for this demand-driven heterogeneity. First, the sectoral composition of departmental economies plays a central role: departments specialized in mining and commodity-intensive activities, such as La Guajira, Cesar, Meta, and Bolívar, experience the sharpest contractions following a tightening, while more diversified or agriculturally oriented departments such as Tolima and Cundinamarca exhibit comparatively muted responses. The cyclical position of the dominant sector further modulates transmission dynamically: when the leading sector enters the monetary tightening cycle from a position of strength, it partially buffers the contractionary impulse; when it is in a weak phase, the shock propagates more forcefully to the departmental aggregate.

Second, the depth of local credit intermediation amplifies monetary transmission. Departments with above-trend outstanding bank credit at the time of a monetary tightening are more sensitive to changes in the policy rate. Inflation and economic activity respond more to the monetary shock relative to less financially leveraged departments. The cross-sectional evidence shows that cities experiencing larger contractions in economic activity also exhibit larger declines in total credit and inflation, with the relationship holding robustly across identification strategies.

Third, integration into external markets constitutes an additional amplification channel. Departments with stronger external market performance, as measured by the TAM-2 component of the IDC, experience larger

contractions in economic activity following a monetary tightening. This pattern is consistent with both an expenditure-switching channel, operating through the exchange rate appreciation that reduces export competitiveness, and a trade-credit channel, whereby tighter financial conditions raise the cost of working capital for firms engaged in cross-border transactions. The aggregate evidence that oil and coal exports contract markedly following monetary tightening reinforces this interpretation at the departmental level.

Fourth, labor-market informality amplifies the regional effects of monetary policy, which might happen through a higher sensitivity of local labor income and household demand. Departments in which informality is temporarily above its own historical average experience larger declines in employment and economic activity after a monetary tightening, together with stronger disinflation. This pattern suggests that informality operates as an amplifier of the effects of monetary policy through demand. Informal employment relationships are generally more flexible and less protected, allowing labor adjustment to occur more rapidly, while informal workers typically face more unstable income streams, weaker access to formal credit, and lower coverage by social insurance mechanisms. As a result, income losses are more likely to translate into immediate reductions in household spending, reinforcing the contraction in local demand.

Taken together, these findings have two broad implications. For the analysis of monetary policy in emerging market economies, they demonstrate that aggregate impulse responses mask substantial cross-sectional heterogeneity that is related to structural characteristics of local economies. Ignoring this heterogeneity risks both misidentifying the transmission mechanism and underestimating the distributional consequences of monetary policy decisions. For the Colombian policy debate specifically, the results suggest that the effectiveness and real costs of monetary policy vary considerably across the national territory, with commodity-intensive, financially deeper, more trade-exposed, and more informal regions bearing a systematically larger share of the real and price adjustment following a tightening cycle. This spatial asymmetry, a consequence of the single-instrument constraint inherent in any centralized monetary framework, might call for complementary regional stabilization tools such as targeted transfers, credit-support mechanisms, or labor-market policies aimed at mitigating the unequal incidence of aggregate monetary shocks across Colombian regions.

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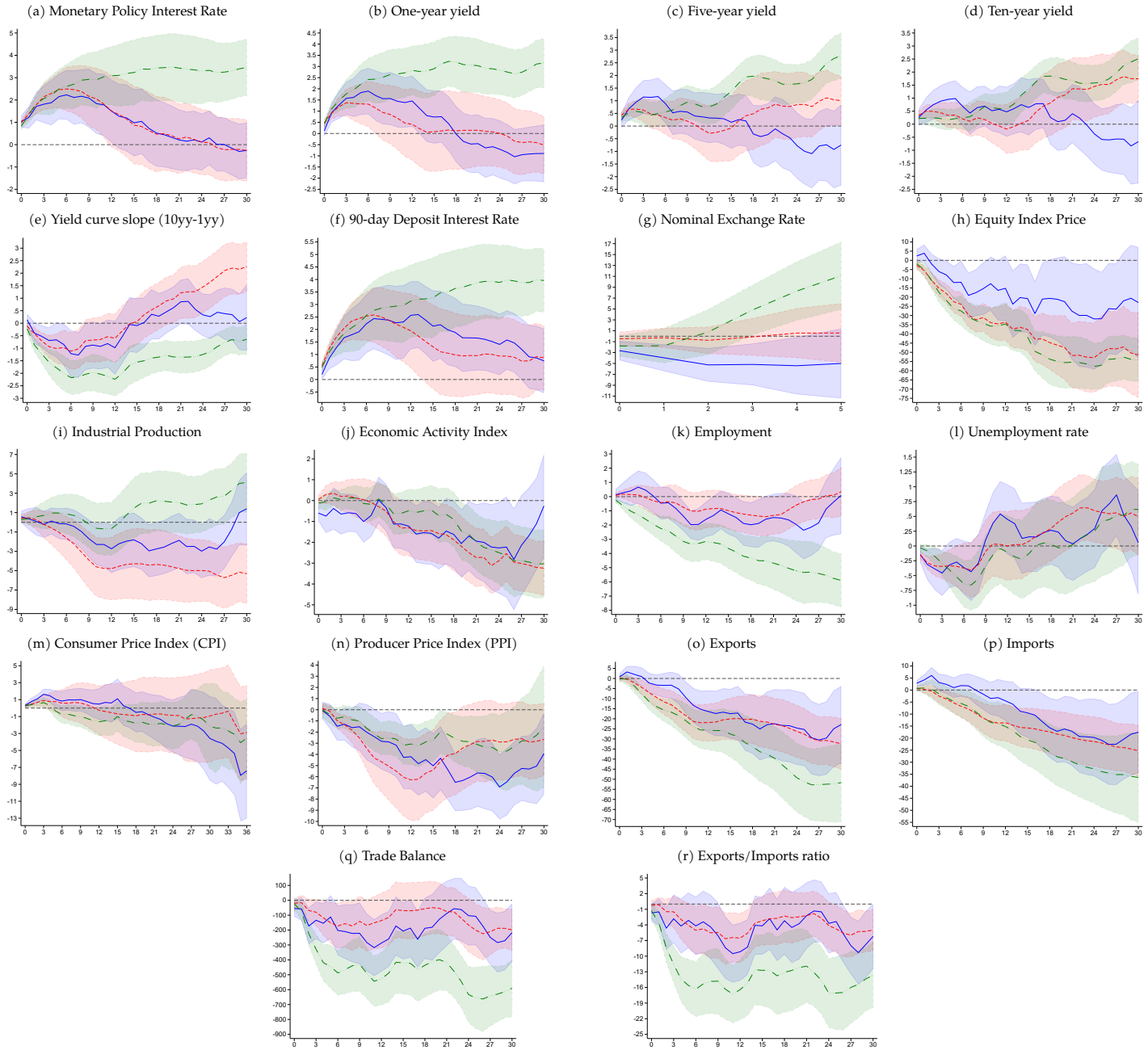
Appendix

A Appendix of the section *Revisiting the Domestic Effects of Monetary Policy Shocks in Colombia*

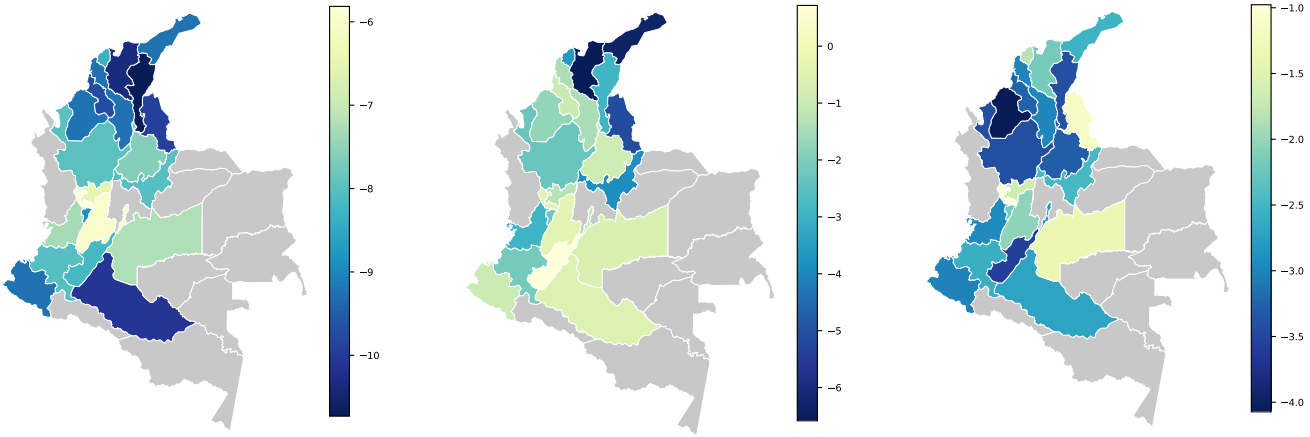
Figure A1: Effects of Monetary Policy in Colombia: Robustness to Sample Size



Note: This figure plots the monthly response of 18 Colombian variables upon three identified exogenous monetary shocks for the largest sample available: 2002m3–2025m4 (Laborde (2026) in blue solid; López et al. (2020) in red dashed; and Romero et al. (2021) in green dash and three points). For interest rates, trade balance and unemployment the dependent variable is the h+1-period change in the level of the variable. For the rest of the variables, the dependent variable is the h+1-period change in the natural logarithm of the variable. The specification has 12 lags of the dependent variable except for interest rates, where the specification has no lags. The time series of industrial production, economic activity index (ISE), employment, unemployment, exports, imports, and trade balance are smoothed using one month moving averages. The shaded areas show a 68 percent confidence interval.

Figure A2: Map with minimum inflation response

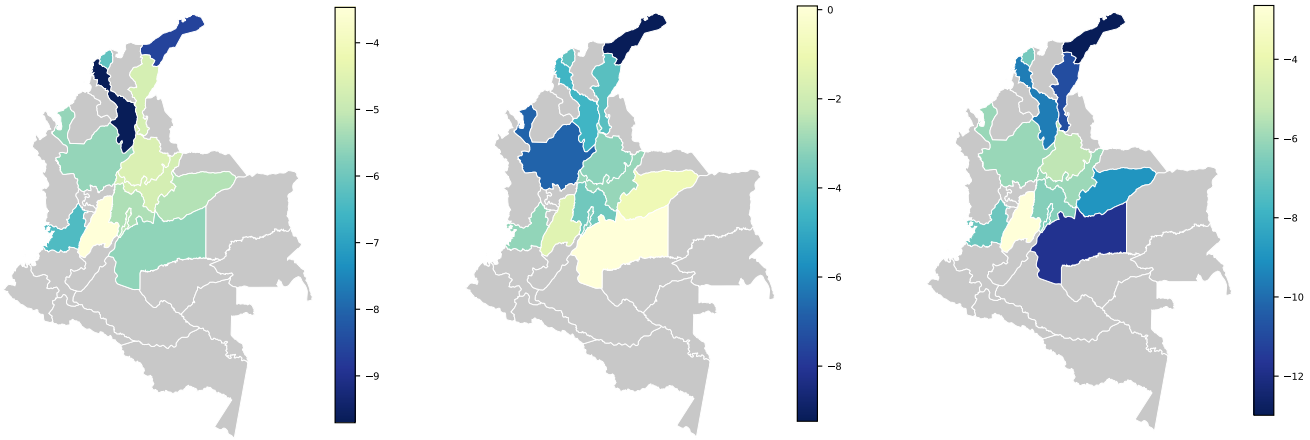
(a) Bloomberg (b) Romer and Romer (c) OIS



Note: This figure plots the average inflation response (y-axis) versus the average ITAED response (x-axis)

Figure A3: Map with minimum ITAED response

(a) Bloomberg (b) Romer and Romer (c) OIS



Note: This figure plots the average inflation response (y-axis) versus the average ITAED response (x-axis)