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GLOBAL SUPPLY CHAIN INFLATIONARY PRESSURES AND MONETARY POLICY IN MEXICO: A DISAGGREGATED PRICES ANALYSIS

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Abstract

This work examine the impact of stress in the global supply chains on inflation and monetary policy in Mexico, a representative emerging market economy. Using non-linear local projections, we estimate the degree of monetary policy tightening required in a high-stress supply chain environment and compare it to that in a low-stress environment. We instrument the monetary policy shocks with shocks to the federal funds rate. Results suggest that in a high-stress regime, the effect of an increase in the monetary policy interest rate on inflation over a one-year period is reduced considerably. We argue that this reduction is due to the slow response of inflation expectations to a monetary policy tightening in a high-stress regime. Furthermore, raising the interest rate has an effect on producer price inflation, a channel that is absent in a low-stress regime. This finding highlights the role of monetary policy in stabilizing inflation when facing supply shocks that are not necessarily permanent.

List of abbreviations

Abbreviation	Meaning
ARDL	Autoregresive Distributed Lags Model
Banxico	Central Bank of Mexico
BDI	Baltic Dry Index
CPI	Consumer Price Index
FTA	Free Trade Agreement
G7	Group of Seven
GSCPI	Global Supply Chain Pressure Index
HAC	Heteroskedasticity and Autocorrelation Consistent
IGAE	Economic Activity Index (Mexico)
IHS	Information Handling Services
IMF	International Monetary Fund
INPC	National Consumer Price Index (Mexico)
INPP	Producer Price Index (Mexico)
IPI	Industrial Production Index
LP	Local projections
NAFTA	North American Free Trade Agreement
NBER	National Bureau of Economic Review
NLLP	Non-linar local projections
PPI	Producer Price Index
STAR	Smooth Transition Autoregressive Model
TIIE	1-month interbank equilibrium interest rate (Mexico)
US	United States
USMCA	United States-Mexico-Canada Agreement
VAR	Vector Autoregressive Model

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1. Introduction

A series of shocks to the global economy between 2017 and 2023 has resulted in inflationary pressures not observed since the mid-1970s. Compounding these challenges, fiscal measures enacted in response to the COVID-19 pandemic, geared toward sustaining consumption levels throughout 2020-2021, have further fueled upward pressures on prices. The combination of heightened geopolitical tensions and the health emergency imposed substantial disruptions on the "just in time" production process, a hallmark of globalization. As a result, the global supply chain has been under considerable stress. Against this backdrop, central banks around the world have faced the daunting task of tackling extraordinarily high and persistent inflation.

Advanced economies have undertaken a more forceful monetary policy response than in previous inflationary episodes. This implies higher borrowing costs for emerging market economies, in addition to their own struggle to cope with higher and persistent inflation. Under this scenario of high inflation in advanced economies and surges in commodity prices, a tightening in the stance of monetary policies in the short to medium term is expected. The monetary authorities in emerging market economies have also deployed their policy response under a particularly challenging scenario for local and global macroeconomic conditions.

In this disertation, we examine how consumer price inflation in Mexico, a representative emerging market economy, responds to changes in monetary policy under two different regimes: low-stress and high-stress levels, measured with the Global Supply Chain Pressure Index published by the Federal Reserve Bank of New York. This is, we estimate the effect of a (structural) shock to the monetary policy rate on inflation, given the pass-through from global to domestic inflation. Using non-linear local projections (NLLPs), we estimate the effects of monetary policy shocks on inflation in each regime. Our results suggest that monetary policy is less effective in reducing inflation when the global supply chain is under high stress than when it is under low stress. Specifically, the main finding is that in a high-stress regime, monetary policy reduces inflation 40% less compared to the low-stress regime.

Local projections (LP), introduced by Jordà (2005), have a number of desirable characteristics for policy evaluation. First, they provide robust estimates of how the response variable (domestic inflation in Mexico) reacts to an impulse variable (monetary policy interest rate shock) in a single-equation model. This, in turn, allows introduction of non-linearities (hence, LP become

NLLP). In this work, we follow Auerbach and Gorodnichenko (2012) by estimating a smooth transition autoregressive model, first proposed by Granger and Terasvirta (1993). We use as trigger variable the aforementioned Global Supply Chain Pressure Index.

Second, given the inherent lag between monetary policy interest rate changes and their effects on domestic inflation, the direct forecasting mechanics of local projections provide a sound and straightforward forecast for the path of inflation and standard errors. In particular, local projections can estimate the additional tightening of the monetary policy stance required in a high-stress regime in order to achieve the same effect as in a low-stress regime.

Third, and particularly relevant for this disertatioin, as discussed in Jordà (2023), we can estimate the LP, thus the NLLP, via instrumental variables. More precisely, we use shocks to the (shadow) federal funds rate as an instrument for changes in Mexico's monetary policy interest rate. In a single equation context, identification of the shock is a previous step required for valid estimation of the LP, since the reference interest rate reacts to changes in inflation. We follow Jordà et al. (2020) in obtaining the shocks to the federal funds rate and argue why this is a valid instrument. Briefly, the reference interest rate set by Banco de México is related to unexpected changes in the monetary policy rate set by the Fed. These changes, however, are independent from domestic macroeconomic factors in Mexico.

This disertation contributes to a growing literature analyzing the effects of global shocks on inflation and the state-dependent effectiveness of monetary policy. In particular, this literature has highlighted the importance of considering global factors as main drivers of domestic inflation. Forbes (2019) argues that incorporating global factors increases the forecasting power of models for inflation, especially when including variables related to global slack and supply chains.

Wei and Xie (2020) provide a theoretical framework that relates monetary policy to global supply chains. Specifically, they propose a small-open economy New Keynesian model characterized by multiple production stages. With Canada serving as the baseline, they evaluate various monetary policy rules in the face of diverse stochastic shocks, including those specific to production stages and foreign consumption. Their findings point to a positive correlation between increased economic openness (measured by export share) and a heightened optimal weight on both upstream inflation and Producer Price Index (PPI) inflation. This insight underscores the relevance of PPI behavior in a context of consumer price inflation targeting.

The relevance of global supply chains can also be identified by the greater divergence between consumer and producer prices (Wei and Xie, 2018). Moreover, there is a higher degree of synchronization of producer prices across countries through the global input-output network (Auer et al., 2019). Indeed, Auer et al. (2017) investigate the influence of global value chains on domestic inflation, using data from 18 countries between 1982 and 2006. Their results indicate that as these chains expand, the susceptibility of domestic inflation to global economic conditions increases, whereas its reactivity to domestic slack decreases. Intermediate trade proves pivotal in this dynamic.

Since 2020, the COVID-19 shock encompassed demand and supply shocks, creating demand-supply imbalances on a global scale with slow-to-dissipate supply chain disruptions. Di Giovanni et al. (2022) studied this for the US and the Euro Area, where bottlenecks played a key role in inflation in the former, and, to a greater extent, in the latter. Carriére-Swallow et al. (2023) estimated the effect of shipping costs, measured by the Baltic Dry Index (BDI), on inflation in a large panel of countries. Their empirical approach relies on LP and the identification of a shock in the index is based on its lack of correlation with domestic conditions in small open economies. Their results suggest that changes in the BDI have nonneglegible effects on four measures of inflation: headline inflation, imports inflation, producer price inflation and 12-month ahead inflation expectations. The authors note that economies with a larger share of imports as consumption goods display larger responses to changes in the BDI.

IMF (2022b) analyzed the pass-through of external factors to consumer prices for the Middle East and Central Asia using local projections. The report found that supply chain disruptions (proxied by the Global Supply Chain Pressure Index), among other external drivers like food or oil, affect domestic inflation with great lag and persistence. The pass-through is positive and significant from month 12 up until month 21. In another report, IMF (2022a) examined Oman's case using an ARDL model, and similarly, they found that shocks (disruptions) to the supply chain take up to 22 months to vanish from CPI.

Regarding monetary policy effectiveness, Fornaro and Wolf (2023) argue that supply shocks can depress aggregate demand via a wealth effect, which tends to amplify, leading to a more persistent impact on inflation. They claim that in this situation, a smooth and successful disinflation may require a policy combination of monetary tightening and subsidies to business investment. Additionally, about its effectiveness in prices in different sectors of the economy.

Additionally, about monetary policy effectiveness in prices of different sectors of the economy, Baumeister et al. (2013a) find that durable goods prices are the most sensitive to interest rate innovations and contribute the least to price dispersion. On the other hand, nondurable goods prices, and to a lesser extent services, account for a large share of cross-sectional heterogeneity. In this line, Bouakez et al. (2009) notice that prices in sectors such as mining, construction, agriculture, and durable goods react more strongly to monetary policy changes. In contrast, prices in services and non-durable goods are less responsive to monetary policy shifts. Also, the output effects of a monetary policy shock arise from price stickiness in certain sectors, where slow price adjustments transmit the impact of the policy shock to other sectors, thereby influencing the broader economy.

Among the main contributions of this disertation is the finding that the effectiveness of monetary policy in stabilizing inflation is lower in a regime with high stress on the global supply chain, especially within the first year after a change in interest rates. A possible explanation of this is the affectation of the expectations channel. Furthermore, it explores the differentiated effectiveness on different sector prices, finding that the reduction of monetary policy actions comes principally of non-food, services and non-core inflation related sectors of the economy. A further contribution is the identification strategy and the application of the NLLP to monetary policy in an emerging market economy. Finally, from a policy standpoint, our findings indicate that even in cases where supply shocks are not deemed permanent, monetary policy continues to play a crucial role in steering inflation towards the designated target within an inflation-targeting framework. This stands in contrast to the empirical literature predating 2020.

The rest of the disertation is organized as follows. In Section 2, we include a description of the Global Supply Chain Pressure Index and its relation to Mexico. We then describe the econometric methods in Section 3. We devote Section 4 to present the results from the estimation. Section 5 discusses the main policy implications and some concluding remarks.

2. Inflation in Mexico and the Global Supply Chain Pressure Index

2.1. Inflation in Mexico

In this disertation, we focus on the response of consumer price inflation to monetary policy shocks, using the National Consumer Price Index in Mexico (INPC in Spanish) as the measure of inflation, and the 1-month interbank equilibrium interest rate (TIIE in Spanish) as the measure of monetary policy shocks. Our sample comprises monthly data starting from January 2005 and ending in December 2022.[1]

Figure 2.1 displays the behavior of inflation and the 1-month interbank equilibrium interest rate over the relevant time period. As Chiquiar et al. (2010) show, consumer price inflation in Mexico has displayed the properties of a stationary time series since 2001. However, the inflation point target of 3% (with a variability interval of plus-minus 1%) has been achieved only four times within the sample period.[2] This may reflect the impact of several shocks that hit the Mexican economy since 2005: the Global Financial Crisis in 2008-2009; the European sovereign debt crisis of 2010-2011; the sharp drop in oil prices in 2014; the uncertainty over NAFTA renegotiation and the liberalization of domestic gasoline prices in early 2017; and the COVID-19 pandemic and its aftermath from 2020 on.

As shown in Figure 2.1, from May 2020 to the end of the sample, inflation in Mexico started an upward trend, reaching levels well above the central bank's target and the highest within the sample. An important distinction between the recent inflationary behavior from 2020 to 2022 and previous episodes is that a large number of economies faced the same challenge simultaneously. Both advanced and emerging market economies have experienced inflation rates significantly exceeding their averages for the 2000-2019 period, regardless of the varying fiscal stimuli applied or the extent of COVID-19-related mobility restrictions.

The monetary policy response has, in turn, entailed a sequence of increases in the policy

[1] The starting point of the sample is due to structural conditions and limitations in data accessibility, it is noteworthy that Banco de México officially adopted an inflation targeting framework for guiding monetary policy in 2003. Consequently, data from preceding years might offer less insight into the relation between interest rates and consumer price inflation. Furthermore, the availability of crucial data is constrained by the fact that the Producer Price Index, a pivotal control variable within the purview of this disertation, capturing the measure of intermediate goods prices for national companies, is only accessible from January 2005 onward.

[2] The lowest inflation rates were observed in 2011 (3.41%), 2013 (3.97%), 2015 (2.13%), and 2020 (2.12%).

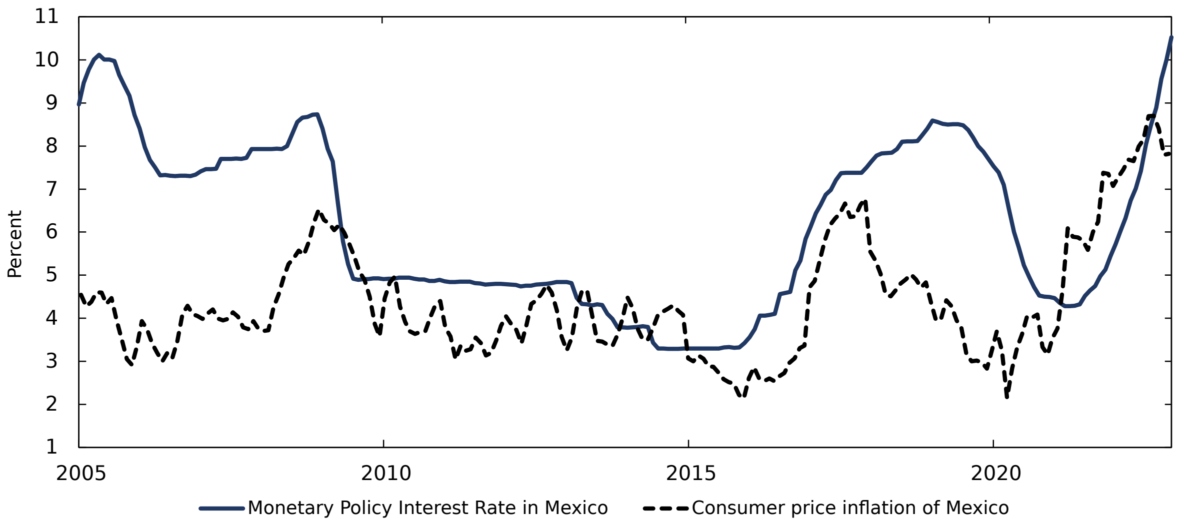


Figure 2.1: Consumer price inflation of Mexico and 1-month interbank equilibrium interest rate.

interest rate. As depicted in Figure 2.1, the central bank of Mexico significantly tightened its monetary policy from June 2021 to December 2022. This period represents the longest and most aggressive tightening cycle undertaken by the central bank within the sample. Inflation, however, remained persistently above the point target of 3%.

In this context, 1-month and 12-month ahead inflation expectations (at annual rate) from surveys also remained above the point target, and increased further during 2021-2022, as shown in Figure 2.2. Inflation expectations are closely monitored within an inflation targeting framework, as the expectations channel is one of the principal mechanisms for monetary policy transmission. Moreover, the time frame over which monetary policy changes in Mexico have a full effect on inflation is estimated at 24 months (de México, 2016b).[3] It is important to note that inflation expectations on both the 1-month and 12-month horizons co-move and have achieved levels above the 4% upper bound level for protracted periods. Within an inflation targeting framework, with a credible central bank, we would expect that inflation expectations adjust relatively quickly in response to changes in the monetary policy stance.

2.2. Inflation and Global Supply Chain Pressures

The behavior of inflation and its expectations, even in a context of monetary policy tightening, suggests that other determinants are at play. There is a growing literature analyzing the role of supply side and global price indicators on monetary policy effectiveness, and on pass-through from global to domestic inflation (Wei and Xie, 2020; Carriére-Swallow et al., 2023;

[3] All references from Banco de México (Banxico for short) are documents available only in Spanish.

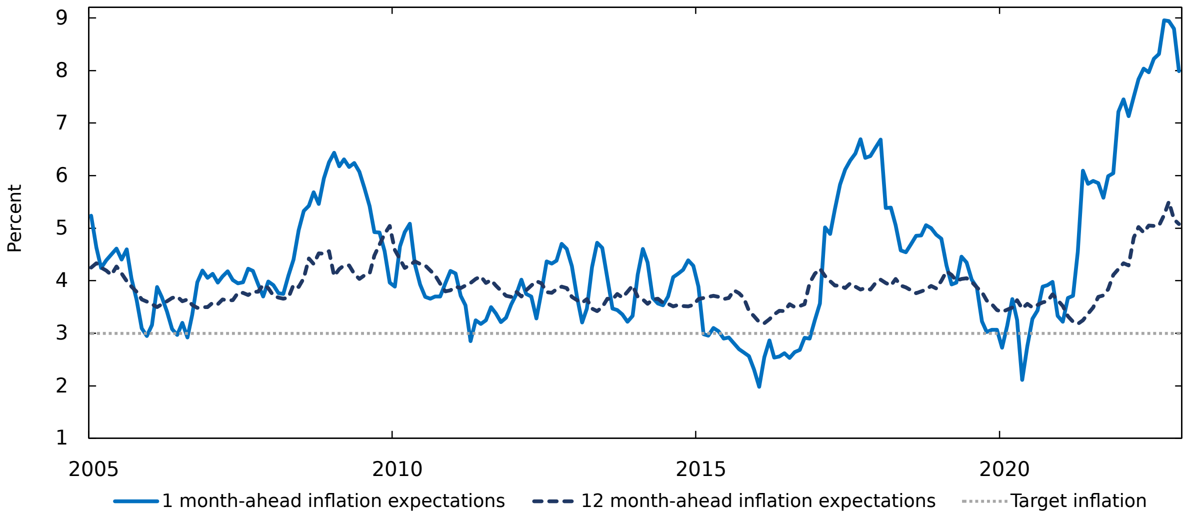


Figure 2.2: 1-month and 12-month ahead survey inflation expectations.

IMF, 2022b). Figure 2.3 displays the Global Supply Chain Pressure Index (GSCPI) published by the Federal Reserve Bank of New York. The index considers global transportation costs, delivery times, backlogs, and other relevant factors.[4] Unlike trade data, the GSCPI provides an approximate measure of possible imbalances between demand and supply that can be attributed to supply disruptions.

Benigno et al. (2022) proposed the GSCPI as a measure to assess pressures on global supply chains. This index includes country-specific supply chain information and global measures of transportation costs. In its construction, the authors strive to keep only supply-side phenomena of each component and then statistically combine them. As for the country-specific information, they limit their sample to China, Japan, Korea, Taiwan, UK, US, and the Euro Area. For each country, they gather three supply chain measures. Each series is statistically treated to remove demand effects via specific sub-components of the IHS Markit's Purchasing Managers' Index: delivery time, backlogs and purchased stocks. The authors then regress these sub-components on the new orders series and use the residuals of the regression to build the GSCPI. There are 27 country-specific residuals series, as well as two global shipping rates and four price indexes for airfreight covering the aforementioned economies. Finally, the authors combine these residuals series via Principal Component Analysis and define the first component (the one capable of reproducing most of the variance of all the series) as the GSCPI.[5]

Figure (2.3) shows the time series of the GSCPI, where we highlight some relevant episodes. The peaks during the Global Financial Crisis (first shaded area) arise naturally, although Benigno

[4] Source: NY Fed: (https://www.newyorkfed.org/research/gscpi.html).

[5] Further details on how the GSCPI is built can be found in Benigno et al. (2022), p. 4-5, from which our description heavily draws.

et al. (2022) warn that, in that particular episode, some demand effects may have not been removed from the index. They attribute peaks in 2011 and from 2017 to 2019 to the Tohuku earthquake (and the ensuing tsunami that affected the Fukushima nuclear reactor), the floods in Thailand, and the US-China trade war, respectively. All these events caused supply disruptions, but non as severe as that related to the COVID-19 pandemic.

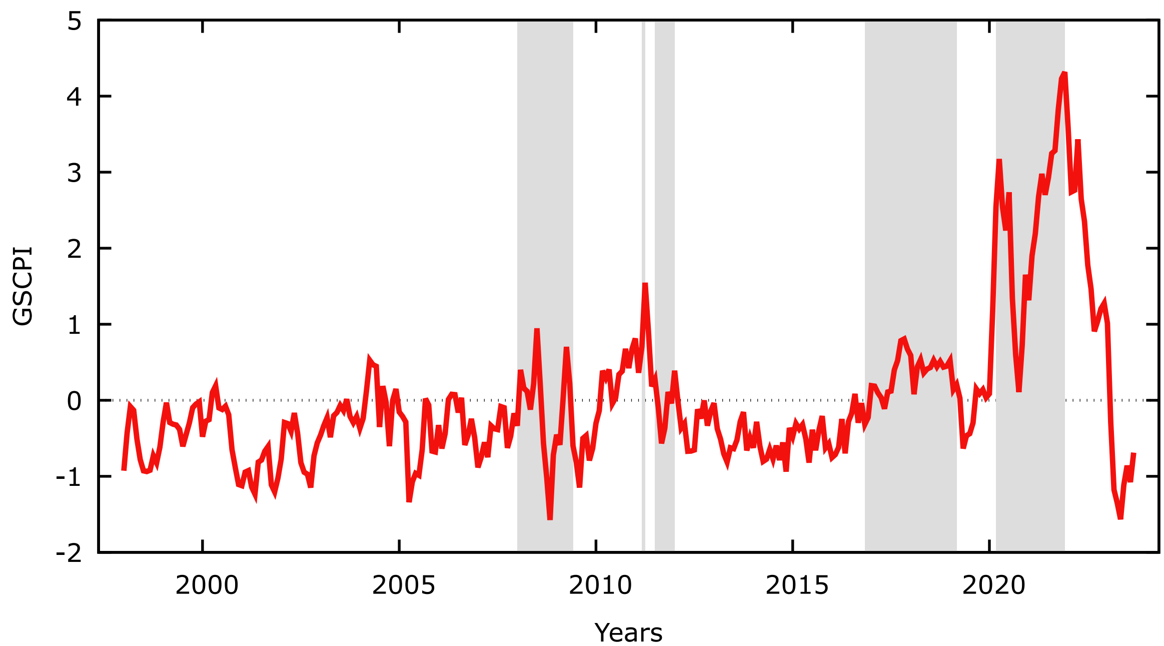


Figure 2.3: Global Supply Chain Pressure Index (trigger variable). Shades correspond (in chronological order) to: the GFC, the Fukushima nuclear accident in Japan, the floods in Thailand, the US-China trade war, and the COVID-19 pandemics. Sources: Own making with data from the New York Federal Reserve, NBER and Wikipedia.

In this disertation, we aim to uncover the role of episodes of global supply chain stress (proxied with the GSCPI) on the effectiveness of the monetary policy in reducing consumer price inflation in an emerging market economy. In particular, we assess if these episodes lessen or delay its effectiveness. The underlying reasoning for this hypothesis is based on evidence suggesting that there may be a nonnegligible pass-through from global to domestic inflation in the Mexican economy. The latter has been documented in Carriére-Swallow et al. (2023) in a panel data analysis for advanced and emerging market economies. Their results show that the aforementioned pass-through is rather strong, especially in emerging market economies with a high degree of trade openness, such as Mexico.[6]

[6] In contrast, Arango-Castillo et al. (2022) show that the pass-through is somewhat smaller in emerging economies than in advanced economies, nonetheless, in all cases the impact of global inflation to domestic inflation may be considered to have a relevant role on explaining (headline and core) inflation variance.

It has been argued that supply shocks typically are challenging for central banks (Végh et al., 2017) as any interest rate reduction may stimulate the demand while maintaining unaltered (an already shocked) supply. Monetary policy could, however, reduce financial pressures on firms and households (through the balance sheet channel), and thus allow for a faster recovery. Nonetheless, when shocks originate abroad, from a shortage of intermediate goods for instance, the effects of the latter channel are less obvious. A rise in the reference interest rate may disincentive consumption (affecting the demand side) and therefore reduce inflationary pressures. In parallel, it could increase financial costs to producers, which may eventually translate into further reductions of the domestic supply, generating inflationary pressures. It is unclear which effect dominates. It may well be the case that an increase in the policy interest rate effectively reduces inflation if the impact on the demand side more than compensates the one on the supply side.

In short, there seems to be a pass-through from global to domestic inflation. If surges in global inflation are a response to changes in the supply side, this could affect the effectiveness of monetary policy in a small open economy, especially if it has a high degree of trade openness. In this regard, Mexico can be considered an appropriate case of study: it is a small open economy that is highly integrated into global trade, with more than 90% of its exports governed by one of the 67 free trade agreements (FTAs) it has signed. Of special relevance are the FTAs signed with the US and Canada (NAFTA, 1994-2019, and USMCA, 2020 onwards). Moreover, Mexico is among the top ten importers.[7] The degree of global integration of Mexico stands out in industries such as automotive manufacturing, electronics, and aerospace. This has been evident during the COVID-19 pandemic and the Russia-Ukraine war. In both cases, severe intermediate-goods shortages disrupted the production chains, particularly in the aforementioned sectors (de México, 2016a, 2022).[8]

[7] Source: World Bank (https://wits.worldbank.org/).

[8] As suggested by an anonymous referee, inflation in Mexico may be subject to further shocks from global prices as it is undergoing an increasing inflow of direct foreign investment. The latter is caused by re-allocation of large manufacturing firms. This is an interesting venue for future research.

3. Econometric Methods

Local projections (LP), introduced by Jordà (2005), have become a popular tool in empirical macroeconomic research (Ramey, 2016). Ongoing research in this field has revealed that impulse response analysis based on LP, including p lags to address serial correlation, is approximately equivalent to that obtained through a VAR(p) model (Plagborg-Møller and Wolf, 2021; Li et al., 2022). It is also straightforward to obtain LP estimates with standard errors that are robust to heteroskedasticity and autocorrelation. This is achieved by using a suitable semi-parametric estimator of the error variance matrix, such as the Newey and West (1987) estimator, and including lags of the response variable (Montiel Olea and Plagborg-Møller, 2021; Jordà, 2023). In addition, the single equation set-up required to obtain impulse responses through LP allows to seamlessly introduce non-linearities (Auerbach and Gorodnichenko, 2012).

In this disertation, we are interested in the response of (accumulated) consumer price inflation (and its sector disaggregations) in Mexico h periods ahead, y_{t+h}, to an exogenous monetary policy intervention in period t, Δr_t. We control for a set of relevant macroeconomic factors, $\boldsymbol{x}_t$, which also includes lags of y_t. The LP are obtained as the estimates for β_h in the following linear model:

$$y_{t+h} \quad = \quad \alpha_h + \Delta r_t \beta_h + \boldsymbol{x}_t' \boldsymbol{\gamma}_h + \nu_{t+h}, \quad h = 1, \dots H \tag{3.1}$$

where, as detailed in Jordà (2005), ν_{t+h} is a scalar moving average process of order h and $\alpha_h, \boldsymbol{\gamma}_h$ are parameters. We measure monetary policy interventions as changes in the target interest rate level decided by the central bank. These interventions, however, are endogenous to both the inflation measurment and the set of macroeconomic factors. Thus, direct estimation of (3.1) through ordinary least squares would yield invalid estimates and standard errors for β_h. In order to deal with the issue of endogeneity, we adopt an identification strategy based on the use of external instruments.[1]

[1] We thank an anonymous referee for suggesting this identification strategy. In previous drafts of this disertation we obtained structural shocks through a VAR with shocks identified by recursive ordering.

3.1. Identification with external instruments

Identification of structural shocks through external instruments, recently adopted in macroeconomics, has by now been extensively used in the literature for both structural VAR (Mertens and Ravn, 2013; Gertler and Karadi, 2015; Caldara and Kamps, 2017; Stock and Watson, 2018; Montiel Olea et al., 2021; Wei and Guo, 2022; Braun and Brüggemann, 2023) and LP (Owyang et al., 2013; Jordà et al., 2015; Ramey, 2016; Ramey and Zubairy, 2018; Mertens and Montiel Olea, 2018; Stock and Watson, 2018; Bräuning and Sheremirov, 2023).

In this disertation, we follow Jordà et al. (2020) in order to obtain an exogenous measure of Δr_t. To that end we note, as Figure 3.1 shows and an uncovered interest rate parity argument would suggest, that the monetary policy rate in Mexico is closely related to that in the US (Ahmed, 2023). Thus, we estimate shocks to the shadow federal funds rate from Wu and Xia (2016) as the residuals obtained by projecting this rate onto its main determinants. In particular, we estimate the model:

$$\Delta r_t^* \quad = \quad \alpha^* + \boldsymbol{x}_t^{*'} \boldsymbol{\gamma}_h^* + \eta_t, \tag{3.2}$$

where Δr_t^* is the first difference of the (shadow) federal funds rate and $\boldsymbol{x}_t^*$ are co-variates previously used to explain monetary policy decisions (Jordà et al., 2020). More precisely, $\boldsymbol{x}_t^*$ contains the US industrial production, Consumer Price Index (both in log-difference), the 1-year ahead inflation expectations and the market 10-year yield on US Treasuries. Note that, by construction, the estimated Fed policy shocks, $\widehat{\eta}_t$, are orthogonal to economic activity and inflationary pressures in the US, and to global financial conditions (measured by the 10-year yield).

We now argue that $\widehat{\eta}_t$ is a valid instrument for $\widehat{\Delta r}_t$. Specifically, we focus on the relevance, contemporaneous exogeneity and lead-lag exogeneity conditions outlined in Stock and Watson (2018) and Jordà (2023). Regarding relevance, we note that unexpected changes in monetary policy stance in the US will necessarily be related to changes in monetary policy rate in Mexico, since the latter is a small open economy with a highly liquid currency and free capital movement.[2] Indeed, the estimate for $Cov(\Delta r_t, \widehat{\eta}_t)$ is 0.18 with a t-statistic of 2.69, hence statistically different from zero. Regarding contemporaneous exogeneity, we note that shocks to the federal funds rate are orthogonal to macroeconomic factors in Mexico, and in particular to y_t. It would be hard to argue that consumer inflation in Mexico is part of the information set evaluated by Fed officials in setting the monetary policy stance. In this sense, we estimate $Cov(y_t, \widehat{\eta}_t)$ not different from zero, statistically, at -0.08 with a t-statistic of -1.14.

[2] Banco de México's Monetary Policy Committee meetings are scheduled at most one week after the Fed's FOMC meets. According to the BIS Triennial Central Bank Survey of foreign exchange and Over-the-counter (OTC) derivatives markets in 2022, the Mexican Peso ranked third among the Emerging Markets currencies in terms of foreign exchange market turnover.

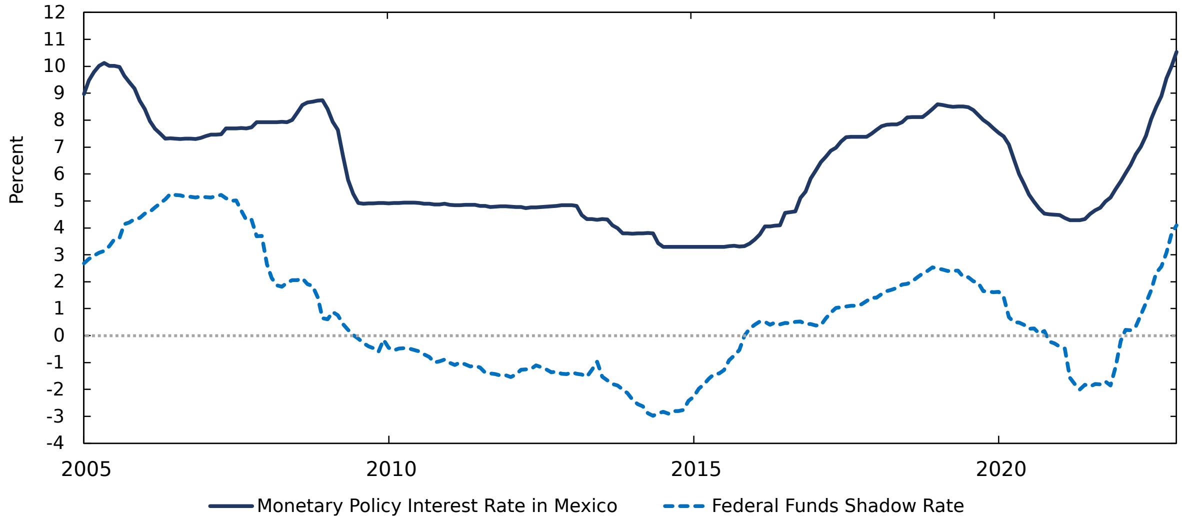


Figure 3.1: 1-month interbank equilibrium interest rate and Wu and Xia (2016) Shadow Federal Funds Rate.

To argue that the lead-lag exogeneity condition is satisfied, we note that instrumental variables regression entails estimating the first stage regression:[3]

$$\Delta r_t \quad = \quad \delta_0 + \widehat{\eta}_t \psi + \boldsymbol{x}_t' \boldsymbol{\delta} + u_t, \tag{3.3}$$

and then estimating the analog to model (3.1) using the fitted values, $\widehat{\Delta r}_t$ from (3.3):

$$y_{t+h} \quad = \quad \alpha_h + \widehat{\Delta r}_t \beta_h + \boldsymbol{x}_t' \boldsymbol{\gamma}_h + \nu_{t+h}, \quad h = 1, \ldots H \tag{3.4}$$

where we note that any estimate $\widehat{\nu}_{t+h}$ is orthogonal to $\widehat{\eta}_t$ by construction. In fact, any information related to $\widehat{\eta}_t$ included in (3.4) is included in $\widehat{\Delta r}_t$, but the latter is orthogonal to $\widehat{\nu}_{t+h}$. Moreover, as mentioned earlier, the information set used to estimate $\widehat{\beta}_h$ and included in $\boldsymbol{x}_t$ contains lags of y_t yielding lag-exogeneity. We finally note that standard errors of $\widehat{\beta}_h$ can be estimated with the Newey and West (1987) estimator, and are therefore robust to heteroskedasticity and autocorrelation.

3.2. Non-linear Local Projections

As we argued in Section 2.2, consumer inflation in Mexico may be unevenly affected by inflationary pressures originated in the supply chain. To model explicitly the latter, we introduce a

[3] In Table 6.2 we present results from the first stage regression estimates.

non-linearity in (3.4) in the form of a smooth transition autoregression (STAR) (Granger and Terasvirta, 1993). This model allows us to account for both sharp, but temporary, and smooth changes in the GSCPI between high- and low-stress regimes.

We focus on obtaining non-linear local projections (NLLP), and thus we estimate the sequence of STAR models:

$$y_{t+h} = (1 - F(z_{t-1})) \left[\beta_h^L \widehat{\Delta r}_t + \boldsymbol{x}_t' \boldsymbol{\gamma}_h^L\right] + F(z_{t-1}) \left[\beta_h^H \widehat{\Delta r}_t + \boldsymbol{x}_t' \boldsymbol{\gamma}_h^H\right] + \nu_{t+h}, \quad (3.5)$$

$$F(z_{t-1}) = \frac{\exp\{-\kappa z_{t-1}\}}{1 + \exp\{-\kappa z_{t-1}\}}, \quad (3.6)$$

where parameters are now indexed by the regime (L for low or H for high), the trigger (regime-indicating) variable, z_t, is the GSCPI and (3.6) is the logistic probability density function with curvature parameter $\kappa > 0$. It is important to note that $F(\cdot)$ is a function of the lag of z_t to avoid feedback, as in Auerbach and Gorodnichenko (2012) and Passos and de Melo Modenesi (2021).

Some remarks are in order before presenting estimation results. As mentioned above, the main focus is on the response of the accumulated consumer inflation to a monetary policy intervention. We measure the former as 100 times the log difference between the Consumer Price Index in period $t + h$ and that in period t. When describing our findings, we use the convention of $\widehat{\beta}_h$ measuring the response of a 100 basis points increase in the monetary policy rate, that is $\widehat{\Delta r}_t = 1$ percentage point. We focus on a 24-month horizon since the effects of monetary policy decisions on prices are estimated to be relevant up to approximately 18 months (Banxico, 2016). Estimation of (3.5) yields the NLLP in the form of $\widehat{\beta_h^L}$ and $\widehat{\beta_h^H}$ for the low- and high-inflationary pressure regimes, respectively. Using Jordà (2023) notation, adjusted to account for regime changes, these functions are given by

$$\begin{aligned} \mathcal{R}^L(h) &= \widehat{\beta}_h^L \quad h = 1, \ldots 24, \\ \mathcal{R}^H(h) &= \widehat{\beta}_h^H \quad h = 1, \ldots 24. \end{aligned} \quad (3.7)$$

We also provide estimates of $\mathcal{R}^L(h)$ and $\mathcal{R}^H(h)$ for the variables relevant for the transmission mechanisms of monetary policy to the price level. In particular, we estimate the NLLP of inflation expectations 1-month ahead and inflation expectations 12-months ahead. Additionally, and given the focus on supply-side inflationary pressures, we present the (accumulated) NLLP of the Producer Price Index in Mexico. The latter results allow us to illustrate one of the propagation mechanisms that explain our main results. Finally, we note that the trigger variable is taken as the cyclical component of z_t, obtained through the Hodrick-Prescott filter, as in Auerbach and Gorodnichenko (2012). Since the GSCPI is a standardized measure with data available up to 2023, filtering serves to recenter the time series at zero, regardless of the sample. Results are invariant to this transformation.

4. Results and implications

In this section, we present the estimated NLLP of the consumer price inflation conditional on the level of the GSCPI. The STAR model (3.5) and the first stage regression (3.3) were estimated including one lag of the response variable y_t, as suggested by the Bayesian Information Criterion.[1] As we mentioned above, all standard errors are estimated using a HAC variance matrix. The estimation spans from January 2005 to December 2022, aligning with both structural constraints and data availability. Regarding the former, Banco de México formally adopted an inflation targeting framework for conducting monetary policy in 2003, thus data in prior years may be less informative about the relationship between interest rates and consumer price inflation. Regarding data availability, the Producer Price Index is only available from January 2005.

The vector of control variables, $\boldsymbol{x}_t$, is similar to that used in previous empirical studies of monetary policy and impulse response analysis in Mexico (Capistrán et al., 2019; Ibarra and Téllez-León, 2020; Alba et al., 2023).[2] Domestic economic activity, measured by the log-difference of Economic Activity Index (IGAE), accounts for pressures on prices on the demand side. Log-difference of Producer Price Index inflation (INPP) is used to control for domestic supply inflationary pressures, which may present with a lag on consumer price inflation. The latter index may be particularly important in accounting for the direct effects of stress in the GSCPI, given that the manufacturing sector represents nearly 20% of economic activity in Mexico. The 1-month ahead consumer price inflation expectations control for changes in the near-term monetary policy outlook, while the 12-month ahead expectations control for the effect of expectations on the monetary policy stance. The exchange rate depreciation rate is included to control for both inflationary pressures in the tradable sector, and interest rate pressures from capital flows.

In all estimations, we control for global variables that are invariant across regimes. These include the log-difference of the VIX, which gauges financial market stress; the log-difference of oil prices, accounting for non-core inflationary pressures and potential secondary effects on the overall Consumer Price Index; and the log-difference of the G7 Industrial Production Index

[1] The Akaike Information Criterion suggested using 12 lags, but results for mean estimates are qualitatively similar. We discuss this issue below along with further robustness checks.

[2] Table 6.1 in the Appendix contains a description of the variables that are considered in the analysis. To transform variables that are available on a daily basis to monthly frequency, we used an average.

to factor in external demand pressures and supply constraints.

4.1. Periods of High Stress on the Global Supply Chain

As a previous step to discuss the NLLP, we present the estimated probability of being in the high-stress regime for the GSCPI. Figure 4.1 displays $F(z_{t-1})$ with a solid line with values from 0 to 1 on the right-side axis. It is important to stress that, unlike discrete Markov-Switching models, the STAR model allocates a probability to the high-stress regime that may differ from 0 or 1 to each period in the sample. The cut-off value for $F(z_{t-1})$ that we use to distinguish between the low- and high-stress regimes is 0.5.

Inspection of Figure 4.1 reveals that whenever the GSCPI increases on consecutive periods, or sharply, the probability of being in the high-stress regime increases. Focusing on the period 2020-2022, it is interesting to note that according to the estimate, the high-stress regime has been in place for the majority of the time with a short transition period. There is only one similar episode in the sample where the probability of high-stress regime was high for a long period, between 2010 and 2011. As noted by Benigno et al. (2022), the latter episode is associated with the tsunami in Japan that led to a decrease in production of nuclear energy. An important difference between these two episodes of high stress in the supply chain is the stark challenges to the so-called just-in-time production scheme experienced in the 2020-2022 period.

In the post-2020 period, economies in general, and industries in particular, have faced a variety of obstacles to the production of manufactured goods. These in turn have translated into persistent pressures from the supply side to the consumer price inflation. From the estimation of the probability of being in the high-stress regime, it is noteworthy that pre-2020 factors in key members of the manufacturing supply chain that may have caused stress, others than COVID-19, such as wars, elections or trade barriers, do not appear to have a lasting effect on the GSCPI.

Regarding wars, in 2014 and 2022, the conflict between Russia and Ukraine, which may easily translate into upward pressures on gas, oil or other commodities, does not seem to cause a lasting change towards high-stress regime. With respect to elections, between 2005 and 2022 India, China and the US had several episodes of political stress, but none translate into a lasting low- or high-stress regime. An additional source of stress on the supply chain may stem from tariffs imposed by the US on Chinese goods, starting on 2017. These may have an effect on supply with a lag (Amiti et al., 2019), and translate into consumer price inflation.

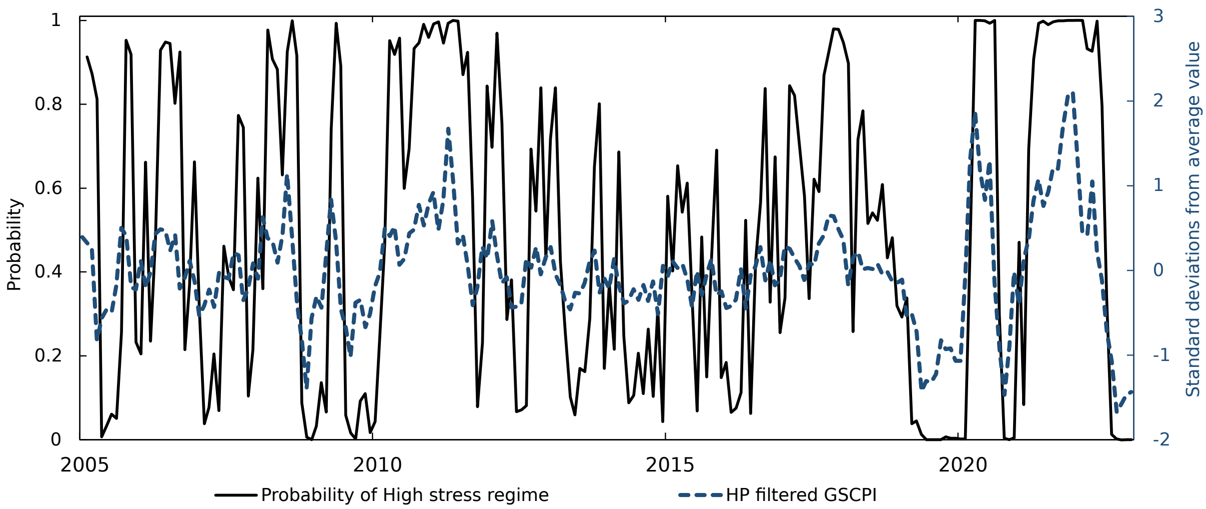


Figure 4.1: Global Supply Chain Pressure Index (left-axis) and regime transition function (right-axis).

4.2. Non-linear Local Projection Estimates

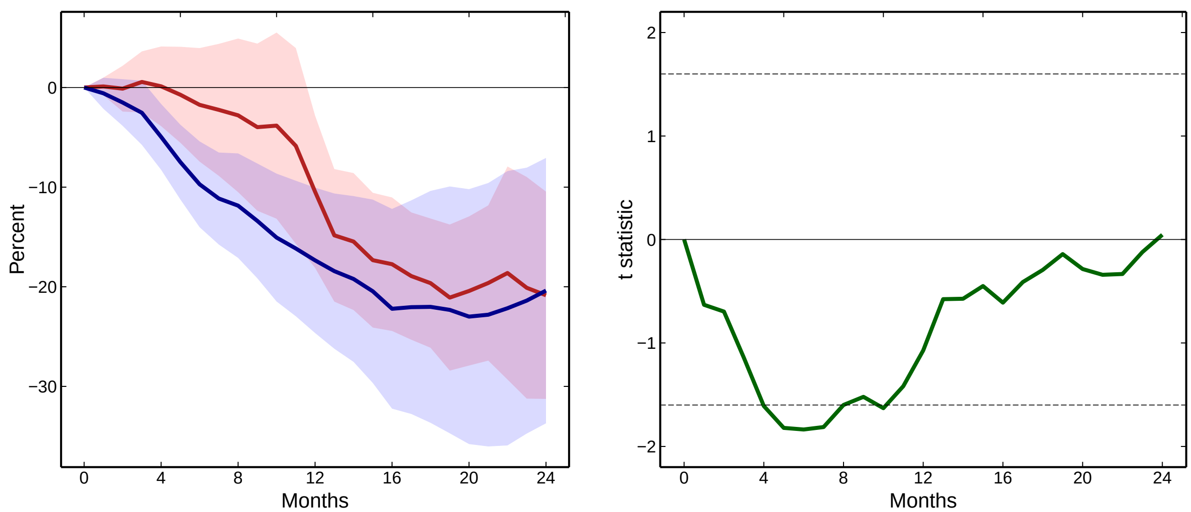
We now present the NLLP estimated as in (3.7). In presenting the results, we discuss the dynamic response in each regime along with the Welch (1951) t-test for differences in two independent means.[3] In particular, we present the test statistic for the null hypothesis that $\mathcal{R}_h^L = \mathcal{R}_h^H$ for each h, and refer to this as the point-by-point Welch test. We also present the p-value for the test of the null hypothesis $\sum_{h=1}^{H} H^{-1}\mathcal{R}_h^L = \sum_{h=1}^{H} H^{-1}\mathcal{R}_h^H$ and refer to this as the mean Welch test.

Figure 4.2 presents the main results of the disertation. In particular, the NLLP panel shows the accumulated response of the log-consumer price level (INPC). Note that the response variable is in the so-called "long differences" (Jordà, 2023) $y_{t+h} = 100(log(INPC_{t+h}) - log(INPC_t))$. Thus, we find that, in the low stress on the global supply chain regime (blue line), accumulated consumer inflation response is negative and statistically different from zero 3 months after a 100 basis points interest rate shock (increase). The accumulated decrease of inflation 12 months after the shock is 15.1 percent (or log-points). Hence, the average effect per month is about 1.26 percentage points. It is important to note that the size of the shock is considerably large and, by construction, exogenous to the price dynamics in Mexico. In the second year (20 months) after the shock, the largest accumulated effect of the increase in the monetary policy interest rate on the price level reaches -23 percent. Thus, we find that the average effect per month is less than 1 to 1 in the 24-month horizon. To put these results in context, the 24-month accumulated consumer inflation observed in Mexico averaged 8.85 and 13.11 percent in 2021 and 2022,

[3] We thank an anonymous referee for suggesting to test for statistically meaningful differences in the NLLP.

respectively.

The estimated NLLP for the high-stress regime (red line) is negative and statistically different from zero starting in period 12. This is, within said regime we estimate that a monetary policy shock has no effect on the price level in the first year. We do find, however, that the accumulated effect after 24 months in the high-stress regime is similar to that in the low-stress regime at -20.4 and -20.8 percent, respectively. Importantly, as reflected by the point-by-point Welch t-test statistic panel in Figure 4.2 (dotted lines correspond to $\pm$ 1.6), we find that the NLLP for the low- and high-stress regimes are statistically different at the 90% level of confidence for the 4-10 horizons. The mean Welch test p-value of 0.0618 allows to reject the null hypothesis of equal means.



NLLP

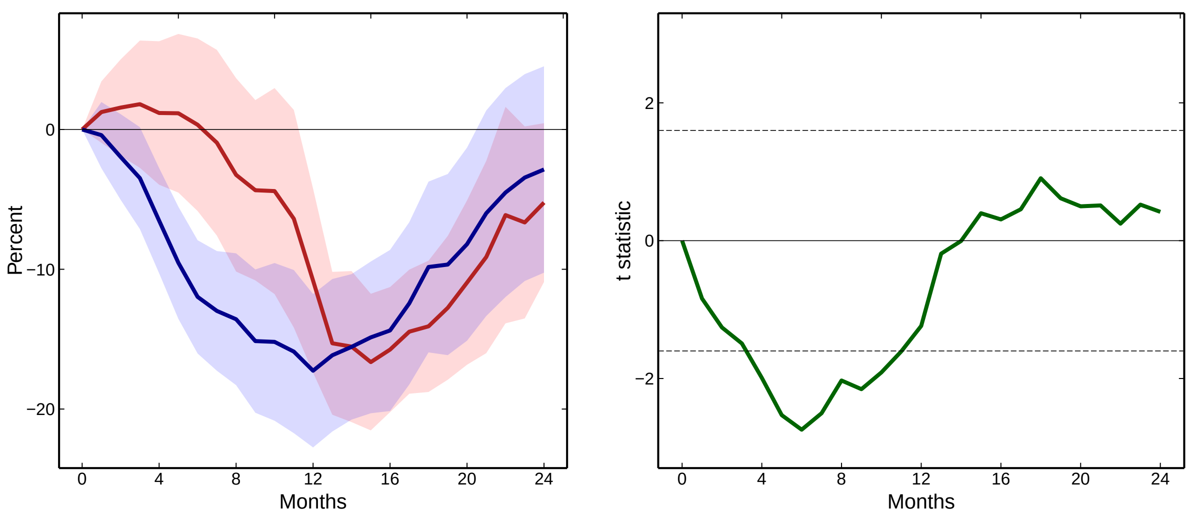
Point-by-point Welch t-test statistic

Figure 4.2: Accumulated response of the (log-difference) Consumer Price Index to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime. Mean Welch test p-value is 0.0618.

To shed light on this result, we explore further the response of the short- and long-run inflation expectations. These are variables that reflect the transmission mechanisms of monetary policy within an inflation targeting regime (Banxico, 2016). Recent estimates point to their important role in explaining inflation dynamics in emerging markets (IMF, 2023). Figure 4.3 shows the NLLP of the 1-month ahead inflation expectations with respect to the monetary policy shock η_t (substituting in (3.4) the INPC long differences).[4] Results suggest that, in the

[4] We note that in this case the response variable is in levels, but by including the first lag as a regressor the NLLP are equivalent to estimating "long differences" (Jordà, 2023). He also warns of the LP analysis based on levels, since many macroeconomic variables have a unit root. This is not the case however. The DF-GLS test statistic for 1-month ahead expectations is -1.83 and the critical value for a 90% level test is -1.61.

low-pressure regime, inflation expectations decrease 4 periods after the monetary shock and by the 12th period reach an accumulated effect of -15 percent. Interestingly, the decrease in inflation expectations reverses in the second year. This is, the effect of the shock is temporary and dissipates after 20 periods. The NLLP for the high-pressure regime, in contrast, suggests that monetary policy cannot influence inflation expectations in the the short run. In fact, the estimates are negative and statistically different from zero only 12 months after the shock. We note that, by then, expectations adjust as much as in the low-pressure regime. In this sense, results from the point-by-point-Welch test suggest that the NLLP are statistically different between periods 4 and 11. Indeed, the mean of the NLLP in each regime is different, as suggested by the 0.0794 p-value of the mean Welch test. As in the case of the low-pressure regime, the effect of the shock reverts to zero at the end of the second year. Overall, these estimates suggest that the central bank requires to maintain interest rates high for a longer period to achieve the same effect on inflation expectations when there is high stress in the global supply chain.



NLLP

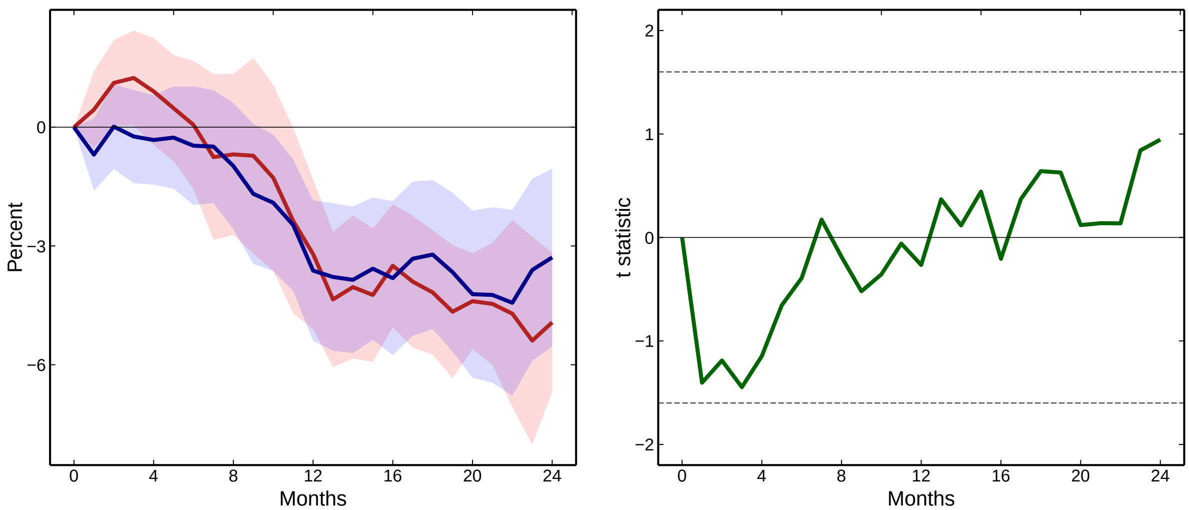
Point-by-point Welch t-test statistic

Figure 4.3: Accumulated response of 1-month ahead inflation expectations to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime. Mean Welch test p-value is 0.0794.

Given that in an inflation targeting regime monetary policy aims to lower inflation expectations also in the long run, we conducted a similar estimation to that presented in Figure 4.3, but using the 12-month ahead inflation expectations. In this case, however, we do not find a difference between the NLLP across regimes. Figure 4.4 displays these results with a p-value of the mean Welch test of 0.9652.[5] After a shock to the monetary policy interest rate, we estimate that

[5] As in the case of the 1-month ahead inflation expectations, the response variable is in levels. We included the

12-month ahead inflation expectations are reduced by 2.4 percent one year later, and by about 4.9 percent two years later. This suggests that the great majority of the effect of an exogenous monetary policy rate increase on 12-month ahead inflation expectations is observed 1 year later. Interestingly, and in contrast with the estimated effect on the 1-month inflation expectations, we are not finding that the effects from the shock revert during the 24-period horizon. This result confirms that monetary policy can influence medium-term inflation expectations, but also that this is independent from changes across regimes of stress in the global supply chain.



NLLP

Point-by-point Welch t-test statistic

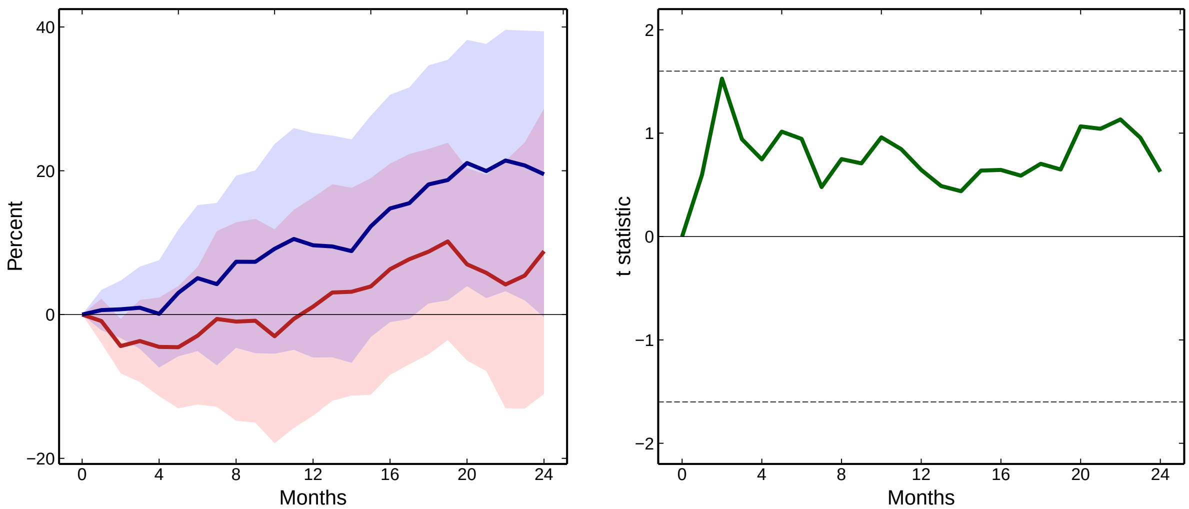
Figure 4.4: Accumulated response of 12-month ahead inflation expectations to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime. Mean Welch test p-value is 0.9652.

Figure 4.5 reports our findings from substituting in (3.4) the long difference of the Consumer Price Index by the Producer Price Index. Results suggest that the response is negative statistically significant only in the high-stress regime 2 months after the shock. The point-by-point and the mean Welch tests (with a 0.0000 p-value) suggest that this response of producer inflation is different across regimes. This result suggests that, in a high-stress regime, the monetary policy seems to have a role in accommodating shocks from the supply side regardless of their characterization as permanent or transitory.

4.2.1. Dissaggregated prices analysis

Now, we explore the different levels of aggregation of the Consumer Price Index. As an overview, here is evidence of considerable heterogeneity in the pricing behavior of firms in Mexico. Ser-

first lag as a regressor and find a DF-GLS test statistic of -1.83, hence we can reject the presence of a unit root at the 90%.



NLLP

Point-by-point Welch t-test statistic

Figure 4.5: Accumulated response of the (log-difference) Producer Price Index to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime. Mean Welch test p-value is 0.0000.

vice prices tend to be more rigid than the average, whereas agricultural product prices change constantly. The frequencies and magnitudes of price changes appear to be stable. However, when inflation is significantly affected by shocks, the frequency of price changes increases, primarily (Ysusi et al., 2010). This motivates the study of the price components dynamics, specially under the stress of global supply chains. Particularly, this permits to fine tune the argument and elaborate on the specific price channels.

As an initial approach, it is important to highlight that inflation in food items and services reacts less to monetary policy changes compared to non-food items, as can be identified when comparing Figures 4.8, 4.9 and 4.7 in both regimes. This finding aligns with existing literature from other countries and is a significant result for Mexico, as this aspect had not been previously studied in detail. The literature primarily explains this phenomenon through the lens of price rigidity. In particular, service prices tend to be more rigid compared to goods prices, leading to a slower pass-through of cost shocks. The variation in price responses can be partially attributed to market power, as more competitive sectors often cannot fully pass on the impacts of monetary policy to prices. However, this dispersion also highlights the presence of different transmission channels within each sector (for the US, see Boivin et al. (2009); for the UK, Mumtaz et al. (2009)). Focusing on the supply side, as is the aim of this work, several factors can explain why some prices respond more quickly than others to changes in monetary policy. First, sectors with more interconnected input-output production networks are particularly sensitive to the monetary policy rate, with shocks propagating more intensely along the supply chain (Luo and Villar, 2023), this could be the case of non-food goods. Second, industries heavily reliant on imports experience less persistent price changes due to increased external competition (Mumtaz et al., 2009), here, exchange rate could gain importance. Finally, financial constraints vary across sectors. For some industries, an increase in interest rates may represent a significant cost shock (Baumeister et al., 2013b; Kumar and Dash, 2020; Luo and Villar, 2023; Aruoba and Drechsel, 2024).

When examining goods prices (4.6), no statistically significant difference is observed between high-stress and low-stress regimes (in the long difference of this variable). However, a look on its interior reveals moderate evidence of differing behavior in non-food goods between regimes (Figure 4.7). In particular, non-food prices are less responsive in the high stress regime by, approximately, 8 basis points 7 months after the monetary policy interest rate shock and by (non-statistically significant) 10 basis points 12 months after the same shock. A plausible explanation is that non-food goods are largely durable products. These goods undergo more intensive transformation processes involving natural resources and capital intensive processes, making them more exposed to intermediate goods markets and, in consequence, to preassures on global supply chains. When considering international links, the exchange rate could gain relevance, as in periods of uncertainty it can depreciate substantially and affect price formation, specially for import intensive sectors (for example, in the automotive or computer equipment sectors). In contrast, there is no statistical difference in the behaviour of food items (Figure 4.8), this could highlight the domestic nature of food items industry (it is important to highlight that this foods items, included in the core inflation component, are different of that included in the agriculture and livestock industry).

About the services prices response, illustrated in Figure 4.9, it also show differentiated behavior between regimes. This can be attributed to their limited ability to pass through cost shocks to prices, reflecting the nature of supply chain stress. Service prices adjust more slowly due to their inherent rigidity, which impacts the overall transmission of supply chain disruptions to final prices. A monetary policy interest rate shock is less effective on services prices by 3 basis point 7 months after. Nevertheless, the difference between regimes is reduced to 1 basis points 12 months after the shock.

Third, non-core inflation, the most volatile component of inflation, also exhibits differentiated behavior between regimes (Figure 4.10). By itself, these impulse responses are relevant in the lense that it is believed that monetary policy does not have a relevant effect of non-core component, nevertheless, this empirical method finds otherwise. For this, it is needed a more extensive analysis. About the differentiated responses, it may stem from supply chain pressures linked to transportation costs (such as gasoline) or other energy inputs that affect the production of intermediate goods in global supply chains. The energy costs shocks of these inputs can lead

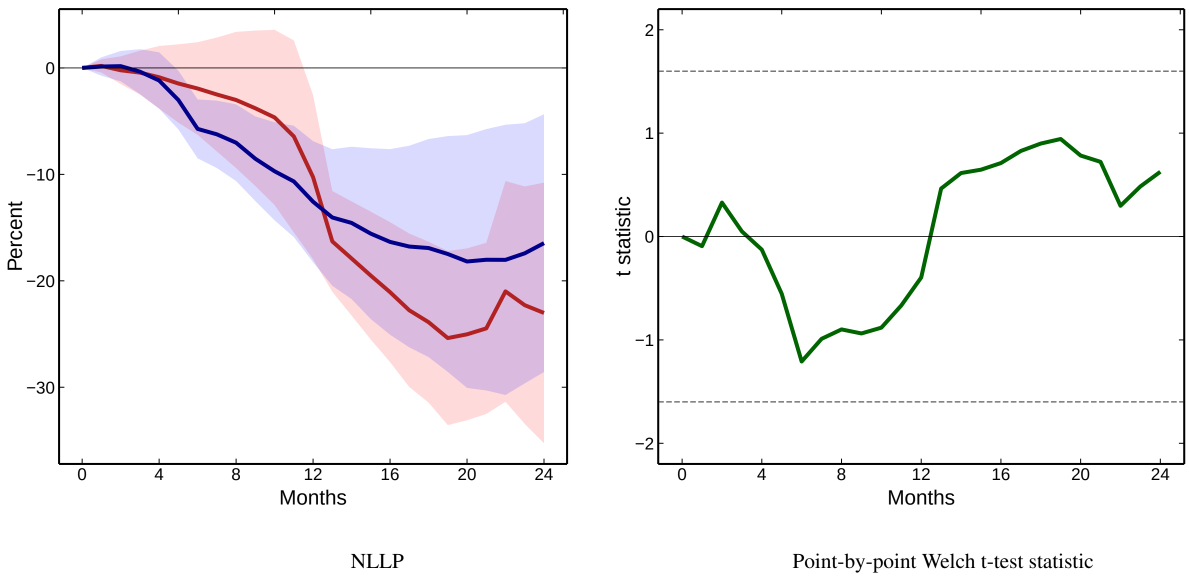
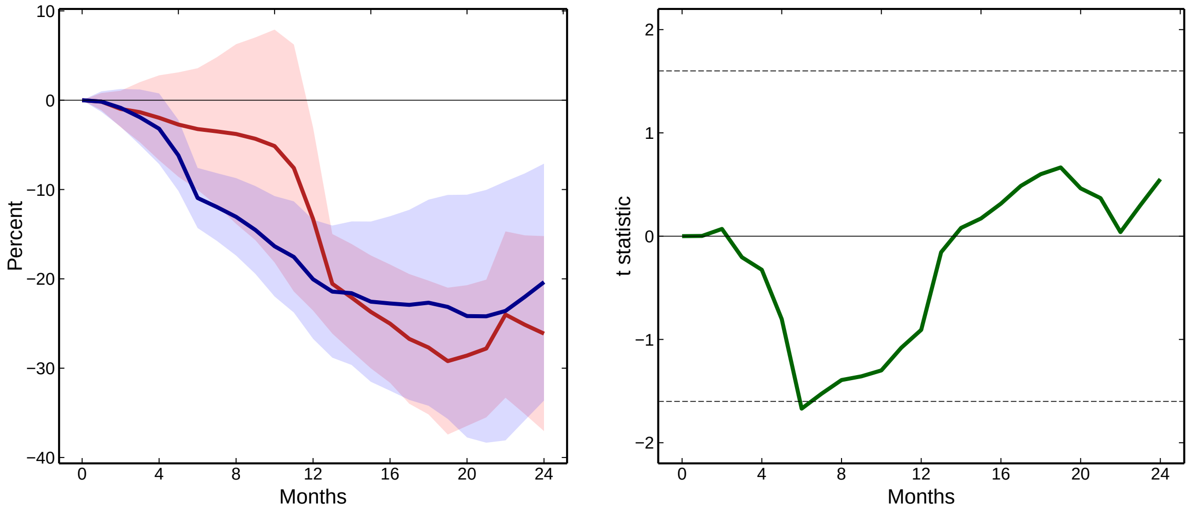


Figure 4.6: Accumulated response of the (log-difference) Goods Prices to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime.

to significant variations in non-core inflation. Frequently, these energy prices are determined internationally, so, in the scenario of a global shock, the monetary policy rate of a small open economy losses influence. This component shows an statistically different response between month 5 and 6, and between month 10 and 11. The response is different by 10 to 13 basis points in these months.

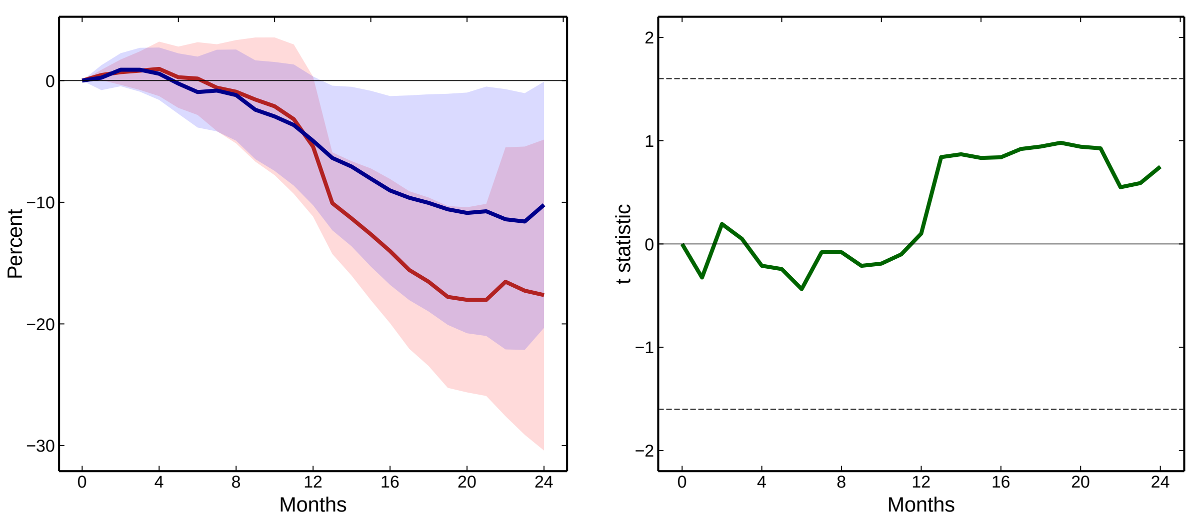
Finally, it is interesting to note that the specific shape of the impulse response functions of inflation components and expectations under the high-stress regime could be attributed to the prolonged duration of global supply chain pressures periods. When the long shock eventually dissipates, monetary policy begins to operate again with the effectiveness typical of a low-stress regime. This transition highlights the temporal nature of the supply chain disruptions and their impact on the efficacy of monetary policy interventions.



NLLP

Point-by-point Welch t-test statistic

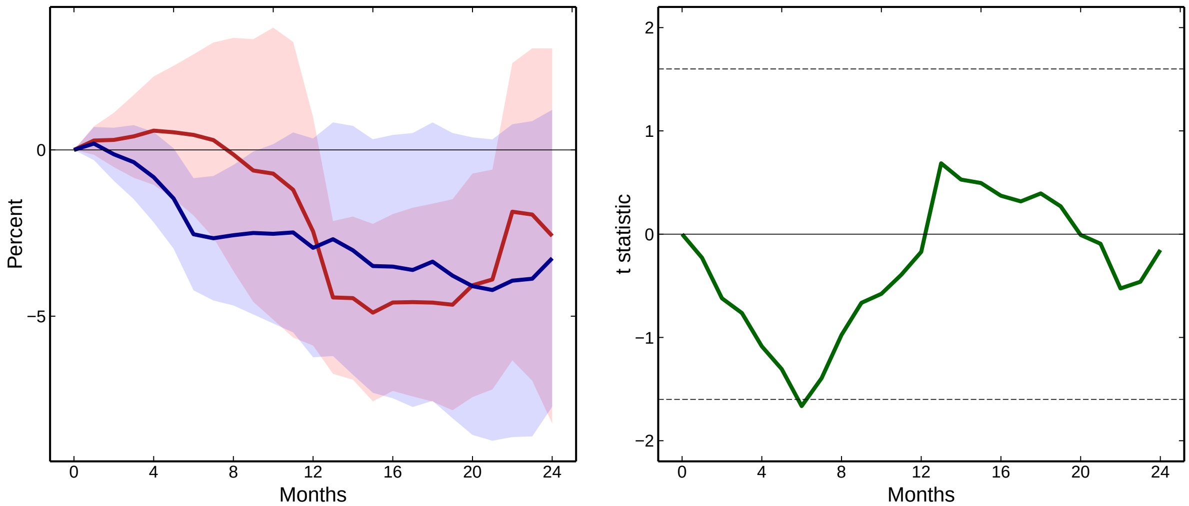
Figure 4.7: Accumulated response of the (log-difference) Non-food Prices to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime.



NLLP

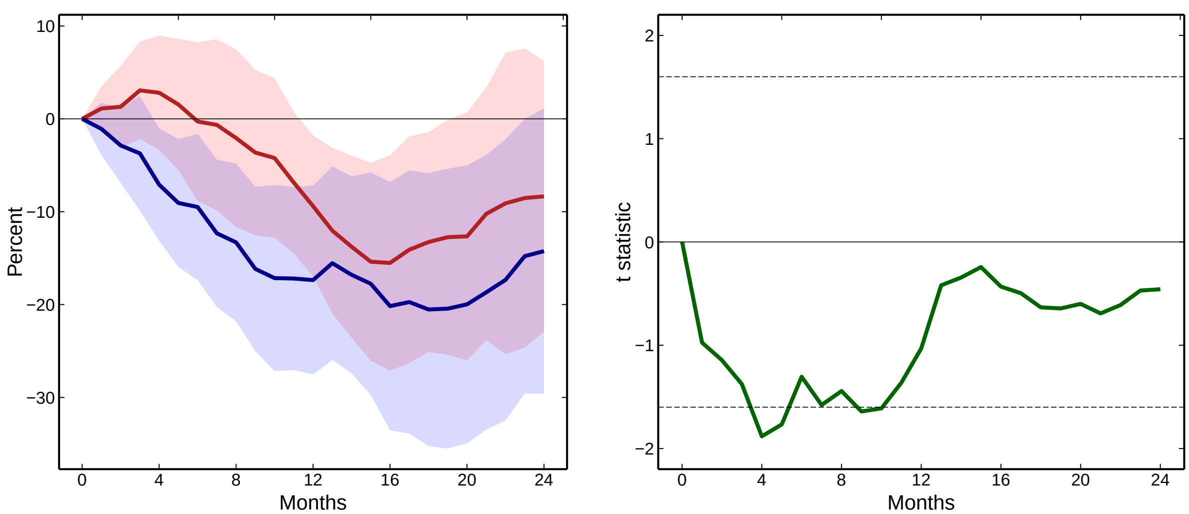
Point-by-point Welch t-test statistic

Figure 4.8: Accumulated response of the (log-difference) Food Prices to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime.



NLLP Point-by-point Welch t-test statistic

Figure 4.9: Accumulated response of the (log-difference) Services Prices to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime.



NLLP Point-by-point Welch t-test statistic

Figure 4.10: Accumulated response of the (log-difference) Non-core Prices to a shock in monetary policy interest rate (90% confidence intervals). Red: high-stress regime. Blue: low-stress regime.

5. Policy Implications and Concluding Remarks

The findings in this shed light on the diminished effectiveness of monetary policy in influencing consumer price inflation during periods of heightened stress in the global supply chain. Our results reveal a notable absence of response in consumer price inflation to an interest rate shock within the initial 12 months under conditions of high supply chain stress. In stark contrast, within low-stress environments, we estimate a relatively swifter and anticipated negative reaction of prices to an increase in interest rates.

To rationalize why, the non-linear local projections analysis shows that in the high stress on the global supply chain regime there are smaller downward effects on 1-month ahead inflation expectations when interest rates rise. Moreover, the monetary policy shock reduces the 12-month inflation expectations in both regimes, but with some delay in the high-pressure regime. These results indicate a diminished absolute effectiveness of monetary policy, as well as longer delay before a policy shock leads to lower inflation. Additionally, dissagregated prices analysis suggest the relevance of intermediate goods and exchange rate shocks in price formation of non-food goods in global supply chains stress scenario. Also, highlights the rigidity of services prices and cost pass through.

Interestingly, while pressures originated in prices of intermediate goods (that are mainly determined in the international markets) are outside the influence of the central bank in Mexico, our results suggest there seems to be a role for monetary policy in a small open economy in its goal of stabilizing consumer price inflation. This contrasts with previous findings where, if the shocks are believed to be initiated on the supply side and short-lived, changes in the monetary policy stance may be counter-productive. In sum, the findings also challenge the belief that monetary policy has limited influence on non-core inflation, in which more analysis is needed.

Overall, our analysis suggests that pressures in the supply chain translate into an additional obstacle for central banks in achieving their inflation target, since influencing the consumer price level will take longer and may require a tighter monetary policy stance. All results are, of course, subject to some caveats. Among these is, first, that the post-2020 period is still recent at the time of writing. This reduces the ability of any model to determine whether the shocks are long- or short-lived. Second, while miss-specification is a lesser problem for local projections with respect to VAR models, controls for trends in the global manufacturing sector may be important. Third, while Mexico presents several features common across emerging market economies, some idiosyncrasies (e.g. high integration with the US economy and proximity) are present.

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Appendix

Variable	Source
Trigger	
Global Supply Chain Pressure Index	Federal Reserve Bank of New York
US	
Shadow Federal Funds Rate	Federal Reserve Bank of Atlanta
Producer Price Index SA	Federal Reserve
1-year ahead inflation expectations	Federal Reserve
Consumer Price Index SA	Federal Reserve
10-year yield on US Treasuries	Federal Reserve
Mexico	
Consumer Price Index (*INPC*) SA	INEGI
Economic Activity Index (*IGAE*) SA	INEGI
Producer Price Index (*INPP*) SA	INEGI
1-month interbank interest rate (*TIIE*)	Banco de México
1-month ahead inflation expectations	Banco de México
12-month ahead inflation expectations	Banco de México
Peso-US Dollar Nominal Exchange Rate	Banco de México
Global variables	
SP500 Implied Volatility (VIX)	CBOE
WTI Crude Oil Prices	US Energy Info. Admin.
G7 Industrial Production Index	OECD

Table 6.1: Model variables (monthly data) and sources. Notes: The Federal Reserve Bank of Atlanta stopped updating the series after February of 2022. We completed the series with the observed values of the Federal Funds Rate from then on. All expectations refer to consumer price inflation expectations. SA stands for seasonally-adjusted.

Dependent variable: Δr_t

	Inflation (response) in the second stage			
	Consumer	1-month	12-month	Producer
First stage estimate: $\widehat{\psi}$	0.1251	0.1255	0.1357	0.1251
Standard Error	0.0600	0.0610	0.0618	0.0600
t-statistic	2.0838	2.0572	2.1954	2.0838
(p-value)	(0.0384)	(0.0409)	(0.0293)	(0.0384)
F-test	5.5718	5.3852	4.8890	5.5718
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 6.2: Instrumental variable first stage regression results.