EVOLVING SPILLOVERS OF U.S. MONETARY POLICY TO EMERGING MARKETS

A Master's Thesis

by
NİDA AKTAŞ

Department of
Economics
İhsan Doğramacı Bilkent University
Ankara
September 2025

To Doğu

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The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

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NİDA AKTAŞ

In Partial Fulfillment of the Requirements for the Degree of
MASTER OF ARTS IN ECONOMICS

THE DEPARTMENT OF
ECONOMICS
İHSAN DOĞRAMACI BİLKENT UNIVERSITY
ANKARA

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By Nida Aktaş

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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Burçin Kısacıkoğlu
Advisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

_____

Özlem Kına
Examining Committee Member

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

_____

Emre Ekinci
Examining Committee Member

Approval of the Graduate School of Economics and Social Sciences

_____

Refet S. Gürkaynak
Director

ABSTRACT

EVOLVING SPILLOVERS OF U.S. MONETARY POLICY TO EMERGING MARKETS

Aktaş, Nida

M.A., Department of Economics

Supervisor: Asst. Prof. Burçin Kısacıkoğlu

September 2025

This study investigates how the spillover effects of U.S. monetary policy tightenings on emerging markets have evolved over time, specifically examining the changes in the magnitude of these effects. The analysis focuses on the tightening periods of 1994, 2004, 2015, and 2022, utilizing a four-variable Bayesian Vector Autoregression (BVAR) model with stochastic volatility. The findings reveal apparent differences in both the magnitude of the impacts and the dominant channels across time and countries. In particular, exchange rate and real economy responses vary depending on each country's specific periods and structural vulnerabilities. Overall, the results show that the spillover effects of U.S. monetary policy shocks have not weakened uniformly over time; instead, they have differed depending on the nature of the shocks, global financial conditions, and domestic dynamics of the countries.

Keywords: Spillover effects, Emerging markets, Monetary policy tightening, Bayesian vector autoregression, Stochastic volatility

ÖZET

ABD PARA POLİTİKALARININ GELİŞMEKTE OLAN ÜLKELERE YAYILMA ETKİLERİ

Aktaş, Nida
Yüksek Lisans, İktisat Bölümü
Tez Danışmanı: Dr. Öğr. Burçin Kısacıkoğlu

Eylül 2025

Bu çalışma, ABD para politikası sıkılaşmalarının gelişmekte olan ülkeler üzerindeki yayılma etkilerinin zaman içindeki seyrini ve bu etkilerin şiddetindeki değişimleri incelemektedir. 1994, 2004, 2015 ve 2022 sıkılaşma dönemlerini kapsayan analizde, stokastik volatiliteye sahip dört değişkenli bir Bayesyen vektör otoregresyon (BVAR) modeli kullanılmaktadır. Bulgular, aktarımın gücünde ve baskın kanallarında hem zaman hem de ülke bazında belirgin farklılıklar olduğunu göstermektedir. Özellikle döviz kuru ve reel ekonomi tepkilerinin dönemlere ve ülkelerin yapısal kırılganlıklarına göre değiştiği bulunmuştur. Genel olarak sonuçlar, ABD para politikası şoklarının yayılma etkisinin zamanla tek yönlü olarak zayıflamadığını; aksine şokların niteliğine, küresel finansal koşullara ve ülke içi dinamiklere bağlı olarak farklılaştığını ortaya koymaktadır.

Anahtar Kelimeler: Yayılma etkisi, Gelişmekte olan ülkeler, Para politikası sıkılaşması, Bayesyen vektör otoregresyonu, Stokastik volatilite.

ACKNOWLEDGMENTS

I would like to begin my acknowledgements with my esteemed advisor, Burçin Kısacıkoğlu. What began as mentorship during my undergraduate studies evolved into him becoming my advisor in my master's program, and he always gave everything he could. I owe him immense gratitude for his guidance.

I must also thank Eray Yücel, Emin Karagözoğlu, and Hasan Tolga Bölükbaşı countless times to give them the credit they deserve, because my two-year master's journey was extremely challenging, and all three always ensured that I could stay strong mentally. Without them, this path would have been dull and unbearable. By starting with Hüseyin Çağrı Sağlam, I am also grateful to all my department professors as they educated us so well about both the world of economics and the real world. I have always admired their unwavering integrity. I also owe thanks to Refet Gürkaynak; throughout both my undergraduate and master's education, I took on many responsibilities, and the inspiration and encouragement I received from him played a huge role in that.

I extend my deepest thanks to my valuable committee members, Özlem Kına and Emre Ekinci, for sharing their time and constructive feedback with me.

When it comes to my friends, I don't know where to begin or whom to name first, but I must start with my comrades-in-arms Hasan Mirasyedi, Zeynep Başak Eken, and Utku Çam, because I cannot imagine my two-year master's experience without them. During the first year of my master's, I had the opportunity to

spend a lot of time with my dear friend İrem Deşdemir and share the same home, which became one of the most beautiful nuances of my life. Every moment of my master's journey was filled with them, and I am so glad they were there. Speaking of friends, I must also mention Hatice, Berkan, Ecem, Ali, Benan, and Senem. I have spent not only my master's years but all my time with them, and I am grateful for the presence of each and every one of them.

Before moving on to my family, there are two more families I gained at Bilkent, whose existence I always wish to continue: Radio Bilkent and TDP. If I could develop even one good character, the influence of these two families is limitless. I hope these families, which hold such a big place in my heart, will always remain and continue to offer their invaluable opportunities to other young people as well.

I saved my deepest gratitude for last. To my dear brothers Halil Han and Okan, my beloved mother, my cherished family, and my dear second family the Yurtsevers—thank you for your presence in my life. My life's path has always been challenging, and your presence has always made it bearable. In fact, I don't know if I will ever again go through a year as difficult as this past one, and if I managed to make it through in the end, my dear aunts and their children deserve endless credit. And of course, my beloved husband Muhammed and his entire wonderful family, especially Hatice, İnanç, and Nihat trio—thank you for supporting me endlessly in every way.

I want to thank Mir Global Logistics for their support throughout my undergraduate and graduate studies. I would also like to thank Serpil Çevik and Şant Manukyan for their constant encouragement.

Finally, I offer endless gratitude and thanks to my life itself, which, by opening ever more challenging paths, seems determined to turn me into the bravest warrior in the world.

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CHAPTER 1

INTRODUCTION

The saying, “When America sneezes, the rest catch a cold,” illustrates how U.S. monetary policies can have significant effects on many countries around the world. The impact of these policies goes beyond the actual decisions made; even the mere suggestion of a potential policy change can lead to serious consequences, particularly for emerging markets.

Many readers might recall the Taper Tantrum episode in 2013, when the FED Chairman Ben Bernanke mentioned the possibility of slowing the pace of asset purchases (quantitative easing). This comment triggered strong reactions in international markets, leading to a sharp decline in asset prices. As a result, emerging markets faced massive capital outflows and significant depreciations of their local currencies.

Less than a year later, the Governor of the Reserve Bank of India remarked, “The U.S. should worry about the effects of its policies on the rest of the world." (Reuters, 2014). Yet, the factors that the Fed considers when making decisions are more closely related to its economic structure and current economic conditions. Therefore, emerging markets must be aware of their vulnerabilities and take precautions accordingly. Thus, this thesis is motivated by the perspective of an economics student living in a developing country.

The U.S. Federal Reserve (FED), as a central bank with a dual mandate objective, aims at maximum employment and stable prices. When these deviate from the target range, FED intervenes in markets through one of its instruments, the Federal Funds Rate (FFR). Changes in the FFR first impact the value of the dollar against other currencies and subsequently influence borrowing costs, capital flows, asset prices, and real economic activities, among other factors. Therefore, emerging markets, whose operations are dollar-based, are heavily affected by changes in the FFR. The spillover effects of monetary policy tightening periods—periods when the FFR rises—particularly affect emerging markets. This thesis works on this topic and asks whether these spillover effects have strengthened or weakened over time.

Crespo Cuaresma et al. (2019) showed that the spillover effect of tightenings after the Global Financial Crisis (GFC) was weaker than before the GFC. However, their time frame covers 1995–2013 and thus excludes both the tightening period starting in 2015 and the one starting in 2022. The post-COVID tightening period that began in 2022, in particular, has characteristics that set it apart from the previous ones, because the FFR rose much more rapidly compared to other tightening periods, and supply-side effects heavily influenced the shocks experienced during COVID period. Therefore, the situation may diverge from the findings of Crespo Cuaresma et al. (2019).

This thesis explores how the spillover effects of U.S. monetary tightening have evolved over time. Particularly, incorporating the most recent tightening period of 2022 provides a timely response to this question. The organization of the thesis is as follows: it begins with an introduction, followed by a literature review, a section on data and variables, and the methodology. This is followed by the empirical results and robustness checks, and ends with the conclusion section.

CHAPTER 2

RELATED LITERATURE

A large and growing body of literature studies how U.S. monetary policy shocks spill over internationally, with particular attention to emerging markets. A central theme is that these spillovers' magnitude, persistence, and even direction vary substantially over time, across countries, and with the nature of the shocks themselves.

2.1 Time Variation and Globalization Effects

According to early evidence using time-varying parameter models and global VAR frameworks, spillover effects are highly state- and period-dependent. For instance, as a consequence of shifting global financial conditions and policy regimes, spillovers were stronger prior to the Global Financial Crisis (GFC) but weakened thereafter (Crespo Cuaresma et al., 2019). Their research also reveals that globalization has two functions: de jure globalization, or formal openness without robust networks, can make economies more vulnerable to U.S. shocks, whereas de facto globalization, or long-standing, deep trade and financial ties, increases resilience.

Chen and Tillmann (2025) state that spillovers are contingent upon the cyclical state of the U.S. economy. Tightening shocks appear muted during booms but

have strong contractionary effects on a global scale when the U.S. economy is weak. Because the 2022–2023 tightening took place during a period of strong U.S. growth, they categorize it as unusually benign. Additionally, according to Engler et al. (2023), global financial conditions are primarily driven by risk perception rather than trade channels. They are influenced by both monetary policy and U.S. economic news, particularly employment surprises.

2.2 Monetary Policy Transmission Mechanisms

Recent studies have shown significant variation in how monetary policy is transmitted between countries. Covering 33 economies since 1991, Deb et al. (2023) find that tightening shocks have a rapid impact on real activity but only with lags on inflation. This effect is much stronger in economies with tight financial conditions, flexible exchange rates, developed financial systems, and credible policy frameworks.

This heterogeneity is supported by evidence specific to each country. For instance, Eklou (2023) documents that credit channels and exchange rates dominate in Malaysia, with their effectiveness increasing when global monetary conditions tighten and decreasing in high-inflation environments. Similarly, Ugazio and Xin (2024) decompose shocks into pure policy shocks and information shocks, showing that the latter can even stimulate growth if they signal improved U.S. prospects.

In addition, Huertas (2022) reveals a systematic reaction pattern by combining econometric analysis and interviews with EM central bankers: To combat capital flight and currency depreciation, EM central banks usually increase policy rates after U.S. tightening; however, some with managed exchange rates prefer FX interventions over rate hikes.

2.3 High-Frequency Identification and Changing Transmission Post-2022

A new generation of high-frequency datasets improves the identification of monetary policy shocks. Bolhuis et al. (2024) use daily interest rate swap changes around policy announcements for 29 economies (2000–2022) to separate central bank information effects from exogenous shocks, demonstrating that even small open economies' monetary surprises have an international impact.

Using such tools, Barrett and Platzer (2024) indicate that the 2022–23 tightening cycle showed transmission that was significantly weaker than historical norms: approximately one additional rate hike was required to achieve the same effects as before the pandemic, which indicates either reduced shock potency or offsetting global factors.

2.4 Post-Pandemic Inflation, Policy Space, and Financial Stability

The causes of post-pandemic inflation and how they interact with monetary policy are the subject of several studies. While Giannone and Primiceri (2024) contend that demand forces predominated in both the U.S. and the Euro Area, Blanchard and Bernanke (2023) highlight supply-side origins, such as commodity prices and obstacles to supply. These perspectives are reconciled by di Giovanni et al. (2023), which demonstrates how inflation changed from supply shocks in 2020 to demand spikes fueled by energy prices in 2021–2022.

Lastly, it has also been emphasized how important policy space is. While Adrian et al. (2022) caution that extended support created new financial vulnerabilities, including risk migration to less regulated sectors, Bergant and Forbes (2023) demonstrate that countries' responses during the pandemic were determined by pre-existing room for monetary, fiscal, FX, and macroprudential actions.

CHAPTER 3

DATA AND VARIABLES

This thesis, which evaluates the course over time of the United States' spillover effects on emerging markets, has examined Brazil, Chile, India, South Africa, and South Korea. The reason for choosing these countries as representatives stems from both the availability of data for these countries and the fact that each is a developing country sensitive to American monetary policies.

Since the course of the spillover effect over time is to be evaluated, the results of the United States' four different tightening periods have been compared. Following figure reflects the FFR movements from 1990 to 2024 and each FFR hike period represents a monetary tightening period. As it is seen from Figure 3.0.1 (Federal Reserve Bank of St. Louis, 2025), the first is the sudden tightening period in 1994, which took place with a preemptive intention to control inflation. The second is the measured pace tightening in 2004. At that time, the FED raised the rate at each meeting at a quarter-point pace. Third comes the 2015 tightening period. The tightening period that started in 2015 came after seven years in which the policy rate was kept at 0 following the Global Financial Crisis and after abundant quantitative easing. The last tightening period is the rate hike in 2022, which was the fastest to occur. In summary, the four tightening periods between 1990 and 2024 have been considered, and the reason for examining these years is data accessibility.

Figure 3.0.1: U.S. Federal Funds Rate, 1990-2024 (Federal Reserve Bank of St. Louis, 2025).

Changes in the United States' policy rate affect many economic matters in emerging markets, from their local currency to their production. To observe these effects, this thesis examines the changes that occur in the local country's bilateral exchange rate (ER), consumer price index (CPI), and industrial production (IP) in response to the changes in FFR. In this scenario, the FFR reflects changes in American policy as the FED's monetary policy instrument. The first look is at the effect of this shock on the bilateral exchange rate because this variable represents financial and external competitiveness channels, and is the channel most quickly affected. Then comes the consumer price index. The consumer price index is affected both by the exchange rate and by demand contraction, and both of these are again affected by changes in the FFR. Finally, the industrial production variable comes. Each of the issues of borrowing costs, local currency movements, and capital inflows/outflows is influenced by the FFR and constitutes a circumstance that deeply affects a country's industrial production. Therefore, all three variables are extremely sensitive to the FFR, and while the bilateral exchange rate reflects financial effects, industrial production and the consumer price index reflect more of the real effects.

Bringing all of this together, this thesis examines the effects of the FED's FFR decision on the ER, CPI, and IP variables of Brazil, Chile, India, South Africa, and South Korea by using monthly data from 1990 to 2024 and the stochastic

volatility with random inertia method. While the FFR is used in levels, the ER, CPI, and IP data are used in growth form. More detailed information about the data is found in Table 3.1. The method will be explained in detail in the Methodology section.

Table 3.1: Monthly data description

Variable	**Definition**
FFR	Federal Funds Rate of the U.S.; Source: Federal Reserve Bank of St. Louis, 2025.
ER	Exchange rate of the domestic country (domestic currency per U.S. dollar); Source: Investing.com, 2025.
CPI	Consumer Price Index of the domestic country; Source: FRED, 2025.
IP	Industrial production index of the domestic country; Source: FRED, 2025.

Note: FFR, CPI, and IP data are obtained from FRED; exchange rates are from investing.com. FFR is kept in levels; ER, CPI, and IP are used as monthly changes.

CHAPTER 4

METHODOLOGY

This thesis uses the Bayesian vector autoregression with stochastic volatility model to examine the changes in U.S. spillover effects over time and applies the sign restriction method to identify the structural shocks. The Data and Variables section explains that the model includes four variables. Since these variables are collected as monthly data, the system follows the literature and uses 12 lags.

4.1 Vector Autoregression Models (VAR)

Following Christiano et al. (1994) notation, let Z_t is a vector containing four variables: the FFR of the U.S. and the ER, CPI, and IP of the target emerging market. These variables are influenced not only by their own current and past values but also by the current and past values of the other variables in the system. To capture these interactions, the structural vector autoregression model is specified as follows:

$$A_0 Z_t = A_1 Z_{t-1} + \ldots + A_{12} Z_{t-12} + \varepsilon_t. \tag{4.1}$$

where $Z_t = [\,\mathrm{FFR}, \mathrm{ER}, \mathrm{CPI}, \mathrm{IP}\,]'$ is the variable vector, A_0 captures contemporaneous relationships among variables, A_i's capture lagged effects to show how past values affect today and ε_t are the structural shocks which are the true economic shocks (e.g., monetary policy shocks, demand shocks). A stan-

dard assumption is that these shocks are uncorrelated and have variance one: $\varepsilon_t \sim N(0, I)$. However, structural form cannot be estimated directly as ε_t is not observable, but instead, the combined impact $u_t = A_0^{-1}\varepsilon_t$ could be observed. Thus, by multiplying the structural form equation 4.1 with A_0^{-1}, the reduced form VAR is obtained as:

$$Z_t = B_1 Z_{t-1} + \ldots + B_{12} Z_{t-12} + u_t, \tag{4.2}$$

where $B_i = A_0^{-1} A_i$. Now, as $u_t = A_0^{-1}\varepsilon_t$, variance-covariance matrix of u_t is $\Sigma_u = A_0^{-1}\Sigma_\varepsilon (A_0^{-1})'$ and as $\Sigma_\varepsilon = I$, the variance-covariance matrix of u_t becomes $\Sigma_u = A_0^{-1}(A_0^{-1})'$. Now u_t can be easily estimated by ordinary least squares. However, to recover the structural shocks of interest (ε_t), some restrictions must be imposed on A_0 for identification. Thus, the identification problem in this setup is to find a A_0 matrix that satisfies $\Sigma_u = A_0^{-1}(A_0^{-1})'$. This task will be handled with sign restriction method by following the literature (Uhlig, 2005) and the details will be explained in 4.3 Identification section.

Lastly, starting from the reduced-form representation $Z_t = B_1 Z_{t-1} + \ldots + B_{12} Z_{t-12} + u_t$ and applying the same logic to Z_{t-1}, we obtain $Z_{t-1} = B_1 Z_{t-2} + \ldots + B_{12} Z_{t-13} + u_{t-1}$, and so on. Thus, when this recursive method is followed, the Wold Representation is obtained as followed:

$$Z_t = \sum_{h=0}^{11} \Psi_h \, u_{t-h},$$

$$\text{where } \Psi_0 = I_n, \qquad \Psi_h = \sum_{i=0}^{h} B_i \, \Psi_{h-i} \;\; (h = 1, \ldots, 12),$$

$$\text{which can be also written as } \Psi_h = \sum_{i=0}^{h} (A_0^{-1} A_i) \, \Psi_{h-i} \;\; (h = 1, \ldots, 12).$$

Then, if Θ_h is defined as $\Theta_h = \Psi_h A_0^{-1}$, Z_t becomes

$$Z_t = \sum_{h=0}^{11} \Theta_h \varepsilon_{t-h}.$$

The Θ_h matrices give the Impulse Response Functions (IRFs) and column j of Θ_h shows how all variables respond at horizon h to a unit shock in $\varepsilon_{j,t}$. IRFs are the tools this thesis benefited from for the analysis.

4.2 Bayesian Framework

Classical VAR models assume constant parameters and homoscedastic errors, which fail to capture structural breaks, volatility clustering, and regime changes common in U.S. monetary tightening episodes. To address this, a Bayesian VAR with stochastic volatility and random inertia is used. The Bayesian approach treats parameters as random variables and combines prior information with the likelihood via Bayes' rule, producing posterior distributions that incorporate both parameter and model uncertainty.

4.2.1 Stochastic Volatility

In a standard VAR without stochastic volatility, Σ_u is constant across all t, implying homoscedasticity. However, macroeconomic and financial data often exhibit volatility clustering, where periods of relative calm alternate with episodes of heightened uncertainty. To capture this, the variance-covariance matrix is allowed to evolve over time as

$$\Sigma_t = F \Lambda_t F', \tag{4.3}$$

where F is a lower triangular matrix describing contemporaneous relations, and

$$\Lambda_t = \mathrm{diag}(e^{\lambda_{1t}}, \ldots, e^{\lambda_{nt}})$$

contains time-varying volatilities for each variable.

The key difference is that while Σ_u represents a single, constant covariance

matrix for the entire sample, Σ_t changes with t, enabling the model to scale shocks differently across calm and turbulent periods. This time variation comes from the log-volatilities λ_{it}, each of which follows a latent AR(1) process

$$\lambda_{it} = \mu_i + \phi_i(\lambda_{i,t-1} - \mu_i) + \sigma_i \eta_{it}, \qquad \eta_{it} \sim N(0,1), \tag{4.4}$$

so that the conditional variance of shocks evolves smoothly over time rather than being fixed.

4.2.2 Random Inertia

The key refinement is the introduction of random inertia. Standard time-varying parameter models often allow coefficients and volatilities to drift too freely, even in the absence of strong evidence for structural change. Random inertia addresses this by introducing a persistence parameter γ_i into each volatility equation:

$$\lambda_{it} = \gamma_i \lambda_{i,t-1} + (1 - \gamma_i)\mu_i + \sigma_i \eta_{it}. \tag{4.5}$$

When $\gamma_i \approx 1$, volatility changes slowly, reflecting highly persistent dynamics. Lower values of γ_i induce stronger mean reversion toward the long-run mean μ_i, preventing unrealistic parameter drift. This feature ensures the model remains stable in calm periods but adapts rapidly during crises or structural breaks such as U.S. monetary tightening cycles.

4.2.3 Bayesian Estimation

Bayesian inference requires specifying priors for all unknowns. For the VAR coefficients $\beta = \mathrm{vec}(A_1, \ldots, A_p)$, Minnesota-type shrinkage priors center coefficients on persistence for own lags and on zero for cross-variable and longer lags, reflecting parsimony and avoiding overfitting. The contemporaneous matrix F receives independent priors on its off-diagonal elements, with diagonal elements

normalized for identification. For the stochastic volatility parameters $(\mu_i, \phi_i, \sigma_i)$, standard conjugate priors are used: μ_i is normally distributed, ϕ_i is drawn from a transformed Beta ensuring stationarity, and σ_i^2 follows an inverse-gamma prior. The inertia parameters γ_i are assigned Beta priors so that the data determine the appropriate degree of persistence in each volatility process.

Because the posterior distribution of all parameters is not analytically tractable, estimation proceeds using Markov Chain Monte Carlo (MCMC) methods with a block Gibbs sampler. At each iteration, the algorithm sequentially samples:

1. VAR coefficients conditional on volatilities using standard Bayesian regression formulas;
2. Volatility states λ_{it} via simulation smoothers or Metropolis–Hastings steps;
3. Stochastic volatility parameters $(\mu_i, \phi_i, \sigma_i)$ from their conjugate posteriors;
4. Inertia parameters γ_i from Beta conditional posteriors;
5. The contemporaneous matrix F equation-by-equation.

After discarding initial burn-in draws, the remaining posterior samples approximate the joint distribution of all model parameters. These draws are then used to compute impulse responses.

All computations use the BEAR Toolbox (Dieppe et al., 2018), which implements hierarchical priors, stochastic volatility, and random inertia estimation along with IRFs.

4.3 Identification

There are many identification methods in the VAR literature, including zero contemporaneous restrictions, zero long-run restrictions, and sign restrictions.

The choice of identification method strongly depends on the research question. This thesis focuses on whether the magnitude of the spillover effects of U.S. monetary tightening on emerging markets strengthens or weakens over time, rather than on what kinds of effects U.S. monetary tightening has on emerging markets. The latter question has been extensively studied in the literature and already has widely accepted answers. As Calvo et al. (1993), Eichengreen & Gupta (2015), and Iacoviello & Navarro (2019) have shown, U.S. monetary tightening episodes typically lead to exchange rate depreciation, falling output, and declining prices in emerging markets, and the directional effects are well-established in the literature. Therefore, the objective of this study is not to re-identify the direction of responses but rather to examine how their magnitude has evolved over time. This thesis, following Uhlig (2005), thus imposes sign restrictions consistent with economic theory.

In line with theory, this study assumes that an increase in the FFR appreciates the value of the dollar and causes the currencies of emerging markets to depreciate against it. Since the ER variable is expressed as domestic currency per dollar, an increase in the FFR raises the dollar's value in terms of the domestic currency, so the sign of this variable is "+." Following the ER variable, model has CPI and IP. Because an increase in the FFR has a slowdown effect on both output and prices globally, the signs for these two variables are "–." The sign restrictions are shown in the following table.

Table 4.1: Sign restrictions of baseline model

Variable	**FFR**	**ER**	**CPI**	**IP**
FFR	+			
ER	+	+		
CPI	-	+	+	
IP	-			+

Note: "+" ("–") denotes a positive (negative) response; empty cells are unrestricted.

CHAPTER 5

EMPIRICAL RESULTS

In this section, the IRFs for Brazil, Chile, India, South Africa, and South Korea will be examined by using the stochastic volatility with random inertia technique around the 1994, 2004, 2015, and 2022 tightening periods. The question of how U.S. spillover effects have evolved over time will be answered for each country individually. For each country, data from 1990 to 2024 have been collected, and the periods 1990–1998 for the 1994 tightening, 1999–2006 for the 2004 tightening, 2009–2017 for the 2015 tightening, and 2018–2024 for the 2022 tightening have been utilized. The IRFs are drawn in response to a 25 basis points FFR increase.

Before passing to countries, in the light of Methodology chapter, Z_t could be thought of as

$$Z_t = B_1 Z_{t-1} + \ldots + B_{12} Z_{t-12} + A_0^{-1} \varepsilon_t, \tag{5.1}$$

and suppose the IRFs of eq. 5.1 will be calculated. When a 25 bps FFR increase is introduced to the system, the same standardized disturbance/shock (the S vector) is applied to all countries, as shown below:

$$Z_t = B_1 Z_{t-1} + \ldots + B_{12} Z_{t-12} + A_0^{-1} S$$

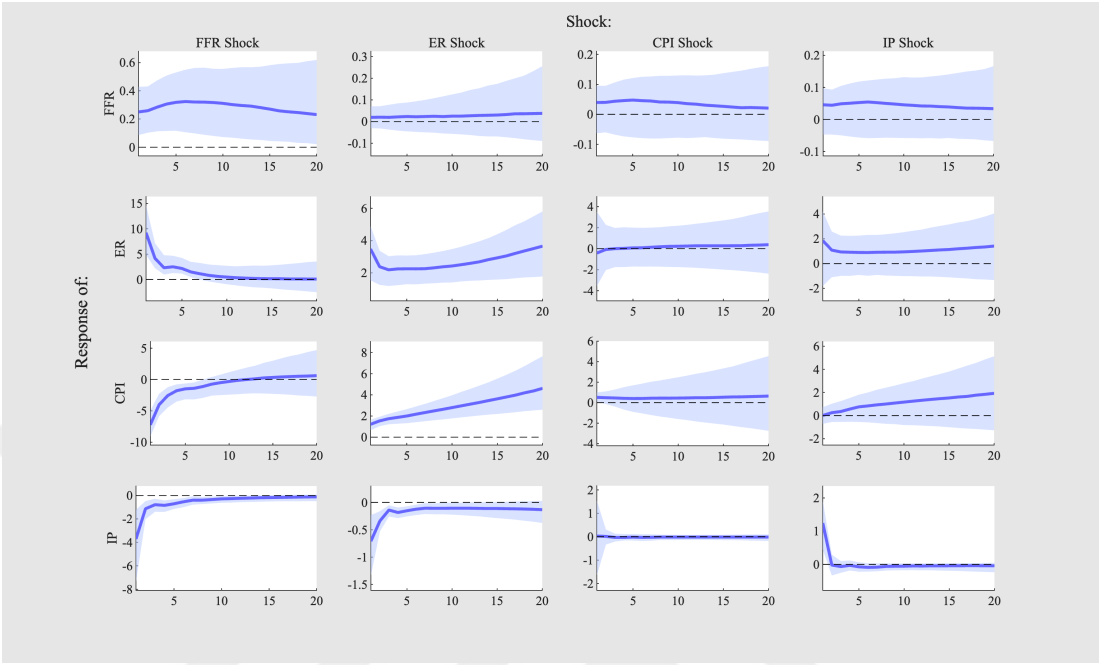
However, the way this shock is transmitted depends on B_i matrix in the VAR

system. After the initial shock, the propagation of responses is governed by the VAR dynamics, summarized in B_i. This matrix determines how shocks will feedback into the system over time. Because macroeconomic structures, persistence, and cross-variable linkages differ by country and by episode, each country's and each episode's B_i matrix is unique. As a result, the shape and persistence of the FFR IRF differ across countries and periods, even though the same type of shock has been applied.

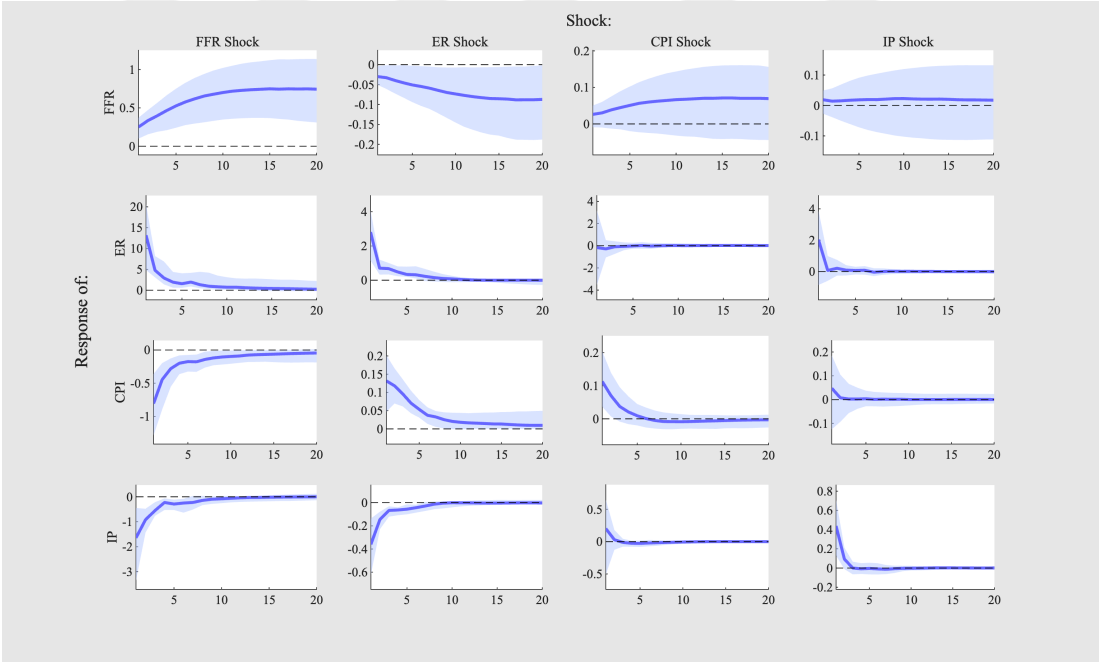
Thus, even with the same definition of a "25 bps FFR shock," the FFR IRFs are naturally not identical across countries. This reflects differences in the autoregressive dynamics (through B_i).

5.1 Brazil

In Brazil, the responses to a normalized 25 bps U.S. monetary tightening show strong but time-varying spillovers that closely track the country's structural breaks. At the height of the Tequila Crisis and the Real Plan transition in 1994, a 25 bps shock caused a significant devaluation of the real (above 10 percent), significant disinflation, and a contraction in industrial production around 5 percent, highlighting Brazil's extreme vulnerability at the time. In contrast, the effects are more limited in 2004 under the inflation-targeting regime and with stronger macroeconomic institutions. The exchange rate still depreciates by about 10–15 percent, but the impact on output and prices is less severe and less persistent. The 2015 liftoff period presents a different picture. When rescaled to 25 basis points, the responses seem large, with output falling by almost 4 percent and the real depreciating by over 10 percent. However, this is primarily due to the Fed's actual increments being so small, which resulted in a low estimated standard deviation of shocks. The results should be interpreted as the hypothetical effects of a 25 bps tightening under those circumstances rather than what actually occurred in 2015, as normalization magnifies the responses. The 2022 episode provides the opposite caveat. Although the normalized responses indicate a moderate depreciation, mild disinflation, and a 2 percent contraction in output, the true effects were probably more pronounced because actual Fed hikes frequently exceeded 25 basis points. These trends collectively demonstrate that Brazil has been continuously exposed to U.S. monetary tightening. However, the extent and duration of spillovers have been influenced by both domestic regime changes and international circumstances, ranging from the Real Plan through the implementation of inflation targeting to the post-COVID era.

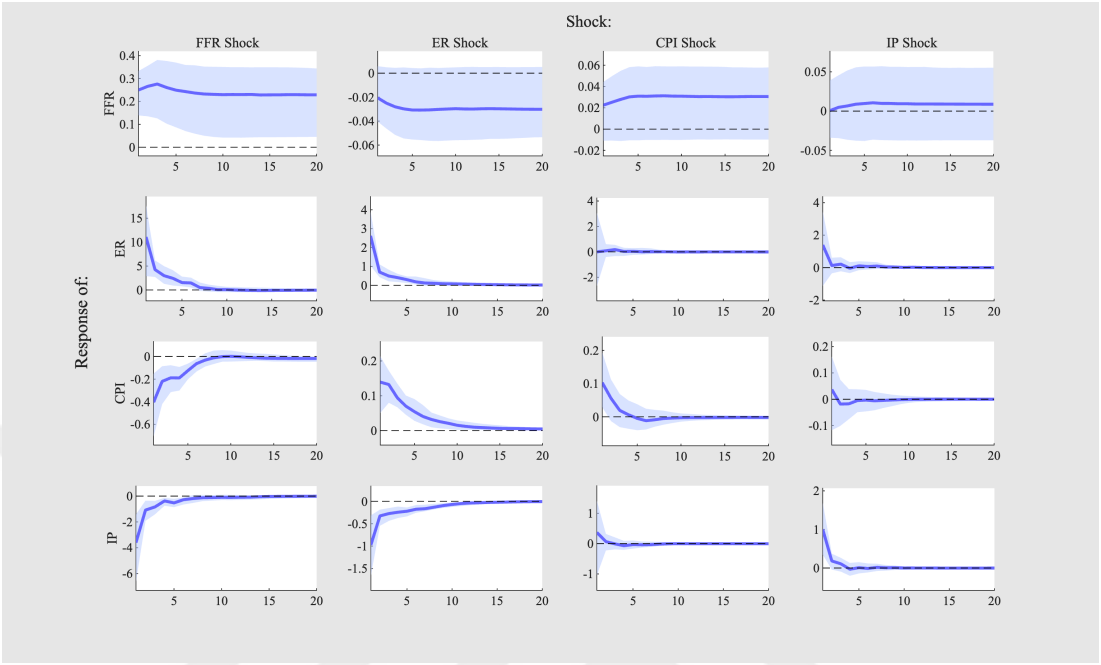


(a) 1994 tightening episode

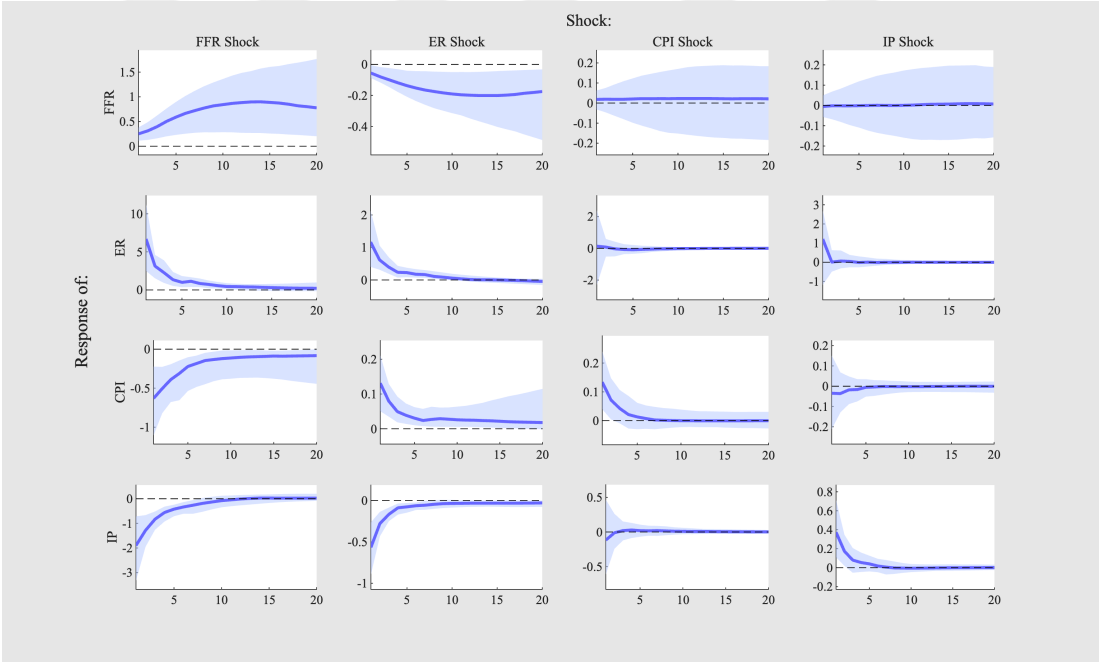


(b) 2004 tightening episode

Figure 5.1.1: Impulse responses for Brazil: 1994 and 2004 tightening episodes.



(a) 2015 tightening episode

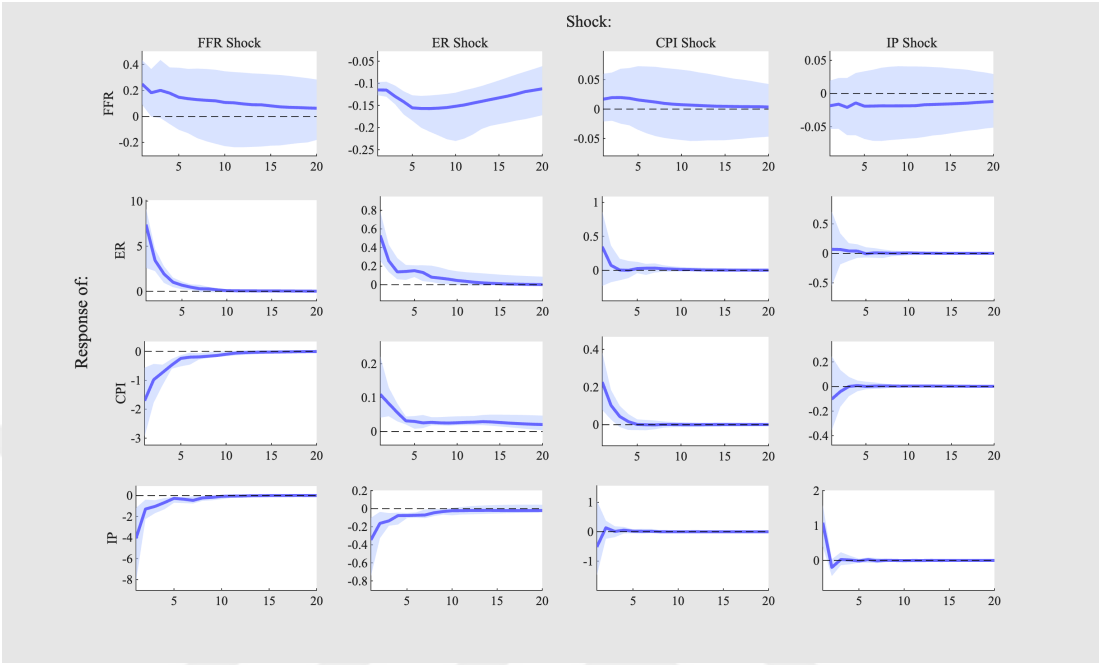


(b) 2022 tightening episode

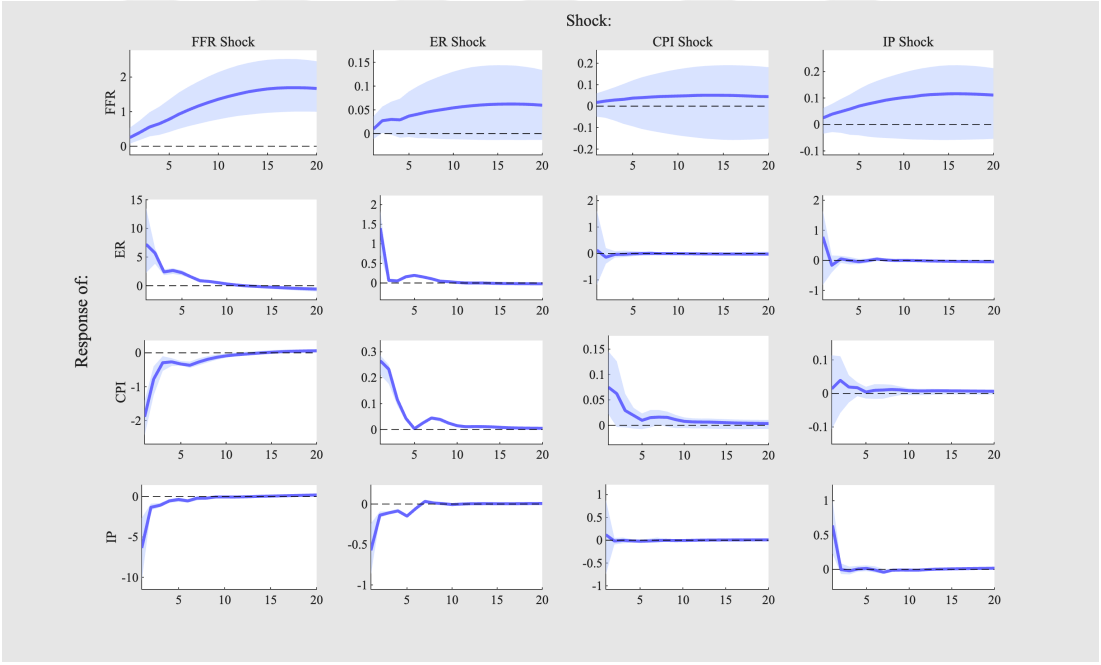
Figure 5.1.2: Impulse responses for Brazil: 2015 and 2022 tightening episodes.

5.2 Chile

Although their strength varies from episode to episode, Chile's impulse responses to a normalized 25 basis point U.S. monetary tightening demonstrate significant and persistent spillovers. In 1994, Chile's sensitivity to external shocks during its ongoing financial liberalization is reflected in the peso's roughly 7 percent depreciation, consumer prices' nearly 2 percent decline, and industrial production's nearly 4 percent decline. The pattern is still the same in 2004, even with stronger institutions under the inflation-targeting framework: output falls more sharply, by almost 6 percent, the peso loses about 7 percent, and the CPI declines modestly, by about 1-2 percent. Similar dynamics can be seen in the 2015 liftoff, with the exchange rate declining by about 7 percent, the CPI falling by about 1-2 percent, and output contracting by about 4 percent. However, these effects are amplified by the normalization process because the Fed's actual increases were modest and volatility was low, so the IRFs represent a counterfactual 25 bps hike under calm conditions rather than actual historical impacts. When the Fed took an aggressive post-COVID stance in 2022, Chile's external responses became more noticeable, with the peso depreciating by roughly 15 percent, the CPI falling by only about 1 percent, and output contracting by about 3 percent. These findings imply that Chile's economy has been continuously exposed to U.S. monetary tightening, with the exchange rate channel being powerful. However, the magnitude of the output and disinflationary effects has not varied as the exchange rate channel.

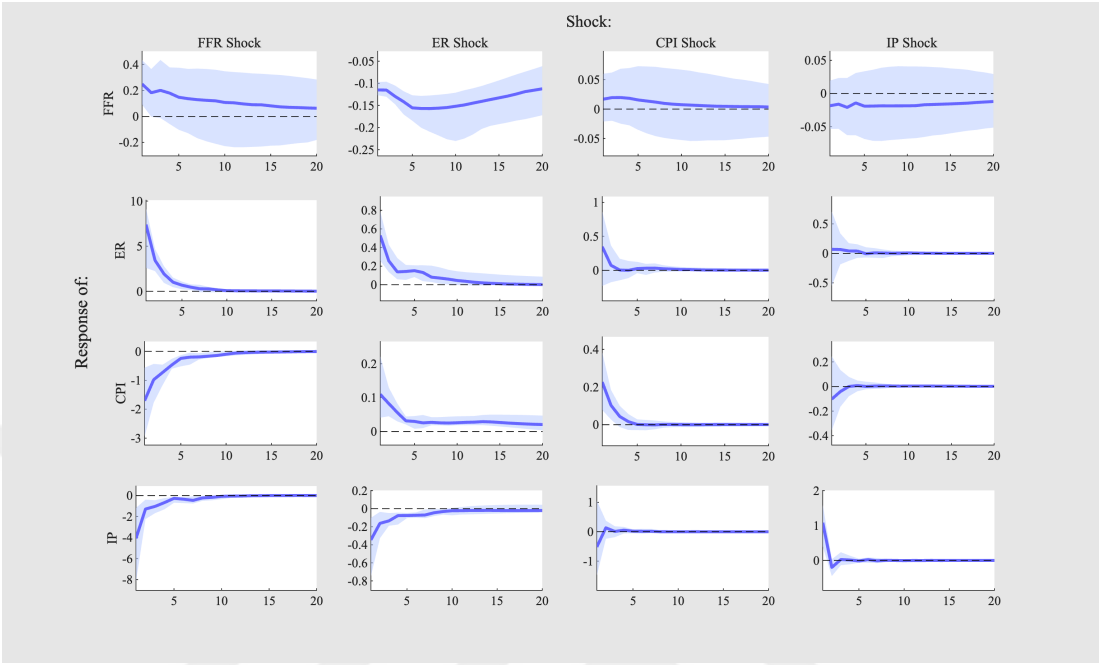


(a) 1994 tightening episode

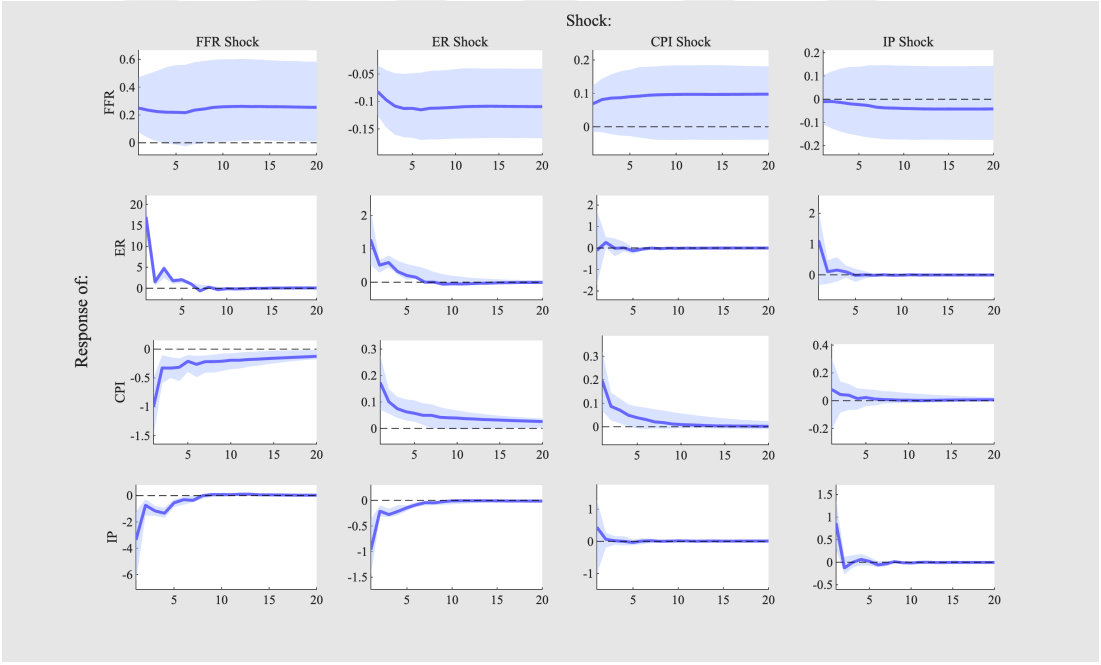


(b) 2004 tightening episode

Figure 5.2.1: Impulse responses for Chile: 1994 and 2004 tightening episodes.



(a) 2015 tightening episode

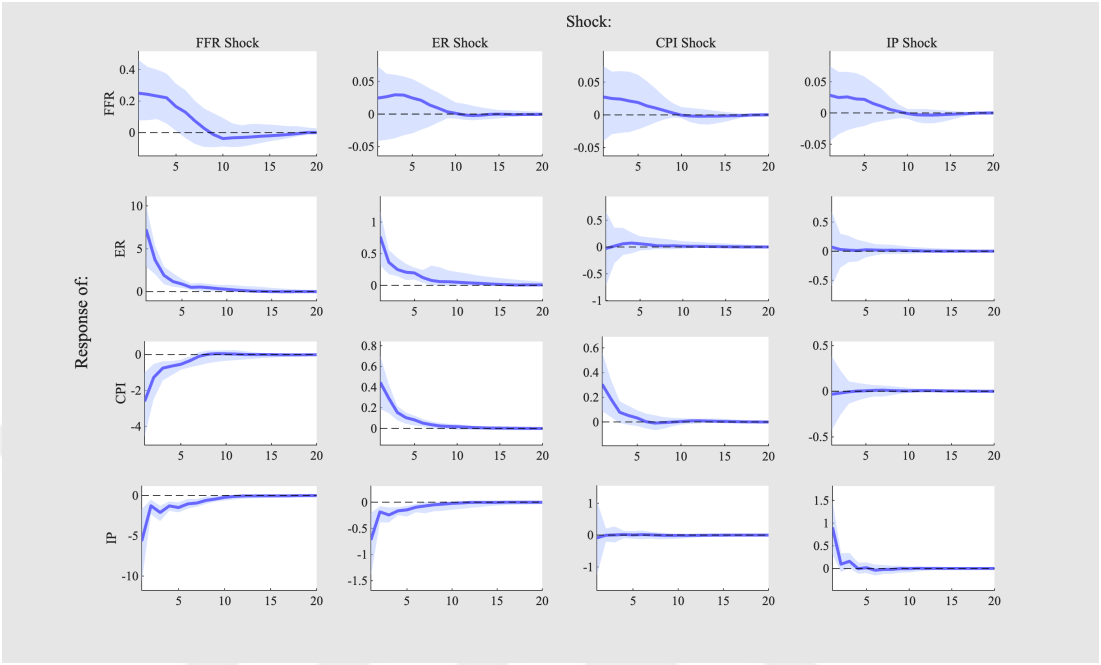


(b) 2022 tightening episode

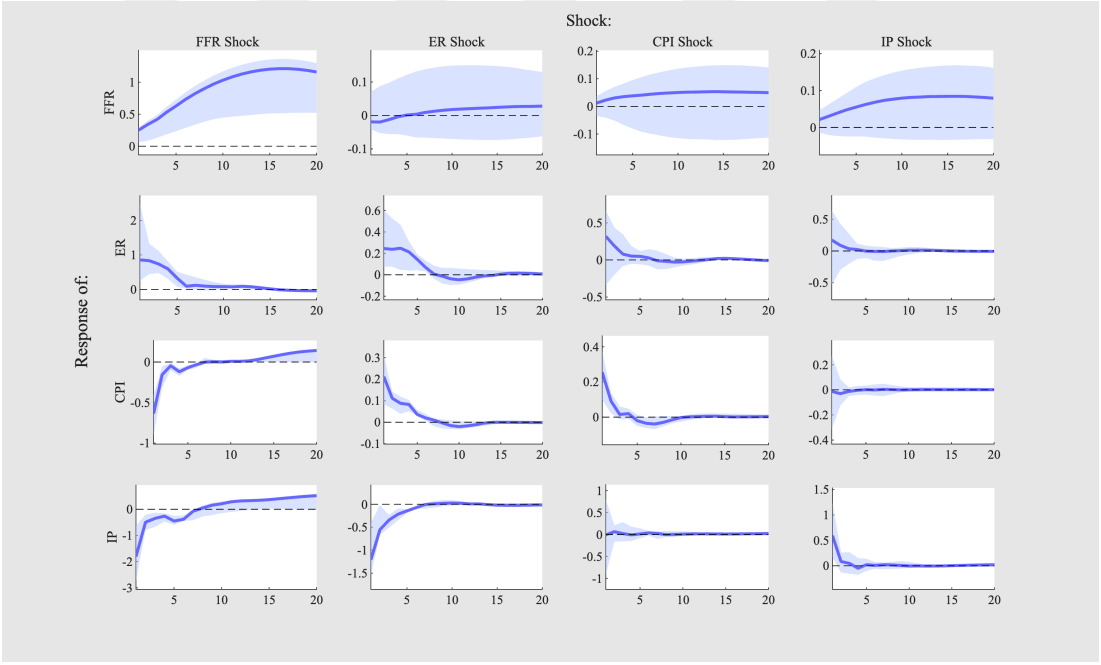
Figure 5.2.2: Impulse responses for Chile: 2015 and 2022 tightening episodes.

5.3 India

Both domestic circumstances and the normalization process are reflected in the notable variation in India's responses to a normalized 25 basis point U.S. tightening across episodes. The rupee depreciates by roughly 7 percent, the CPI drops by about 2 percent, and industrial production contracts by 5 percent in 1994, during continuous liberalization and the aftermath of external crises. These events underscore India's external vulnerabilities during the early reform era. By 2004, the spillover effects had significantly diminished: output declined by only 1-2 percent, the CPI fell by approximately half a percent, and the exchange rate weakened by around 1 percent. These trends align with a period characterized by stronger growth and increased capital inflows. However, the normalized effects of the 2015 liftoff episode are incredibly large: output contracts by an astounding 20 percent, the CPI drops by 7 percent, and the rupee depreciates by 15 percent. The very low volatility of U.S. rate movements in 2015 is the reason for these magnitudes, which do not accurately reflect what actually occurred. India's responses are mechanically amplified once they are rescaled to a hypothetical 25 bps shock. The normalized IRFs show how vulnerable India would have been in the event of a standard-sized tightening under those circumstances, even though the actual historical effects were probably more minor. The rupee only depreciates by about 2 percent, the CPI declines by about 1 percent, and output declines by about 5 percent in 2022 due to the Fed's aggressive rate-hiking. These figures are moderate in comparison to 2015, but they probably underestimate the true impact because actual Fed hikes were greater than the 25 basis points. Overall, India's experience shows how sensitive its economy is to U.S. policy shocks and how crucial it is to interpret normalized responses carefully, especially during times of abnormally high or low global volatility.

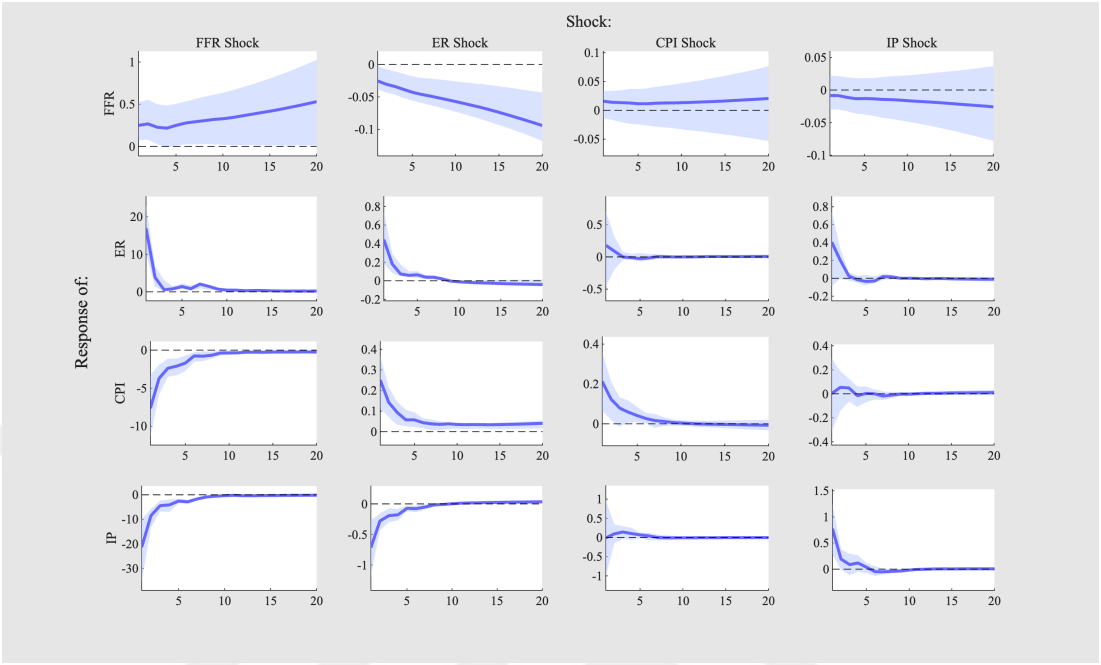


(a) 1994 tightening episode

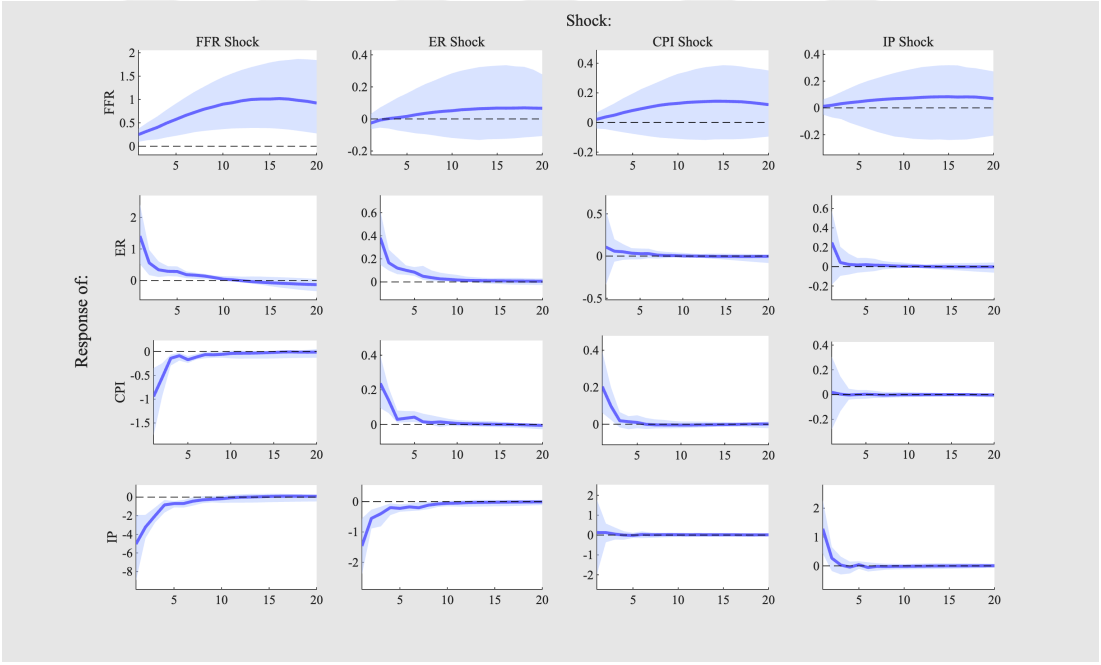


(b) 2004 tightening episode

Figure 5.3.1: Impulse responses for India: 1994 and 2004 tightening episodes.



(a) 2015 tightening episode

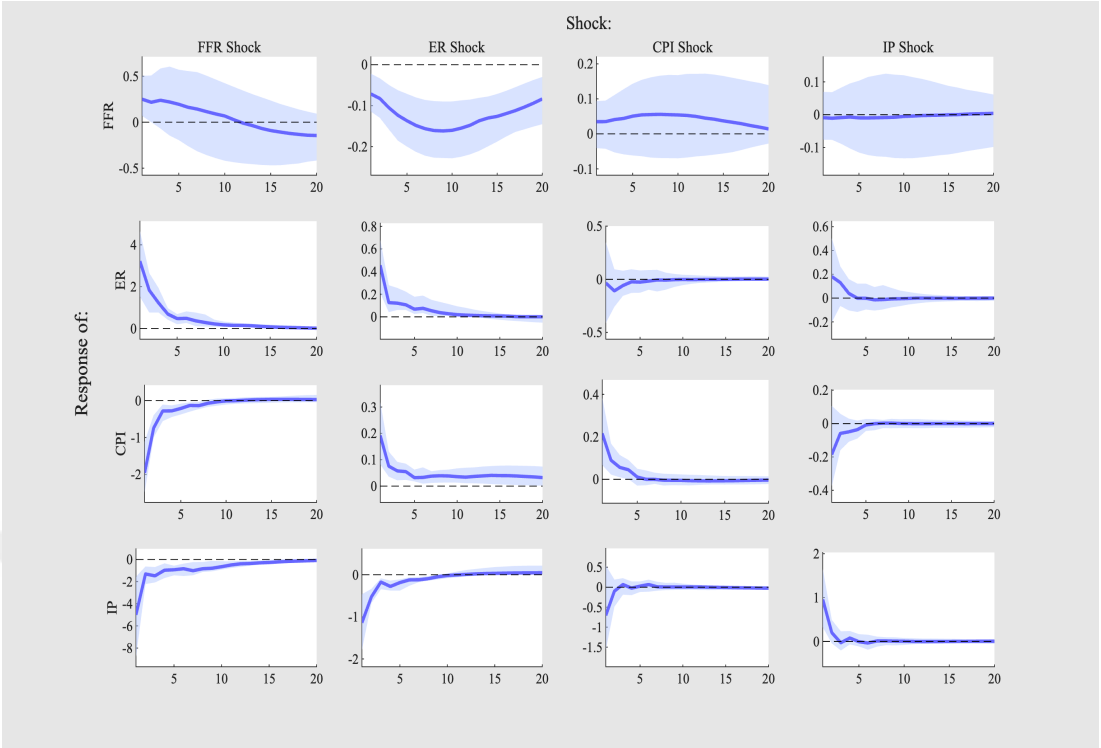


(b) 2022 tightening episode

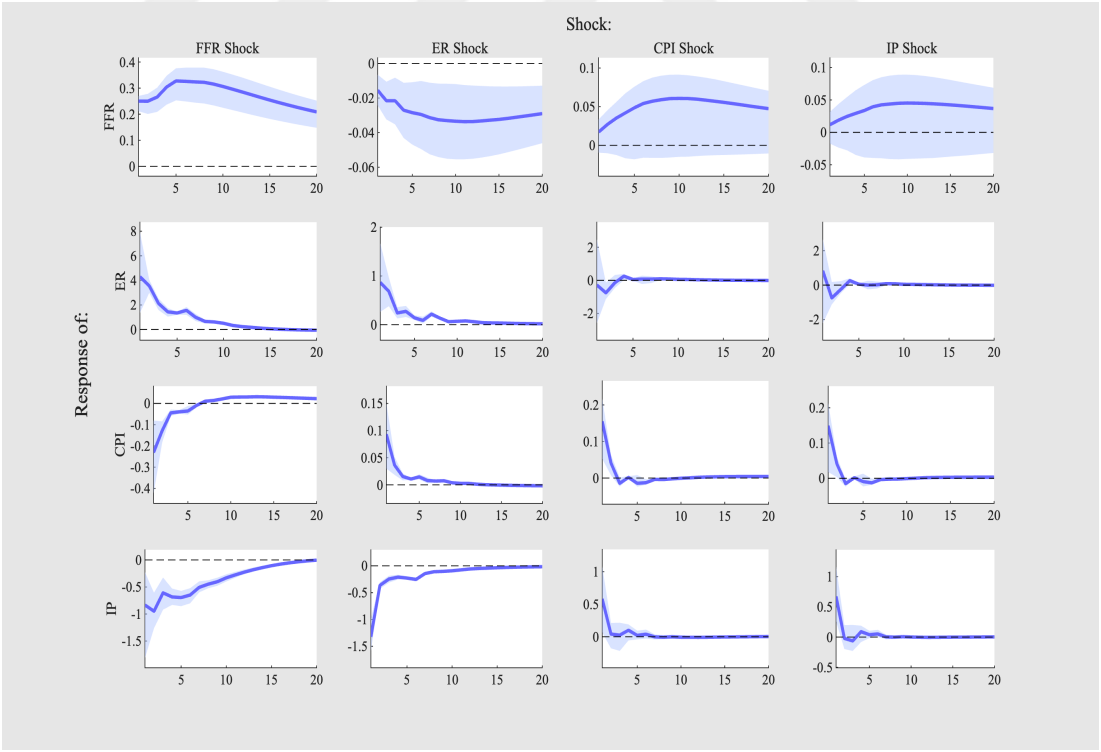
Figure 5.3.2: Impulse responses for India: 2015 and 2022 tightening episodes.

5.4 South Africa

The normalized 25 bps responses for South Africa show persistent vulnerabilities, albeit differing magnitudes depending on the tightening episode. A 25 bps U.S. shock in 1994, during a time of political instability and fragile macroeconomic foundations, causes the rand to depreciate by roughly 3–4 percent, the CPI to drop by about 2 percent, and the output to contract by more than 4 percent, highlighting the economy's extreme sensitivity at the time. By 2004, the effects were less severe due to more stable institutions and a supportive global environment: industrial production fell by about 1 percent, consumer prices only slightly decreased (by about 0.2 percent), and the rand weakened by about 4 percent. However, once normalized, the 2015 liftoff yields abnormally large responses, with output contracting by as much as 10 percent, the CPI dropping by 3 percent, and the exchange rate depreciating by over 20 percent. Since the standard deviation of shocks was low and U.S. rate increments were small, these magnitudes should not be interpreted literally but rather as a mechanical consequence of scaling. The IRFs thus show the hypothetical impact of a full 25 bps tightening on South Africa under those circumstances. The rand depreciates by 6 percent in 2022, the CPI declines by about 1 percent, and output declines by about 5–6 percent due to the Fed's aggressive tightening following COVID-19. However, the actual historical effects were probably greater than those depicted in the normalized responses, as actual hikes in the majority of meetings exceeded 25 basis points. When combined, these findings show that South Africa has continuously experienced significant output and exchange rate spillovers from U.S. monetary shocks, with the apparent magnitude of effects in individual episodes influenced by both domestic fragilities and the process of normalization used for changes in U.S. policy.

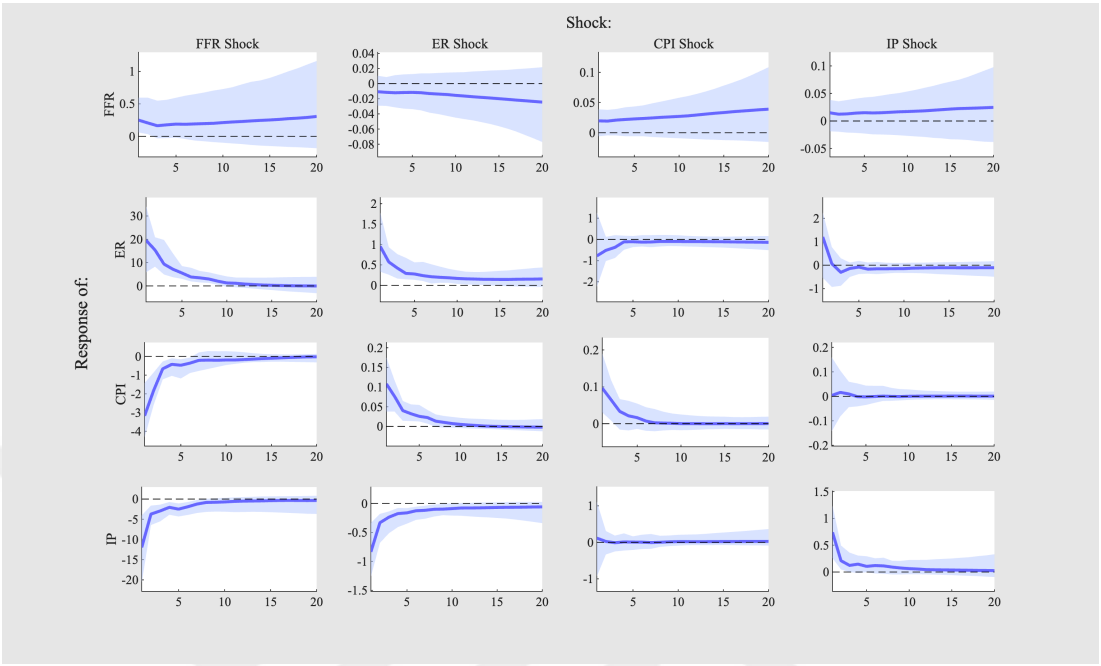


(a) 1994 tightening episode

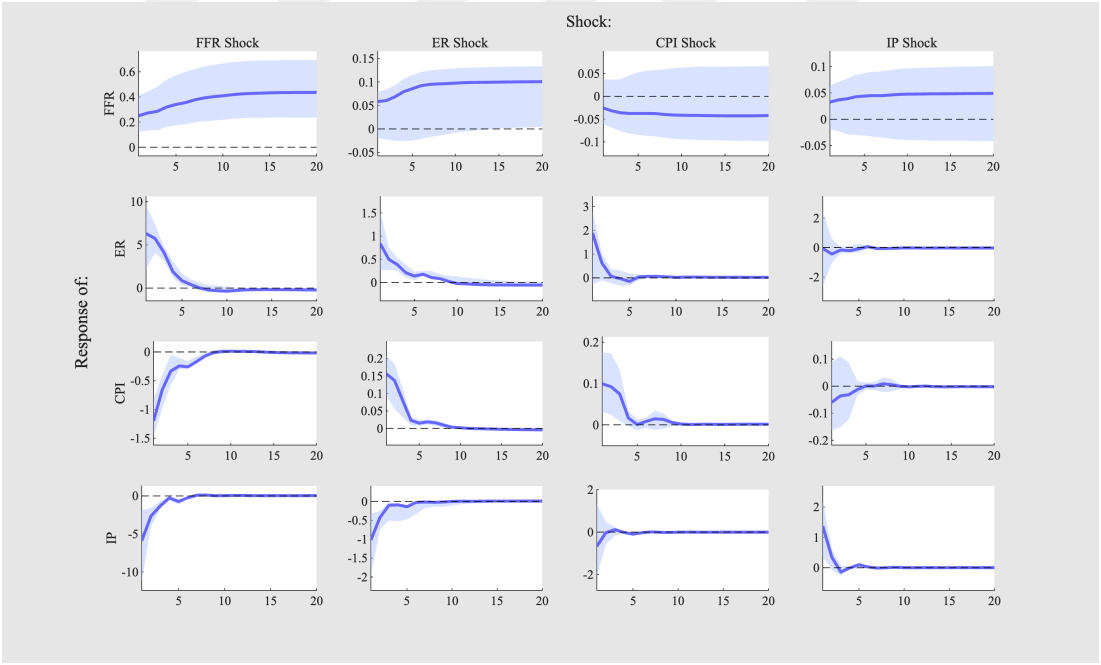


(b) 2004 tightening episode

Figure 5.4.1: Impulse responses for South Africa: 1994 and 2004 tightening episodes.



(a) 2015 tightening episode

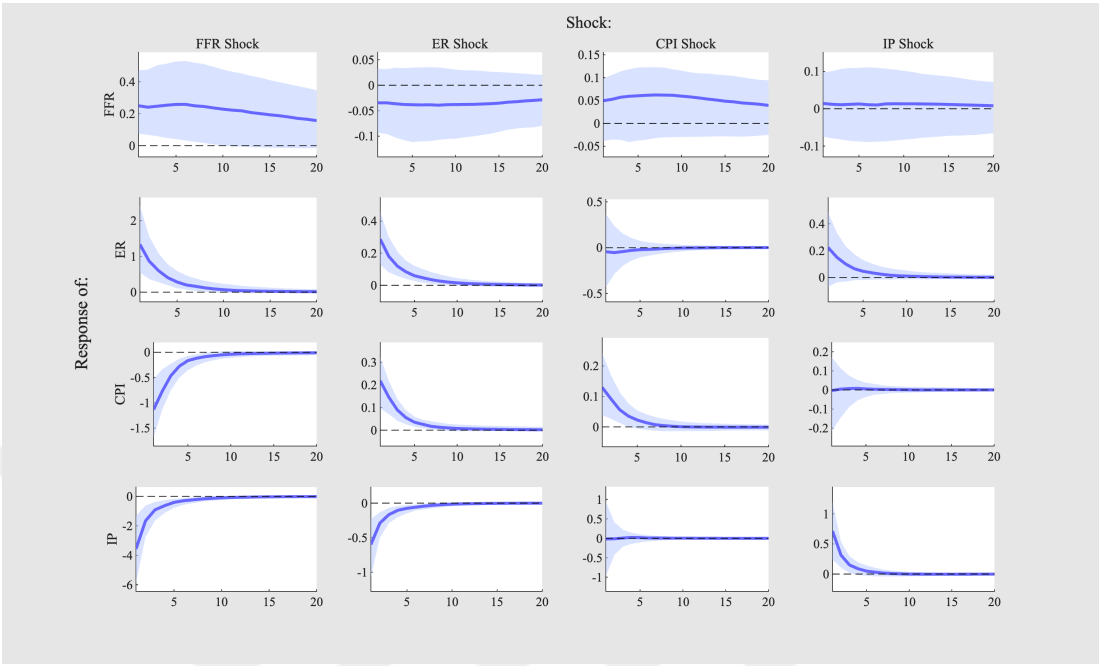


(b) 2022 tightening episode

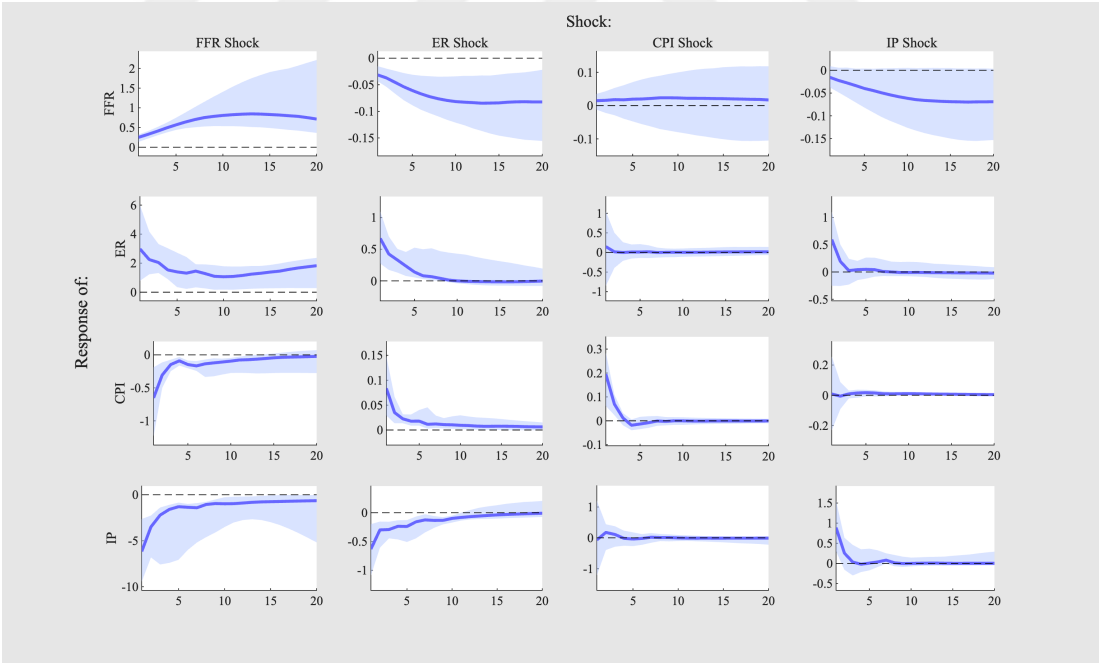
Figure 5.4.2: Impulse responses for South Africa: 2015 and 2022 tightening episodes.

5.5 South Korea

In the 1994 episode, a normalized 25 basis point U.S. tightening causes moderate but persistent effects in South Korea: the won depreciates by about 1 to 2 percent, the CPI drops by about 1 percent, and industrial production contracts by 4 percent, all of which are consistent with an economy that is still financially integrating. In the 2004 episode, the exchange rate weakens by about 3 percent, the CPI slightly declines (by -0.5 percent), and IP falls by 5 percent. The 2015 liftoff is notable because, when scaled to 25 basis points, the IRFs reveal a significant IP drop of roughly 10 percent, a modest but negative CPI response, and a very large depreciation of exchange rate roughly 15 to 20 percent. These magnitudes should not be taken literally; the estimated shock variance is low due to the minimal U.S. rate movements in 2015, and the 25 bps normalization mechanically amplifies the paths. They are more accurately understood as the counterfactual impact of a full 25 bps hike in those calm circumstances. Korea again suffers a significant devaluation of 4 percent, a mild disinflation of –0.5 to –0.6 percent, and an IP contraction of 5 percent in 2022 due to the Fed's aggressive tightening. Since many actual hikes exceeded 25 basis points in this case, the normalized IRFs probably underestimate the historical impact. Overall, Korea remains sensitive to U.S. policy shocks through both the exchange rate and activity channels. At the same time, the perceived size of episode-specific effects depends crucially on the normalization relative to the prevailing U.S. rate volatility.

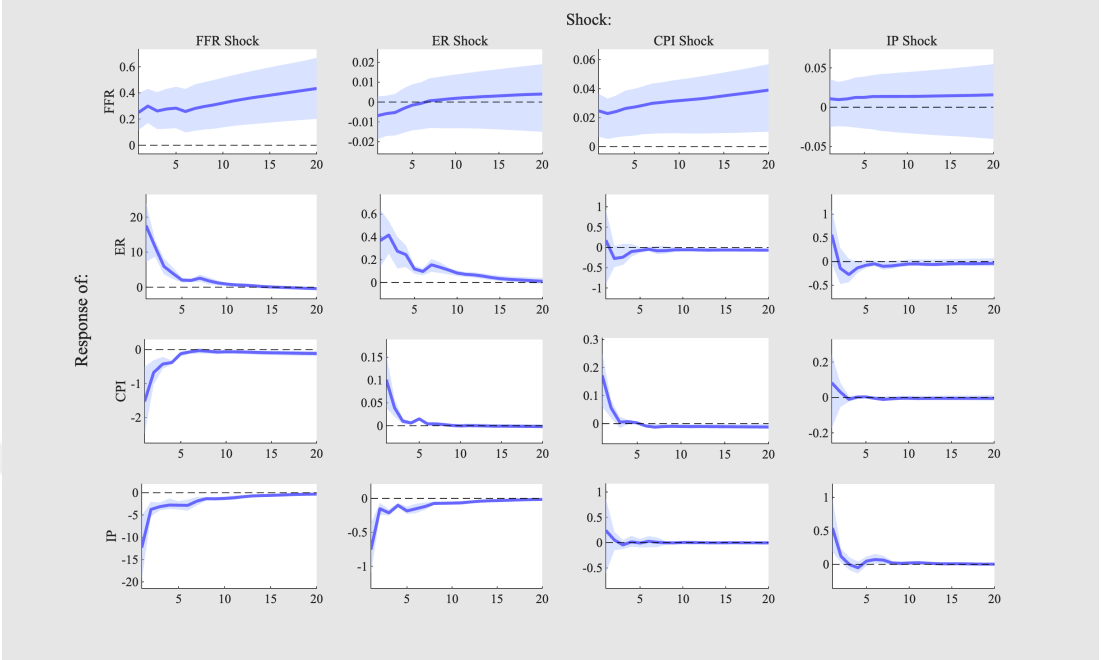


(a) 1994 tightening episode

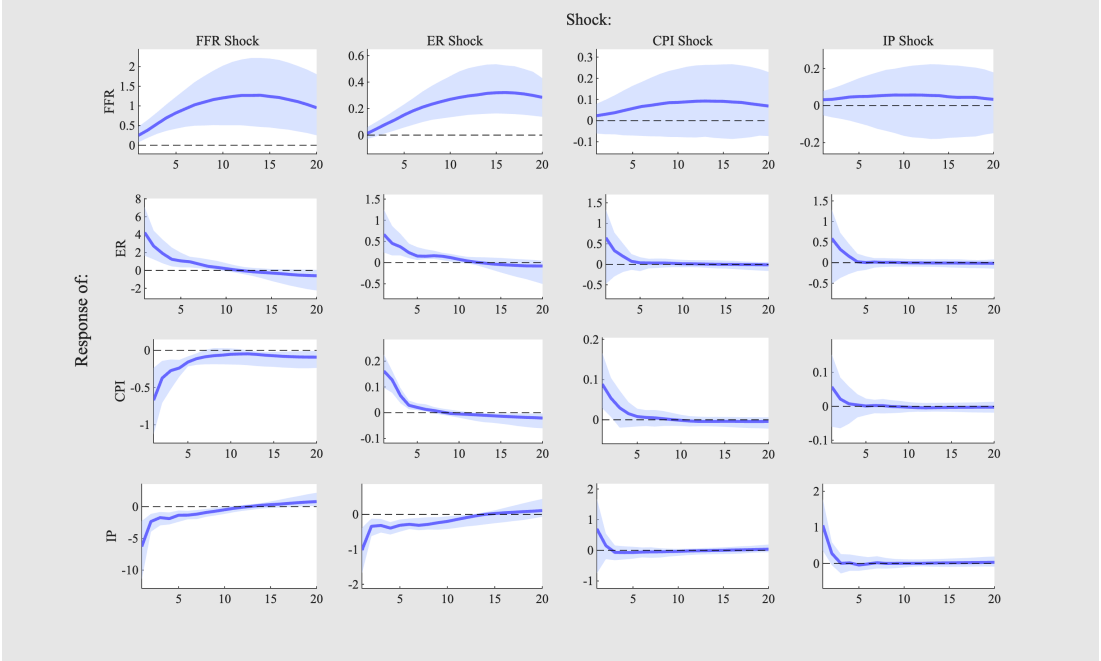


(b) 2004 tightening episode

Figure 5.5.1: Impulse responses for South Korea: 1994 and 2004 tightening episodes.



(a) 2015 tightening episode



(b) 2022 tightening episode

Figure 5.5.2: Impulse responses for South Korea: 2015 and 2022 tightening episodes.

CHAPTER 6

ROBUSTNESS CHECKS

This section will test the robustness of the main results to alternative model specifications. For this purpose, two variables have been replaced with alternatives, and the number of lags has been extended. All these decisions follow the methods most commonly used in the literature.

First, the nominal effective exchange rate (NEER) data, calculated separately for each country by the Bank for International Settlements, has been used instead of the bilateral exchange rate. These data are taken from BIS (2025) for all countries. NEERs are geometric trade-weighted averages of bilateral exchange rates. Therefore, after a tightening, the analysis will not only consider the value of the local currency against the dollar but also its average position against the currencies of other countries included in the same trade basket. This will reveal whether the local currency depreciates more against the dollar compared to other countries' currencies or whether the changes are parallel across countries. If the bilateral exchange rate and NEER results differ, this would imply that U.S. monetary policy shocks do not transmit equally to all trading partners. Thus, this variable allows us to consider whether U.S. monetary policy works primarily through bilateral relations with the U.S. or through broader capital flows and global risk pricing channels.

The second changed variable is industrial production. Instead of IP data, the

countries' manufacturing production index (MNF) data has been used. For Brazil, South Africa, and South Korea, the IMF (2025) database is used. However, for Chile and India, the FRED (2025) database is used since the IMF database does not cover 1990-2024. MNF directly measures sectors that are heavily demanded in trade and are more sensitive to interest rate changes, while IP also covers sectors such as mining and energy, which are less sensitive. Therefore, if the results remain essentially unchanged, it would imply that the findings regarding real economic activity are not very sensitive to the choice of production variable. In contrast, differing results would suggest that the shocks propagate mainly through the manufacturing and trade sectors. Initially, monthly unemployment data were included in the models of Brazil, Chile, and South Korea instead of IP data, and the results were very similar to the baseline model. However, since monthly unemployment data for India and South Africa do not go back before 2000, MNF was preferred instead of unemployment.

Finally, to test whether the results are sensitive to the number of lags, the number of lags was increased from 12 to 18.

The sign restriction table for the new variables is shown below.

Table 6.1: Sign restrictions of robustness model

Variable	**FFR**	**NEER**	**CPI**	**MNF**
FFR	+			
NEER	-	+		
CPI	-	-	+	
MNF	-			+

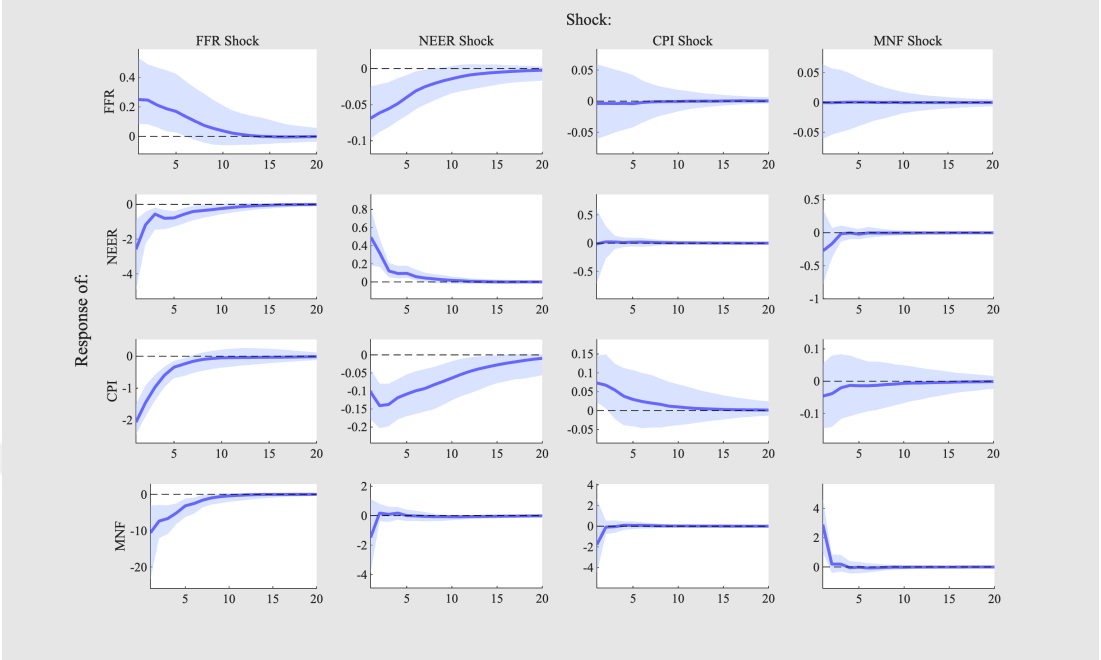
Note: A "+" (or "–") denotes the variable's positive (or negative) response to the specific shock. And an empty cell denotes an unrestricted response.
Note: NEER measures the value of the domestic currency relative to its trading partners. A "–" sign restriction therefore implies that an increase in the U.S. federal funds rate leads to a depreciation of the domestic currency against the trade partners.

6.1 Brazil (Robustness)

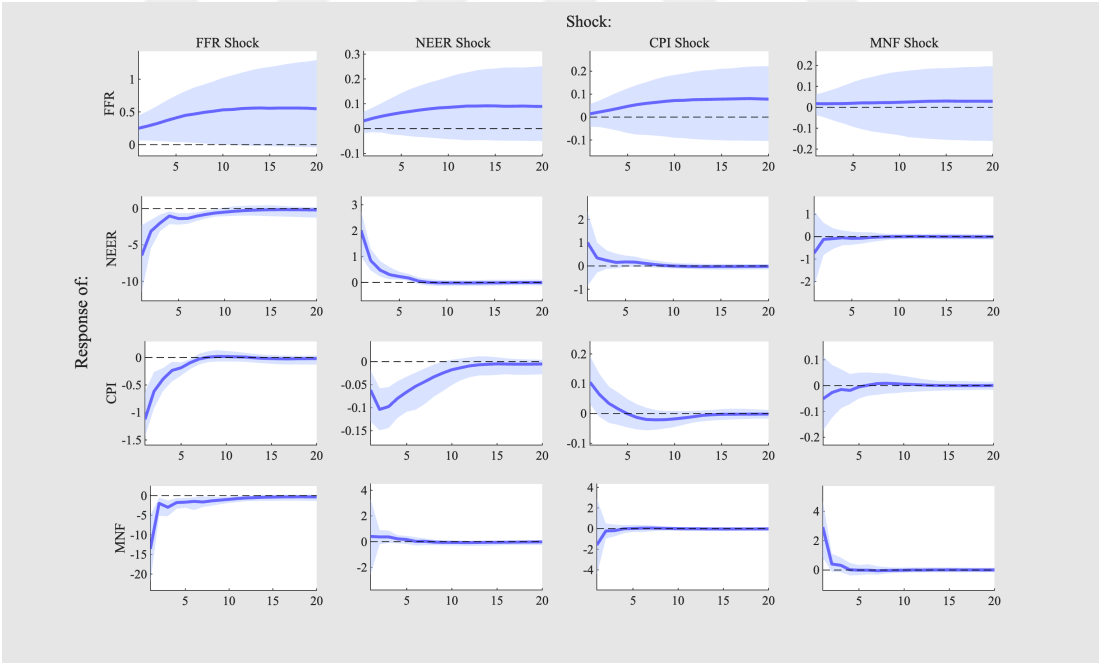
The robustness results, in which IP is substituted with MNF and ER with NEER, provide significant nuance while generally validating the baseline findings. Following a U.S. tightening, the NEER responses exhibit significant depreciations, following a trajectory similar to the ER's in the baseline model. The magnitude is constantly lower, suggesting that Brazil's bilateral depreciation against the dollar is greater than the average depreciation compared to its wider trading partners. This supports the idea that Brazil's currency is particularly sensitive to dollar movements, which dominate over trade-weighted dynamics.

Real-side responses are significantly stronger when MNF is used in place of IP. MNF experiences much more severe contractions than the aggregate industrial production index, frequently surpassing normalized IRF declines of ten to twenty percent. This implies that tradable and financially sensitive manufacturing sectors bear disproportionate amounts of monetary policy spillovers. The normalization process is also reflected in the scale of the responses in MNF: the rescaled 25 bps responses appear magnified in some cases, especially when volatility was historically low, because the standard deviation of shocks varies by episode.

When combined, the robustness checks verify that the three primary channels found in the baseline—output contraction, disinflationary pressure, and exchange rate depreciation—remain intact. They also point out that Brazil's vulnerabilities are particularly severe in sectors highly dependent on external demand and financing conditions, as well as in its bilateral dollar exposure.

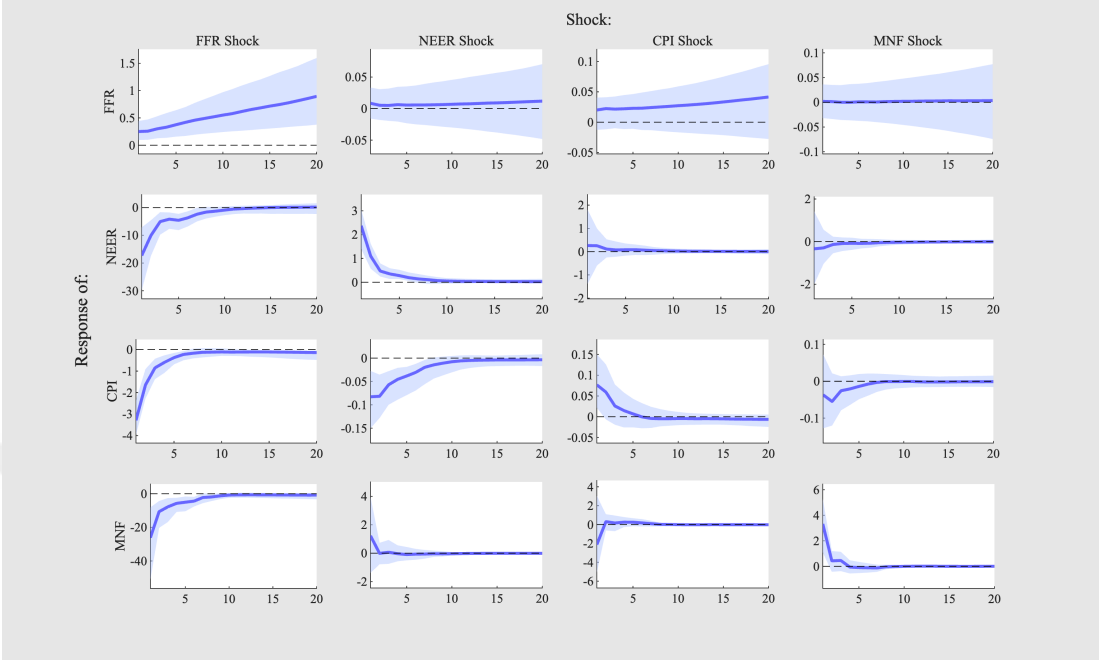


(a) 1994 tightening episode (robustness)

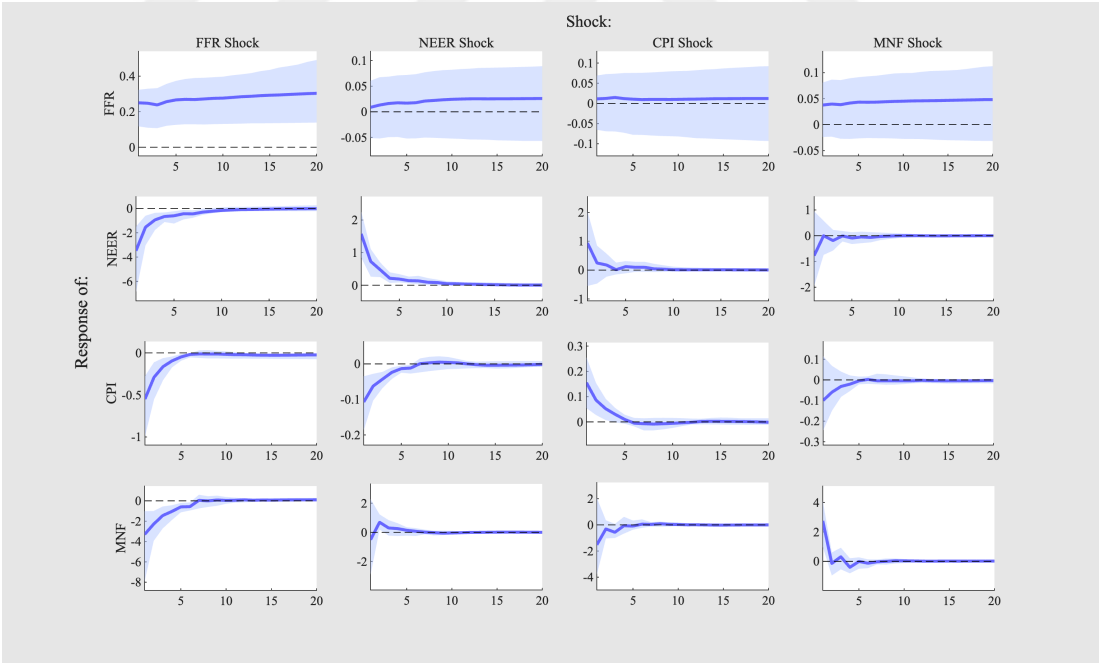


(b) 2004 tightening episode (robustness)

Figure 6.1.1: Robustness: impulse responses for Brazil, 1994 and 2004 tightening episodes.



(a) 2015 tightening episode (robustness)



(b) 2022 tightening episode (robustness)

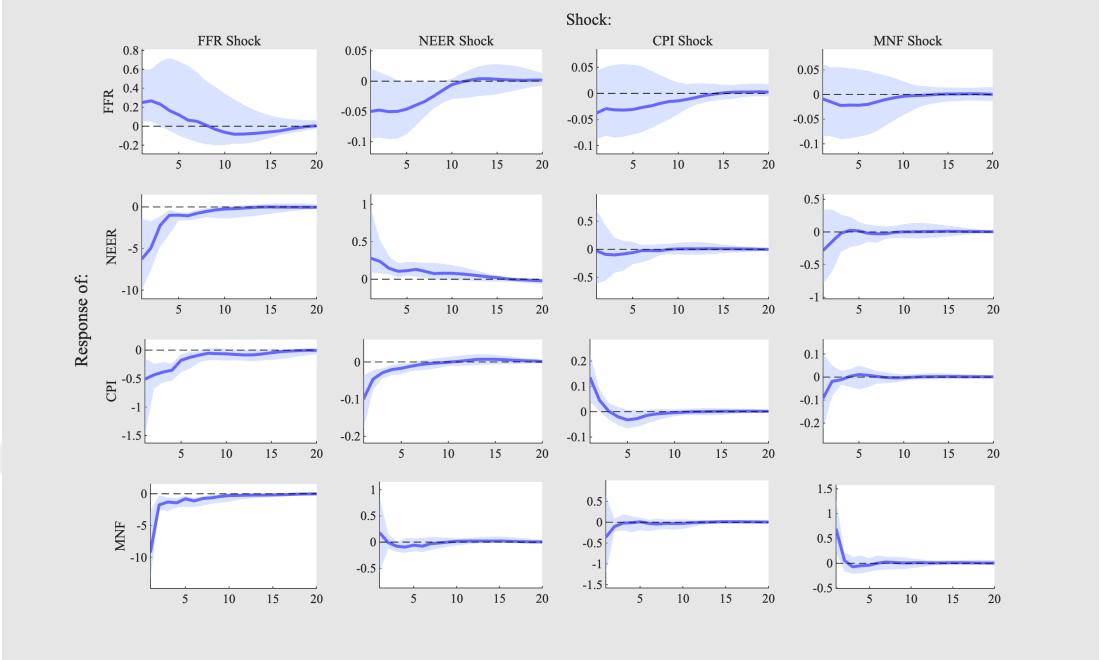
Figure 6.1.2: Robustness: impulse responses for Brazil, 2015 and 2022 tightening episodes.

6.2 Chile (Robustness)

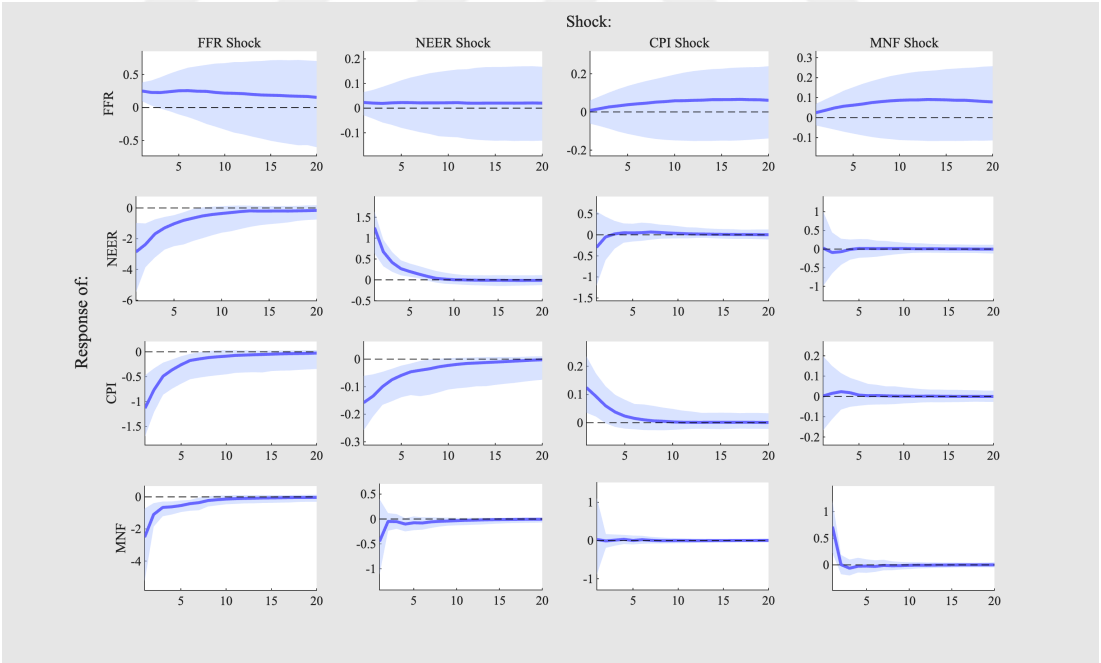
The robustness results add nuance while confirming the primary patterns from the baseline when ER is substituted with NEER and IP with MNF. Although the magnitudes are smaller, the NEER responses are similar to the bilateral ER. This highlights the dollar's pivotal role in world financial conditions by showing that Chile's currency depreciates against the dollar more severely.

Since manufacturing is a tradable industry that is highly vulnerable to demand and interest rate shocks, real-side spillovers are especially strong in this sector, as evidenced by the substitution of MNF for IP. The MNF responses move more closely with aggregate IP in calmer times, but they are typically larger during fragile episodes like 1994 and 2022, reflecting manufacturing's increased exposure to global financing pressures.

When taken together, the robustness checks support the baseline message: Chile consistently transmits U.S. monetary shocks through real activity contraction and exchange rate depreciation, with manufacturing especially vulnerable.

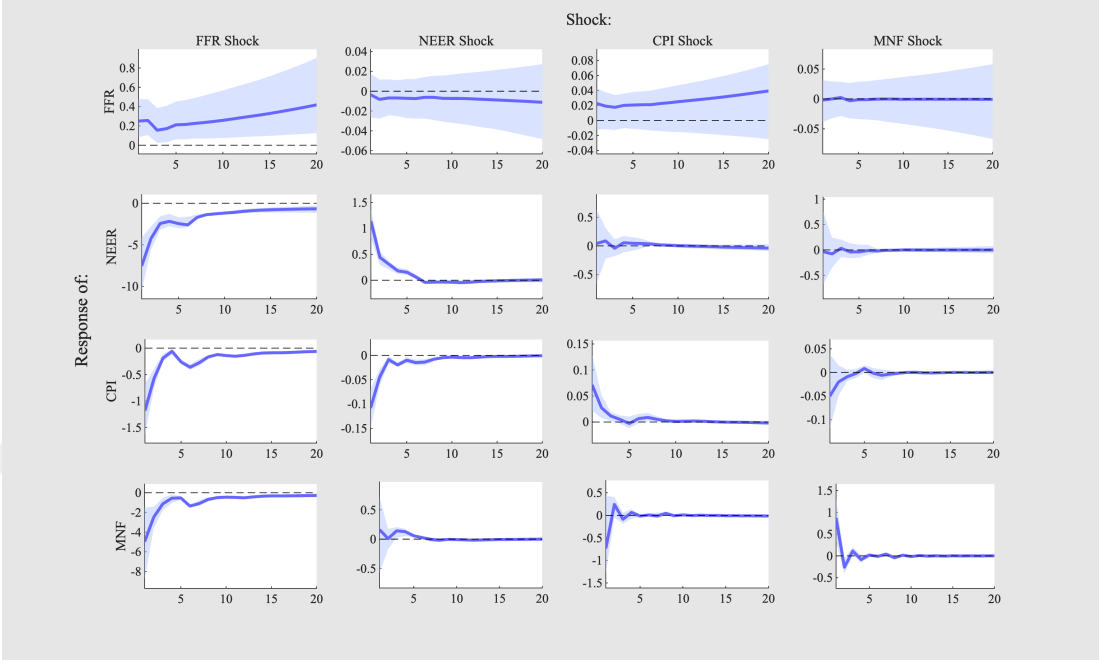


(a) 1994 tightening episode (robustness)

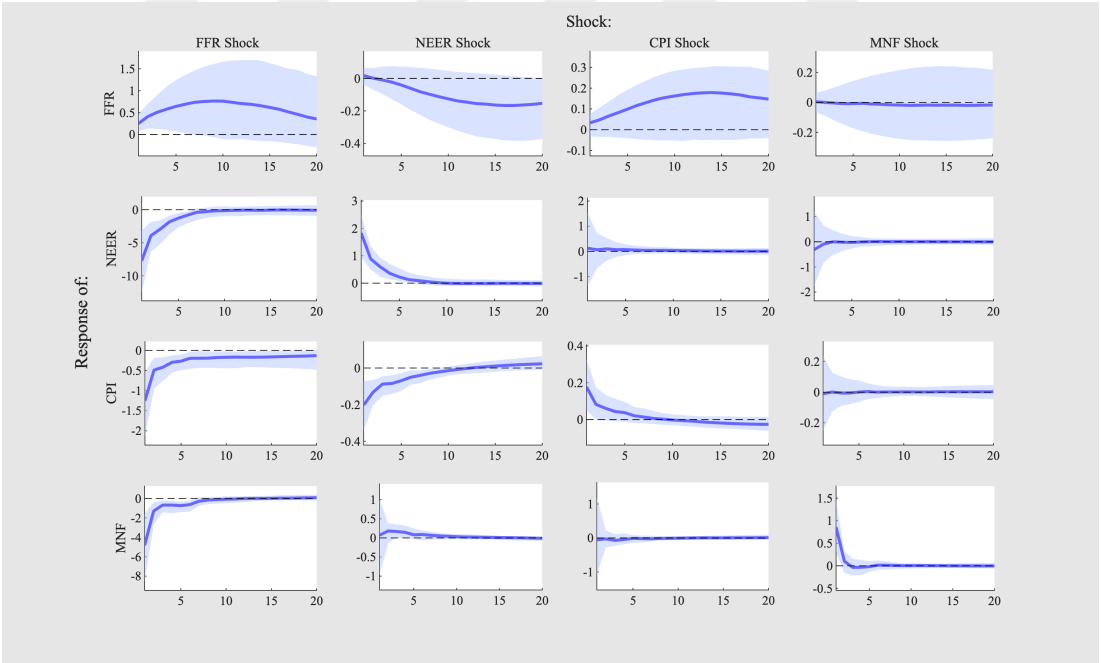


(b) 2004 tightening episode (robustness)

Figure 6.2.1: Robustness: impulse responses for Chile, 1994 and 2004 tightening episodes.



(a) 2015 tightening episode (robustness)



(b) 2022 tightening episode (robustness)

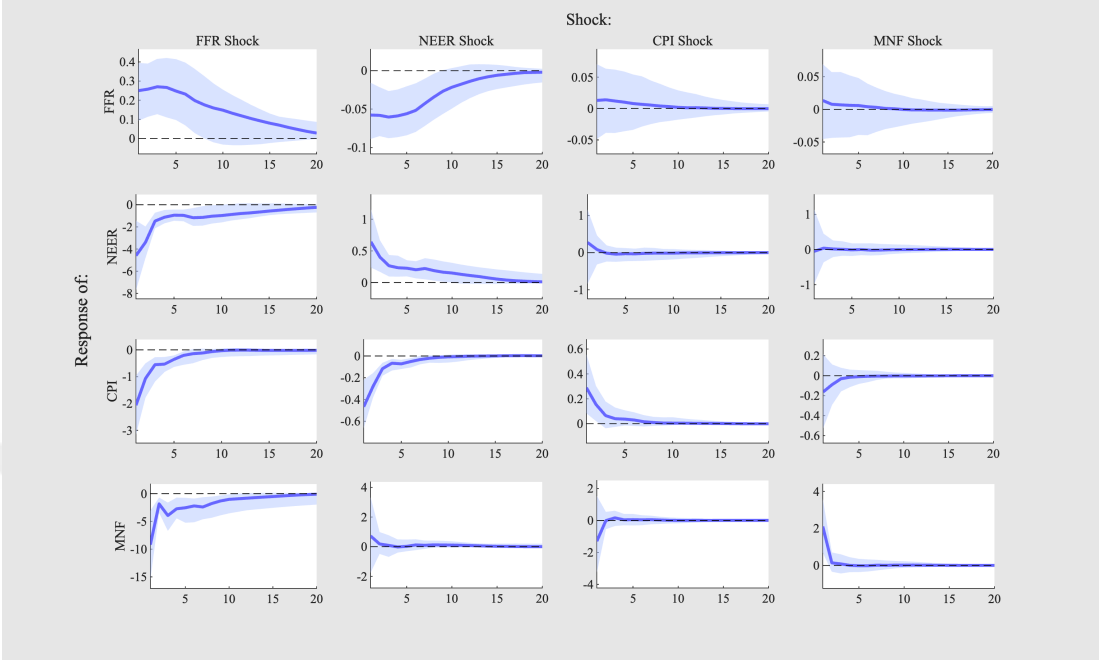
Figure 6.2.2: Robustness: impulse responses for Chile, 2015 and 2022 tightening episodes.

6.3 India (Robustness)

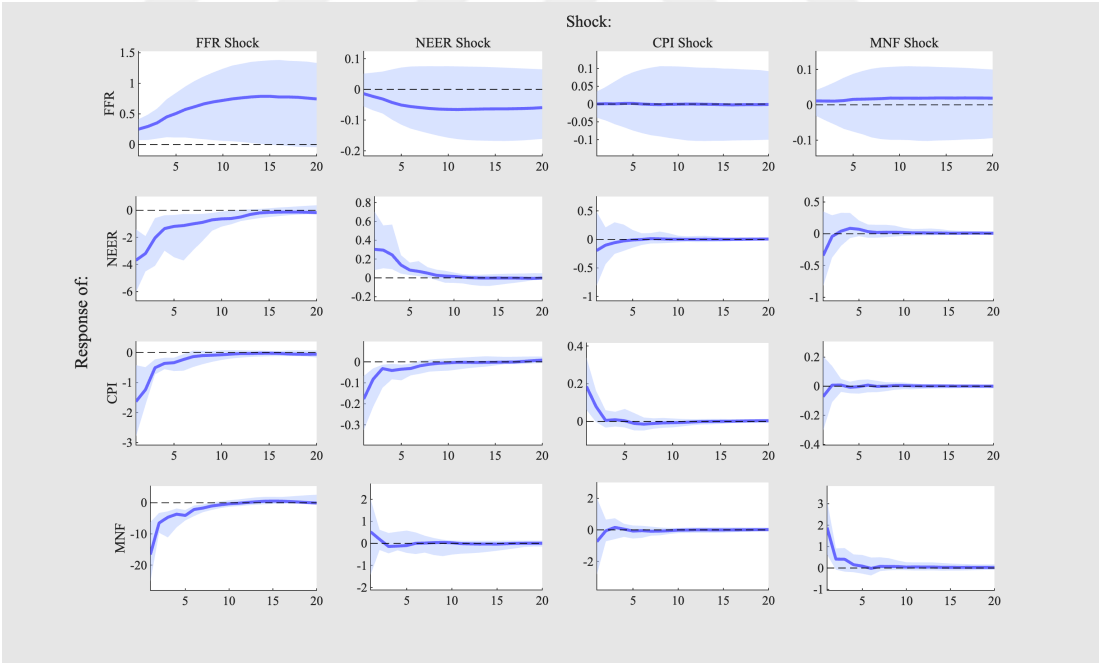
In contrast to the other countries, India's responses to the ER and NEER are nearly identical. This indicates that India's depreciation against its trading partners is almost equal to that against the dollar. This implies that the difference between bilateral and trade-weighted exchange rate measures is minimized because the currencies of India's trading partners also exhibit strong co-movements with the dollar.

The manufacturing sector is more vulnerable to interest rate and demand shocks, particularly during fragile episodes, as evidenced by the MNF results, which exhibit similar patterns as IP but with significantly stronger negative responses. However, the extremely slow pace of U.S. tightening in 2015 produced low volatility, and scaling to a 25 basis point shock mechanically inflates the MNF responses above past levels. On the other hand, the normalized results probably underestimate the actual size of the shock in 2022, when the Fed regularly raised rates by more than 25 basis points per meeting.

The scale of the MNF responses demonstrates the increased vulnerability of interest-sensitive sectors—subject to interpretation caveats in 2015 and 2022 due to normalization—while the robustness results for India collectively validate the baseline findings with the added insight that the ER–NEER equivalency reflects the strong dollar co-movement of its trading partners.

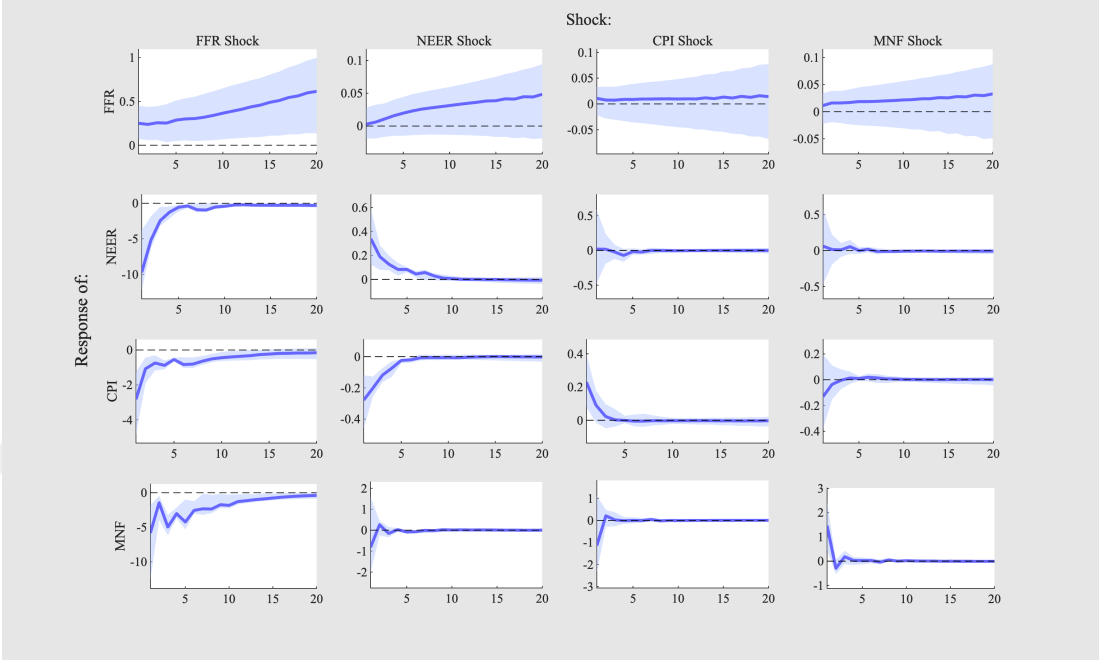


(a) 1994 tightening episode (robustness)

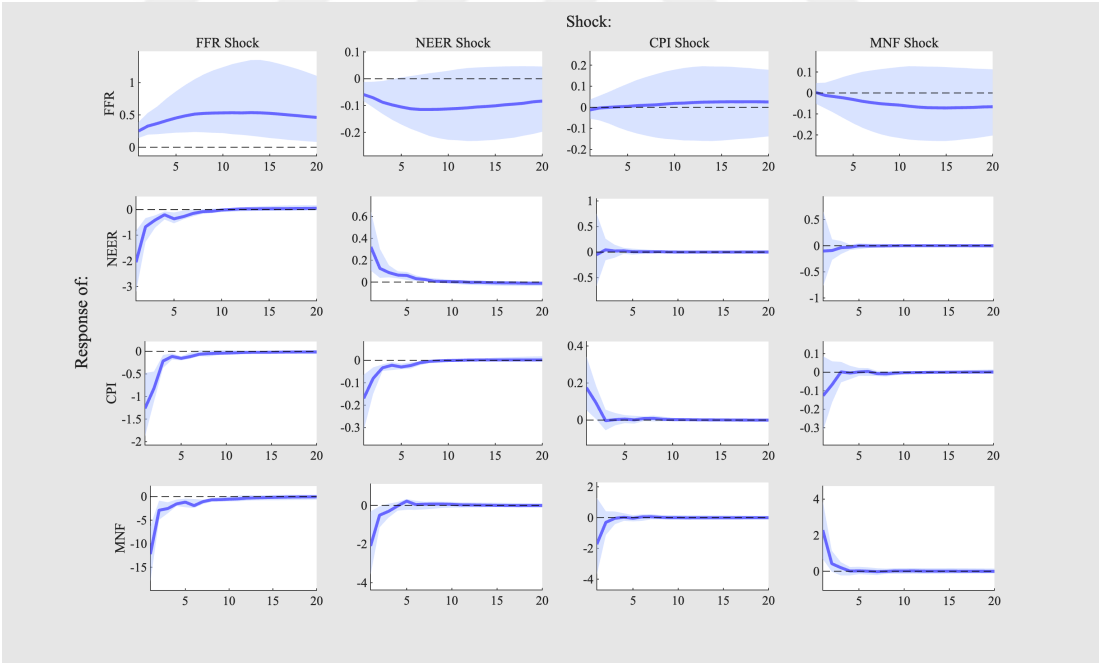


(b) 2004 tightening episode (robustness)

Figure 6.3.1: Robustness: impulse responses for India, 1994 and 2004 tightening episodes.



(a) 2015 tightening episode (robustness)



(b) 2022 tightening episode (robustness)

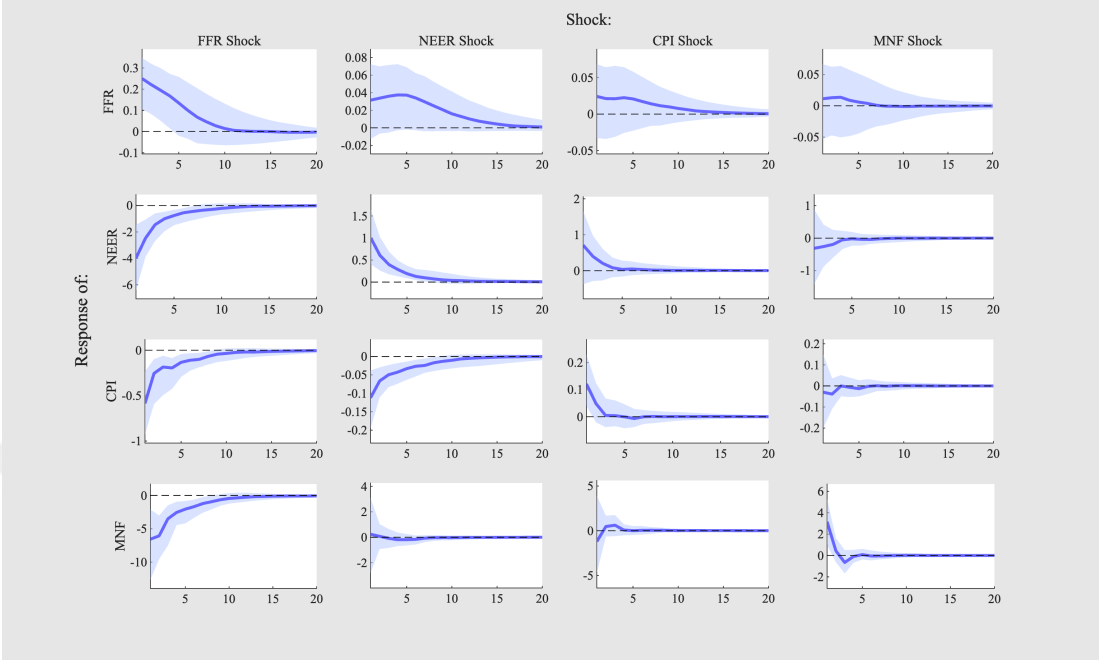
Figure 6.3.2: Robustness: impulse responses for India, 2015 and 2022 tightening episodes.

6.4 South Africa (Robustness)

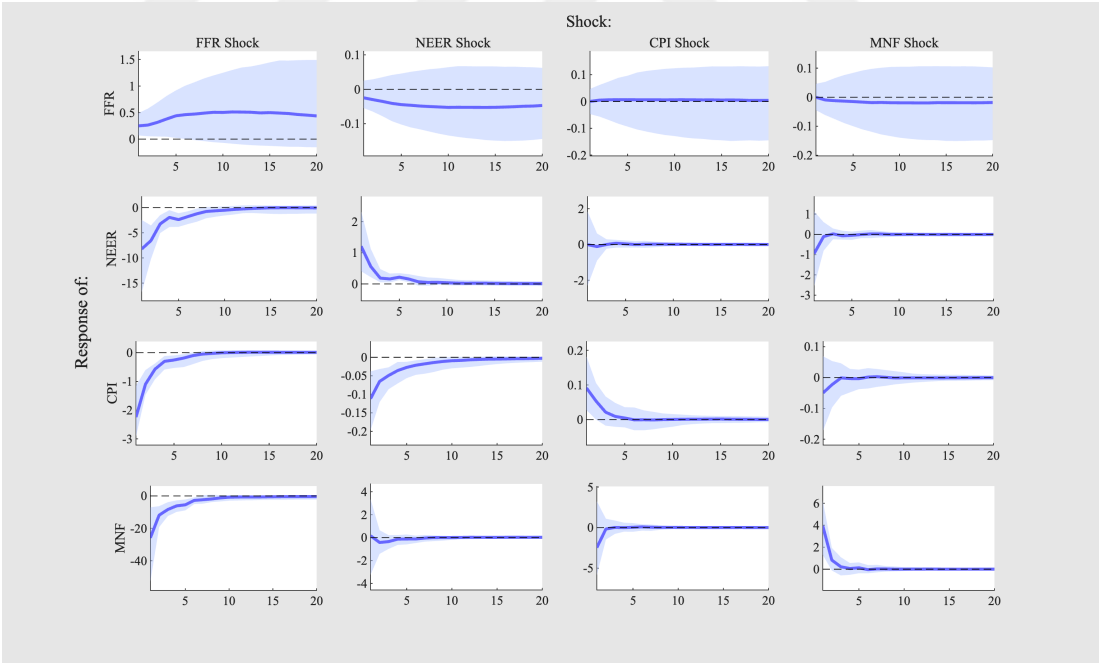
The robustness model for South Africa draws attention to the distinctions between bilateral and multilateral exchange rate dynamics. At first, the rand was more susceptible to its wide range of trading partners, but the dollar effects took center stage as time went on. This change illustrates how the dollar's influence on world financial conditions grew, leading to the post-pandemic tightening when it was evident that the dollar controlled financial spillovers.

The manufacturing sector is particularly vulnerable to global monetary shocks, as evidenced by the MNF's consistently stronger negative reactions than industrial production. These interest-sensitive sectors experience the most substantial declines in demand when interest rates rise, and the severity of these effects is heightened during fragile periods.

Lastly, normalization must be considered when interpreting the episodes of 2015 and 2022. When the shock is normalized to 25 basis points, the responses appear significantly larger than they would have under the observed pace of policy change because the Fed's tightening in 2015 was unusually gradual, with tiny actual increments. In 2022, by contrast, the Fed's hikes were larger than 25 basis points, meaning that the normalized responses understate the accurate scale of spillovers.

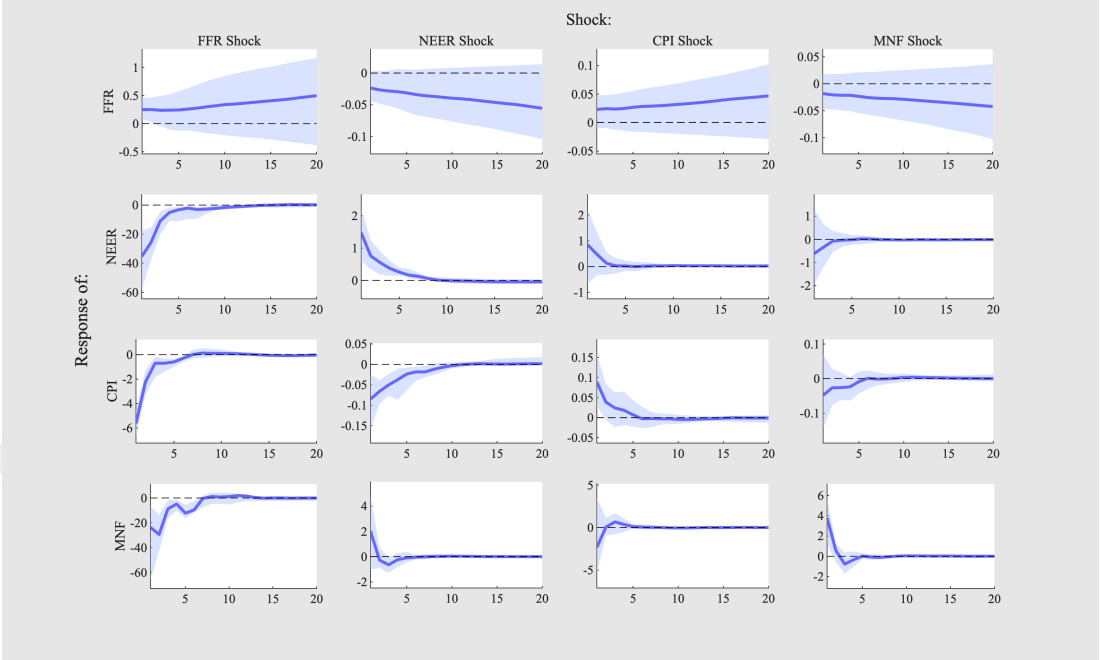


(a) 1994 tightening episode (robustness)

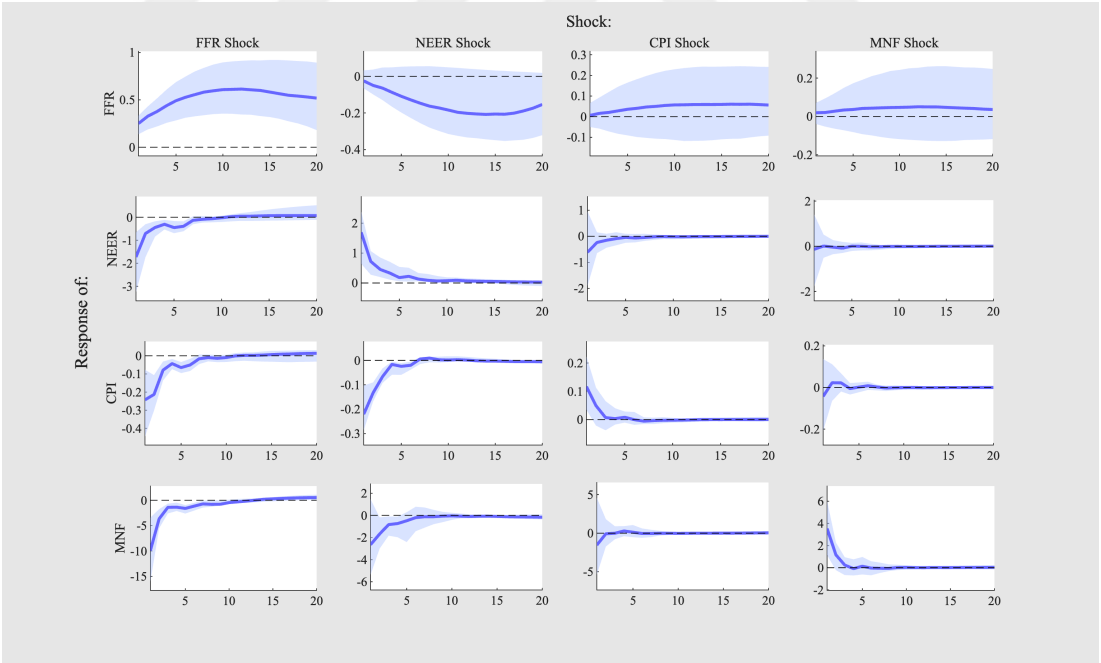


(b) 2004 tightening episode (robustness)

Figure 6.4.1: Robustness: impulse responses for South Africa, 1994 and 2004 tightening episodes.



(a) 2015 tightening episode (robustness)



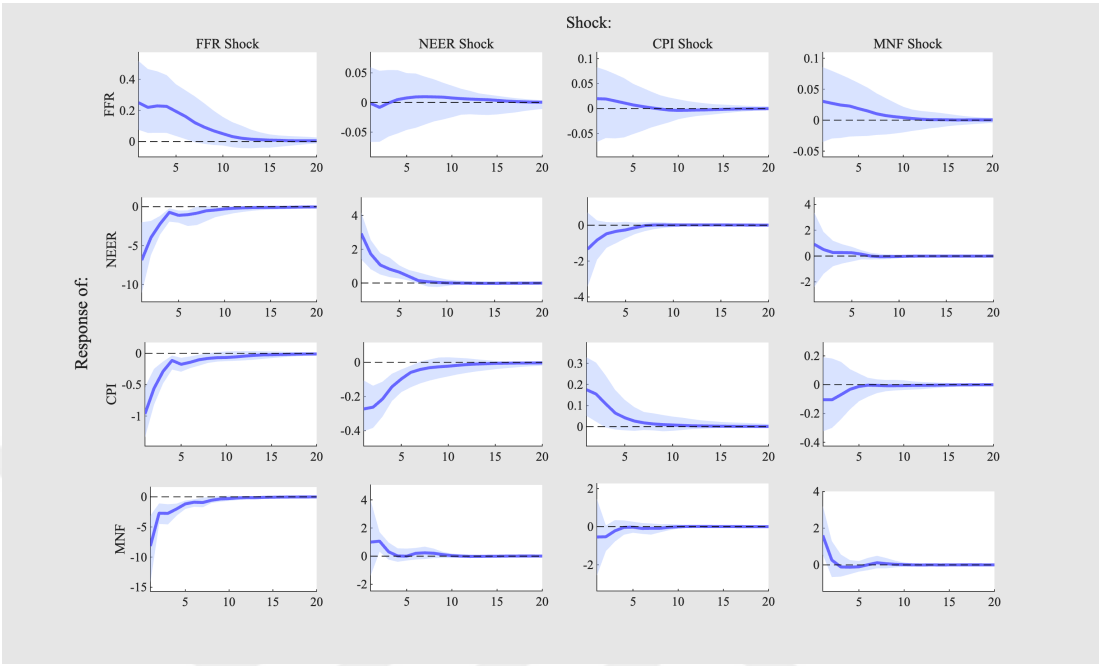
(b) 2022 tightening episode (robustness)

Figure 6.4.2: Robustness: impulse responses for South Africa, 2015 and 2022 tightening episodes.

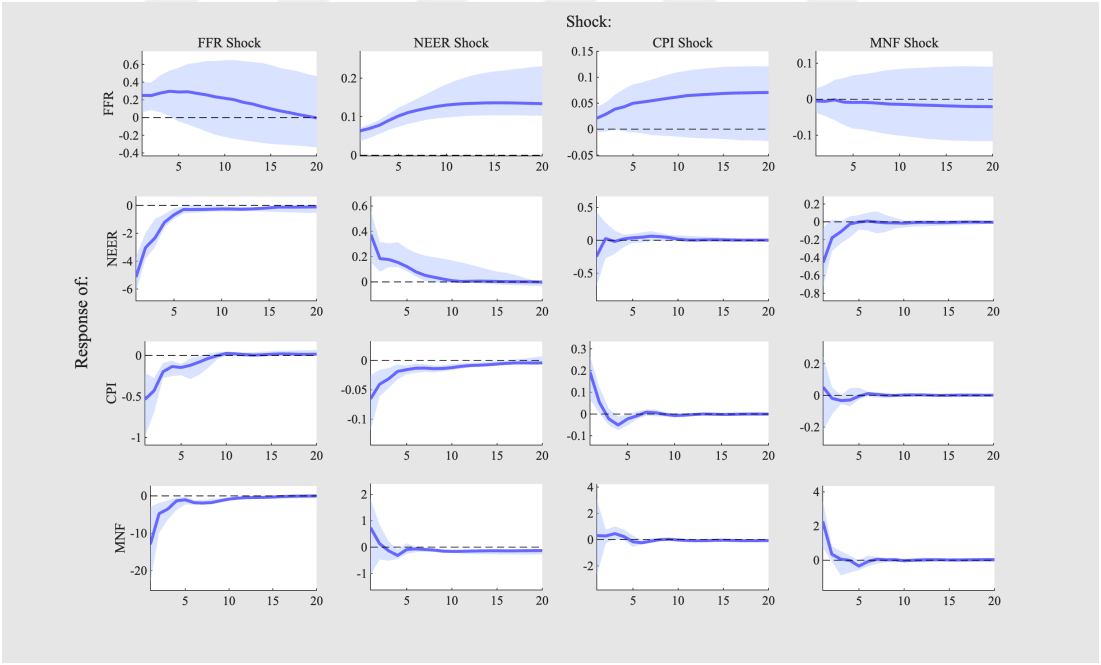
6.5 South Korea (Robustness)

The robustness results for South Korea demonstrate that while multilateral pressures were initially more powerful, they eventually gave way to the dollar's dominance. Given Korea's susceptibility to a wide range of trading partners and its loose reserve policies in the years preceding the Asian Financial Crisis, the NEER responses in 1994 and 2004 were greater than the bilateral ER. However, the bilateral ER depreciation had become much more noticeable by 2015, which was indicative of the dollar channel's growing dominance in transmitting the tightening of global financial conditions. Although the NEER and ER effects are still significant in 2022, the overall picture indicates that South Korea's external vulnerability is primarily driven by the dollar, even though multilateral spillovers are important.

Particularly during fragile episodes, the MNF consistently displays greater negative responses than aggregate IP. This implies that, although the gap in relation to IP is not as significant as in some other emerging markets, Korea's manufacturing sector—which is heavily reliant on trade, credit, and international demand—is disproportionately impacted by U.S. monetary shocks.

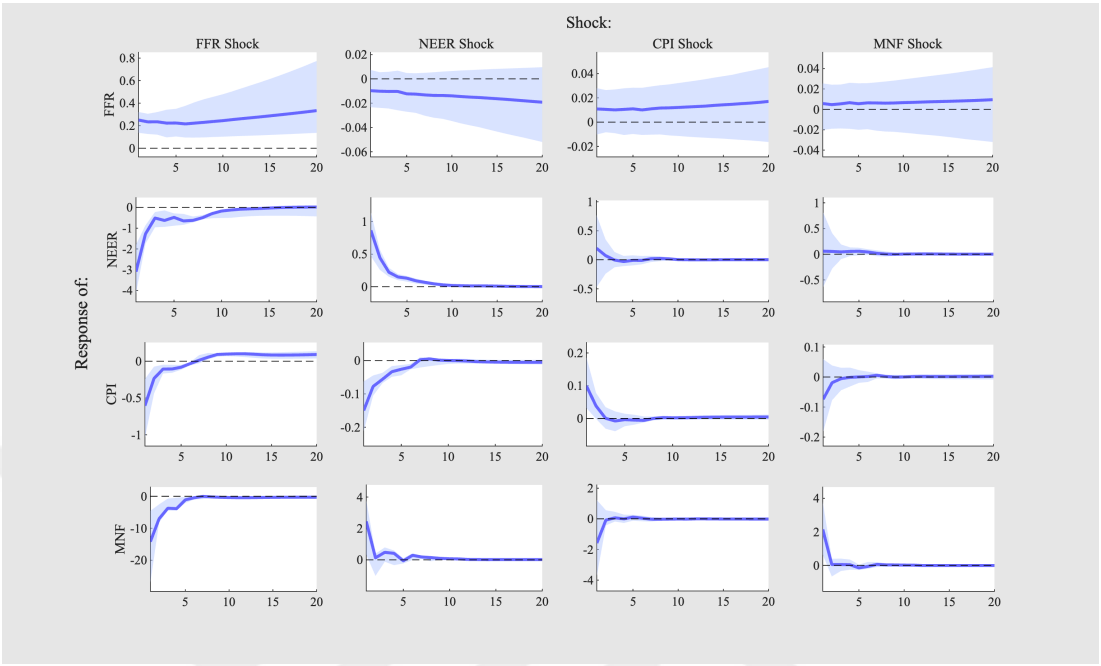


(a) 1994 tightening episode (robustness)

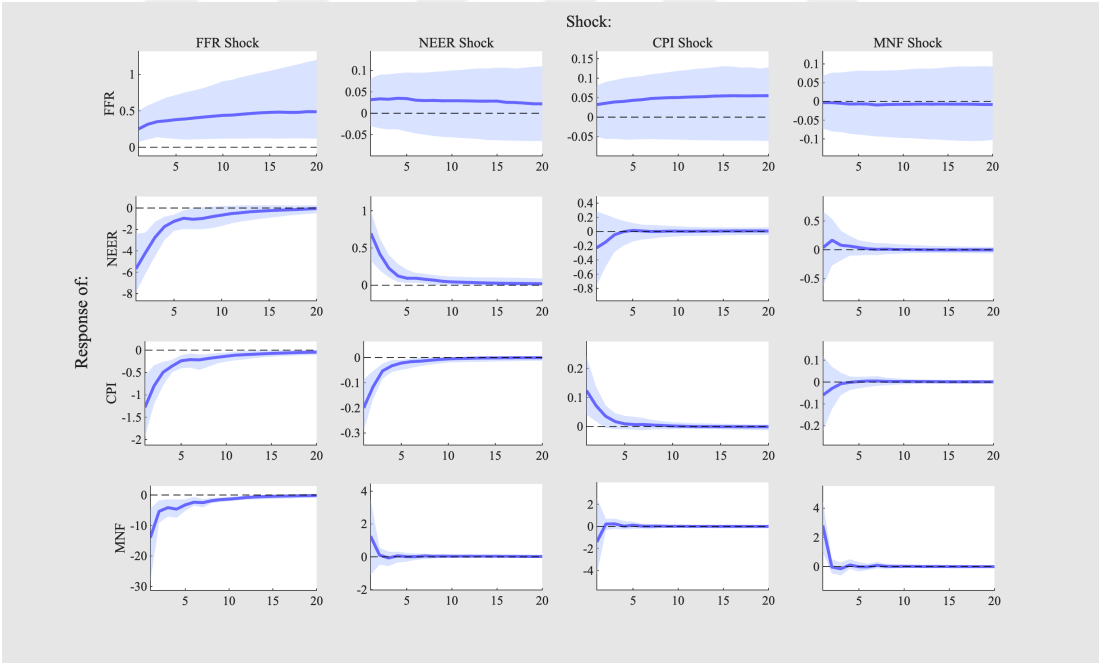


(b) 2004 tightening episode (robustness)

Figure 6.5.1: Robustness: impulse responses for South Korea, 1994 and 2004 tightening episodes.



(a) 2015 tightening episode (robustness)



(b) 2022 tightening episode (robustness)

Figure 6.5.2: Robustness: impulse responses for South Korea, 2015 and 2022 tightening episodes.

CHAPTER 7

CONCLUSION

This study uses a Bayesian VAR with stochastic volatility and random inertia to examine the spillover effects of U.S. monetary tightening episodes on emerging markets over time. The findings show significant variation across countries, variables, and episodes, with notable variations in real activity responses, inflation, and exchange rates.

The exchange rate is the most reliable and immediate channel across all baseline estimates. Chile's post-COVID exposure is highlighted by the country's most substantial and most persistent bilateral depreciations, particularly in 2022. Although the severity varies depending on the domestic regime, South Africa's post-Apartheid liberalization and subsequent inflation-targeting framework and Brazil's Real Plan transition in 1994 exhibit recurring exchange rate pressure episodes. As a result of their increased exposure to international capital flows and deeper financial integration, Korea and India exhibit growing sensitivity over time. With the exception of stressful situations like Brazil in 1994 or India in 2015, CPI responses are typically more moderate but disinflationary. The most varied responses are seen in real activity: South Africa and India suffered significant output losses in 2022, Brazil saw severe contractions in 1994 and 2015, and Korea's output channel grew more intense following the Asian Crisis.

The robustness checks refine these insights. The dollar channel dominates for

most countries when bilateral ER and NEER are substituted. Brazil and Chile see stronger bilateral depreciations than against their wider trade baskets, while India's ER-NEER responses are almost the same, indicating that its trading partners follow the dollar closely. South Africa and Korea better demonstrate the evolution of dollar dominance; in the 1990s, multilateral pressures were more important, but by the 2010s and 2020s, the dollar increasingly controlled spillovers. The real side effects are exacerbated when manufacturing output is substituted for industrial production. Manufacturing's sensitivity to global demand and financing conditions is highlighted by the fact that it consistently responds more strongly than aggregate activity, especially during fragile episodes like 1994 and 2022.

Normalization is a crucial methodological caution. Scaling to a hypothetical 25 basis point shock in 2015, when actual U.S. rate hikes were gradual and volatility was low, inflates the responses and makes them appear more severe. On the other hand, normalization probably underestimates the actual effects in 2022, when the Fed raised rates by more than 25 basis points. The necessity to understand normalized IRFs as counterfactuals rather than exact outcomes is highlighted by this asymmetry.

When combined, the results cast doubt on the idea that U.S. monetary spillovers have weakened over time since the Global Financial Crisis by Crespo Cuaresma et al. (2019). Although Chen and Tillmann (2025) suggests that the 2022 tightening was relatively benign, the tightening in 2022 shows that emerging markets are still highly vulnerable, with real activity contraction and exchange rate depreciation on par with previous crises. The findings verify that spillover strength varies according to domestic and international financial circumstances, and that the dollar still plays a crucial and expanding role in shock transmission.

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