Global Monetary Spillovers: Sources of Shocks and Country Vulnerabilities*

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Abstract

Underlying macroeconomic vulnerabilities are documented to make emerging economies particularly responsive to tightening of U.S. monetary policy stance. However, the source of U.S. monetary tightening is often neglected in accounting for cross-border spillovers of such shocks. In order to explore the sources and channels through which U.S. policy changes transmit to emerging economies, we augment a standard two-country New Keynesian model with foreign currency debt in bank balance sheets that are credit constrained and with imperfectly anchored inflation expectation. We show that higher U.S. interest rates arising from stronger U.S. demand generate modestly positive spillovers to economies with stronger fundamentals, but such a shock may be detrimental for vulnerable emerging economies due to tightening of their financial conditions. We also show that U.S. monetary shocks driven by a more hawkish Fed policy stance cause a slowdown in all emerging economies, with the effect being much larger for those with underlying vulnerabilities.

Keywords: Financial Frictions; U.S. Monetary Policy Spillovers; Adaptive Expectations; Covid-19 Pandemic.

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*The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York, the Board of Governors of the Federal Reserve, or the Federal Reserve System.

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1 Introduction

The cross-border effects of a shift in monetary policy stance in the United States have always been in focus of policymakers and academics. An empirical literature is rapidly developing that aims to quantify these cross-border monetary spillovers, with the common finding that changes in the stance of U.S. policy have sizable effects on economic activity in emerging economies (EMEs).[1] One prominent theme within this literature is an emphasis on the financial channel of spillovers, whereby a rise in U.S. rates transmits to foreign economies via tighter credit market conditions abroad. Recent work by Giovanni, Kalemli-Ozcan, Ulu and Baskaya (2017) finds that the financial channel involves deviations from uncovered interest parity (UIP) that fluctuate countercyclically, with the premium on domestic relative to foreign borrowing costs rising as global financial conditions tighten.

These effects of the U.S. monetary policy shocks on EMEs have been enhanced by the presence of foreign currency-denominated debt in firms' balance sheets, which render the latter vulnerable to domestic currency depreciation.[2] Under these conditions, many EME central banks have faced pressure to respond by tightening their own monetary policy, in an effort to mitigate capital outflows and currency depreciation.[3] By raising policy rates, however, EME central banks run the risk of contributing to the initial contractionary forces—via a reduction in domestic aggregate demand resulting from higher real rates—and thereby exacerbate the downturn.

The policy response by EME central banks just described stands at odds with prescriptions from standard open-economy New Keynesian (NK) models found in the literature.[4] These models recommend loosening domestic policy in response to a contractionary policy rate hike in foreign economies, and allowing the exchange rate to depreciate, in an effort to mitigate the drop in the domestic output gap. In a recent paper Akinci and Queralto (2019) show that this prescription continues to hold—in fact, even more forcefully—in an economy with imperfect financial intermediation

[1]Examples include Rey (2015), Bruno and Shin (2015), Dedola et al. (2017), Iacoviello and Navarro (2018), Bräuning and Ivashina (2019), and Miranda-Agrippino and Rey (2020).

[2]See Bruno and Shin (2015) for evidence that foreign currency liabilities, especially in the corporate sector, are still sizable in EMEs.

[3]For example, Curcuru et al. (2018) find that government bond yields in Korea, Brazil, and Mexico are strongly correlated to US yields around FOMC announcements—consistent with markets' expectation that central banks in these countries tend to hike policy rates along with the Fed.

[4]E.g. Gali and Monacelli (2005).

and partly dollarized private-sector balance sheets, despite the fact that the latter would a priori seem to make exchange rate stability especially desirable.[5] The reason is that in our economy, the premium on the domestic currency endogenously rises following a policy hike by the domestic central bank, which makes it more costly (in terms of lost output) to attempt to prevent depreciation of the domestic currency.

However, the literature cited above typically assumes fully anchored inflation expectations, along with rational expectations on the part of all agents. This assumption is likely not realistic for EMEs, which generally do not have a long experience with inflation targeting regimes, and often have histories of very high inflation episodes. Accordingly, in this paper we extend the existing literature to allow for imperfectly anchored inflation expectations, and use the resulting framework to analyze the implications of different monetary policies by EME central banks in the face of tightening monetary policy in advanced economies.

Another unexplored dimension of cross-border spillovers in the quantitative macro-finance literature is the extent to which monetary tightening in the U.S. is driven by stronger demand. The analysis typically focuses on the effects of "pure" monetary policy shocks (i.e., changes in the monetary policy stance that do not represent a direct response to changes in the U.S. macroeconomic environment). This approach, however, provides an incomplete assessment of how U.S. monetary policy actions spill over to foreign economies. It is because a change in the stance of U.S. monetary policy usually represent responses to macroeconomic shocks.Depending on the shocks prompting U.S. monetary policy changes, the spillovers and the channels through which they transmit to foreign economies may differ.

In order to explore the sources and channels through which U.S. monetary policy changes may tranmist to foreign economies, we extend the model in Akinci and Queralto (2019) to allow for a belief mechanism that is a hybrid of adaptive and rational expectations, along the lines of Gertler (2017).[6] This mechanism postulates that agents form expectations about macroeconomic aggregates in an adaptive fashion, consistent with survey evidence in Coibion and Gorodnichenko (2012). At the same

[5]Many authors have argued that dollarized balance sheets are an important rationale for the desire to smooth exchange rate fluctuations. For example, Calvo and Reinhart (2002) and Hausmann et al. (2001).

[6]The mechanism is in the spirit of recent work on "behavioral" approaches to expectation formation—e.g. Gabaix (2016), García-Schmidt and Woodford (2019), Farhi and Werning (2017)—in part motivated by an attempt to resolve the "forward guidance puzzle" (Giannoni et al. (2015)).

time, individuals' expectations of policy are rational in that they understand the central bank's policy rule. In addition, and crucially, agents' beliefs about trend inflation (i.e. the central bank's inflation target) react to actual realized inflation, rather than simply accepting the central bank's announcement of its target. This assumption captures the idea that the public needs to be convinced (with "hard" evidence) that the central bank can indeed deliver on its communicated inflation target.

We show that higher U.S. interest rates arising from stronger U.S. demand generate modestly positive spillovers to economies with stronger fundamentals, but such spillovers may be detrimental for vulnerable emerging economies due to significant tightening of their financial conditions. We also show that "pure" U.S. monetary shocks cause a slowdown in all emerging economies, but the effect of the shock is much larger for those with underlying vulnerabilities.

One general conclusion that emerges from our setting is that global monetary policy spillovers can create significant tradeoffs for EME policymakers, consistent with the remarks above. More specifically, we show how the hybrid belief mechanism can potentially rationalize the response of EME central banks to advanced-economy monetary tightening described earlier. The reason is as follows. When (say) the Federal Reserve tightens policy, the dollar appreciates against the home (i.e. the EME) currency. This makes home's imports from the United States more expensive, and thereby leads to a short-lived rise in the overall CPI inflation rate. Under the standard NK model with rational expectations, the monetary authority optimally "looks through" the transient rise in inflation, and instead worries about the decline in the home output gap. Thus, optimal policy tends to call for a reduction in the policy rate.

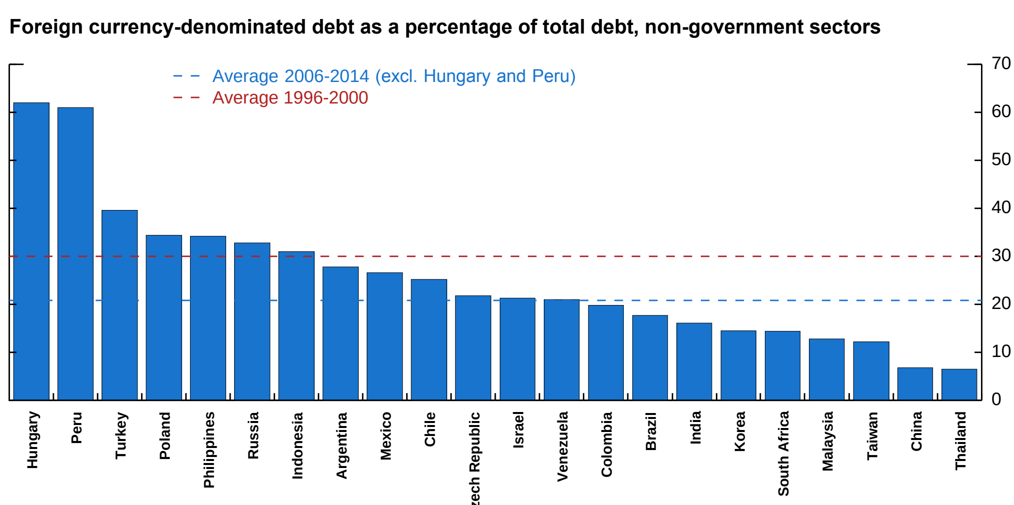
Under the hybrid adaptive/rational expectations belief mechanism, the picture differs considerably. Now the short-lived rise in CPI inflation feeds into agents' beliefs about trend inflation, and can thereby induce a much more persistent rise in actual inflation. The central bank thus may face a persistently higher inflation rate—along with a persistently lower output gap—resulting from the imperfect credibility of the central bank's inflation target.

We use the model to analyze how the domestic central bank's tradeoff worsens due to imperfect anchoring of expectations about trend inflation. We also explore the effects of forward guidance (central bank communication about future policy) under the different environments described above. More generally, we argue that our extensions to the baseline NK framework—namely, imperfect credibility and financial imperfections with partly dollarized balance sheets—prove very useful in adapting that framework to the analysis of policy in EMEs.

2 Empirical Evidence

An important channel for cross-border spillovers is fluctuations in cost of foreign currency borrowing by EME firms; a stronger U.S. dollar increases debt servicing costs. Figure 1 shows the share of foreign currency-denominated debt in total debt in selected emerging economies. The figure also shows the average foreign debt levels across emerging economies in earlier periods when these economies experienced "currency" crisis (such as Asian crises, or Turkish banking crisis). First, the average foreign currency debt level in these economies is smaller than before (30 percent vs 20 percent), but it is still sizable. Second, our simple figure shows that there is a heterogeneity in terms of how indebted these economies are: the so-called more vulnerable economies like Turkey and Argentina have higher foreign dent levels than economies known to have stronger macroeconomic fundamentals such as Korea and Taiwan.

Figure 1. Foreign currency-denominated debt in selected Emerging Economies



Another commonly referred macroeconomic vulnerability for emerging economies is that inflation expectations in these countries have not been well-anchored while in small open advanced economies they are better anchored, especially after the adoption of explicit inflation targeting regime (see, for example Levin et al. (2004)). Below we document some empirical evidence to argue that inflation expectations are un(-anchored) in emerging economies, even after the adoption of inflation targeting regime. We also compare these results with that of a group of small open advanced economies. Our analysis provides some support for introducing adaptive inflation expectations into a model characterizing a small open emerging economy.

More specifically, we conduct statistical analysis following work by Levin et al. (2004). We regress the first difference of inflation expectations on the first difference of a 3-year moving average of realized CPI inflation as expressed formally by the following equation,

$$\Delta \mathbb{E}_t \pi_{t+h,i} = \alpha_i + \beta_i \Delta \bar{\pi}_{t,i} + \epsilon_{t,i}$$

where $\mathbb{E}_t \pi_{t+h,i}$ is h-period-ahead survey inflation expectations at time t for country i and $\bar{\pi}_{t,i}$ is a three-year moving average of inflation in country i ending at time t. We use inflation expectations survey data collected by Consensus Economics. Originally twice a year and now quarterly, the survey asks market forecasters about their inflation expectations at horizons of 1 year to 10 years ahead. The dataset begins in 1989 or 1990 and becomes quarterly in 2014. The Euro Zone average is the weighted average of inflation expectations in France, Germany, Italy, and the Netherlands using time-varying GDP shares as weights.

Table 1. 6- to 10-year-ahead expectations

	(1) IT adv.	(2) IT eme.	(3) IT and non-IT eme.
$\Delta \bar{\pi}_{it}$	0.0477	0.153**	0.187***
	(1.57)	(2.91)	(5.03)
Constant	-0.00571	-0.0430	-0.0309
	(-1.48)	(-1.33)	(-1.16)
Observations	400	1010	1412

Dependent variable is $\Delta \mathbb{E} \pi_{i,6,t}$. Linear interpolation to quarterly freq.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1 shows results for small open IT advanced economies. The table also displays our regression results for a group of emerging market economies over the 1993-2019 period. For the small open advanced economies. our evidence using data through 2019 suggests that long-run inflation expectations are well anchored after the adoption of inflation targeting regime. For the emerging market economies, on the contrary, inflation expectations at all horizons exhibit highly significant correlation with a 3-year moving average of realized CPI inflation.

3 Sketch of the Model

Our analysis build on the model proposed in Akinci and Queralto (2019) augmented with adaptive expectations. The core framework is a two-country open-economy New Keynesian model (for example, Gali and Monacelli 2005 and Erceg et al. 2007). The critical departure from this literature is that we allow for imperfect financial markets: the financial imperfection leads to endogenous fluctuations in the domestic borrowing spread and in the UIP deviation. The model features financial intermediaries (banks, for short) that have infinite horizons. This feature allows for endogenous persistence in banks' net worth and, crucially, makes the latter endogenous to movements in the exchange value of domestic currency (to the extent that part of banks' liabilities are in foreign currency) as well as to domestic asset prices. We also include a standard set of nominal and real rigidities: nominal price and wage stickiness, habit persistence in consumption, and adjustment costs in investment and in the import share. These features help the model generate empirically realistic effects of monetary policy shocks (as shown by Christiano et al. 2005, for example).

We do not describe the details of the model here, but refer to Akinci and Queralto (2019) for interested readers. Below we briefly outline the inflation expectation formation process in the model economy augmented to incorporate "unanchored inflation expectations". Note that we assume expectation formation for all the model variables but inflation is fully rational. Therefore, only the equations that involve inflation expectations will be modified. Equations are directly taken from Akinci and Queralto (2019), and that corresponds to equations B.27 - B.30 in the appendix:

$$\Pi_t^{-\frac{1}{\theta_p}} = (1-\xi_p)(\Pi_t^o)^{-\frac{1}{\theta_p}} + \xi_p \Pi_{t-1}^{-\frac{\iota_p}{\theta_p}} \tag{1}$$

$$\Pi_t^o = (1+\theta_p)\frac{X_{1t}}{X_{2t}}\Pi_t \tag{2}$$

$$X_{1t} = C_t^{\frac{-1}{\sigma}} MC_t Y_t + \beta \xi_p \Pi_t^{-\iota_p \frac{(1+\theta_p)}{\theta_p}} \mathbb{E}_t \left(X_{1t+1} \Pi_{t+1}^{\frac{1+\theta_p}{\theta_p}} \right) \tag{3}$$

$$X_{2t} = C_t^{\frac{-1}{\sigma}} p_{Dt} Y_t + \beta \xi_p \Pi_t^{\iota_p \left(1 - \frac{1+\theta_p}{\theta_p}\right)} \mathbb{E}_t \left(X_{2t+1} \Pi_{t+1}^{\frac{1+\theta_p}{\theta_p} - 1} \right) \tag{4}$$

where Π_t is the domestic price inflation and domestic prices are denoted by p_{Dt}, C_t denotes the consumption basket, a CES aggregate of a domestically-produced composite good, C_{Dt}, and an imported composite good, M_{Ct}; MC_t is marginal cost, and Y_t denotes domestic output. Equation (1) results from assuming that if firm i does not reset the price in period t, it automatically sets price $P_t(i) = \Pi_{t-1}^{\iota_p} \overline{\Pi}^{1-\iota_p} P_{t-1}(i)$ – i.e. it automatically increases its price by indexing to a combination of previous-period inflation Π_{t-1} and trend inflation (or the CB's inflation target) $\overline{\Pi}$, with ι_p weight on previous-period inflation and $1 - \iota_p$ weight on trend inflation. Thus, one can motivate $\iota_p = 1$ as the central bank's inflation target not being very credible, in the sense that firms' indexation rule assigns it a zero weight (and puts all the weight instead on observed past inflation). For simplicity we set $\overline{\Pi}$ to 1.

Log-linearize Equation (1) around $\Pi_t = 1$:

$$\pi_t = (1 - \xi_p)\pi_t^o + \xi_p \iota_p \pi_{t-1}$$

Log-linearize Equation (2):

$$\pi_t^o = x_{1t} - x_{2t} + \pi_t$$

Substitute π_t^o in the above

$$\begin{aligned} \pi_t &= (1 - \xi_p)(x_{1t} - x_{2t} + \pi_t) + \xi_p \iota_p \pi_{t-1} \\ \xi_p \pi_t - \xi_p \iota_p \pi_{t-1} &= (1 - \xi_p)(x_{1t} - x_{2t}) \\ \frac{\xi_p}{1 - \xi_p} (\pi_t - \iota_p \pi_{t-1}) &= x_{1t} - x_{2t} \end{aligned}$$

Log-linearize Equation (3) and (4):

$$x_{1t} = (1 - \beta\xi_p) \left(-\frac{1}{\sigma} c_t + mc_t + y_t \right) - \beta \xi_p \iota_p \frac{1 + \theta_p}{\theta_p} \pi_t + \beta \xi_p \mathbb{E}_t \left\{ x_{1t+1} + \frac{1 + \theta_p}{\theta_p} \pi_{t+1} \right\}$$

$$x_{2t} = (1 - \beta\xi_p) \left(-\frac{1}{\sigma} c_t + p_{dt} + y_t \right) + \beta \xi_p \iota_p \left(1 - \frac{1 + \theta_p}{\theta_p} \right) \pi_t + \beta \xi_p \mathbb{E}_t \left\{ x_{2t+1} + \left(\frac{1 + \theta_p}{\theta_p} - 1 \right) \pi_{t+1} \right\}$$

Now take the difference $x_{1t} - x_{2t}$

$$x_{1t} - x_{2t} = (1 - \beta\xi_p)(mc_t - p_{dt}) - \beta\xi_p\iota_p\pi_t + \beta\xi_p\mathbb{E}_t\{x_{1t+1} - x_{2t+1}\} + \beta\xi_p\mathbb{E}_t\{\pi_{t+1}\}$$

So again defining $x_t \equiv x_{1t} - x_{2t}$; note that we have the two equations:

$$x_t = \frac{\xi_p}{1 - \xi_p}(\pi_t - \iota_p\pi_{t-1}) \tag{5}$$

$$x_t = (1 - \beta\xi_p)(mc_t - p_{dt}) + \beta\xi_p\mathbb{E}_t\{x_{t+1}\} + \beta\xi_p\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\} \tag{6}$$

To derive the New Keynesian Philips Curve (NKPC) we insert x_t, x_{t+1}:

$$\frac{\xi_p}{1 - \xi_p}(\pi_t - \iota_p\pi_{t-1}) = (1 - \beta\xi_p)(mc_t - p_{dt}) + \beta\xi_p\frac{\xi_p}{1 - \xi_p}\mathbb{E}_t\{\pi_{t+1} - \pi_t\} + \beta\xi_p\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\}$$

$$\pi_t - \iota_p\pi_{t-1} = \frac{(1 - \xi_p)(1 - \beta\xi_p)}{\xi_p}(mc_t - p_{dt}) + \beta\xi_p\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\} + \beta(1 - \xi_p)\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\}$$

$$\pi_t - \iota_p\pi_{t-1} = \frac{(1 - \xi_p)(1 - \beta\xi_p)}{\xi_p}(mc_t - p_{dt}) + \beta\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\} \tag{7}$$

Let

$$\kappa \equiv \frac{(1 - \xi_p)(1 - \beta\xi_p)}{\xi_p}$$

Let's rewrite it by pulling together the π_t terms

$$\pi_t - \iota_p\pi_{t-1} = \kappa(mc_t - p_{dt}) + \beta\mathbb{E}_t\{\pi_{t+1} - \iota_p\pi_t\}$$

$$\pi_t = \frac{\kappa}{1 + \beta\iota_p}(mc_t - p_{dt}) + \frac{\iota_p}{1 + \beta\iota_p}\pi_{t-1} + \frac{\beta}{1 + \beta\iota_p}\mathbb{E}_t\{\pi_{t+1}\} \tag{8}$$

In the "unanchored inflation expectations" extension, we consider two changes:

- Inflation expectations $\mathbb{E}_t\{\pi_{t+1}\}$ in Equation (8) are not rational, but adaptive: they are given by an average between the rational expectation and the average lagged inflation over the past year. In addition, the measure of inflation that price setters look at to form the adaptive part of expectations is not home-good inflation, but rather CPI inflation π_c. The motivation for this is that in this economy inflation expectations are not well-anchored, and that a bout of temporary inflation pressures due to currency depreciation can make agents expect higher future domestic inflation; in this way temporary inflationary pressures (due to currency depreciation) can become "entrenched" and feed into actual inflation.

- Firms not resetting their price *also* index to CPI inflation, rather than home inflation. So the indexation terms in Equation (7) (the ones multiplying ι_p *both* on the LHS *and* on the RHS) are replaced by π_c. In addition, the indexation rate is $\iota_p = 1$, reflecting low credibility of the inflation target.

3.1 Parameter Values

We calibrate the foreign economy to the United States, and take the home economy to represent a bloc of emerging economies, such as the Asian or the Latin American EMs.[7] The calibration is asymmetric: the U.S. is much larger in size, and EM households are assumed to be relatively impatient, which introduces a motive for the latter to borrow from U.S. households. The relative impatience feature can be seen as capturing more-structural differences between EMs and advanced economies, such as faster prospective trend growth in EMs.

Table 2 reports parameter values, followed by our calibration targets. We first describe parameters for non-vulnerable EME bloc. We then discuss if any parameter is calibrated differently for vulnerable EMEs. But we note that in our framework, underlying vulnerabilities cause amplication of the shocks in the more vulnerable emerging markets, causing a differential response of real and financial variables in that bloc compared with the non-vulnerable emerging economy bloc.

We calibrate the U.S. discount factor, β^*, to 0.9950, implying a steady-state real interest rate of 2% per year. This choice follows several recent studies (e.g. Reifschneider 2016) and is motivated by estimates indicating a decline in the U.S. natural rate (see, for example, Holston, Laubach and Williams 2017). We calibrate home discount factor to get real interest rate of 2.6 percent in non-vulnerable EMEs. This target rate is smaller than the estimates of Mexico's long-run natural rate of 3 percent. The size of the home economy relative to the United States is around $\xi/\xi^* = 1/3.35$.

The capital share (α) and capital depreciation rate (δ) are calibrated to the con-

[7] The approach of grouping countries into blocs is often used in larger-scale models for policy analysis, e.g. Erceg et al. (2006).

Table 2. Model Calibration

Parameter	**Symbol**	**Non-Vuln. EME**
Home discount factor	β	0.9938
U.S. discount factor	β^*	0.9950
Habit parameter	h	0.85
Inv. Frisch elas. of labor supply	χ	3.79
Trade price elasticity	$(1+\rho)/\rho$	2
Trade openness, home	ω	0.135
Trade openness, foreign	ω^*	0.095
Relative home size	ξ/ξ^*	1/3.35
Trade adjustment cost	φ_M	10
Capital share	α	0.33
Capital depreciation	δ	0.025
Prob. of keeping price fixed	ξ_p	0.87
Price indexation	ι_p	0.50
Price markup	θ_p	0.20
Prob. of keeping wage fixed	ξ_w	0.70
Wage indexation	ι_w	0.15
Wage markup	θ_w	0.20
Investment adjustment cost	Ψ_I	4
Home Taylor rule coefficients	γ_r	0.92
	γ_π	1.50
U.S. Taylor rule coefficients	γ_r^*	0.82
	γ_π^*	1.50
	γ_x^*	0.25
U.S. Bank survival rate	σ_b	0.98
U.S. Bank fraction divertable	θ	0.40
U.S. Bank transfer rate	ξ_b	0.10
Bank survival rate	σ_b	0.95
Bank fraction divertable	θ	0.41
Bank transfer rate	ξ_b	0.07
Home bias in bank funding	γ	2.58

ventional values of 0.33 and 0.025, respectively. We calibrate the steady-state wage and price markups, θ_p and θ_w, to 20 percent in each case, a conventional value. For the remaining parameters governing household and firm behavior, we rely on estimates from Justiniano et al. (2010). These parameters include the degree of consumption habits (h), the inverse Frisch elasticity of labor supply (χ), the parameters governing price and wage rigidities (ξ_p, ι_p, ξ_w, and ι_w), and the investment adjustment cost

Figure 2. Calibration Targets

varnames	NonVulnerable	Vulnerable
'EME R ann. %'	2.6	3.5
'U.S. R ann. %'	2	2
'x'	0.11099	0.27651
'K / N = phi'	5.2053	4.7038
'RER*Df/(D+RER*Df)'	0.13738	0.35117
'Rk-R (ann. %)'	2.0555	1.8875
'EME exports / GDP'	0.14048	0.14514
'EME imports / GDP'	0.13631	0.13525
'US exports / GDP'	0.091107	0.088004
'US imports / GDP'	0.091107	0.088004
'US leverage'	3.9315	3.9315
'US corp. spread'	0.74564	0.74564

parameter (Ψ_I). These parameters are set symmetrically across the two economies, and their values are fairly conventional. They are listed in the top part of Table 2.

The Taylor rule both at home and in the U.S. features inertia with a coefficient of 0.92 and 0.82, respectively, an estimate also taken from Justiniano et al. 2010. In our baseline experiments we set the home Taylor rule coefficient γ_π to the standard value of 1.5, capturing a rule focused on stabilizing domestic inflation. Turning to the U.S. Taylor rule, we set the coefficients γ_π^* and γ_x^* to 1.5 and 0.25 respectively, conventional values used in the literature (e.g. Taylor 1993).

Turning to parameters governing international trade, we follow Erceg et al. (2007) (who rely on estimates by Hooper et al. 2000) and set the trade price elasticity $(1+\rho)/\rho$ to 2. We impose the restriction that $\omega^* = \omega\xi/\xi^*$, as frequently done in the literature (e.g. Blanchard et al. 2016). We set $\omega = 0.135$, implying that 14 percent of the home economy's output is exported in steady state, as shown in the calibration targets, consistent with evidence. This value is somewhat lower than the ratio of Mexico's exports to the United States as a fraction of GDP (which equaled 0.28 in 2017) but higher than in other EMs (for example, aggregating across the major EMs in Asia and Latin America leads to a ratio of around 0.10 for 2017).[8] The trade adjustment cost parameter φ_M is set to 10, as in Erceg et al. (2005) and Erceg et al. (2006). This value implies a price elasticity of slightly below unity after four quarters, consistent with the evidence that the short-run elasticity is lower than the long-run one.

Regarding the parameters governing financial market frictions, we calibrated U.S.

[8]These statistics refer only to merchandise trade, so do not include services. Source: IMF Direction of Trade statistics.

and EME bloc separately to match their respective leverage ratios and credit spreads in the steady state. We set home bank survival rate σ_b to 0.95, implying an expected horizon of 6 years. This value is around the mid-point of values found in related work using variants of this framework. The remaining three parameters are set to hit three steady-state targets: a credit spread of 200 basis points annually, a leverage ratio of 5.2, and a ratio of foreign-currency debt to domestic debt (D^*/SD) of 10 percent. The target leverage ratio is a rough average of leverage across different sectors. Leverage ratios in the banking sector are typically greater than five,[9] but the corporate sector features a much lower ratio of assets to equity (between two and three in emerging markets).[10] Our target of five reflects a compromise between these two values. Finally, for non-vulnerable EMEs foreign-currency deposits to domestic deposits are around 10 percent, consistent with evidence presented in Chui et al. (2016). These targets imply $\theta = 0.41, \xi_b = 0.07$, and $\gamma = 2.58$. The implied value for the steady-state ratio of foreign liabilities to assets is $x = 0.11$). Financial variables for the U.S. are calibrated similarly to match the corresponding targets depicted in Calibration Targets.

The calibration for Vulnerable EMEs are different than non-vulnerable EMEs only on two grounds. First, we calibrate home discount factor to get real interest rate of 3.5 percent in vulnerable EMEs, slightly higher than neutral real rate estimate for Mexico discussed before. This parameter along with the financial sector parameters discussed before, implies a ratio of foreign-currency debt to domestic debt (D^*/SD) of 28 percent. Second, we assume that vulnerable emerging economy Taylor rule features some small reaction to changed in nominal exchange rate in the Taylor rule (i.e., $\gamma_{\Delta(NER)}$ is zero for non-vulnerable EMEs while it is 0.05 for vulnerable emerging markets).

4 Cross-Border Spillovers from U.S. Shocks

This section uses the medium-scale model with unanchored inflation expectations presented above to explore cross-border spillovers to emerging economies in response to U.S. monetary policy shocks.

[9] For example, bank assets to capital averaged around 10 for Mexico in recent years. Source: IMF Global Financial Stability Report.

[10] See e.g. IMF Global Financial Stability Report October 2015, Chapter 3.

Figure 3 explores the spillovers from U.S. tightening when such tightening is driven by a strengthening of US demand. This type of tightening is actually beneficial for non-vulnerable EMEs, as somewhat tighter financial conditions are more than offset by stronger exports. On the other hand, the shock leads to downward pressure on vulnerable EMEs' GDP, as the extent of financial tightening is much larger (due to the more-adverse financial accelerator) and as the monetary authority is forced to increase policy rates substantially to fight inflation pressures. The figure suggests also a much worse macroeconomic tradeoff for vulnerable EMEs: GDP and inflation move in opposite directions, while they move in the same direction for non-vulnerable EMEs. As depicted in Figure 4, unanchored inflation expectations contribute significantly to the emergence of this tradeoff, and cause EME policy rate to react much more forcefully to U.S. monetary tightening. As a result, vulnerable EME GDP decreases more than the case that features anchored inflation expectations (shown by green line "w/ Dollar-Debt").

Figure 5 shows that matters are very different when the shock is driven by a pure "hawkish" shift in the Fed's reaction function (as would be the case, for example, if the Fed turned more hawkish due to fear of inflation pressures). This type of tightening is much more adverse for EMEs as a whole – it drives down GDP for both vulnerable and non-vulnerable EMEs. The magnitude of the hit is much more substantial for the latter, as are the extent of financial tightening and currency depreciation. As expected, unachored inflations expectations contribute significantly to this outcome (as shown in Figure 6).

5 Conclusion

We have developed a medium-scale quantitative New Keynesian model representing the U.S. economy and an emerging market economy. The latter is subject to financial frictions in the bank/firm balance sheets and unanchored inflation expectations. We investigated the consequences of these features for spillovers from U.S. monetary policy shocks that are demand driven and that are driven by more hawkish U.S. monetary policy stance.

Figure 3. U.S. Demand-Driven Monetary Spillovers

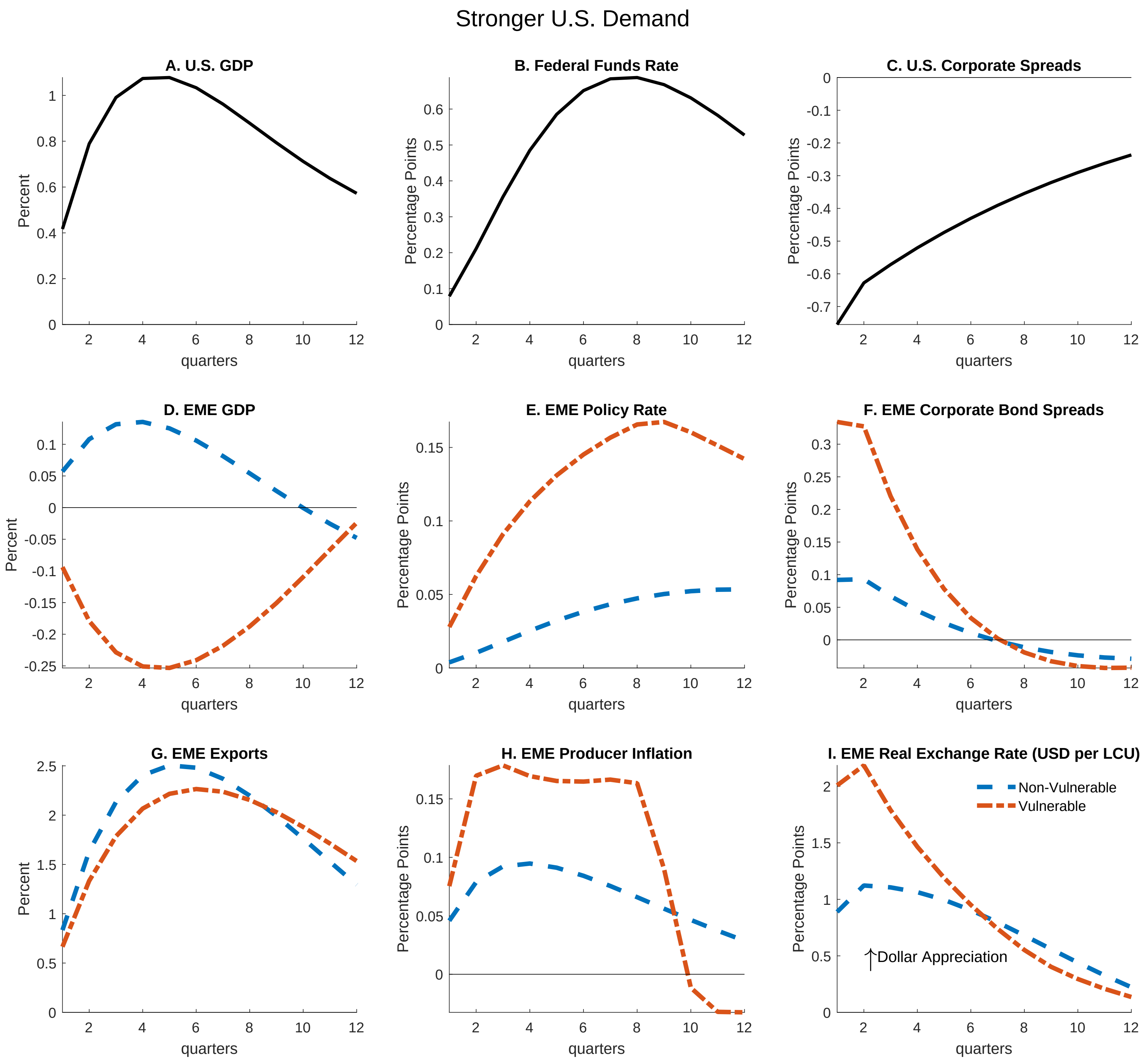


Figure 4. U.S. Demand-Driven Monetary Spillovers: Role of Vulnerabilities

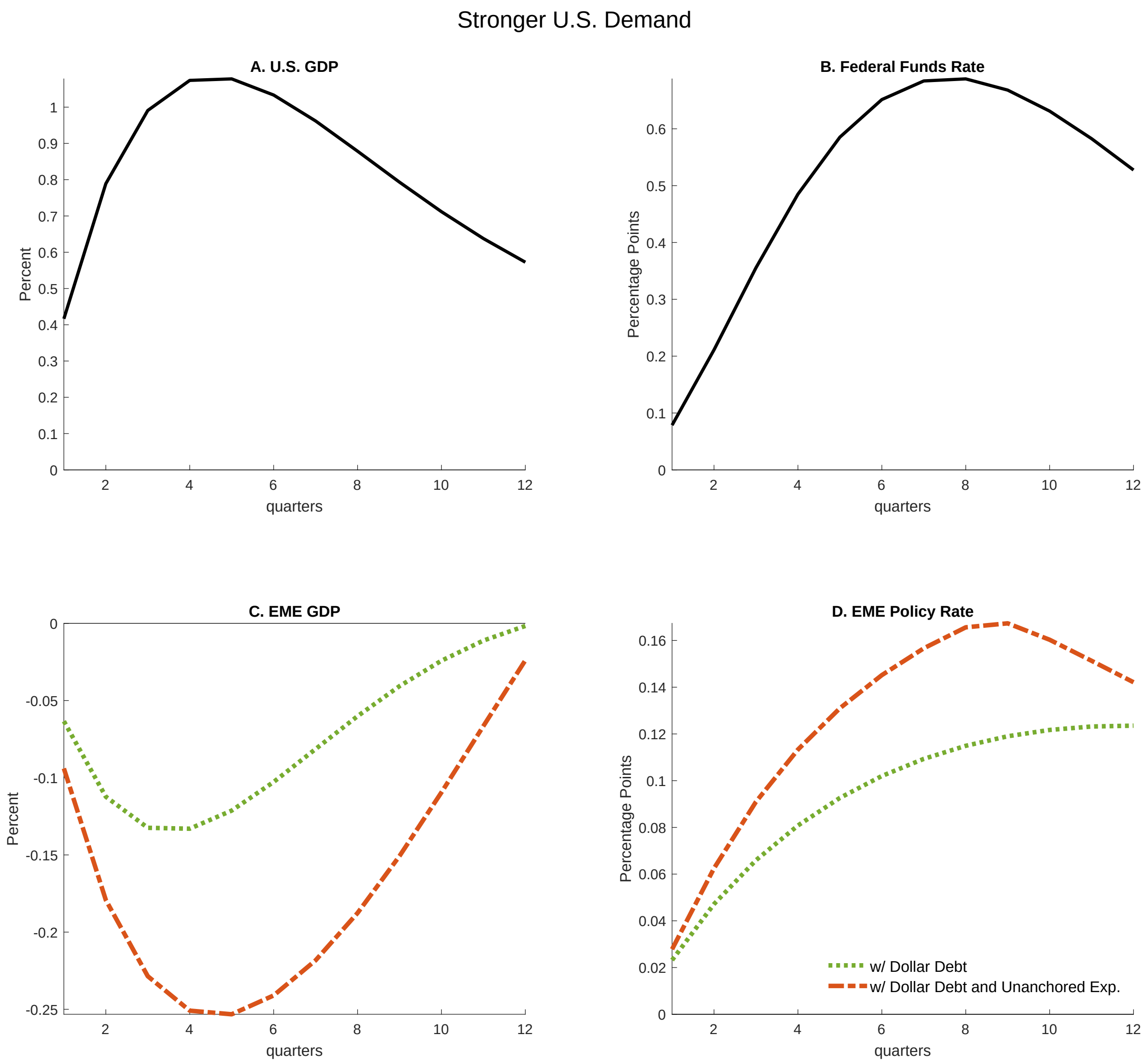


Figure 5. U.S. Monetary Spillovers

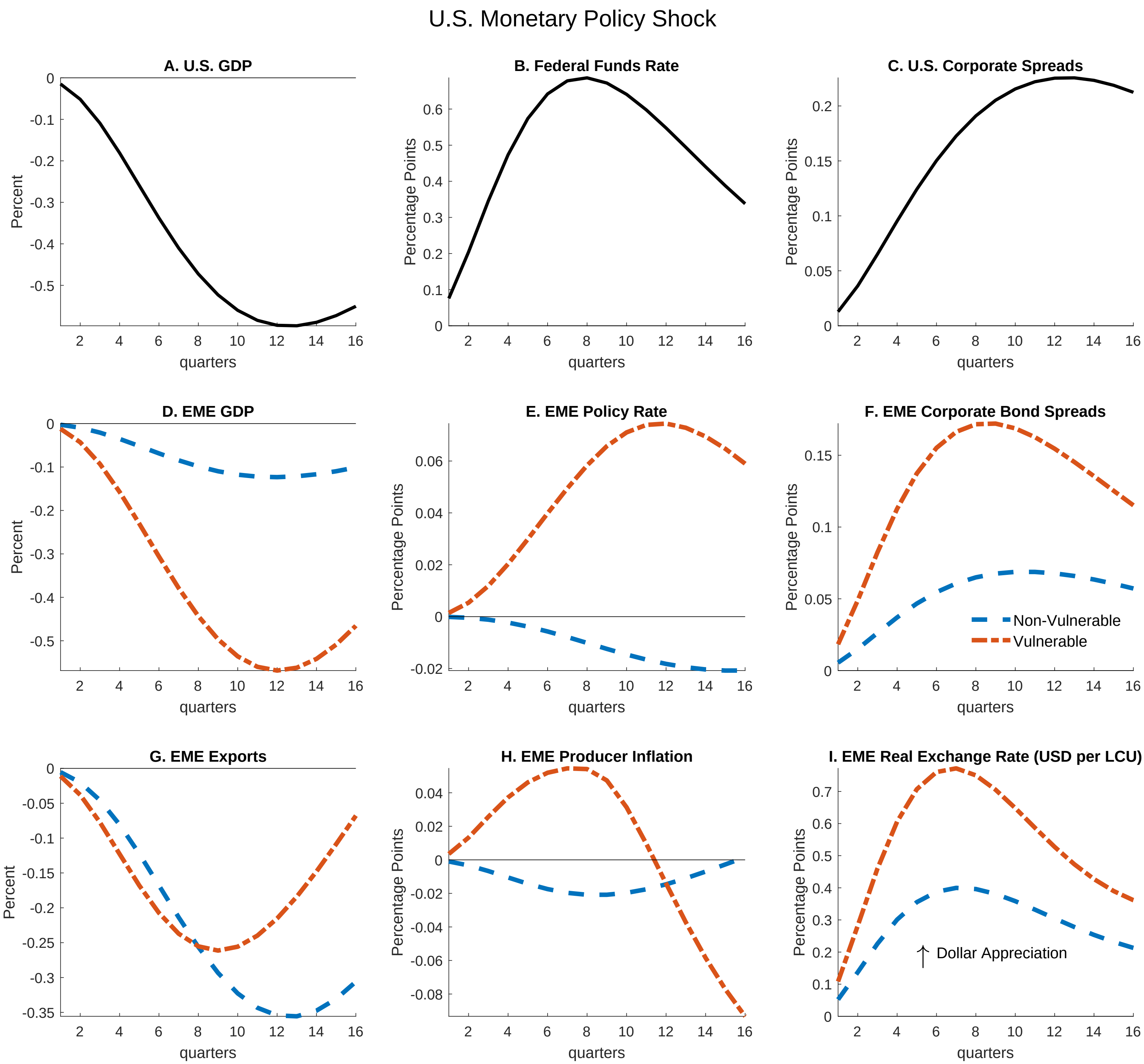
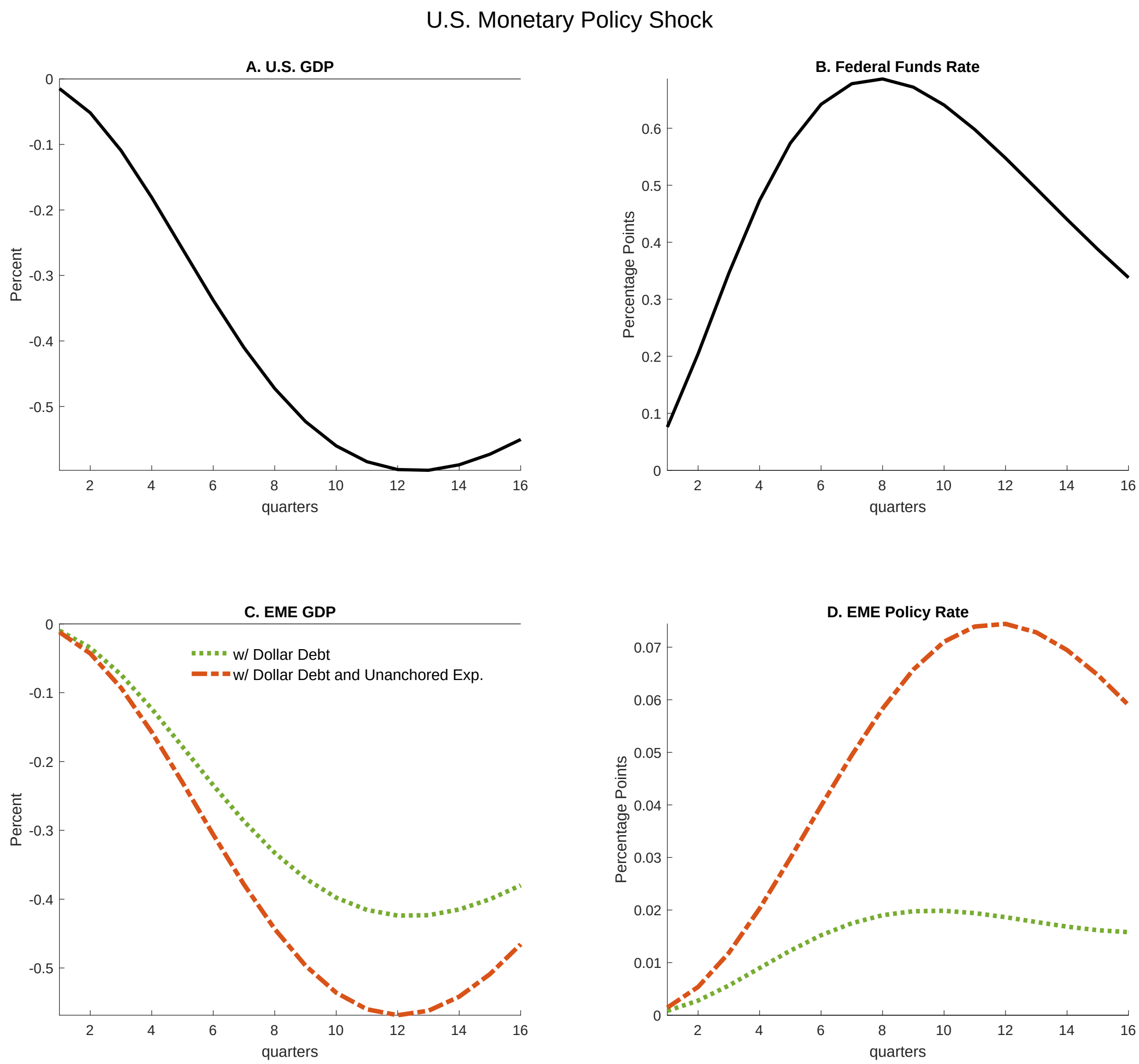


Figure 6. U.S. Monetary Spillovers: Role of Vulnerabilities



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