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U.S. Monetary Policy Spillovers to Emerging Markets: Both Shocks and Vulnerabilities Matter*

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Abstract

Using a macroeconomic model, we explore how sources of shocks and vulnerabilities matter for the transmission of U.S. monetary changes to emerging market economies (EMEs). We utilize a calibrated two-country New Keynesian model with financial frictions, partly-dollarized balance sheets, and imperfectly anchored inflation expectations. Contrary to other recent studies that also emphasize the sources of shocks, our approach allows the quantification of effects on real macroeconomic variables as well, in addition to financial spillovers. Moreover, we model the most relevant vulnerabilities structurally. We show that higher U.S. interest rates arising from stronger U.S. aggregate demand generate modestly positive spillovers to economic activity in EMEs with stronger fundamentals, but can be adverse for vulnerable EMEs. In contrast, U.S. monetary tightenings driven by a more-hawkish policy stance cause a substantial slowdown in activity in all EMEs. Our model also captures the challenging policy tradeoffs that EME central banks face. We show that these tradeoffs are more favorable when inflation expectations are well anchored.

Keywords: Financial Frictions; U.S. Monetary Policy Spillovers; Adaptive Expectations.
JEL classification: E32; E44; F41.

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1 Introduction

The cross-border effects of a shift in the monetary policy stance in the United States have always been a 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 as well as via substantial deviations from uncovered interest parity (UIP) (see Giovanni, Kalemli-Ozcan, Ulu and Baskaya (2017) and Degasperi, Hong and Ricco (2020)).

Typically, such studies focus 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). But another dimension that is gaining prominence in the literature is the extent to which the cross-border spillovers of a monetary tightening in the U.S. may differ depending on the context in which that tightening is taking place. Depending on the shocks prompting U.S. monetary policy changes, the channels through which they transmit to foreign economies may differ. For example, Hoek, Kamin and Yoldas (2020) argue that it matters greatly whether the news about U.S. monetary policy represents a "growth" shock or a "monetary" shock.[2]

Our objective in this paper is to explore the interaction of sources of policy changes and country vulnerabilities in shaping how U.S. monetary policy shifts transmit to foreign economies in a New Keynesian DSGE model. Our model is calibrated to capture empirically relevant features of a wide range of EMEs. We show that higher U.S. interest rates arising from stronger U.S. demand generate modestly positive spillovers to output in economies with stronger fundamentals but can be detrimental for vulnerable EMEs due to tightening of their financial conditions. By contrast, U.S. monetary shocks driven by a more hawkish Fed policy stance cause a slowdown in all EMEs, with the adverse effects being much larger for those with relatively higher vulnerabilities.

While Hoek et al. (2020) use an event-based study to focus on spillovers to EME financial

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

[2] Following Jarociński and Karadi (2020) and Nakamura and Steinsson (2018), Hoek et al. (2020) differentiate between "monetary shocks" and "growth shocks" by analyzing the evolution of U.S. equity prices and yields around FOMC announcements and U.S. employment-report releases.

markets for different types of U.S. interest rate shocks, our DSGE model allows a quantification of the spillovers to real macroeconomic variables as well, which is ultimately what is of most interest. In addition, our model-based approach allows a structural modelling of the vulnerabilities in EMEs that matter most, and thus an assessment of the relative importance of the different underlying channels for non-vulnerable and vulnerable economies. Our model-based results are complementary to and consistent with the conclusions on financial spillovers obtained by Hoek et al. (2020). And, our findings related to the importance of vulnerabilities are also consistent with other evidence in the literature (see, for example, Ahmed et al. (2017), Hoek et al. (2020), and Iacoviello and Navarro (2018)).[3] But, in addition to being able to quantify the effects on real variables and the relative importance of different sources of vulnerabilities, our approach, as discussed below, also gives some additional understanding about the importance of policy credibility and central bank communications.

With respect to modelling the sources of vulnerabilities, the effects of U.S. monetary policy shocks on EMEs may be enhanced by the presence of foreign currency-denominated debt in firms' balance sheets, which render the latter susceptible to domestic currency depreciation.[4] Under these conditions, many EME central banks face pressure to respond by tightening their own monetary policy, in an effort to mitigate capital outflows and currency depreciation.[5] 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.[6] 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. Akinci and Queralto (2019) show that this prescription continues to hold in an economy with imperfect financial intermediation and partly-dollarized balance sheets which features strong financial spillovers, despite the fact that these features might a priori seem to make exchange rate stability especially desirable.[7]

[3]Bowman et al. (2015) reach the same conclusion with respect to the importance of EME vulnerabilities in financial spillovers to emerging markets from unconventional U.S. monetary policy changes.

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

[5]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.

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

[7]The reason is that in this economy, the premium on the domestic currency endogenously rises following

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 many EMEs, especially those without a long experience with inflation targeting regimes and histories of very high inflation episodes. Accordingly, 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).[8] 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 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.

One general implication that emerges from our setting is that global monetary policy spillovers can create significant tradeoffs (understood as the output gap and inflation moving in opposite directions) for EME policymakers, especially in more vulnerable countries, consistent with the discussion above. More specifically, we show how the hybrid belief mechanism can potentially rationalize the response of EME central banks to an advanced-economy monetary tightening described earlier. The intuition 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 hybrid expectations, 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

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.

[8]The mechanism is in the spirit of recent work on "behavioral" approaches to expectation formation—e.g. Gabaix (2020), 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)).

credibility of the central bank's inflation target. In this environment, EME policymakers that aims to stabilize inflation would be forced to raise the policy rate. In recent work, Degasperi et al. (2020) show empirically that fragile EMEs face lower real economic activity and higher CPI inflation in response to unexpected U.S. monetary policy tightening, consistent with our model's predictions. They also show these countries then respond to U.S. tightening by raising short term nominal interest rates, also consistent with the predictions of our model with the hybrid belief mechanism.[9]

We also explore the role of central bank communication about its inflation target in alleviating the tradeoffs faced by EME policy makers in response to a U.S. monetary tightening. More specifically, we now reformulate agents' beliefs about trend inflation such that central bank guidance on inflation has a larger weight in expectation formation, due to, for example, better communication. As we show, more-credible EME central bank communication mitigates the adverse effects of U.S. monetary policy on EME output and improves the tradeoff faced by EME central banks. The reason is that agents now take the announced inflation target more seriously, which in turn limits the impact of a short-lived rise in CPI inflation on agents' beliefs about trend inflation. As a result, the central bank can afford to look through the transient rise in inflation and focus more on the output stabilization objective. The short-term rate then rises much less and output falls less compared to a case with less-credible central bank communication.

The remainder of the paper proceeds as follows: Section 2 lays out some key empirical features of EMEs that help motivate some of our modeling choices, and section 3 presents our model in detail. In section 4 we highlight the role of country vulnerabilities, while section 5 discusses the importance of the sources of U.S. monetary tightenings. After examining the role of central bank communications in section 6, we conclude in section 7.

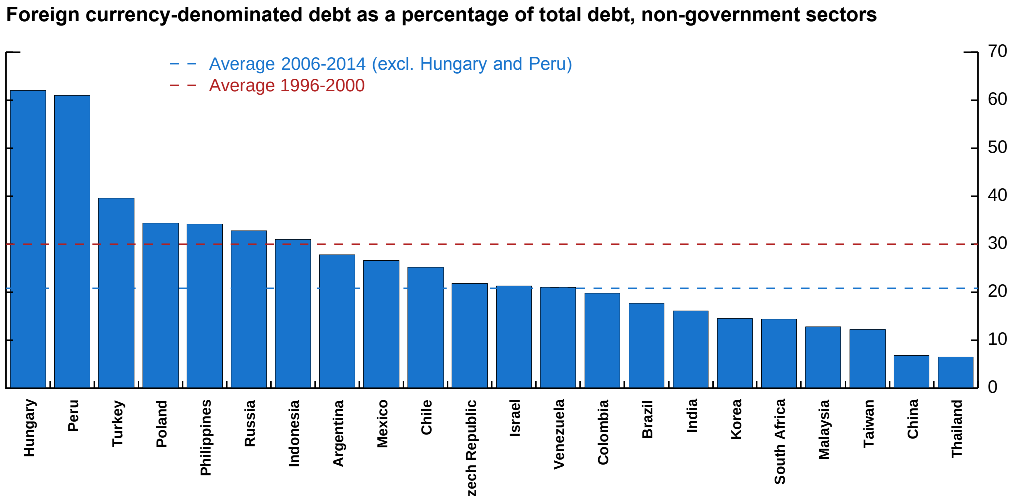
2 Some Key Empirical Features of EMEs

In this section, we lay out some key empirical features of EMEs that will affect the size of spillovers and then discuss some evidence that justifies why inflation expectations may not be fully anchored in many EMEs.

An important channel for cross-border spillovers is fluctuations in the cost of foreign

[9]Note that, as will be clear in the model section, our paper focuses on positive cross-border implications of the U.S. policy tightening under a given policy rule in EMEs that reacts to deviations of the inflation rate from its target and to deviations of the output gap from zero.

Figure 1. Foreign Currency-Denominated Debt in Selected Emerging Economies



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" crises (such as the 1997 Asian crises, or the 2001 Turkish banking crisis). Two features stand out: 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 debt levels than economies known to have stronger macroeconomic fundamentals such as Korea and Taiwan.

Another commonly referred to macroeconomic vulnerability for emerging economies is that inflation expectations in these countries have not been as well-anchored as in small open advanced economies, which have had a longer history of explicit inflation targeting (IT) regimes (see, for example Levin et al. (2004)). Below we document some empirical evidence to argue that inflation expectations are not as well anchored in many EMEs, even those that have adopted IT regimes. We also compare these results on EMEs with that of a group of small open advanced economies to highlight the contrast. This analysis provides some justification for introducing adaptive inflation expectations when characterizing a vulnerable small open EME in our model economy.[10]

[10] Inflation targeting small open advanced economies include Australia, Canada, New Zealand, Sweden, United Kingdom. IT EMEs are Brazil, Chile, Columbia, Czech Republic, Hungary, South Korea, Mexico,

Table 1. 6- to 10-year-ahead expectations (1993-2019)

	(1) Inflation-Targeting AEs	(2) Inflation-Targeting EMEs	(3) All EMEs
$\Delta\bar{\pi}_{it}$	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.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Consensus Economics, London

Our statistical analysis follows the work of Levin et al. (2004). Specifically, we regress the first difference of inflation expectations on the first difference of a 3-year moving average of realized CPI inflation:

$$\Delta\mathbb{E}_t\pi_{t+h,i} = \alpha_i + \beta_i\Delta\bar{\pi}_{t,i} + \epsilon_{t,i} \tag{1}$$

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, London. 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 regression in equation (1) is run as a panel for advanced and emerging economies separately.

Table 1 shows results for small open IT advanced economies (AEs), as well as a group of emerging market economies over the 1993:Q1-2019:Q4 period.[11] For the advanced economies, our evidence suggests that long-run inflation expectations become 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, suggesting expectations are not well anchored. We rerun the regressions for EMEs starting from the date these economies adopted IT regime

Peru, Philippines, Poland, Thailand, Turkey; and other EMEs include Argentina, Indonesia, Malaysia, Romania, Singapore, Slovakia, Taiwan, Ukraine.

[11] Our estimations start from 1993 when most of the countries in our sample adopted IT regimes

Table 2. 6- to 10-year-ahead expectations (2004-2019)

	(1) Inflation-Targeting AEs	(2) Inflation-Targeting EMEs	(3) All EMEs
$\Delta\bar{\pi}_{it}$	0.0222	0.0857*	0.0629*
	(0.67)	(2.28)	(2.22)
Constant	-0.000985	-0.00947	0.00260
	(-0.26)	(-0.60)	(0.11)
Observations	312	798	1122

Dependent variable is $\Delta\mathbb{E}\pi_{i,6,t}$. Linear interpolation to quarterly freq.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Consensus Economics, London

(for the IT EMEs), and the results remain the same.[12]

Table 2 shows results for a panel of countries, as defined before, for the 2004-2019 period. While there is still a positive correlation between the inflation expectations and the actual inflation in the more recent period, the estimated coefficients are smaller and less significant than their full sample counterparts. This result suggests that EMEs have made some progress on achieving monetary policy credibility from their crisis-prone times in the past. In fact, in the case of some EMEs with strong fundamentals this progress may be sufficient to allow them to follow countercyclical monetary policies. That is part of our motivation for distinguishing between vulnerable and non-vulnerable EMEs later and for modeling the non-vulnerable ones as having anchored inflation expectations.

3 Model

Our analysis builds on the model presented 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 as in Akinci and Queralto (2019). More specifically, the model features financial intermediaries (banks, for short) that borrow from domestic households in their own currency and from foreigners in dollars to finance activities of domestic firms. While both types of borrowing are subject

[12] We also run these regressions in levels, truncating the sample to avoid the initial strong disinflation periods in many EMEs in early 1990s. Our results, available upon request, robustly point out that inflation expectations are not well anchored in many EMEs when we use long sample period.

to frictions, the imperfections arising from the latter type of borrowing are more severe, which gives rise to endogenous fluctuations in the domestic borrowing spread and in the UIP deviation. We also include a standard set of nominal and real rigidities in the model: 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).

3.1 Households

Following Erceg, Henderson and Levin (2000), there is a continuum of households indexed by $i \in [0,1]$, each a monopolistic supplier of specialized labor L_{it}. A large number of competitive "employment agencies" combine specialized labor into a homogeneous labor input L_t (in turn supplied to retail firms), according to $L_t = \left(\int_0^1 L_{it}^{\frac{1}{1+\theta_w}} di\right)^{1+\theta_w}$. From employment agencies' cost minimization, demand for labor variety of i is

$$L_{it} = \left(\frac{W_{it}}{W_t}\right)^{-\frac{1+\theta_w}{\theta_w}} L_t, \tag{2}$$

where W_{it} is the nominal wage received by supplier of labor of type i, and the wage paid by goods producers is $W_t = \left(\int_0^1 W_{it}^{-\frac{1}{\theta_w}} dj\right)^{-\theta_w}$.

Household i seeks to solve

$$\max_{\substack{\{C_{Dt+j}, M_{Ct+j}, C_{t+j}, \\ D_{t+j}, W_{it+j}, L_{it+j}\}_{j=0}^{\infty}}} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[\log(C_{t+j} - hC_{t+j-1}) - \frac{\chi_0}{1+\chi} L_{it+j}^{1+\chi} \right] \right\} \tag{3}$$

subject to (2) and to a sequence of budget constraints

$$P_t C_t + P_t D_t + B_t \leq W_{it} L_{it} + P_t R_t D_{t-1} + R_t^n B_{t-1} + \mathcal{W}_{it} + \Pi_t \tag{4}$$

for all t, where C_t and P_t are given, respectively, by

$$C_t = \left[(1-\omega)^{\frac{\rho}{1+\rho}} C_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} (\varphi_{Ct} M_{Ct})^{\frac{1}{1+\rho}} \right]^{1+\rho} \tag{5}$$

$$P_t = \left[(1-\omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right]^{-\rho}. \tag{6}$$

The variable C_t denotes the domestic consumption basket, a CES aggregate of a domestically-produced composite good, C_{Dt}, and an imported composite good, M_{Ct}; D_t is deposits in domestic banks, which pay real (i.e. in terms of the domestic basket) gross interest rate R_t; B_t is holdings of a nominal one-period riskless bond (offered in zero net supply), which pays interest R_t^n (set by the domestic monetary authority) between $t-1$ and t; $\mathcal{W}_{it}$ is the net cash flow from household i's portfolio of state-contingent securities (which ensure that all households consume the same amount C_t, despite earning different wages); and Π_t is bank and firm profits distributed to the household. The variable φ_{Ct} in (5) is given by $\varphi_{Ct} = 1 - \frac{\varphi_M}{2}\left(\frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1\right)^2$, and captures costs of changing the ratio of imports to domestically-produced goods.

The variables P_{Dt} and P_{Mt} denote, respectively, the price of the domestically-produced composite good and of the imported good, and P_t denotes the price of the home consumption basket (i.e. the CPI). In our baseline case, we assume that exporters in each country practice producer currency pricing (PCP):

$$P_{Mt} = e_t^{-1} P_{Dt}^* \tag{7}$$

$$P_{Mt}^* = e_t P_{Dt}, \tag{8}$$

where e_t is the nominal exchange rate (i.e. the price in dollars of a unit of the home currency), P_{Dt}^* is the price of the foreign composite good (in dollars), and P_{Mt}^* is the price of the domestic composite good abroad (throughout, we use * to refer to the foreign economy). The real exchange rate is thus $S_t = e_t P_t / P_t^*$.

For the vulnerable EMs, we will consider the dominant currency paradigm (DCP), consistent with evidence presented in Gopinath et al. (2018). Under DCP, firms in both countries set export prices in U.S. dollars. Thus, U.S. exporters continue to practice PCP, but vulnerable EM producers set one price in domestic currency for goods sold in the domestic market, and another in dollars for goods sold in the United States. Home import prices continue to satisfy $P_{Mt} = e_t^{-1} P_{Dt}^*$, but now each domestic firm j also sets a dollar export price $P_{Mt}^*(j)$ subject to the Calvo price-setting friction. If firm j is not able to reset its export price, it follows indexation rule $P_{Mt}^*(j) = P_{Mt-1}^*(j) \pi_{Mt-1}^{*\iota_p}$, where $\pi_{Mt}^* = P_{Mt}^* / P_{Mt-1}^*$ is export price inflation.

Finally, the household's problem (3) is also subject to a constraint on wage adjustment (nominal wage rigidity), whereby the wage can only be set optimally with probability $1-\xi_w$, and otherwise must follow the indexation rule $W_{it} = W_{it-1} \pi_{wt-1}^{\iota_w}$, where $\pi_{wt} = W_t / W_{t-1}$ is the wage inflation rate.

As in the basic model, the problem facing U.S. households is analogous to (3), with the exception that they can also supply dollar funds D_t^* to EM bankers, at interest rateR_t^*. Other than the features discussed above and its inflation expectations being well-anchored, the U.S. economy mirrors the features of the home country.

3.2 Bankers

The representative household has two types of members: workers and bankers, with measures $1-f$ and f respectively. There is random turnover between bankers and workers: bankers alive in period t survive into $t+1$ with exogenous probability $\sigma_b > 0$, and become workers with complementary probability. Workers become bankers with probability $(1-\sigma_b)\frac{f}{1-f}$, so there is a measure $(1-\sigma_b)f$ of new bankers each period, exactly offsetting the number that exit. Entrant bankers receive a small endowment in the form of fraction $\frac{\xi_b}{f}$ of the value of the capital stock.

Banker i's balance sheet identity is

$$Q_t A_{it} = D_{it} + S_t^{-1} D_{it}^* + N_{it}, \tag{9}$$

where A_{it} is the banker's claims on domestic non-financial firms, which have price Q_t, and N_{it} is the banker's net worth. A continuing banker's budget constraint, expressed in (real) domestic currency, is

$$Q_t A_{it} + R_t D_{it-1} + R_t^* S_t^{-1} D_{it-1}^* \leq R_{Kt} Q_{t-1} A_{it-1} + D_{it} + S_t^{-1} D_{it}^*. \tag{10}$$

The left-hand side of (10) is banker i's uses of funds, consisting of loans to non-financial firms ($Q_t A_{it}$) plus deposit payments inclusive of interest (both domestic, $R_t D_{it-1}$, and foreign, $R_t^* S_t^{-1} D_{it-1}^*$, where R_t and R_t^* denote the gross local-currency and dollar interest rate respectively). The right-hand side is the source of funds, including returns from past loans (the first term) plus deposits issued (to domestic residents and to foreign households: second and third term, respectively). Given frictionless contracting between banks and domestic non-financial firms, the gross return R_{Kt} satisfies

$$R_{Kt} = \frac{Z_t + (1-\delta)Q_t}{Q_{t-1}}, \tag{11}$$

where Z_t is the (real) capital rental rate and δ is capital's depreciation rate.

Combining (9) and (10) yields the evolution of banker i's net worth, conditional on his or her survival into $t+1$:

$$N_{it+1} = (R_{Kt+1} - R_{t+1})Q_t A_{it} + \left(R_{t+1} - R^*_{t+1} S_t / S_{t+1}\right) S_t^{-1} D^*_{it} + R_{t+1} N_{it}. \tag{12}$$

Banker i's objective is

$$V_{it} = \max_{A_{it}, D^*_{it}} \; (1-\sigma_b)\mathbb{E}_t\left(\Lambda_{t,t+1} N_{it+1}\right) + \sigma_b \mathbb{E}_t\left(\Lambda_{t,t+1} V_{it+1}\right) \tag{13}$$

subject to (12) and

$$(1-\sigma_b)\mathbb{E}_t\left(\Lambda_{t,t+1} N_{it+1}\right) + \sigma_b \mathbb{E}_t\left(\Lambda_{t,t+1} V_{it+1}\right) \geq \Theta(x_{it}) Q_t A_{it}, \tag{14}$$

where $x_{it} \equiv S_t^{-1} D^*_{it} / Q_t A_{it}$ and $\Lambda_{t,t+1}$ is the domestic household's real stochastic discount factor between t and $t+1$. Equation (14) is the incentive constraint. We assume $\Theta(x_t)$ is quadratic: $\Theta(x_t) = \theta\left(1 + \frac{\gamma}{2} x_{it}^2\right)$.

All bankers choose the same ratio of dollar debt to assets: $x_{it} = x_t \; \forall i$. The associated first order condition is

$$\varrho_t = \left(\frac{\Theta(x_t)}{\Theta'(x_t)} - x_t\right)^{-1} \mu_t, \tag{15}$$

where ϱ_t and μ_t are given by

$$\varrho_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\Omega_{t+1}\left(R_{t+1} - R^*_{t+1} S_t / S_{t+1}\right)\right] \tag{16}$$

$$\mu_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\Omega_{t+1}(R_{Kt+1} - R_{t+1})\right], \tag{17}$$

with

$$\Omega_t = 1 - \sigma_b + \sigma_b\left[\nu_t + \left(\mu_t + \mu^*_t x_t\right)\phi_t\right], \tag{18}$$

$$\nu_t = \mathbb{E}_t\left(\Lambda_{t,t+1}\Omega_{t+1}\right) R_{t+1}. \tag{19}$$

The leverage ratio $\phi_{it} = Q_t A_{it} / N_{it}$ is also common across bankers and satisfies

$$\phi_t = \frac{\nu_t}{\Theta(x_t) - (\mu_t + \mu^*_t x_t)}. \tag{20}$$

Note that bankers discount future returns using an "augmented" discount factor $\Lambda_{t+1}\Omega_{t+1}$, which accounts for next period's marginal value of funds internal to the bank (given by the variable Ω_{t+1}). From equation (20), the leverage ratio ϕ_t is increasing in ν_t, the saving to the bank in deposit costs from an extra unit of net worth, and in $\mu_t + \varrho_t x_t$, the discounted total excess return on the bank's assets; and decreasing in the fraction of funds banks are able to divert, $\Theta(x_t)$.

Given that banks' leverage ratio ϕ_t and foreign funding ratio x_t do not depend on bank-specific factors, aggregating across banks yields the following relationships between the EM's aggregate assets and foreign debt ($A_t = \int_0^f A_{it} di$ and $D_t^* = \int_0^f D_{it}^* di$ respectively) and aggregate net worth $N_t = \int_0^f N_{it} di$:

$$Q_t A_t = \phi_t N_t, \tag{21}$$

$$S_t^{-1} D_t^* = x_t \phi_t N_t. \tag{22}$$

If bank i is a new entrant, its net worth is given by $N_{it} = \frac{\xi_b}{f} Q_{t-1} A_{t-1}$. Using this condition and (12), aggregating N_{it} across all banks (continuing ones and new entrants) yields the evolution of aggregate net worth:

$$N_t = \sigma_b \left[(R_{Kt} - R_t) Q_{t-1} A_{t-1} + (R_t - R_t^* S_{t-1}/S_t) S_{t-1}^{-1} D_{t-1}^* + R_t N_{t-1} \right] + (1 - \sigma_b) \xi_b Q_{t-1} A_{t-1}. \tag{23}$$

3.3 Firms

There is a continuum of mass unity of retail firms that are subject to pricing frictions. Final output Y_t is a CES composite of retailers' output: $Y_t = \left(\int_0^1 Y_{jt}^{\frac{1}{1+\theta_p}} dj \right)^{1+\theta_p}$, where Y_{jt} is output by retailer $j \in [0,1]$. Let the price set by retailer j be P_{Djt}. The price level of domestic final output is $P_{Dt} = \left(\int_0^1 P_{Djt}^{-\frac{1}{\theta_p}} dj \right)^{-\theta_p}$. Cost minimization by users of final output yields the following demand function for firm j's output: $Y_{jt} = \left(\frac{P_{Djt}}{P_{Dt}} \right)^{-\frac{1+\theta_p}{\theta_p}} Y_t$.

Retailer i uses capital K_{jt} and labor L_{jt} as inputs to produce output Y_{jt}, by means of the production function

$$Y_{jt} = K_{jt}^{\alpha} L_{jt}^{1-\alpha}. \tag{24}$$

The (real) labor and capital rental rates are W_t/P_t and Z_t respectively. Firm j can reset its price with probability $1-\xi_p$, and otherwise must follow the indexation rule $P_{Djt} = P_{Djt-1}\pi_{t-1}^{\iota_p}$, where $\pi_t = P_{Dt}/P_{Dt-1}$ is inflation of domestically-produced goods.

3.4 Capital Producers

The domestic representative capital good producer uses domestic output to produce capital goods, subject to costs of adjusting the level of investment I_t given by $\phi_{It} = \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}}-1\right)^2 I_t$ and expressed in units of the home good. The representative capital producer solves

$$\max_{\{I_{t+j}\}_{j=0}^{\infty}} \quad \mathbb{E}_t\left\{\sum_{j=0}^{\infty}\Lambda_{t,t+j}\left[Q_{t+j}I_{t+j}-\frac{P_{Dt+j}}{P_{t+j}}\phi_{It+j}\right]\right\} \tag{25}$$

where Q_t denotes the real (i.e. in units of the home consumption basket) price of the capital good. Similar to consumption, investment goods are a composite of domestic (I_{Dt}) and imported (M_{It}) goods, also subject to costs of adjusting the imported-domestic good mix:

$$I_t = \left[(1-\omega)^{\frac{\rho}{1+\rho}} I_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}}\left(\varphi_{It}M_{It}\right)^{\frac{1}{1+\rho}}\right]^{1+\rho}, \tag{26}$$

with $\varphi_{It} = 1-\frac{\varphi_M}{2}\left(\frac{M_{It}/I_{Dt}}{M_{It-1}/I_{Dt-1}}-1\right)^2$.

Optimality with respect to the investment aggregate I_t gives rise to an investment–Tobin's Q relation:

$$Q_t = 1+\frac{P_{Dt}}{P_t}\left[\psi_I\left(\frac{I_t}{I_{t-1}}-1\right)\frac{I_t}{I_{t-1}}+\frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}}-1\right)^2\right]-\mathbb{E}_t\left\{\Lambda_{t,t+1}\frac{P_{Dt+1}}{P_{t+1}}\psi_I\left(\frac{I_{t+1}}{I_t}-1\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right\} \tag{27}$$

3.5 Market Clearing, Balance of Payments, and Monetary Policy

The market clearing condition for the home good is as follows:

$$Y_t = C_{Dt}+I_{Dt}+\phi_{It}+\frac{\xi^*}{\xi}\left(M_{Ct}^*+M_{It}^*\right), \tag{28}$$

where ξ^* and ξ, are, respectively, the population sizes of the foreign and home economies (note that all variables are expressed in per-capita terms). Home output is either used domestically (for consumption or investment) or exported. Capital and labor market clearing require $K_t = \int_0^1 K_{jt}dj$ and $L_t = \int_0^1 L_{jt}dj$, respectively. The aggregate capital stock evolves according to $K_{t+1} = (1-\delta)K_t + I_t$. In turn, market clearing for claims on EM physical capital (held by EM banks) requires $A_t = (1-\delta)K_t + I_t$.

The balance of payments, obtained by aggregating the budget constraints of agents in the home economy, is given by

$$D_t^* - R_t^* D_{t-1}^* = S_t \left[\frac{P_{Mt}}{P_t}(M_{Ct} + M_{It}) - \frac{P_{Dt}}{P_t}\frac{\xi^*}{\xi}(M_{Ct}^* + M_{It}^*) \right]. \tag{29}$$

Equation (29) states that the EME's net accumulation of foreign liabilities, expressed in (real) dollars, equals the negative of the value of net exports.

We assume that monetary policy in the home country follows an inertial Taylor rule:

$$R_{t+1}^n = \left(R_t^n\right)^{\gamma_r} \left(\beta^{-1}\pi_t^{\gamma_\pi} x_t^{\gamma_x}\right)^{1-\gamma_r} \varepsilon_t^r, \tag{30}$$

where the monetary policy rate reacts only to domestic inflation and output gap. The parameter ε_t^r is an exogenous shock, and x_t refers to the output gap.[13]

3.6 Unanchored Inflation Expectations

To better capture the policy tradeoffs faced by vulnerable EMEs, we modify the inflation expectation formation process in the model economy just described to incorporate the possibility of imperfectly anchored inflation expectations, along the lines of Arias et al. (2016) and Ajello et al. (2020). Specifically, we assume that inflation expectations are formed in an "adaptive" manner, and are thus affected to some extent by realized inflation. Note that we assume expectation formation for all the model variables but inflation to be fully rational. Therefore, only the equations that involve inflation expectations will be modified.

Our key motivation for modifying the inflation expectation process is that as shown in Section (2), longer-run inflation expectations, particularly in the EMEs, are influenced by a range of factors beyond the central bank's inflation target, including realized inflation. Accordingly, we consider the possibility that high realized "headline" inflation in vulnerable EMEs is the catalyst for a rise in longer-run inflation expectations. To implement this, we

[13] Compared to a Taylor rule specification that assigns some weight to exchange rate stabilization, this specification helps us better highlight the policy tradeoffs faced by EME central banks with deanchored inflation expectations in response to foreign monetary policy shocks. Any tradeoff in our model then arises endogenously due to the underlying vulnerabilities of EMEs, rather than due to an assumption that monetary policy responds to the exchange rate.

assume that agents form inflation expectations according to:

$$\tilde{\mathbb{E}}_t \left\{\hat{\pi}_{t+1}\right\} = \iota \frac{1}{k} \sum_{j=0}^{k-1} \hat{\pi}_{ct-j} + (1-\iota)\mathbb{E}_t \left\{\hat{\pi}_{t+1}\right\}, \tag{31}$$

where $\mathbb{E}$ denotes the "rational" (i.e. model-implied) expectations operator, and $\tilde{\mathbb{E}}$ is its "adaptive" counterpart. The variable π_{ct} denotes "headline" inflation, given by $\pi_{ct} = \frac{\pi_t}{p_{Dt}/p_{Dt-1}}$. We set $k = 8$, implying that agents consider the average headline inflation realization over the past two years in forming their expectations.

In the baseline model described above, one can write the equations for inflation determination under the Calvo pricing assumption as:

$$\pi_t^{-\frac{1}{\theta_p}} = (1-\xi_p)(\pi_t^o)^{-\frac{1}{\theta_p}} + \xi_p \pi_{t-1}^{-\frac{\iota_p}{\theta_p}} \tag{32}$$

$$\pi_t^o = (1+\theta_p)\frac{x_{1t}}{x_{2t}}\pi_t \tag{33}$$

$$x_{1t} = C_t^{\frac{-1}{\sigma}} mc_t Y_t + \beta\xi_p \pi_t^{-\iota_p \frac{(1+\theta_p)}{\theta_p}} \mathbb{E}_t \left(x_{1t+1} \pi_{t+1}^{\frac{1+\theta_p}{\theta_p}} \right) \tag{34}$$

$$x_{2t} = C_t^{\frac{-1}{\sigma}} p_{Dt} Y_t + \beta\xi_p \pi_t^{\iota_p \left(1-\frac{1+\theta_p}{\theta_p}\right)} \mathbb{E}_t \left(x_{2t+1} \pi_{t+1}^{\frac{1+\theta_p}{\theta_p}-1} \right) \tag{35}$$

where π_t is the domestic price inflation (recall that the relative price of domestic goods is denoted by $p_{Dt} = P_{Dt}/P_t$), and mc_t is marginal cost for domestic firms. All other variables and parameters are as defined in Section (3.3).

Equation (32) results from assuming that if firm i does not reset the price in period t, it automatically sets price $p_{Dt}(i) = \pi_{t-1}^{\iota_p} \overline{\pi}^{1-\iota_p} p_{D,t-1}(i)$; 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.

One can easily show that with fully rational expectations, the linearized New Keynesian Phillips Curve (NKPC) takes the following form:

$$\hat{\pi}_t = \frac{\kappa}{1+\beta\iota_p}\left(\hat{mc}_t - \hat{p}_{dt}\right) + \frac{\iota_p}{1+\beta\iota_p}\hat{\pi}_{t-1} + \frac{\beta}{1+\beta\iota_p}\mathbb{E}_t\left\{\hat{\pi}_{t+1}\right\} \tag{36}$$

where $\kappa \equiv \frac{(1-\xi_p)(1-\beta\xi_p)}{\xi_p}$, and all variables are expressed as log deviations from their respective steady states (and denoted by hat).

Under adaptive expectations, we consider two modifications to (36). First, we replace the rational expectation in (36) (the last term) with its adaptive counterpart in (31). Second, we assume that firms not resetting their price also index to headline inflation, rather than domestic inflation. Thus, the indexation term in Equation (36) is replaced by $\hat{\pi}_{c-1}$. We also set $\iota_p = 1$. The resulting NKPC takes the following form:

$$\hat{\pi}_t = \frac{\kappa}{1+\beta}\left(\hat{mc}_t - \hat{p}_{dt}\right) + \frac{1}{1+\beta}\hat{\pi}_{ct-1} + \iota\frac{1}{k}\sum_{j=0}^{k-1}\hat{\pi}_{ct-j} + \frac{\beta(1-\iota)}{1+\beta}\mathbb{E}_t\left\{\hat{\pi}_{t+1}\right\} \tag{37}$$

Below, we will assume that inflation dynamics for vulnerable EMEs are characterized by the equation above. In contrast to standard versions of the NKPC, equation (37) features greater weight on backward-looking inflation terms, due to the nature of the adaptive expectations in (31). These backward-looking terms capture not only domestic-good inflation, but overall headline inflation (due to the assumed effect of the latter on expectations). In addition, the weight on the forward-looking inflation term in (37) is lower than in the standard NKPC.[14] Overall, the formulation is meant to capture the notion that in this economy inflation expectations are not well anchored, and therefore a bout of temporary inflation pressures can make agents doubt the degree of commitment to price stability of the CB—and therefore expect higher future domestic inflation as well. In this way temporary inflationary pressures (due to, for example, currency depreciation) can become "entrenched" and feed into actual inflation.

3.7 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 EMEs.[15] 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 EMEs and advanced economies, such as faster prospective trend growth in EMEs.

[14] This feature of our model resembles Gabaix (2020)'s behavioral model "cognitive discounting" in expectations formation.

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

Table 3 reports parameter values, and Table 4 displays key long run variables from data that we target in the calibration. We consider two different calibrations of the EME bloc: a baseline case in which borrower balance sheets are strong (in the sense that they have very low levels of dollar-denominated debt) and another with fragile balance sheets, with considerable levels of dollar debt. We first describe the baseline case and then discuss the "fragile" calibration—the latter will be another important feature characterizing EME vulnerabilities. In our framework, underlying vulnerabilities cause amplification of the shocks in the vulnerable group of countries, causing a differential response of real and financial variables in that bloc compared with their non-vulnerable counterparts.

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 2.3 % per year for home economy. This target rate is smaller than the estimates of Mexico's long-run natural rate of 3% per year. The size of the home economy relative to the United States is $\xi/\xi^* = 0.68$.

The capital share (α) and capital depreciation rate (δ) are calibrated to the conventional 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 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 3.

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 $\omega = 0.14$, implying that 14 percent of the home economy's output is exported in steady state, as shown in Table 4, consistent with evidence. This value is 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 EMEs (for example, aggregating across the major EMEs in Asia and Latin America leads to a ratio of around 0.10 for 2017).[16] The trade

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

Table 3. Model Calibration

Parameter	**Symbol**	**Home**	**U.S.**
Conventional Parameters			
Home discount factor	β	0.9943	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	ω	0.14	0.095
Relative home size	ξ/ξ^*	0.68	
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	-
Taylor rule coefficients			
	γ_r	0.90	0.82
	γ_π	1.50	1.50
	γ_x	0.025	0.25
Financial Sector Parameters			
Bank survival rate	σ_b	0.95	0.98
Bank fraction divertable	θ	0.41	0.40
Bank transfer rate	ξ_b	0.075	0.10
Home bias in bank funding	γ	2.58	-

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.

The Taylor rule both at home and in the U.S. features inertia with a coefficient of 0.90 and 0.82, respectively, an estimate for the latter are taken from Justiniano et al. 2010. In our baseline experiments we set the home and U.S. Taylor rule coefficients, γ_π and γ_π^*, to the standard value of 1.5, capturing a rule focused on stabilizing domestic inflation. We set the coefficients on output gap, γ_x^*, to 0.25 for the U.S., a conventional value used in the

Trade statistics.

Table 4. Calibration Targets

Variables and Symbols	**Home: Baseline**	**Home: Vulnerable**	**U.S.**
Real interest rate, R, ann. %	2.275	3.6	2
Foreign funding ratio, x, %	5	28	–
Leverage ($\phi = QK/N$)	5	5	4
Noncore funding ratio, %	6	35	–
Credit Spread, $(\text{ER}_K - R), ann.\ bpt$	200	200	75
Exports/GDP, %	14	14	9

literature (e.g. Taylor 1993). The home country features a smaller weight on the output gap than in the U.S., consistent with estimates presented in Leibovici (Second Quarter 2019) who show that the Taylor rule coefficient on the output gap takes a wide range of values but, on average, is close to zero in a group of emerging countries.

Regarding the parameters governing financial market frictions, we calibrated U.S. 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 around 5, and a ratio of foreign-currency debt to total debt (i.e., the non-core funding ratio $(D^*/(D^* + SD))$ of 6 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,[17] but the corporate sector features a much lower ratio of assets to equity (between two and three in emerging markets).[18] Our target of five reflects a compromise between these two values. Finally, for non-vulnerable EMEs the ratio of foreign-currency deposits to total assets (i.e., the foreign funding ratio) is around 5 percent, consistent with evidence presented in Chui et al. (2016). These targets imply $\theta = 0.41, \xi_b = 0.075$, and $\gamma = 2.58$. Financial variables for the U.S. are calibrated similarly to match the corresponding targets depicted in Table 4.

The calibration for vulnerable EMEs is different from non-vulnerable EMEs on two grounds. First, we calibrate the home discount factor to get a real interest rate of 3.6 percent in vulnerable EMEs, slightly higher than neutral real rate estimate for Mexico discussed before. This parameter value, along with the financial sector parameters discussed

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

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

before, implies a ratio of foreign-currency debt to total debt of 35 percent. Second, we calibrate ι in Equation (31) to 0.9, so that inflation expectations in the adaptive case are mostly backward-looking.

4 The Role of Country Vulnerabilities

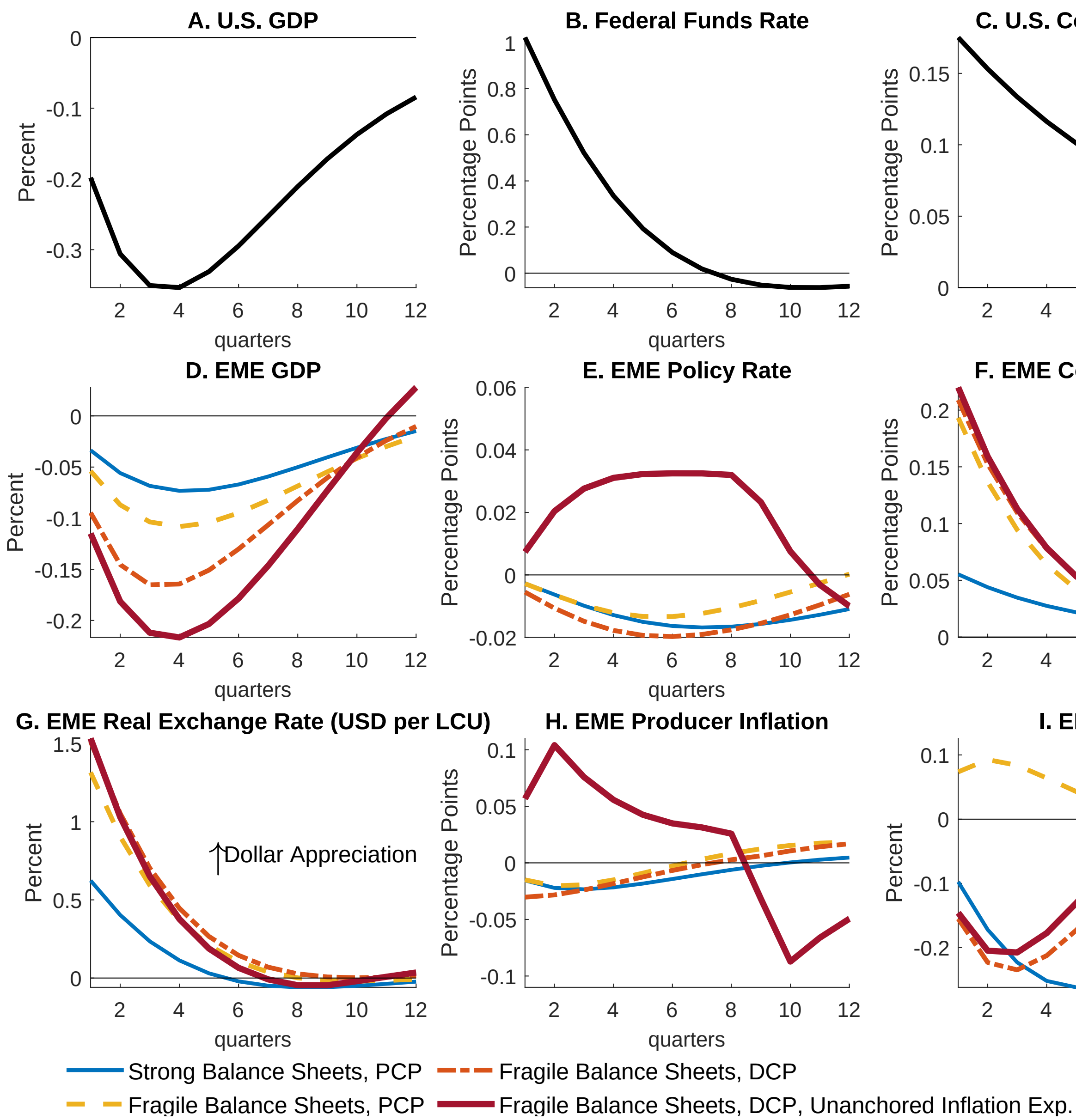
We begin our analysis by presenting the effects of a 100 basis point unexpected and exogenous U.S. monetary tightening, and show how the shock interacts with the potential country vulnerabilities outlined before. In order to clarify the role of each vulnerability in our model economy, Figure 2 shows the effect of the shock when each of the underlying vulnerabilities is added one at a time. More specifically, we first show the effect of the U.S. monetary policy shock on an EME with strong private balance sheets (i.e., with very low levels of currency mismatch) and under the PCP assumption. Second, we discuss the role of fragile balance sheets in amplifying the impact of the shock. Third, we allow for the fact that many emerging economies invoice their exports in dollars, and show the implied dynamics in this case. Finally, we add the presence of imperfectly anchored inflation expectations.

The black solid lines in the first row of Figure 2 show the effects of the Fed funds rate hike on the U.S economy. Overall, the shock has empirically realistic effects on the United States, with U.S. GDP falling around 0.35 after a year—close to the structural vector autoregression (SVAR) estimate presented in Akinci and Queralto (2019), and broadly similar to those found by other authors, like Christiano et al. (2005). Financial conditions tighten in the United States (as seen in the third panel showing an increase in U.S. corporate credit spreads), consistent with the evidence in Rey (2015) and Gertler and Karadi (2015).

Moving to the cross-border spillover effects of the shock, a first key observation from the figure is that the effects of the U.S. tightening on activity in the EME with strong balance sheets are modest, with GDP falling by slighlty more than 0.05 percent (second row, first column). The reason is that the tightening of EME financial conditions is fairly limited in this case, as balance sheets are not very vulnerable to currency depreciation. In addition, the EME central banks can afford to cut rates somewhat, without fears of the adverse effects of exchange rate depreciation on their economies.

With fragile balance sheets (yellow dashed line), the U.S. monetary tightening triggers a noticeably larger increase in EME credit spreads and a larger depreciation of EME currencies, as well as a bigger hit to GDP. As in Akinci and Queralto (2019), a strong three-way interaction between balance sheets, financial conditions, and currency values, magnifies the

Figure 2. U.S. Monetary Shock and Country Vulnerabilities



Note: The black lines in the first row show the effects on the U.S. economy of a monetary shock that raises the federal funds rate by 100 basis points on the U.S. economy. The colored lines in the middle and bottom rows show the effects on EMEs under different assumptions on their vulnerabilities.

effect of the shock. The resulting financial tightening lowers domestic absorption through a slowdown in investment spending, despite a much stronger offset from exports due to the sharper depreciation.

We next consider the role of dollar trade invoicing in shaping the effects of the shock.

Under fragile balance sheets and DCP, EME GDP drops by about 0.15 percent (dash-dotted orange line)—considerably more than under PCP. The reason for the larger hit to activity is that under DCP, the currency depreciation of the home currency fails to translate into lower prices of home goods abroad, and thus its benefits in terms of boosting exports are sharply diminished: observe that now EME exports decline sharply, in contrast to a slight increase in the PCP case. Put differently, under fragile balance sheets and DCP, the home economy's output suffers the costs of a depreciating currency (which work to depress domestic absorption via the financial feedback effects described earlier) without any of the potential benefits (arising due to a boost in exports).[19]

Finally, in the presence of unanchored inflation expectations, the drop in EME GDP is larger still, about 0.25 percent—nearing the drop in U.S. GDP itself. The EME central bank faces a worsened tradeoff in this case, as the large exchange rate depreciation feeds into actual domestic producer inflation via an increase in inflation expectations. EME central banks are forced to tighten policy to fight inflationary pressures, causing output to be much harder hit in response to the U.S. tightening.

5 Sources of U.S. Monetary Tightening and Spillovers

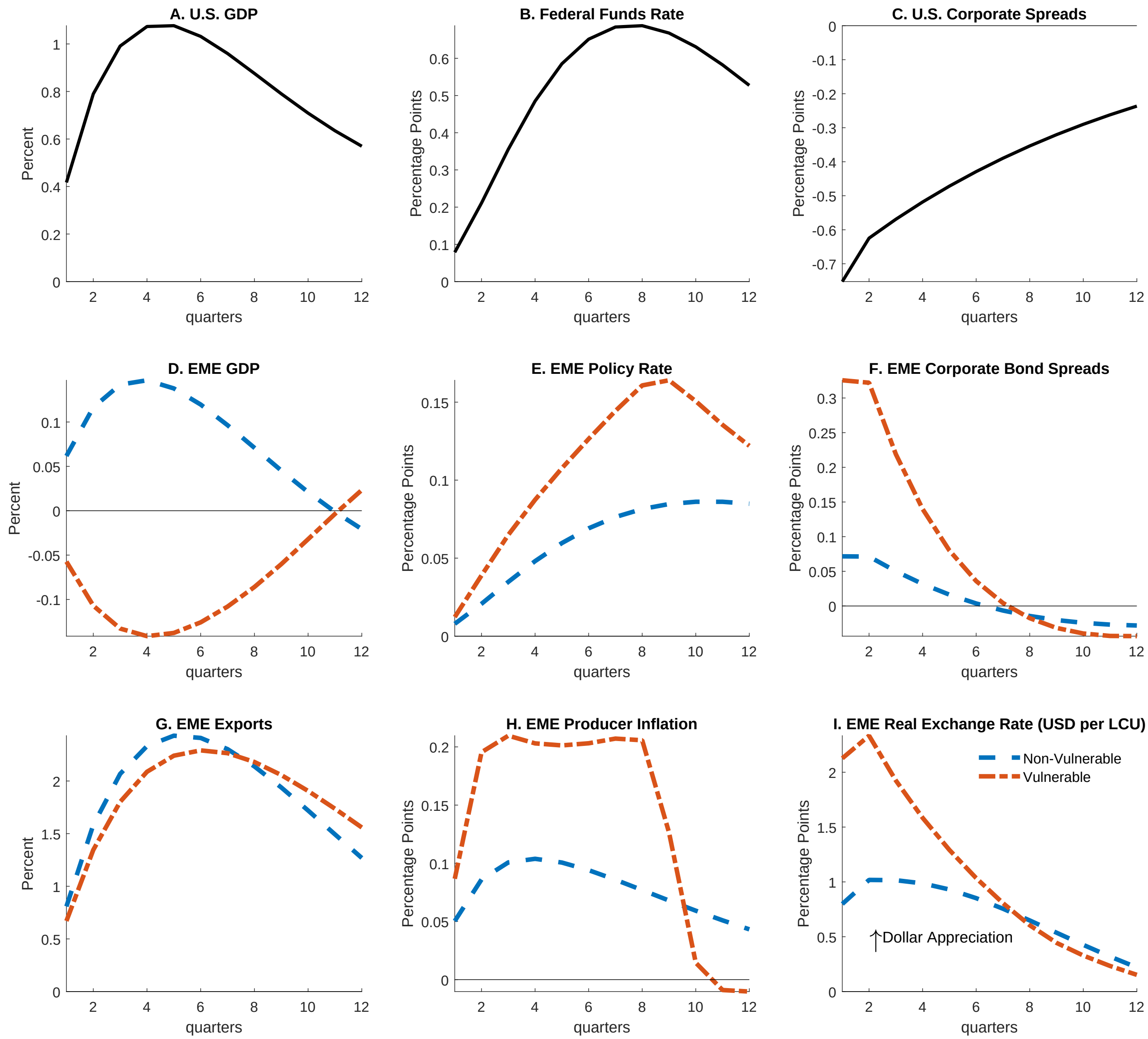
The purpose of this section is to explore how spillovers from U.S. interest rate increases to EMEs depend on the shock driving the U.S. monetary action, and how that interacts with EMEs' own vulnerabilities. Thus, we consider the effects on what we call "non-vulnerable" EMEs, as well as on "vulnerable" ones. The first group is characterized by strong balance sheets, well-anchored inflation expectations, and domestic-currency export pricing (as in the thin blue line in Figure 2). The second group is characterized by fragile balance sheets with considerable levels of dollar-denominated debt, poorly anchored inflation expectations, and dollar export pricing (as in the thick red line in Figure 2).

We begin by exploring U.S. demand-driven monetary spillovers, as depicted in Figure 3. In this experiment, we assume that U.S. economy experiences a boost in domestic aggregate demand (driven by both higher consumption and investment) that increases U.S. GDP by 1 percent after a year.[20] As shown in the first row of panels, this implies that Fed tightens the monetary policy stance gradually by about 70 basis points after two years. As shown in

[19] This finding is consistent with evidence in Shousha (2019).

[20] We engineer this scenario by adding a positive shock to U.S. households' marginal utility of consumption, which boosts desired consumption demand, as well as a positive impulse to U.S. banks' equity values, leading to a rise in investment spending.

Figure 3. U.S. Monetary Tightening Driven By Stronger U.S. Aggregate Demand

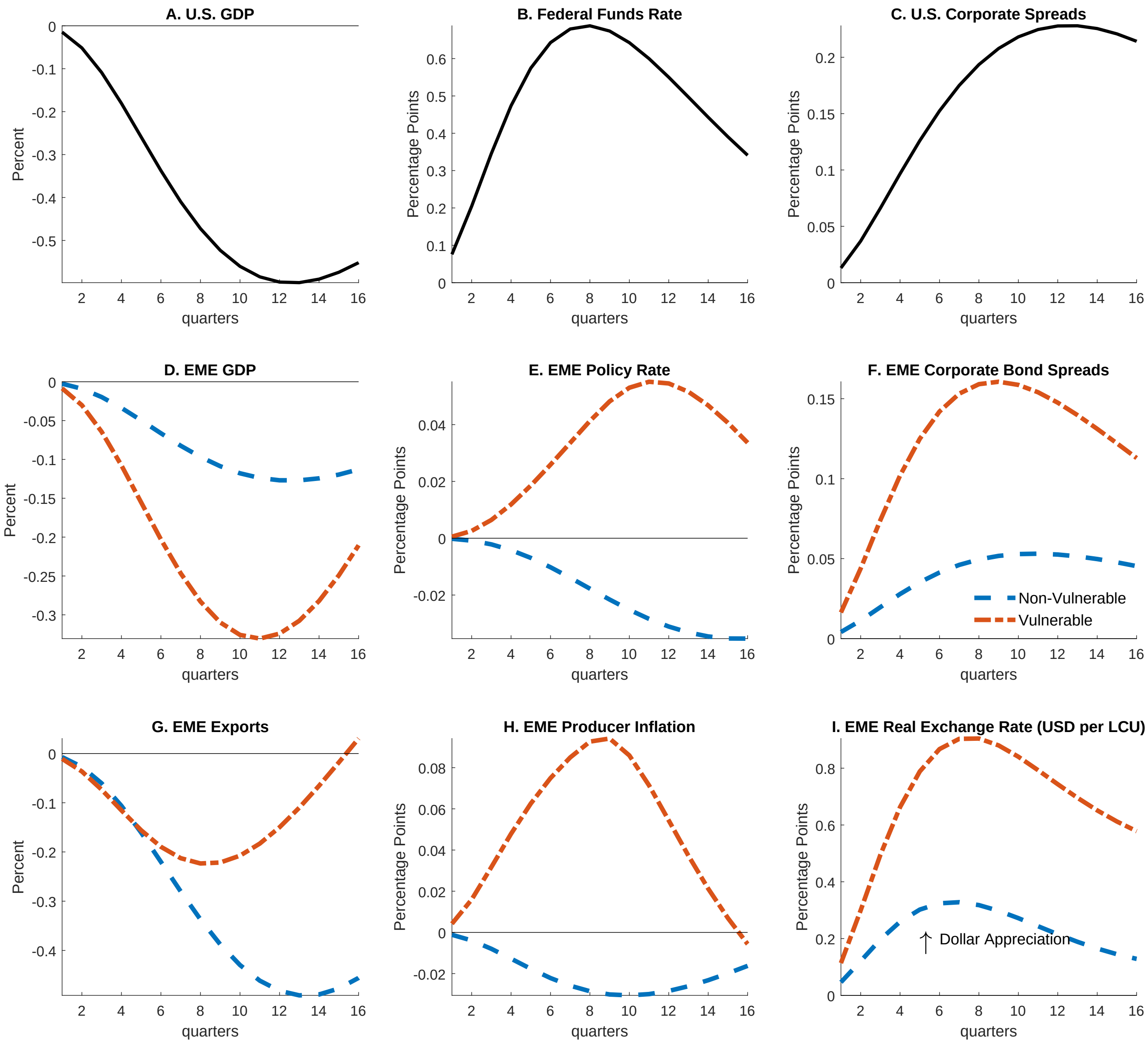


Note: The black lines in the first row show the effects of a demand shock that raises U.S. GDP by 1 percent after about a year on the U.S. economy. The dashed blue line shows the effects of the shock on non-vulnerable EMEs. The dashed dotted red line displays the effect on vulnerable EMEs.

the last panel of the first row, U.S. corporate credit spreads decrease by 75 basis points on impact and remain low for an extended period.

The second and the third panel rows of the figure show the cross-border effects of the shock on both non-vulnerable (dashed blue line) and vulnerable (red dashed-dotted lines)

Figure 4. U.S. Monetary Tightening Driven By More-Hawkish Policy Stance



Note: The black lines in the first row show the effects of "pure" U.S. monetary policy shock that replicates the path of FFR in Figure (3) on the U.S. economy. The dashed blue line shows the effects of the shock on non-vulnerable EMs. The dashed dotted red line displays the effects on vulnerable EMEs.

EMEs. Starting with the non-vulnerable EMEs, this type of tightening is actually beneficial for these countries, 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, because the extent of financial tightening is much larger (due to the more-adverse financial accelerator) and because the monetary authority is forced to increase policy rates substantially to fight inflationary pressures despite falling domestic output. In this respect, the figure suggests also a much worse macroeconomic tradeoff for vulnerable EMEs: observe that GDP and inflation move in opposite directions for these countries, while they move in the same direction for non-vulnerable EMEs. As discussed before, unanchored inflation expectations contribute significantly to the emergence of this tradeoff, and cause the EME policy rate to react much more forcefully to the U.S. tightening.

Figure 4 shows that matters are very different when the shock is driven by a pure "hawkish" shift in the Fed's reaction function. In this figure, we assume exactly the same path of the federal funds rate as in Figure 3, but this time driven by a sequence of exogenous shifts in the U.S. Taylor rule (i.e., by "pure" monetary shocks). The idea is that the Fed exogenously turns more hawkish, for example to stave off fears of undesirably high inflation. This type of tightening is much more adverse for the 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 extents of financial tightening and currency depreciation. As expected, poorly anchored inflation expectations contribute significantly to this outcome.

6 The Role of Central Bank Communication

In this section we consider the effects of U.S. monetary tightening on EME economic activity and inflation, when central bank inflation guidance has a larger weight in agents' expectations formation. More specifically, agents' perceived inflation target now not only reflects realized inflation, but may also react to central bank communications about its target. With this modification, we want to capture a situation in which central banks can increase their credibility through better communications. The important role played by the communication to manage economic agents' expectations has been emphasized in the earlier literature (see, for example, Blinder (1999)). Our objective in this section is then to show quantitatively how better communication may alleviate the tradeoffs faced by EME central bank in response to unexpected U.S. monetary policy tightening. To be sure, it may not be straightforward in practice for a central bank to convince the public to expect a given level of inflation. However, given the history of less-than-fully credible policy in many EMEs, the expectations formation mechanism likely changes only slowly over time in these countries. Improved communication, in turn, can help accelerate this process. Our results below are meant to illustrate the benefits of these improvements in the face of a U.S. tightening.

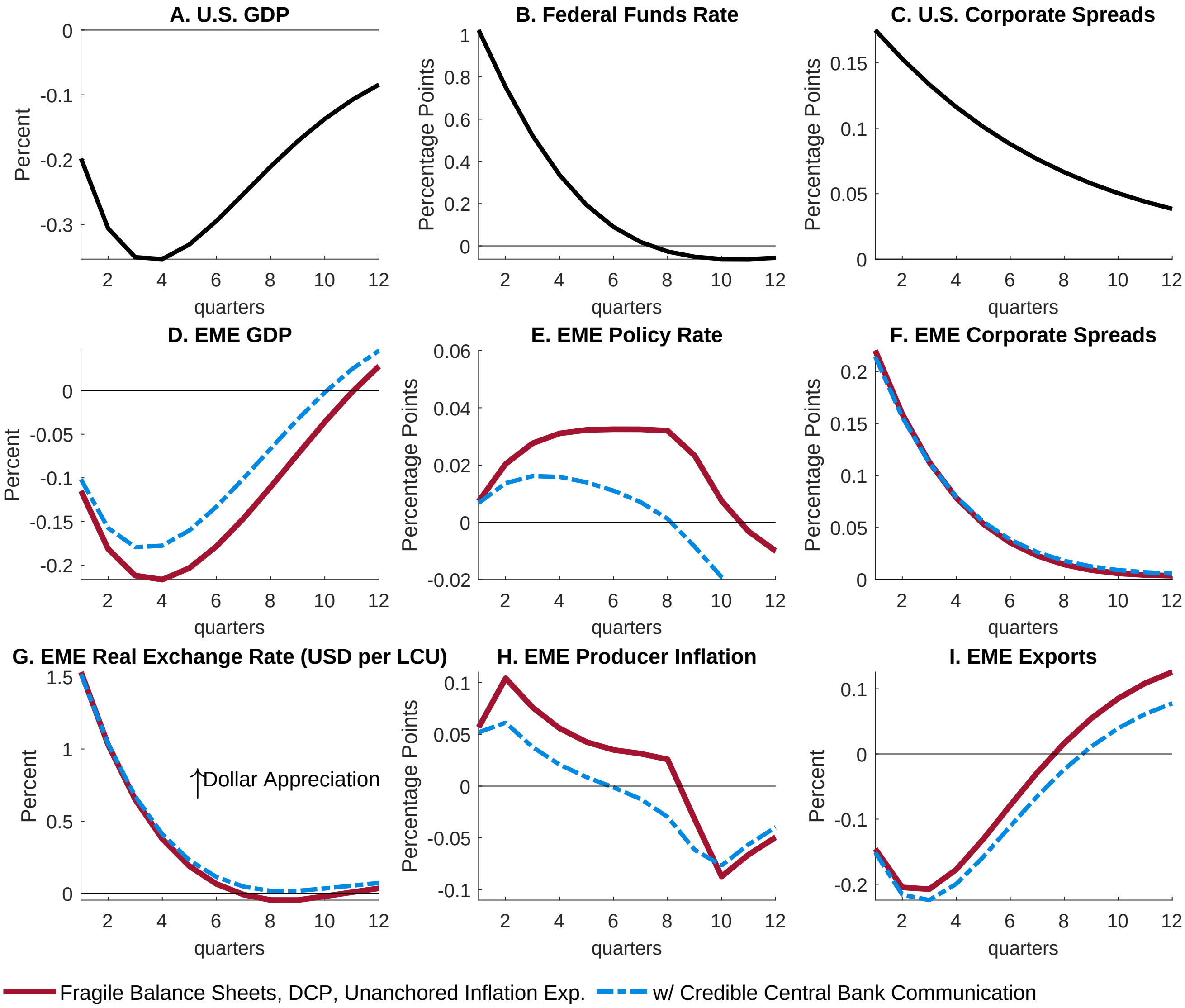
Under better central bank communication formulation, inflation expectations shown in (31) can be rewritten as the following:

$$\tilde{\mathbb{E}}_t \left\{\hat{\pi}_{t+1}\right\} = \iota(1-\zeta)\overline{\pi_t} + \iota\zeta\overline{\pi}_t^{CB} + (1-\iota)\mathbb{E}_t \left\{\hat{\pi}_{t+1}\right\} \tag{38}$$

where ζ is strictly positive, implying that price-setting agents now assign some weight to the announced inflation target by the central bank.

Figure 5 shows the results with more-credible central bank communication. More specifically, the figure displays the effects of a *one-time* unexpected U.S. monetary tightening on EMEs when these countries face fragile balance sheets (i.e., partly-dollarized balance sheets), trade invoiced in dollars and unanchored inflation expectations, both without credible central bank communication (red line) and with credible central bank communication (blue line, $\zeta = 0.5$). Note that impulse responses shown in red are reproduced from Figure 2, and plotted along with the impulse responses under the modified inflation expectation formulation in (38) (thus, they correspond to what we have labelled as "vulnerable" EMEs). As discussed before, in the presence of unanchored inflation expectations, the drop in EME GDP is quite large, nearing the drop in U.S. GDP itself. The EME central bank faces a tradeoff in this case, as the large exchange rate depreciation feeds into actual domestic producer inflation via

Figure 5. Role of Central Bank Communication



Note: The dashed blue lines show the effects of a monetary shock that raises the federal funds rate by 100 basis points on the EMEs with more credible EME central bank communication. The red line is reproduced from Figure 2 for comparison.

an increase in inflation expectations. EME central banks are then forced to tighten policy to fight inflationary pressures. More-credible EME central bank communication mitigates the adverse effects of U.S. monetary policy on EME output and improves the tradeoff faced by EME central banks. This is because agents now take announced inflation target more seriously, which in turn limits the impact of short-lived rise in CPI inflation on agents' beliefs about trend inflation. As a result, EME central banks can afford to look through the transient rise in inflation to some extent and focus more on output stabilization objective.

This implies that short term rates rise less and EME output falls less compared to the case without credible central bank communication.

7 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 constraining balance sheets and poorly anchored inflation expectations (due to a hybrid belief mechanism that combines rational expectations with adaptive expectations)—both widely seen as key vulnerabilities afflicting some EMEs. The latter feature of the model allows long-run inflation expectations to be a function of realized inflation, enabling a feedback loop between realized and expected inflation.

We have investigated the consequences of these features for spillovers from U.S. monetary policy tightenings, depending on whether these tightenings are driven by stronger U.S. demand or by a more-hawkish U.S. policy stance. We show that strong fundamentals (i.e., a combination of local-currency denominated debt and well anchored inflation expectations) prove to be the best form of insulation from foreign monetary policy shocks, especially if these shocks are driven by more-hawkish monetary policy stance. We also show that the possibility of deanchoring of inflation expectations creates a rationale for central banks in EMEs to respond to foreign monetary shocks by tightening the local policy stance. Lastly, we demonstrate that credible central bank communication regarding the inflation target could be a useful tool for EME central banks as a way to alleviate policy tradeoffs in the face of external monetary policy shocks.

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