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Abstract

We use a macroeconomic model to explore how policy drivers and country vulnerabilities matter for the transmission of U.S. monetary policy shifts to emerging markets. Our model features imperfections in domestic and international financial markets and imperfectly anchored inflation expectations. We show that higher U.S. interest rates arising from stronger U.S. demand generate modestly positive spillovers to activity in emerging markets with stronger fundamentals, but can be adverse for vulnerable countries. In contrast, U.S. monetary tightenings driven by a more-hawkish policy stance cause a substantial slowdown in all emerging markets. Our model captures the challenging policy tradeoffs that emerging market central banks face, and we show that these tradeoffs are more favorable when inflation expectations are well anchored. We use our model to estimate the effects on emerging markets of the 2022-23 U.S. monetary tightening, and compare the model-predicted effects against actual real and financial outcomes in those countries.

Key words: spillovers, monetary policy, emerging markets

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1 Introduction

The cross-border effects of shifts in the U.S. monetary policy stance have long been a focus of both policymakers and academics alike. A considerable empirical literature has developed in recent years that aims to quantify these cross-border spillovers, with the common finding that changes in the stance of U.S. policy have sizable effects on economic activity and financial markets in emerging market 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—that is, changes in the monetary policy stance that do not represent a direct response to changes in the U.S. macroeconomic environment and that are typically identified as an error term of a policy reaction function. But a dimension that is gaining increasing prominence in the literature is the extent to which the cross-border spillovers of a U.S. monetary tightening 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 (2022) argue that a highly relevant consideration for the extent of spillovers is whether the news about U.S. monetary policy represents a "growth" shock resulting from a higher level of aggregate demand or a "monetary" shock reflecting hawkish shifts in the monetary policy reaction function in response to inflationary concerns.[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, within the context of a New Keynesian dynamic stochastic general equilibrium (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 on output in economies with stronger fundamentals, but can be detrimental for vulnerable EMEs due to a 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 higher vulnerabilities. We also consider the most recent U.S. tightening cycle of 2022–23 and find, when feeding through the model the specific combination of growth and monetary shocks that our model identifies as the driver of

[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] Following Jarociński and Karadi (2020) and Nakamura and Steinsson (2018), Hoek et al. (2022) distinguish between "monetary" and "growth" shocks by analyzing the evolution of U.S. equity prices and yields around FOMC announcements and U.S. employment-report releases, with positive comovements between equity prices and yields associated with growth shocks and negative comovements associated with monetary shocks.

the U.S. tightening in this cycle, that EMEs have generally proved more resilient than the model would predict, particularly the more-vulnerable ones.

The Hoek et al. (2022) paper mentioned previously uses an event-based approach to focus on spillovers to EME financial markets for different types of U.S. interest rate shocks in narrow windows around the Federal Open Market Committee (FOMC) meetings. The paper finds that adverse spillovers to EME financial markets from U.S. policy rate increases are larger for more vulnerable EMEs and, importantly, that the effects on EME financial markets are less deleterious for meetings in which interest rate increases mostly reflect positive news about growth. Our DSGE model also has implications for EME financial markets, in addition to the activity effects mentioned earlier. These implications are complementary to, and fully consistent with, the conclusions on financial spillovers obtained by Hoek et al. (2022).

But our approach based on a fully structural model has three distinct advantages. First, it allows us to quantify the spillovers to real macroeconomic variables (in addition to financial ones) and to trace out the dynamics of both macroeconomic outcomes and financial markets together in a joint framework. Second, it enables us to model structurally the EME vulnerabilities that matter most, and thus to provide an assessment of the relative importance of the different underlying sources of vulnerability.[3] Third, our approach can be used to compare the model's prediction to actual outcomes for particular episodes, and we do so to provide insights about spillovers to less- and more-vulnerable EMEs—for both real and financial variables—from the most recent, highly aggressive U.S. tightening in response to unusually strong inflationary pressures.

We model two important specific sources of EME vulnerability. The first is the presence of foreign currency-denominated debt in firms balance sheets, which lead to adverse consequences from domestic currency depreciation.[4] We model this vulnerability following Akinci and Queralto (2023), who show that the presence of unhedged dollar liabilities in EME firms' balance sheets, combined with an endogenous currency premium that increases when balance sheets deteriorate, can generate strong feedback effects that amplify the effects of foreign monetary policy shifts. The second vulnerability is imperfect anchoring of inflation expectations—a property typical of many EMEs with histories of high-inflation episodes and earlier absence of inflation targeting monetary frameworks. In the model, we incorporate the feature that inflation expectations are not well-anchored by postulating that the firms that do not set prices optimally instead rely on past inflation surprises to guide pricing decisions.[5] We view this approach as a simple and

[3]Our findings related to the importance of EME vulnerabilities are also consistent with time-series evidence in the literature (see, for example, Ahmed et al. (2017) and Iacoviello and Navarro (2018)). Relatedly, Bowman et al. (2015) reach similar conclusions on 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 sizable in EMEs.

[5]This assumption is motivated by evidence in the diagnosis expectations literature that highlights agents' strong reaction to surprise observations (Bordalo et al., 2020), and is in the spirit of recent work on "behavioral" approaches to expectation

flexible way of capturing imperfectly anchored inflation expectations due to the central bank's inflation target lacking full credibility.

One general implication that emerges from our setting is that global monetary policy spillovers can create significant tradeoffs (understood as output and inflation reacting in opposite directions) for EME policymakers, especially in more vulnerable countries, consistent with the discussion above. More specifically, we show how imperfectly anchored inflation expectations can rationalize the response of EME central banks of raising their own policy rates in response to an advanced-economy monetary tightening. This policy response stands at odds with prescriptions from standard open-economy New Keynesian models in the literature (see, for example, Gali and Monacelli 2005), and even from models, such as that in Akinci and Queralto (2023), in which the presence of dollar-denominated liabilities would seem to provide a case for raising rates to defend the exchange rate.[6] To understand the intuition, first consider the case when inflation expectations are well-anchored. In such a case, when (say) the Federal Reserve tightens policy, the dollar appreciates against the EME currency. This makes home's imports from the United States more expensive, leading to a short-lived rise in the overall CPI inflation rate, but with no direct effect on producer inflation. In the standard New Keynesian models, the monetary authority optimally looks through the transient rise in CPI inflation, and instead worries about the decline in the home output gap—calling for a reduction in the policy rate.

Under imperfect anchoring of inflation expectations, instead, the short-lived rise in CPI inflation feeds into agents' "perceived" 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 persistently lower output—resulting from the imperfect credibility of the central bank's inflation target. In this environment, EME policymakers that aim to stabilize inflation would 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 imperfect anchoring.[7]

The remainder of the paper proceeds as follows: Section 2 lays out some key empirical features of EMEs that helps motivate some of our modeling choices. Section 3 presents our model in detail. Section 4.1 presents a simplified setting—close to the textbook three-equation model—that helps convey the basic

formation—for example, Gabaix (2020), García-Schmidt and Woodford (2019), or Farhi and Werning (2017).

[6] Akinci and Queralto (2023) show that the endogeneity of the currency premium makes a policy of defending a currency peg very costly in terms of output volatility, as it implies that domestic rates need to rise more than one-for-one with policy rates to maintain the exchange rate constant.

[7] Curcuru et al. (2018) also 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.

intuition, and Section 4.2 analyzes the full model's implications for the role of country vulnerabilities and of the sources of U.S. monetary tightenings. Section 5 applies the results of the model to the spillover effects from the most recent U.S. tightening that began in 2022. We conclude in Section 6.

2 Evidence on imperfectly anchored inflation expectations in EMEs

In this section we document some empirical evidence to argue that inflation expectations are not as well anchored in many EMEs as in advanced economies. Levin et al. (2004) discuss the beneficial macroeconomic effects of inflation targeting (IT) regimes, which have been in place much longer for many advanced economies than for EMEs that have adopted them. But we find that even in some EMEs that have now adopted IT regimes, inflation expectations are less well-anchored than in their advanced-economy peers. The results of our analysis provide justification for introducing backward-looking inflation expectations when characterizing a vulnerable small open EME in our model economy.[8]

We put together a dataset of long-term inflation expectations for 20 EMEs based on survey data of 6- to 10-year inflation forecasts by private forecasters. The data are collected by Consensus Economics, London. Originally twice a year, but now quarterly, the survey asks market forecasters about their inflation expectations at horizons 1 year to 10 years ahead. The data runs from 1993 through 2019. Table 1 provides summary statistics of the long-term inflation expectations data. Figure 1 shows the time series of these expectations, averaged across more-vulnerable and less-vulnerable EMEs. We split EMEs in these two groups based on the vulnerability index in Ahmed et al. (2017). As seen in the figure, long-term inflation expectations are much higher on average, and also more volatile, in the more-vulnerable group.

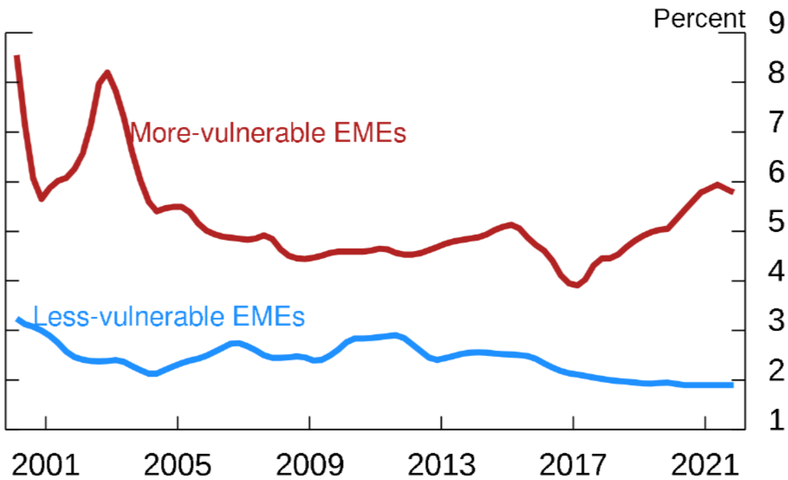
Table 1
Long-term inflation expectations in EMEs:
Summary statistics

	Median	**Min-max range**
$\mathbb{E}[x_t]$	3.39	$[2.00, 9.99]$
$\sigma[x_t]$	1.04	$[0.19, 12.50]$
$corr[x_{t-1}, x_t]$	0.92	$[0.71, 0.99]$

Note: Statistics for 6- to 10-year-ahead inflation forecasts (x_t) from Consenus Economics, London. Data is quarterly (interpolated from semi-annual for most of the sample) and covers period 1993-2019.

[8] Inflation targeting small open advanced economies include Australia, Canada, New Zealand, Sweden, United Kingdom. Inflation targeting small open EMEs are Brazil, Chile, Columbia, Czech Republic, Hungary, South Korea, Mexico, Peru, Philippines, Poland, Thailand, Turkey; and other EMEs include Argentina, Indonesia, Malaysia, Romania, Singapore, Slovakia, Taiwan, Ukraine.

Figure 1: Long-term inflation expectations



Note: One-year moving average of 6- to 10-year inflation expectations. More-vulnerable EMEs include Argentina, Brazil, Colombia, Mexico, and Turkey. Less-vulnerable EMEs include Malaysia, South Korea, Taiwan, and Thailand. Source: Consensus Economics.

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

$$\Delta \mathbb{E}_t \left[\pi_{i,t+h}\right] = \alpha + \beta \Delta \bar{\pi}_{i,t} + \epsilon_{i,t} \tag{1}$$

where $\mathbb{E}_t \left[\pi_{i,t+h}\right]$ is an h-period-ahead survey inflation expectation at time t for country i and $\bar{\pi}_{i,t}$ is a three-year trailing moving average of inflation in country i ending at time t. The regression is run as a panel for advanced and emerging economies separately.

Table 2 shows results for small open advanced economies (AEs) with IT regimes, as well as a group of EMEs over the 1993:Q1–2019:Q4 period.[9] For the advanced economies, our evidence suggests, as in Levin et al. (2004), that long-run inflation expectations became well anchored after the adoption of inflation targeting regimes. For the EMEs, on the contrary, inflation expectations at all horizons exhibit a highly significant correlation with the 3-year moving average of realized CPI inflation, suggesting expectations are not as well anchored. We also ran the regressions for EMEs starting from the date these economies adopted IT regime (for the IT EMEs), and the results still pointed to a significant difference between EMEs and advanced economies.[10]

Next, we provide some evidence on heterogeneity among EMEs by investigating the degree of unanchoring in two groups of EMEs: a "vulnerable" group, defined as the EMEs in our sample with vulnerability

[9] Our estimation starts from 1993 when most of the countries in our sample adopted IT regimes.

[10] We also ran these regressions in levels, truncating the sample to avoid the initial strong disinflation periods in many EMEs in early 1990s. Our results are robust to this alternative.

Table 2
6- to 10-year-ahead inflation expectations regression, equation 1 (1993-2019)

	(1) IT AE	(2) IT EME	(3) IT and non-IT EME
$\Delta\pi_{it}$	0.048	0.153**	0.187***
	(1.57)	(2.91)	(5.03)
Constant	-0.006	-0.043	-0.031
	(-1.48)	(-1.33)	(-1.16)
Observations	400	1010	1412

Dependent variable is 6- to 10-year-ahead expected inflation.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

IT AEs: Australia, Canada, New Zealand, Sweden, United Kingdom. **IT EMEs**: Brazil, Chile, Colombia, Czech Republic, Hungary, Korea, Mexico, Peru, Philippines, Poland, Thailand, Turkey. **Non-IT EMEs**: Argentina, Indonesia, Malaysia, Romania, Singapore, Slovakia, Taiwan, Ukraine.

Table 3
6- to 10-year-ahead inflation expectations regression, equation 1 (1993-2019), less- v. more- vulnerable EMEs

	(1) IT AEs	(2) EME Non-Vul.	(3) EME Vul.
$\Delta\pi_{it}$	0.048	0.098*	0.148*
	(1.57)	(2.12)	(2.45)
Constant	-0.006	-0.055	-0.039
	(-1.48)	(-1.51)	(-0.82)
Observations	400	832	662

Dependent variable is 6- to 10-year-ahead expected inflation.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

higher than the median in Ahmed et al. (2017), and a "non-vulnerable" group, in which the vulnerability index is below the median. Table 3 shows that the estimated slope coefficient on past inflation is positive for both groups, but 50 percent larger for the vulnerable group. Thus, the more-vulnerable EMEs do seem to have a noticeably larger degree of unanchoring compared to the less-vulnerable EMEs—which, in turn, also appear to feature more-imperfectly anchored inflation expectations than the advanced economies.

Finally, Table 4 shows results for the 2004–2019 period. While there is still a positive association between inflation expectations and actual inflation in the more recent period, the estimates are smaller and less significant than their full-sample counterparts. This result suggests that EMEs have made some progress on achieving monetary policy credibility relative to their crisis-prone times in the past. For some EMEs with strong fundamentals, this progress may be sufficient to allow them to follow countercyclical monetary policies in the traditional way highlighted by benchmark New Keynesian models. That is part

Table 4
6- to 10-year-ahead expectations (2004-2019)

	(1) IT AE	(2) IT EME	(3) IT and non-IT EME
$\Delta\pi_{it}$	0.022	0.086*	0.063*
	(0.67)	(2.28)	(2.22)
Constant	-0.001	-0.009	0.003
	(-0.26)	(-0.60)	(0.11)
Observations	312	798	1122

Dependent variable is 6- to 10-year-ahead expected inflation.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

of our motivation for modeling the non-vulnerable EMEs as having well-anchored inflation expectations.

3 Model

The baseline framework is a two-country New Keynesian model consisting of the home country, a small EME, and the foreign economy, the U.S. In addition to the standard trade linkages, the model features financial linkages between these two countries: EME financial intermediaries can borrow from the foreign economy (in dollars) as well as from domestic households (in local currency). The model allows for key EME vulnerabilities that have been emphasized in the literature, including endogenous deviations from uncovered interest parity and currency mismatches, modeled as in Akinci and Queralto (2023); dollar invoicing of EME exports, as highlighted in Gopinath et al. (2018); and a backward-looking component of EME long-term inflation expectations, consistent with the evidence presented in Section 2.

The model distinguishes between two sources of U.S. monetary tightenings, by allowing for two distinct fundamental shocks in the U.S. triggering movements in the U.S. monetary policy rate. Thus, the U.S. is subject to “growth” shocks, leading to a persistent expansion of aggregate demand that triggers inflationary pressures and calls for higher policy rates; and to “monetary” shocks, where the monetary tightening reflects a pure hawkish shift in the U.S. monetary reaction function—capturing, for example, a more-aggressive response to inflation. The model includes a standard set of nominal and real rigidities that help generate empirically realistic effects of monetary policy shocks (as shown by Christiano et al. 2005, for example). The home economy comprises households, labor unions, bankers, firms, and the central bank. We next describe each of these agents before briefly outlining the foreign economy.

3.1 Households

A continuum of households of measure $\mathcal{N}$ live in the home economy, each with two types of members: workers and bankers, with measures $1-f$ and f respectively. Workers supply labor and return their wages to the household. Each banker manages a financial intermediary and also transfers any earnings back to the household. There is perfect consumption insurance between household members. Each household supplies a differentiated labor type to an economy-wide labor union, providing the basis for modeling wage rigidities, as in Erceg, Henderson and Levin (2000).

Household i chooses: (i) a consumption index C_t, consisting of consumption of a domestically-produced good, $C_{D,t}$, and an imported consumption good, $M_{C,t}$; (ii) deposit holding with domestic financial intermediaries D_t (denominated in terms of the consumption index); (iii) holdings of a one-period nominal risk-free bond B_t (the aggregate net supply of which is 0); and (iv) the nominal wage, $W_{i,t}$, and supply of its own labor variety, $L_{i,t}$. The household's objective is:

$$\max_{\substack{\{C_{t+j},C_{Dt+j},M_{Ct+j},\\ D_{t+j},B_{t+j},W_{i,t+j},L_{i,t+j}\}_{j=0}^{\infty}}} \mathbb{E}_t\left[\sum_{j=0}^{\infty}\beta^j U(C_t, C_{t-1}, L_{i,t})\right] \tag{2}$$

where $U(C_t, C_{t-1}, L_{i,t})$ is the period utility function given by

$$U(C_t, C_{t-1}, L_{i,t}) = \log(C_{t+j} - hC_{t+j-1}) - \frac{L_{i,t+j}^{1+\varphi}}{1+\varphi}. \tag{3}$$

The consumption index C_t satisfies

$$C_t = \left[(1-\omega)^{\frac{1}{\eta}} C_{D,t}^{\frac{\eta-1}{\eta}} + \omega^{\frac{1}{\eta}}\left(\varphi_{C,t} M_{C,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{4}$$

where $(1-\omega) > 1/2$ is home bias, $\eta \geq 1$ is the elasticity of substitution between domestic and foreign goods, and $\varphi_{C,t} = 1 - \frac{\varphi_M}{2}\left(\frac{M_{C,t}/C_{D,t}}{M_{C,t-1}/C_{D,t-1}} - 1\right)^2$ is a variable that reflects costs of changing the ratio of imported to domestically-produced goods, with parameter $\varphi_M > 0$ capturing the magnitude of these costs.[11]

The maximization in (2) is subject to a sequence of budget constraints

$$P_tC_t + P_tD_t + B_t \leq W_{i,t}L_{i,t} + P_tR_tD_{t-1} + R_t^nB_{t-1} + \mathcal{F}_{i,t} + \Pi_t \tag{5}$$

for each t, where R_t denotes the gross real interest rate on deposits, R_t^n denotes the gross nominal interest

[11] These costs, which can be interpreted as trade costs, help the model capture the relatively sluggish response to shocks of the ratio of imports to domestic goods and are used frequently in the literature—for example, Blanchard et al. (2016) and Christiano et al. (2005).

rate on the risk-free bond, $\mathcal{F}_{i,t}$ 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 consumer price index (CPI), P_t, satisfies

$$P_t = \left[(1-\omega)P_{D,t}^{1-\eta} + \omega P_{M,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{6}$$

where $P_{D,t}$ is an index of domestically-produced goods and $P_{M,t}$ is an index of imported goods. In Section 3.5 below we describe our assumptions on international prices.

Household i's utility maximization problem (2) is also subject to a demand curve for its own labor variety (described in the next subsection),

$$L_{i,t} = \left(\frac{W_{i,t}}{W_t}\right)^{-\epsilon_w} L_t, \tag{7}$$

and to a constraint on nominal wage adjustments whereby the nominal wage $W_{i,t}$ can only be set optimally with probability $1-\theta_w$, and otherwise must follow the indexation rule $W_{i,t} = W_{i,t-1}\overline{\pi}_t^{\iota_w}$, where $\iota_w \in [0,1]$ is a parameter capturing the degree of indexation and $\overline{\pi}_t$ is a measure of perceived trend inflation, described below.

3.2 Employment agencies

As in Erceg, Henderson and Levin (2000) each household i is a monopolistic supplier of a specialized labor variety. A large number of competitive "employment agencies" combine specialized labor into a homogeneous labor input L_t (in turn supplied to final goods firms), according to

$$L_t = \left(\int_0^1 L_{i,t}^{\frac{\epsilon_w-1}{\epsilon_w}}\, di\right)^{\frac{\epsilon_w}{\epsilon_w-1}}. \tag{8}$$

From employment agencies' cost minimization, demand for labor variety of i satisfies equation (7) above, with the wage paid by final goods firms on the homogeneous labor input, W_t, given by

$$W_t = \left(\int_0^1 W_{i,t}^{1-\epsilon_w} dj\right)^{\frac{1}{1-\epsilon_w}}. \tag{9}$$

3.3 Bankers

Each banker in the home economy operates a financial intermediary. Bankers exit randomly, with any banker operating in period t continuing into period $t+1$ with exogenous probability σ and exiting with the complementary probability $1-\sigma$. Bankers that exit rebate their earnings to the household, and begins a career as a worker. Workers in the household become bankers with probabilty $(1-\sigma)\frac{f}{1-f}$, so the aggregate measure of operating bankers remains constant. Entrant bankers receive a small equity endowment so they can start operations.

Banker i chooses assets $A_{i,t}$, deposits issued to domestic households in the local currency $D_{i,t}$, and deposits issued to U.S. households in dollars, $D^*_{i,t}$. (Throughout, we use * to refer to foreign variables.) Assets $A_{i,t}$ are risky claims on EME productive capital. The banker chooses state-contingent sequences $\left\{A_{i,t+j}, D_{i,t+j}, D^*_{i,t+j}\right\}_{j=0}^{\infty}$ to maximize

$$V_{i,t} = \mathbb{E}_t\left[\sum_{j=1}^{\infty}\Lambda_{t,t+j}(1-\sigma)\sigma^{j-1}N_{i,t+j}\right], \tag{10}$$

where $N_{i,t+j}$ is terminal net worth if the banker exits at $t+j$ and

$$\Lambda_{t,t+j} = \beta^j U_{C,t+j}/U_{C,t} \tag{11}$$

is the household's stochastic discount factor (SDF), with

$$U_{C,t} = \left(C_t - hC_{t-1}\right)^{-1} - \beta h\left(C_{t+1} - hC_t\right)^{-1}. \tag{12}$$

The banker's budget constraint is

$$Q_tA_{i,t} + R_tD_{i,t-1} + R^*_t\mathcal{S}_t^{-1}D^*_{i,t-1} \leq \left[\frac{Z_t}{P_t} + (1-\delta)Q_t\right]A_{i,t-1} + D_{i,t} + \mathcal{S}_t^{-1}D^*_{i,t} \tag{13}$$

for each t, where Q_t is the real market price of a claim on a unit of capital; Z_t is the nominal payoff generated by capital holdings; δ is capital's depreciation rate; R^*_t is the real interest rate in the foreign currency; and $\mathcal{S}_t$ is the real exchange rate, expressed as the price of the home consumption index in terms of the foreign index.

The balance sheet identity is

$$Q_tA_{i,t} = D_{i,t} + \mathcal{S}_t^{-1}D^*_{i,t} + N_{i,t}, \tag{14}$$

stating that the value of the banker's assets must equal the sum of domestic and foreign deposits plus net worth $N_{i,t}$. Combining this identity with (13) yields the evolution of net worth,

$$N_{i,t} = (R_{K,t} - R_t)Q_{t-1}A_{i,t-1} + \left(R_t - R^*_t\mathcal{S}_{t-1}/\mathcal{S}_t\right)\mathcal{S}_{t-1}^{-1}D^*_{i,t-1} + R_tN_{i,t-1}, \tag{15}$$

with $R_{K,t} \equiv \frac{\frac{Z_t}{P_t}+(1-\delta)Q_t}{Q_{t-1}}$.

The banker faces a leverage constraint arising due to a moral hazard problem. This problem takes the following form. After borrowing funds, the banker may decide to not repay creditors and instead divert assets for personal gain. Diverting means selling a fraction $\Theta_t \in (0,1)$ of assets secretly in secondary markets. The fraction Θ_t depends upon the composition of the banker's liability portfolio:

$$\Theta_t = \Theta\left(\frac{\mathcal{S}_t^{-1} D_{i,t}^*}{Q_t A_{i,t}}\right), \tag{16}$$

where $\Theta(\cdot)$ is a function satisfying $\Theta' > 0$. Thus, the banker is able to divert more assets when the fraction of assets financed by foreign liabilities is larger—capturing the notion that EME capital is worse collateral for dollar-denominated loans than for domestic-currency loans. As discussed in detail in Akinci and Queralto (2023), this assumption leads to a failure of UIP, with the UIP premium on EME currencies varying inversely with aggregate EME net worth. This dependency, combined with the presence of dollar debt in EME intermediaries' balance sheets, implies feedback effects that amplify the effects of foreign shocks. Aside from the assumptions related to foreign debt, this type of agency friction, first introduced by Gertler and Kiyotaki (2010), is widely used in closed-economy studies featuring financing frictions.

The banker's portfolio choice must then satisfy the incentive constraint

$$V_{i,t} \geq \Theta\left(\frac{\mathcal{S}_t^{-1} D_{i,t}^*}{Q_t A_{i,t}}\right) Q_t A_{i,t}, \tag{17}$$

requiring the banker's continuation value to be no smaller than the value of diverting funds—as otherwise, no creditor would be willing to lend.

The individual banker's problem can be solved by undetermined coefficients. Guess that the continuation value $V_{i,t}$ satisfies $V_{i,t} = \Psi_t N_{i,t}$, with Ψ_t independent of banker-specific variables. Define

$$\phi_{i,t} \equiv \frac{Q_t A_{i,t}}{N_{i,t}}, \tag{18}$$

$$x_{i,t} \equiv \frac{\mathcal{S}_t^{-1} D_{i,t}^*}{Q_t A_{i,t}}, \tag{19}$$

where $\phi_{i,t}$ is the ratio of assets to net worth, the banker's leverage, and $x_{i,t}$ is the ratio of foreign financing to assets, which will both turn out to be the same across bankers.

From (15),

$$\frac{N_{i,t}}{N_{i,t-1}} = \Big[(R_{K,t} - R_t) + (R_t - R_t^* \mathcal{S}_{t-1}/\mathcal{S}_t)\, x_{t-1}\Big]\phi_{t-1} + R_t. \tag{20}$$

Given (10), (17) and (20) we may express the banker's problem as

$$\Psi_t = \max_{x_t, \phi_t} \quad (\mu_t + \varrho_t x_t)\,\phi_t + \nu_t \tag{21}$$

subject to

$$\Theta(x_t)\phi_t \leq \Psi_t = (\mu_t + \varrho_t x_t)\,\phi_t + \nu_t, \tag{22}$$

where

$$\mu_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\Omega_{t+1}(R_{K,t+1} - R_{t+1})\right], \tag{23}$$

$$\varrho_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\Omega_{t+1}\left(R_{t+1} - R^*_{t+1}\mathcal{S}_t/\mathcal{S}_{t+1}\right)\right], \tag{24}$$

$$\nu_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\Omega_{t+1}\right]R_{t+1}, \tag{25}$$

with

$$\Omega_{t+1} \equiv 1 - \sigma + \sigma\Psi_{t+1}. \tag{26}$$

The variable μ_t is the excess marginal value to the banker of assets over deposits; ϱ_t is the excess marginal cost of domestic relative to foreign funding; and ν_t is the marginal cost of domestic funding. Note that the banker uses the discount factor $\Lambda_{t,t+1}\Omega_{t+1}$ to evaluate payoffs, which weighs the household's SDF with the prospective value of a unit of net worth to the banker. Condition (22) makes clear that the incentive constraint places a constraint on leverage ϕ_t.

The first-order condition associated with the choice of x_t is

$$\varrho_t = \left(\frac{\Theta'(x_t)}{\Theta(x_t) - \Theta'(x_t)x_t}\right)\mu_t, \tag{27}$$

equating the marginal value of foreign relative to domestic funding, ϱ_t, to its marginal cost.

As long as the total excess return $\mu_t + \varrho_t x_t$ satisfies $0 < \mu_t + \varrho_t x_t < \Theta_t$, as will be the case in our calibration, the incentive constraint binds. Then from (22), the banker's leverage ϕ_t is given by

$$\phi_t = \frac{\nu_t}{\Theta_t - (\mu_t + \varrho_t x_t)}. \tag{28}$$

Turning to aggregation, let $A_t = \int_0^f A_{i,t}di$, $D^*_t = \int_0^f D^*_{i,t}di$, and $N_t = \int_0^f N_{i,t}di$. Given that ϕ_t and x_t

are independent of bank-specific factors, these aggregates satisfy

$$Q_t A_t = \phi_t N_t, \tag{29}$$

$$\mathcal{S}_t^{-1} D_t^* = x_t Q_t A_t. \tag{30}$$

If banker i is a new entrant, he or she receives an equity endowment given by a fraction ξ of the value of aggregate banker assets in the previous period. If banker i is instead a continuing banker, their net worth is given by (20). Aggregating across all bankers yields the evolution of aggregate net worth:

$$N_t = \sigma\Big[(R_{K,t} - R_t)Q_{t-1}A_{t-1} + \Big(R_t - R_t^* \frac{\mathcal{S}_{t-1}}{\mathcal{S}_t}\Big)\mathcal{S}_{t-1}^{-1} D_{t-1}^* + R_t N_{t-1}\Big] + (1-\sigma)\xi Q_{t-1}A_{t-1}. \tag{31}$$

3.4 Firms

There are two types of firms: Capital producers who manufacture capital goods, and final goods firms who produce final output. We describe each in turn.

3.4.1 Capital producers

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

$$\max_{\{I_{t+j}\}_{j=0}^{\infty}} \quad \mathbb{E}_t\left[\sum_{j=0}^{\infty} \Lambda_{t,t+j}\left(Q_{t+j}I_{t+j} - \frac{P_{D,t+j}}{P_{t+j}}\phi_{I,t+j}\right)\right] \tag{32}$$

where Q_t is the real price of the capital good. As was the case for consumption, investment goods are produced by combining domestic ($I_{D,t}$) and imported ($M_{I,t}$) goods, also subject to costs of adjusting the imported-domestic good mix:

$$I_t = \left[(1-\omega)^{\frac{1}{\eta}} I_{D,t}^{\frac{\eta-1}{\eta}} + \omega^{\frac{1}{\eta}}\left(\varphi_{I,t}M_{I,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{33}$$

with $\varphi_{I,t} = 1 - \frac{\varphi_M}{2}\left(\frac{M_{I,t}/I_{D,t}}{M_{I,t-1}/I_{D,t-1}} - 1\right)^2$.

The associated first-order condition links the price of capital positively with aggregate investment:

$$Q_t = 1 + \frac{P_{D,t}}{P_t}\left[\psi_I\left(\frac{I_t}{I_{t-1}} - 1\right)\frac{I_t}{I_{t-1}} + \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right] - \mathbb{E}_t\left[\Lambda_{t,t+1}\frac{P_{D,t+1}}{P_{t+1}}\psi_I\left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right]. \tag{34}$$

The aggregate capital stock then evolves as

$$K_{t+1} = I_t + (1-\delta)K_t \tag{35}$$

3.4.2 Final goods producers

There is a continuum of mass unity of differentiated retail firms that are subject to pricing frictions. Final output Y_t is a CES composite of retailers' output:

$$Y_t = \left(\int_0^1 Y_{j,t}^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{36}$$

where Y_{jt} is output by retailer $j \in [0,1]$. Letting the price set by retailer j be $P_{D,j,t}$, the price index of domestic final output is then given by $P_{D,t} = \left(\int_0^1 P_{D,j,t}^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}$. Cost minimization by users of final output yields the following demand function for firm j's output: $Y_{j,t} = \left(\frac{P_{D,j,t}}{P_{D,t}} \right)^{-\epsilon} Y_t$.

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

$$Y_{j,t} = K_{j,t}^{\alpha} L_{j,t}^{1-\alpha}. \tag{37}$$

with the (real) labor and capital rental rates given by W_t/P_t and Z_t, respectively.

We use a simple formulation of the Calvo price-setting model to capture imperfectly-anchored long-term inflation expectations for the vulnerable EMEs. As in Calvo, domestic firm j can only set its price $P_{D,j,t}$ optimally with probability $(1-\theta_p)$. With probability θ_p, the firm instead updates its price according to the following rule of thumb:

$$P_{D,j,t} = e^{\overline{\pi}_t} P_{D,j,t-1}, \tag{38}$$

where

$$\overline{\pi}_t = \zeta \left[\pi_t - \mathbb{E}_{t-1}(\pi_t) \right] + \upsilon \overline{\pi}_{t-1}, \tag{39}$$

with parameters υ and ζ satisfying $0 \le \upsilon \le 1, \delta \ge 0$, and where $\pi_t \equiv P_t/P_{t-1}$ is CPI inflation.

We interpret $\overline{\pi}_t$ as agents' perceived "trend" inflation, or "default" inflation in the language of Gabaix (2020). This variable $\overline{\pi}_t$ captures a signal about future inflation that agents can form costlessly. As such, when firms cannot set prices optimally, they instead index their prices to automatically increase at the perceived trend inflation rate. We assume this perceived trend inflation rate to (i) react to the surprise in CPI inflation, $\pi_t - \mathbb{E}_{t-1}(\pi_t)$, with the strength of the response captured by the parameter ζ, and (ii) to have a potentially large backward-looking component, governed by parameter υ. Our formulation is motivated by evidence in the diagnosis expectations literature that finds that agents react strongly to surprise observations (Bordalo et al., 2020). An advantage of this formulation is that it allows the possibility of a "de-anchoring" of long-term inflation expectations to result from a surprise exchange rate depreciation, even if if this depreciation is then reversed.[12]

To illustrate the form of the Phillips curve that results from the formulation above, we follow standard steps to derive the following expression for domestic inflation $\pi_{D,t} \equiv P_{D,t}/P_{D,t-1}$:

$$\begin{aligned}\pi_{D,t} &= (1-\beta\upsilon)\overline{\pi}_t + \lambda\widehat{mc}_t + \beta\mathbb{E}_t[\pi_{D,t+1}] \\ &= \overline{\pi}_t + \lambda\mathbb{E}_t\left[\sum_{i=0}^{\infty}\beta^i\widehat{mc}_{t+i}\right], \qquad (40)\end{aligned}$$

where $\widehat{mc}_t$ denotes real product marginal cost (in log-deviation from steady state) and $\lambda \equiv (1-\beta)(1-\beta\theta_p)/\theta_p$. Thus, actual domestic inflation is linked to the expected sum of future real marginal costs (equivalently, to deviations of actual markups from desired ones), as in the standard setup. But now actual inflation also depends on perceived trend inflation $\overline{\pi}_t$: note that if all future marginal costs were expected to be at steady state, so that $\lambda\mathbb{E}_t\sum_{i=0}^{\infty}\beta^i\widehat{mc}_{t+i} = 0$ (which, under some conditions, is equivalent to current and expected future output gaps being equal to zero), we would observe an inflation rate of $\overline{\pi}_t$ in this economy. As such, $\overline{\pi}_t$ is reminiscent of traditional notions of trend or "underlying" inflation, which is frequently defined as the inflation rate that would prevail in an economy with zero output gaps and no "cost-push" shocks (understood as shocks that enter as intercepts in the Phillips curve).

Iterating (40) forward,

$$\begin{aligned}\mathbb{E}_t[\pi_{D,t+K}] &= \upsilon^K\overline{\pi}_t + \lambda\mathbb{E}_t\left[\sum_{i=K}^{\infty}\beta^i\widehat{mc}_{t+i}\right] \\ &= \upsilon^K\zeta\left[\pi_t - \mathbb{E}_{t-1}(\pi_t)\right] + \phi^{K+1}\overline{\pi}_{t-1} + \lambda\left[\mathbb{E}_t\sum_{i=K}^{\infty}\beta^i\widehat{mc}_{t+i}\right], \qquad (41)\end{aligned}$$

which indicates that one can back out the responsiveness of K-quarters-ahead expected inflation to actual inflation from the two parameters ζ and υ. In turn, the parameter υ heavily influences the autocorrelation of long-term expected inflation. Thus, we can use measures on the latter from our dataset on long-term inflation expectations, along with the empirical responsiveness parameters in Tables 2-4, to back out values for the parameters ζ and υ.

[12]We found that if $\overline{\pi}_t$ instead depends simply on lagged inflation, as often assumed, then it is difficult for currency depreciations to generate a meaningful de-anchoring of inflation expectations, as the subsequent gradual currency appreciation offsets the effects of the initial depreciation.

3.5 International prices

In our baseline case, we assume that exporters in each country practice producer currency pricing (PCP):

$$P_{Mt} = \mathcal{E}_t^{-1} P^*_{D,t} \tag{42}$$

$$P^*_{Mt} = \mathcal{E}_t P_{D,t}, \tag{43}$$

where $\mathcal{E}_t$ is the nominal exchange rate (the price in dollars of a unit of the home currency), $P^*_{D,t}$ is the price of the foreign composite good (in dollars), and $P^*_{M,t}$ is the price of the domestic composite good abroad. The nominal and real exchange rates are linked by the condition

$$\mathcal{S}_t = \mathcal{E}_t \frac{P_t}{P^*_t}. \tag{44}$$

For the vulnerable EMEs, we will assume trade prices follow 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 producers in vulnerable EMEs 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 $P_{M,t} = \mathcal{E}_t^{-1} P^*_{D,t}$, but now each domestic firm j also sets a dollar export price $P^*_{M,j,t}$ subject to the Calvo price-setting friction. If firm j is not able to reset its export price, it follows the indexation rule $P^*_{M,j,t} = P^*_{M,j,t-1}\pi^{*\iota_m}_{M,t-1}$, where $\pi^*_{M,t} = P^*_{M,t}/P^*_{M,t-1}$ is export price inflation.[13]

3.6 The foreign economy

The foreign country has population $\mathcal{N}^*$ and home bias parameter ω^*. Aside from the friction affecting international borrowing and from the imperfect anchoring mechanism, the foreign economy is similar to the domestic one. Thus, we only highlight here the features of the foreign economy related to the sources of U.S. monetary tightening—a key element in our analysis.

3.6.1 The U.S. growth shock

The foreign household maximizes

$$\mathbb{E}_t \left[\sum_{j=0}^{\infty} \beta^{*j} U(C^*_{t+j}, C^*_{t+j-1}, L^*_{i,t+j}; \varepsilon^*_{c,t+j}) \right] \tag{45}$$

[13] We assume for simplicity that the imperfect-anchoring of inflation expectations described earlier applies only to domestic producers setting prices in the domestic market.

where $\varepsilon^*_{c,t}$ is an exogenous preference shifter. In our baseline quantitative model we assume the following form for the utility function:

$$U(C^*_{t+j}, C^*_{t+j-1}, L^*_{i,t+j}; \varepsilon^*_{c,t+j}) = \log(C^*_{t+j} - hC^*_{t+j-1} - \varepsilon^*_{c,t+j}) - \frac{L^{*1+\varphi}_{it+j}}{1+\varphi}, \tag{46}$$

with

$$\varepsilon^*_{c,t} = \rho_c \varepsilon^*_{c,t-1} + \epsilon^*_{c,t}, \tag{47}$$

where $\epsilon^*_{c,t}$ is an *iid* innovation. The exogenous variable $\varepsilon^*_{c,t}$ thus shifts the marginal utility of consumption of U.S. households. We use this variable to engineer a shock to U.S. aggregate demand that leads to a persistent output expansion (a "growth" shock), putting upward pressure on inflation and resulting in an increase in the U.S. policy rate. We assume that an increase in $\varepsilon^*_{c,t}$ also triggers a rise in U.S. banks' net worth. Thus, the evolution of U.S. banks' net worth is

$$N^*_t = e^{\gamma_c \epsilon^*_{c,t}} \left[\sigma^* \left((R^*_{K,t} - R^*_t) Q^*_{t-1} A^*_{t-1} + R^*_t N^*_{t-1} \right) + (1-\sigma^*) \xi^*_b Q^*_{t-1} A^*_{t-1} \right], \tag{48}$$

where γ_c is a parameter governing how much the preference shock "spills over" to U.S. banks' net worth. The goal is to have the "growth" shock $\varepsilon^*_{c,t}$ lead to not only an expansion of U.S. consumption demand, but also to a loosening of financial conditions and a resultant increase in aggregate investment and decrease in credit spreads—capturing a broad improvement in U.S. household and business sentiment. We calibrate γ_c so that the percent expansion in U.S. investment is three times as large as that of consumption, consistent with the higher overall volatility of the former.

3.6.2 The U.S. monetary shock

U.S. monetary policy is governed by an inertial Taylor rule:

$$R^*_{n,t+1} = \left(R^*_{n,t} \right)^{\gamma^*_r} \left(\beta^{*-1} \pi^{*\gamma_\pi}_t x^{*\gamma^*_x}_t \right)^{1-\gamma^*_r} \varepsilon^*_{r,t}. \tag{49}$$

We assume the monetary shock $\varepsilon_{r,t}$ has two components:

$$\varepsilon^*_{r,t} = \tilde{\varepsilon}^*_{r,t} \bar{\varepsilon}^*_{r,t}, \tag{50}$$

where $\tilde{\varepsilon}^*_{r,t}$ is a purely *iid* innovation and $\bar{\varepsilon}^*_{r,t}$ follows an AR(2) process:

$$\bar{\varepsilon}^*_{r,t} = (1 - \rho_{m,1} - \rho_{m,2}) \bar{\varepsilon}^*_{r,t-1} - \rho_{m,1} \bar{\varepsilon}^*_{r,t-2} + \bar{\epsilon}^*_t, \tag{51}$$

with $\bar{\epsilon}_t^*$ following an *iid* stochastic process. The exogenous variable $\tilde{\varepsilon}_{r,t}^*$ captures a transitory monetary innovation of the kind often studied in the empirical literature (e.g. Christiano et al. 2005). The exogenous variable $\bar{\varepsilon}_{r,t}^*$ captures more lasting shifts in U.S. monetary policy—for example, a change in U.S. monetary policy whereby the policy rule becomes persistently more aggressive in its response to inflation (and this change is perfectly understood by the public). The shock also permits capturing forward guidance about these shifts. This shock will prove useful in capturing the 2022–23 U.S. tightening, as we discuss later.

3.7 Market clearing, balance of payments, and monetary policy

The market clearing condition for the home good is

$$Y_t = C_{D,t} + I_{D,t} + \phi_{I,t} + \frac{\mathcal{N}^*}{\mathcal{N}} \left(M_{C,t}^* + M_{I,t}^* \right), \tag{52}$$

where the relative population term $\frac{\mathcal{N}^*}{\mathcal{N}}$ reflects that all variables are expressed on a per-household basis. Home output is either used domestically (for consumption or investment) or exported. Capital and labor market clearing require $K_t = \int_0^1 K_{j,t} dj$ and $L_t = \int_0^1 L_{j,t} dj$, respectively. Market clearing for claims on EME physical capital (held by EME 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

$$D_t^* - R_t^* D_{t-1}^* = \mathcal{S}_t \left[\frac{P_{M,t}}{P_t} (M_{C,t} + M_{I,t}) - \frac{P_{D,t}}{P_t} \frac{\mathcal{N}^*}{\mathcal{N}} (M_{C,t}^* + M_{I,t}^*) \right]. \tag{53}$$

Equation (53) states that the EME's net accumulation of foreign liabilities, expressed in (real) dollars, equals the negative of the value of net exports.

Monetary policy in the home country follows an inertial Taylor rule:

$$R_{t+1}^n = \left(R_t^n \right)^{\gamma_r} \left(\beta^{-1} \pi_t^{\gamma_\pi} \right)^{1-\gamma_r}. \tag{54}$$

The rule above does not include an output gap term. Our motivation for that assumption is the evidence in Kaminsky et al. (2004) indicating that monetary policy in emerging market economies generally does not feature strong countercyclicality, unlike in advanced economies.

3.8 Parameter values

We calibrate the foreign economy to the United States, and take the home economy to represent a bloc of emerging economies. We consider two different calibrations of the home economy, one corresponding to a vulnerable set of EMEs, which we describe first, and another targeting less-vulnerable EMEs. The calibration is asymmetric: The U.S. is much larger in size, and EME households are assumed to be relatively impatient, which introduces a motive for the latter to borrow from U.S. households. This relative impatience can be seen as capturing more-structural differences between EMEs and advanced economies, such as faster prospective trend growth in EMEs. Accordingly, we calibrate the U.S. discount factor, β^*, to 0.995, 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 the home discount factor, $\beta = 0.9925$ to get real interest rate of 3% per year for more vulnerable EMEs. This target rate is consistent with the estimates of Mexico's long-run natural rate from Carrillo et al. (2017).

The U.S. openness parameter, ω^*, is assumed to be arbitrarily small. We also assume that the U.S. is arbitrarily large relative to the EMEs, $\frac{\mathcal{N}^*}{\mathcal{N}} \to \infty$. The rationale for these assumptions is that EMEs are very small in size relative to the United States and have small weight in U.S. consumption and investment baskets. As we will see, this implies that there are no "spillbacks" from the EME onto the U.S. economy. Put differently, the U.S. behaves effectively like a closed economy. This makes the model analysis simpler and more transparent. Turning to the home openness parameter, ω, our target implies that 10% of the home economy's output is exported in steady state. 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 is consistent with other EMEs: Aggregating across the major EMEs in Asia and Latin America leads to a ratio of around 0.10 for 2017.[14]

Table 5 reports the remaining parameter values. 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, $\epsilon/(\epsilon - 1)$ and $\epsilon_w/(\epsilon_w - 1)$, 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 (φ^{-1}), the parameters governing price and wage rigidities (θ_p and θ_w respectively), and the investment adjustment cost parameter (Ψ_I). These parameters are set symmetrically across the U.S. and EMEs, and their values are fairly conventional. 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 $(1+\eta)/\eta$ to 1.8. 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.

The Taylor rule both at home and in the U.S. features inertia with a coefficient of 0.75, taken from

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

Table 5
Parameter Values

	Parameter	Value
Household preferences		
Discount factor (U.S.)	β^*	0.9950
Discount factor (less vul. EME)	β	0.9950
Discount factor (more vul. EME)	β	0.9925
Habit persistence in consumption	h	0.80
Frisch elasticity of labor supply	φ^{-1}	0.26
Substitution elasticity home/foreign goods	η	1.25
Home bias (U.S.)	$1-\omega^*$	1.00
Home bias (less vul. EME)	$1-\omega$	0.80
Home bias (more vul. EME)	$1-\omega$	0.90
Trade adjustment cost	φ_M	10.00
Probability of keeping wages fixed	ϵ_w	0.70
Net wage markup	θ_w	0.20
Wage indexation (less vul. EME)	ι_w	0.15
Production		
Capital share	α	0.33
Capital depreciation rate	δ	0.025
Investment adjustment cost	φ_I	4.00
Probability of keeping prices fixed	ϵ_p	0.87
Net price markup	θ_p	0.20
Price indexation (less vul. EME)	ι_p	0.24
Backward-looking exp. (more vul. EME)	υ	0.875
Reac. to surprise inflation (more vul. EME)	ζ	0.33
Monetary Policy Rule		
Response to inflation	γ_π	1.50
Response to output gap (U.S.)	γ_x^*	0.125
Financial Intermediaries		
Survival Rate (U.S.)	σ^*	0.925
Survival Rate	σ	0.950
Asset diversion parameter (U.S.)	θ^*	0.45
Asset diversion parameter (less vul. EME)	θ	0.41
Asset diversion parameter (more vul. EME)	θ	0.43
Home bias in bank funding (less vul. EME)	γ	0.00
Home bias in bank funding (more vul. EME)	γ	2.58
Transfer rate to new entrants (U.S.)	ξ_b^*	0.275
Transfer rate to new entrants (less vul. EME)	ξ_b	0.120
Transfer rate to new entrants (more vul. EME)	ξ_b	0.052
Shock Processes		
U.S. preference shock persistence	ρ_c	0.9
U.S. monetary shock parameters	$(\rho_{m,1}, \rho_{m,2})$	(0.64, 0.09)

Justiniano et al. (2010). We set the coefficient γ_π to the standard value of 1.5, capturing a rule focused on stabilizing domestic inflation. We set the coefficient on output gap, γ_x^*, to 0.125 for the U.S., a conventional value used in the literature (e.g. Taylor 1993). As discussed previously, we assume the EME policy rule does not respond to any variable other than domestic inflation.

Turning to the parameters related to the home financial market friction, we set the survival rate σ_b to 0.95, implying an expected horizon of bankers of 5 years. This value is around the mid point of the range found in related work. We set the remaining three parameters to hit three steady-state targets: a credit spread of 200 basis points, a leverage ratio of four, and a ratio of foreign-currency debt to domestic debt ($D^*/\mathcal{S}D$) of 30 percent. The target for the credit spread reflects the average value of 5-year BBB corporate bond spreads in major Asian and Latin American emerging market economies over the period 1999-2017 (excluding the global financial crisis period). The target leverage ratio is a rough average across different sectors. Leverage ratios in the banking sector are typically greater than four,[15] but the non-financial corporate sector generally has lower asset-equity ratios (between two and three in emerging markets).[16] Our target of four reflects a compromise between these two values. Finally, evidence in Hahm et al. (2013) on ratios of foreign-currency deposits to domestic deposits in EMEs suggests an average of about 30 percent. This value is also consistent with evidence presented in Chui et al. (2016), showing that average private-sector foreign currency debt across EMEs (for the period 2006-2014) as a percent of total (i.e. domestic- plus foreign-currency denominated) debt is about 20 percent. These targets imply $\theta = 0.43, \xi_b = 0.052$, and $\gamma = 2.58$. The implied value for the steady-state ratio of foreign liabilities to assets is $x = 0.18$ (note that x follows from our targets for ϕ and $D^*/\mathcal{S}D$, via the balance sheet identity (14)).

For the parameters governing the degree of imperfectly-anchored inflation expectations, we use measures from our dataset on long-term inflation expectations, along with the empirical responsiveness parameters in Tables 2-4. Accordingly, we set the parameters ζ and υ to 0.33 and 0.875, respectively. In addition, we assume that wage setters fully index to perceived trend inflation in the vulnerable EMEs—that is, we set $\iota_w = 1$.

Turning to our calibration targeting the less-vulnerable EMEs, there are a few differences to highlight. First, we shut off the imperfect-anchoring mechanism for these countries: We assume that trend inflation $\overline{\pi}_t$ does not play any role in price or wage setting decisions, and that wage and price setters instead index to lagged wage and price inflation to an extent similar to an advanced economy like the United States, with parameters ι_w and ι_p taken from Justiniano et al. (2010). Second, we assume that less-vulnerable EMEs

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

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

have a negligible share of foreign-currency debt and that UIP approximately holds in these countries. Accordingly, we set set set $\beta = 0.995$, which eliminates the incentive to borrow in foreign currency, and we assume that that the enforcement friction does not increase in x (captured by setting γ to a very small number), which eliminates the dependency of UIP premiums on EME net worth. We continue to target a leverage ratio of 4 and a steady-state spread of 200 basis points, leading to somewhat different values for the parameters θ and ξ_b compared to the more-vulnerable case. Third, we set the home bias parameter so that less-vulnerable EMEs export 20 percent of their output in steady state, consistent with the greater openness of the less-vulnerable Asian emerging economies compared to Latin American ones. Finally, we adopt the PCP assumption for trade prices in the less-vulnerable EMEs, while we assume DCP in the more-vulnerable calibration.

Turning to the calibration of the U.S. financial parameters, we set the three parameters σ_b^*, θ^*, and ξ_b^* to hit three targets: A steady state leverage of 3, a steady-state spread of 200 basis points, and an increase in the U.S. spread of 0.2 percentage points following a one-percentage-point hike in the feds funds rate. The first target is a rough estimate of economy-wide leverage, including both financial and non-financial institutions. The second target is the average value of the Gilchrist and Zakrajsek (2012) credit spread. The third target a rough mid point in the empirical estimates in Gertler and Karadi (2015) and Boivin et al. (2010) of the responsiveness of U.S. credit spreads to U.S. monetary shocks.

4 Model analysis

This section describes our baseline set of experiments highlighting how the spillovers to EMEs of U.S. tightenings depend on the source of the tightening and on the degree of EME vulnerabilities. Section 4.1 presents a simplified setting—close to the textbook three-equation model—that helps convey the basic intuition, and Section 4.2 reports results from our full quantitative model.

4.1 A simplified setting for intuition

This section presents a version of the model with a number of simplifying assumptions to the model that bring it closer to standard textbook formulations (e.g. Gali 2015). In particular, we make use of a first-order approximation around a limiting point in the parameter space in which the foreign economy (the U.S.) is arbitrarily large relative to the home economy (the EME). The resulting setting transparently illustrate the basic forces. We rely on the following result.

Proposition (Simplified model). Suppose labor is the only production input ($\alpha = 0$), wages are fully flexible ($\theta_w = 0$), international financial markets are complete, export prices are set in the producer currency, preferences at home and abroad are, respectively, $U(C_t, L_t) = \left(\frac{C_t^{1-\sigma}-1}{1-\sigma} - \frac{L_t^{1+\varphi}}{1+\varphi}\right)$ and $U(C_t^*, L_t^*) = \left(\frac{C_t^{*1-\sigma}-1}{1-\sigma} - \frac{L_t^{*1+\varphi}}{1+\varphi}\right) e^{\varepsilon^*_{c,t}}$, and monetary policy rules are noninertial ($\rho_r = 0$). Then in a first-order approximation around a deterministic steady state with parameters satisfying $\omega^* \to 0$, $\mathcal{N}^*/\mathcal{N} \to \infty$, and $\frac{\mathcal{N}^*}{\mathcal{N}}\omega^* \to \omega$, equilibrium in the two economies is represented by the following set of equations.

Home:

$$y_t = (1-\omega)c_t + \omega\left[-(2-\omega)\eta\tau_t + y_t^*\right], \tag{55}$$

$$c_t = -\frac{1}{\sigma}\left[r_{t+1}^n - \mathbb{E}_t(\pi_{D,t+1} - \omega\Delta\tau_{t+1})\right] + \mathbb{E}_t(c_{t+1}), \tag{56}$$

$$\pi_{D,t} = (1-\beta\phi)\overline{\pi}_t + \lambda(\sigma c_t + \varphi y_t - \omega\tau_t) + \beta\mathbb{E}_t(\pi_{D,t+1}), \tag{57}$$

$$\overline{\pi}_t = \zeta\left[\pi_{D,t} - \omega(\tau_t - \mathbb{E}_{t-1}\tau_t)\right] + \phi\overline{\pi}_{t-1}, \tag{58}$$

$$r_{t+1}^n = \phi_\pi \pi_{D,t}. \tag{59}$$

Foreign:

$$y_t^* = -\frac{1}{\sigma}\left[r_{t+1}^{n*} - \mathbb{E}_t(\pi_{t+1}^*)\right] + \mathbb{E}_t(y_{t+1}^*) + \frac{1}{\sigma}(1-\rho_c)\varepsilon_{c,t}^*, \tag{60}$$

$$\pi_t^* = \kappa y_t^* + \beta\mathbb{E}_t(\pi_{t+1}^*), \tag{61}$$

$$r_{t+1}^{n*} = \phi_\pi\pi_t^* + \phi_y y_t^* + \varepsilon_{r,t}^*. \tag{62}$$

Uncovered interest parity:

$$\tau_t = \left[r_{t+1}^n - \mathbb{E}_t(\pi_{D,t+1})\right] - \left[r_{t+1}^{n*} - \mathbb{E}_t(\pi_{t+1}^*)\right] + \mathbb{E}_t(\tau_{t+1}). \tag{63}$$

Above, $\lambda \equiv (1-\beta\theta_p)(1-\theta_p)/\theta_p$ and $\kappa \equiv \lambda(1+\varphi)$. The equations above determine the home variables $y_t, \pi_{D,t}, r_{t+1}^n, c_t, \overline{\pi}_t$, the foreign variables $y_t^*, \pi_t^*, r_{t+1}^{n*}$, and the terms of trade τ_t (all expressed as log deviations from steady state).

Proof: See Appendix A.

The liming case considered here for parameters $\omega^*, \mathcal{N}^*$, and $\mathcal{N}$ is helpful because it leads to a setup in which the large economy can affect the small one, but not viceversa.[17] The equations above illustrate how the response of EME activity, y_t, depends upon the source of the U.S. tightening and upon the degree of vulnerability (proxied here by the extent of unanchoring, captured by the parameter ζ). The key

[17] Thus, the present setup is in between two well-known paradigms considered in the literature: The model in Gali and Monacelli (2005) with a continuum of small open economies, in which no country can influence developments in other countries; and the model in Benigno and Benigno (2003) with two large economies, in which both countries can influence each other.

equation is (55), where the first term, $(1-\omega)c_t$, captures the role of domestic absorption, and the second term, $\omega\left[-(2-\omega)\eta\tau_t + y_t^*\right]$, captures the role of external factors— themselves driven by two factors: the exchange rate (which varies proportionally with the terms of trade τ_t) and the level of activity in the foreign country (the U.S.), with both an EME currency depreciation (lower τ_t) and higher U.S. output y_t^* leading, other things equal, to an increase in EME GDP, via higher demand for EME-produced goods.

Consider first a case with $\zeta = 0$, intepretable as inflation expectations being well-anchored—capturing less-vulnerable EMEs. Focusing first on a growth-driven tightening, i.e., an increase in $\varepsilon_{c,t}^*$, U.S. output y_t^* and inflation π_t^* rise as a result of the expansion in aggregate demand, and the U.S. policy rate, r_{t+1}^{n*}, rises in response. (Note that due to the much larger size of the foreign economy as modeled here, this economy can effectively be treated as being a closed economy, behaving exactly as in the textbook, closed-economy, three-equation New Keynesian model). Through the UIP condition (63), the rise in r_{t+1}^{n*} puts downward pressure on τ_t—a depreciation of the EME currency. Both the higher y_t^* and the lower τ_t^* will push domestic output up: y_t will expand as domestic firms face higher demand, driven both by higher U.S. income and a cheaper domestic currency.

Now consider a similar increase in r_{t+1}^{n*}, but this time monetary-driven (i.e. induced by an increase in $\varepsilon_{r,t}^*$). U.S. output now moves in the opposite direction: y_t^* falls, pushing EME output down. Note, however, that τ_t still falls—the tighter U.S. policy stance appreciates the dollar against the EME currency. The net effect on y_t will depend on the relative strength of each force, with the trade elasticity η playing a key role, as it governs the magnitude of the rise in demand for EME goods that results from the EME depreciation. Output will not expand as much as in the previous case, however, and it may well fall (if, for example, η is low), but any negative effects are likely to be small.

Consider next a vulnerable EME, characterized by $\zeta > 0$ and $\upsilon > 0$. The effects described previously for each type of shock will continue to play out in a similar way. But now there is an additional effect: the surprise depreciation triggered by a foreign tightening (regardless of whether this tightening is growth- or monetary-driven) feeds into $\overline{\pi}_t$, and thus into $\pi_{D,t}$. The monetary authority will have to respond, pushing down domestic absorption c_t. The response of output will necessarily be lower than with $\zeta = 0$, irrespective of the tightening driver. This response can well be a large negative if ζ is large.

The model just described can qualitatively account for the main patterns in our full-blown quantitative model. The full-blown model discussed in detail earlier, however, adds a number of key relevant features to the simple setup described in this subsection that will help better align the quantitative results to real world features: First, it adds an investment sector subject to financial frictions and an endogenous UIP premium, which act as amplifiers of domestic absorption in the presence of dollar-denominated debt—as discussed extensively in Akinci and Queralto (2023). Second, it adds standard features needed to obtain empirically-realistic aggregate dynamics, including wage rigidity, consumption habits, adjustment costs in investment and in trade, and inertia in monetary policy rules. Finally, the full-blown model considers the role of DCP as an additional vulnerability which dampens the competitiveness gains of currency depreciation. With this mind, we now present quantitative results from the full-blown model.

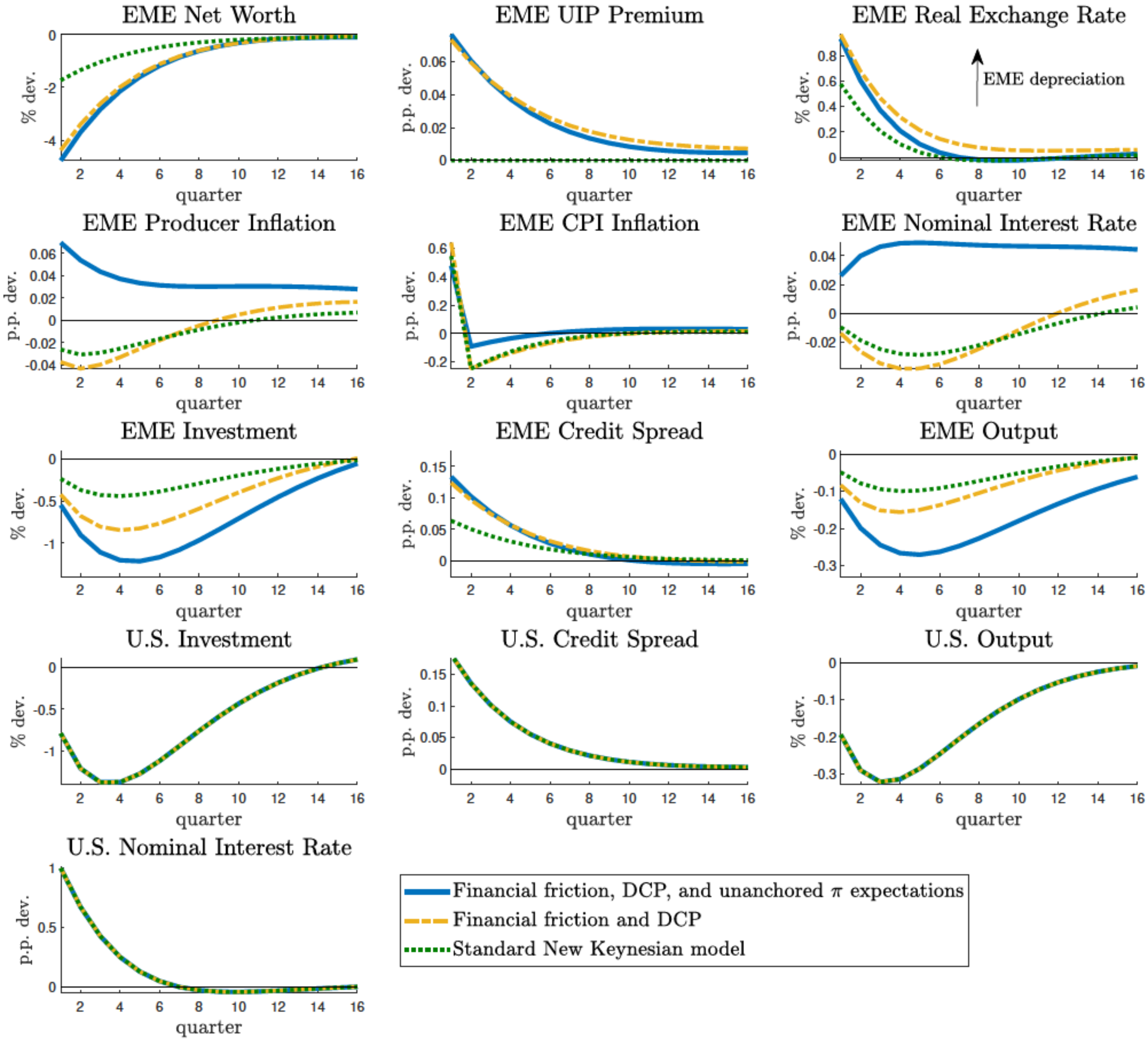
4.2 Monetary policy spillovers: The role of country vulnerabilities and policy drivers

We begin by describing the effects of a 100-basis point unexpected and exogenous transitory U.S. monetary tightening and showing how the shock interacts with the country vulnerabilities outlined before. To clarify the role of each vulnerability, Figure 2 shows the effect of the shock when the vulnerabilities are added one at a time. Thus, we first show the effect of the U.S. monetary policy shock on an EME without any currency mismatches and without feedback from balance sheets to UIP premiums (that is, with $\gamma = 0$), and under the PCP assumption for EME export prices. This case is shown by the green dotted line, which basically amounts to the predictions of a standard NK model augmented with a domestic financial accelerator mechanism. Second, we discuss the role of currency mismatches in balance sheets and of DCP in amplifying the impact of the shock (yellow dashed line). Finally, we add the presence of imperfectly anchored inflation expectations to show the effects when all of the vulnerabilities we model are present (blue solid line).

The bottom two rows of panels in Figure 2 show the effects of a hike in the Federal Funds Rate (FFR) of 1 percentage point on the U.S economy. Overall, the shock has empirically realistic effects on the United States, with U.S. GDP falling by a little over 0.3 percent after a year—a magnitude within the range of estimates based on the structural vector autoregression (SVAR) presented in Akinci and Queralto (2023). Financial conditions tighten in the United States (as seen in the bottom middle panel showing an increase in U.S. corporate credit spreads), consistent with the evidence in Rey (2015) and Gertler and Karadi (2015), and investment falls by almost 1.5 percent, also consistent with SVAR-based estimates. In our setup, the EME vulnerabilities have no consequences for the U.S. economy, so all the three lines overlap in the U.S. effects.

Moving to the cross-border spillover effects of the shock, a first important observation from the figure is that the effects of the U.S. tightening on activity in EMEs with no currency mismatches and with anchored inflation expectations (the green dotted line) are modest, with EME GDP falling by only 0.1 percent. The reason is that the tightening in EME financial conditions is fairly limited in this case, as balance sheets are not very vulnerable to currency depreciation. In addition, the EME central bank can afford to cut rates somewhat, without fears of the adverse effects of exchange rate depreciation on its economy.

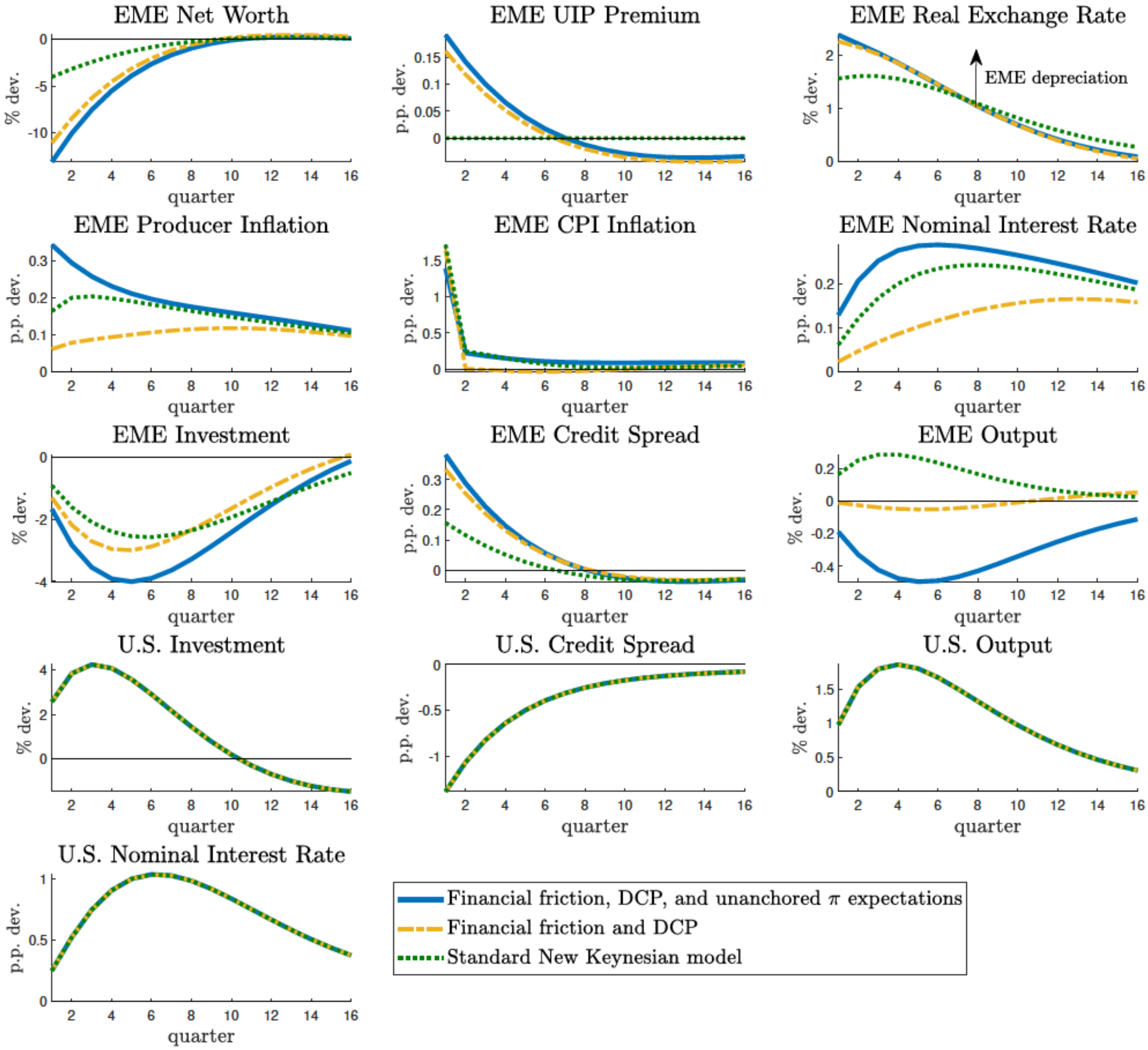
Figure 2: Transitory U.S. monetary shock, role of EME vulnerabilities



Note: Effects of a U.S. transitory monetary shock $\tilde{\varepsilon}^*_{r,t}$ that raises the U.S. nominal policy rate by 1 percentage point. The green dotted lines, labelled "standard New Keynesian model," show the effects in an economy without financial frictions, with producer currency pricing of exports, and with anchored inflation expectations. The yellow dash-dotted lines show the effects in an economy with financial frictions and dollar export pricing. The blue solid lines show the effects in an economy with financial frictions, dollar export pricing, and imperfectly-anchored inflation expectations.

With fragile balance sheets and DCP (yellow dash-dotted line), the U.S. monetary tightening triggers a noticeably larger increase in EME credit spreads and a larger depreciation of the EME currency, as well as a bigger hit to GDP. As in Akinci and Queralto (2023), a strong three-way interaction between balance sheets, financial conditions, and currency values magnifies the effect of the shock. The resulting financial tightening lowers domestic absorption through a slowdown in investment spending, despite a stronger offset from exports due to the sharper depreciation.

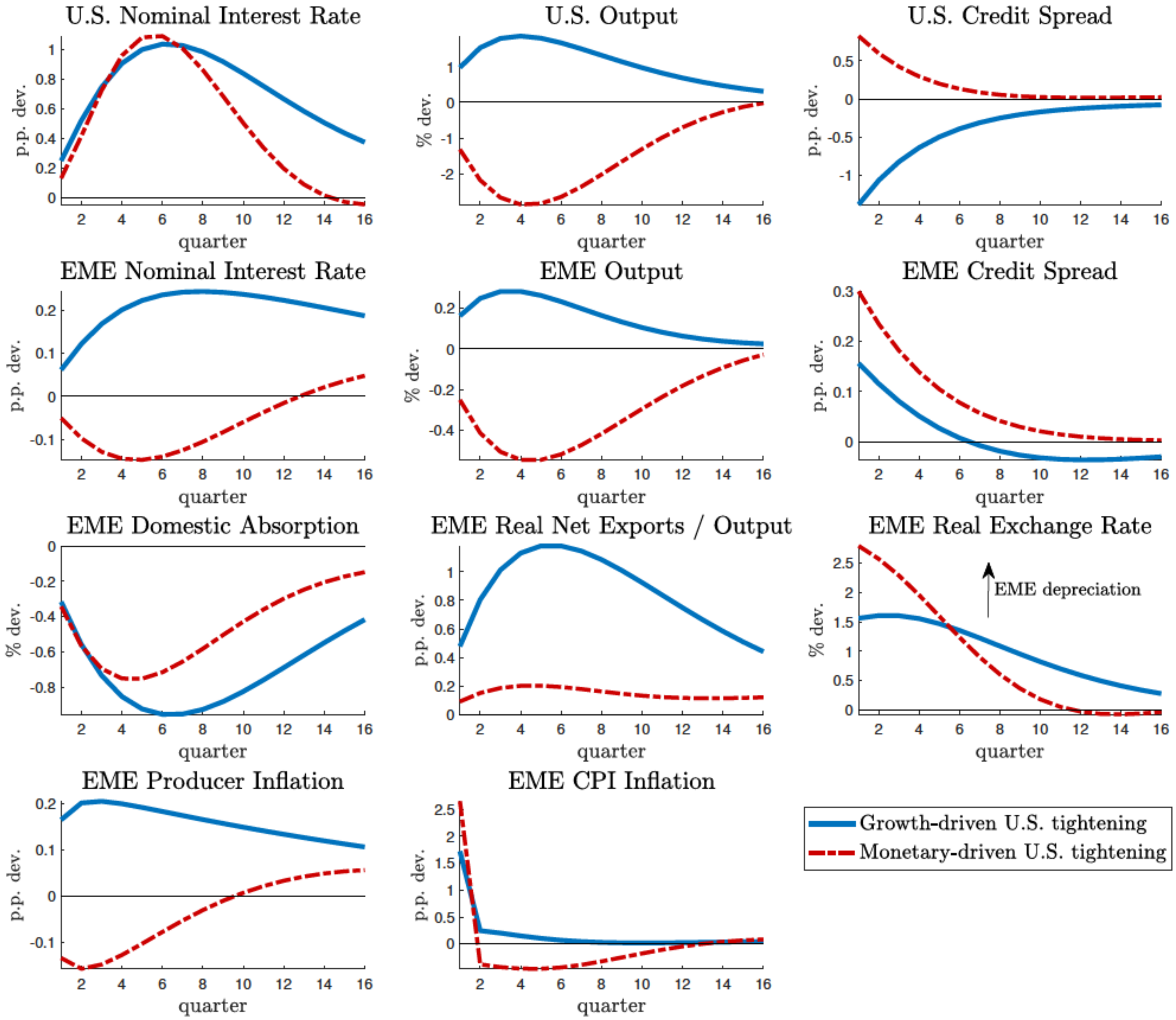
Figure 3: U.S. growth shock, role of EME vulnerabilities



Note: Effects of a U.S. aggregate demand shock $\varepsilon^*_{c,t}$ that raises the U.S. nominal policy rate by 1 percentage point at the peak. The green dotted lines, labelled "standard New Keynesian model," show the effects in an economy without financial frictions, with producer currency pricing of exports, and with anchored inflation expectations. The yellow dash-dotted lines show the effects in an economy with financial frictions and dollar export pricing. The blue solid lines show the effects in an economy with financial frictions, dollar export pricing, and imperfectly-anchored inflation expectations.

Finally, in the presence of unanchored inflation expectations in addition to the credit frictions and DCP (the solid blue lines), the drop in EME GDP is much larger, almost 0.3 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 perceived trend inflation $\overline{\pi}_t$. Actual domestic inflation increases persistently as a result. 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.

Figure 4: Less-vulnerable EME, growth- v. monetary-driven U.S. tightening



Note: Effects of a U.S. policy tightening driven by growth shock $\varepsilon^*_{c,t}$ (blue) and by a persistent monetary shock $\overline{\varepsilon}^*_{r,t}$ (red) on less-vulnerable EME.

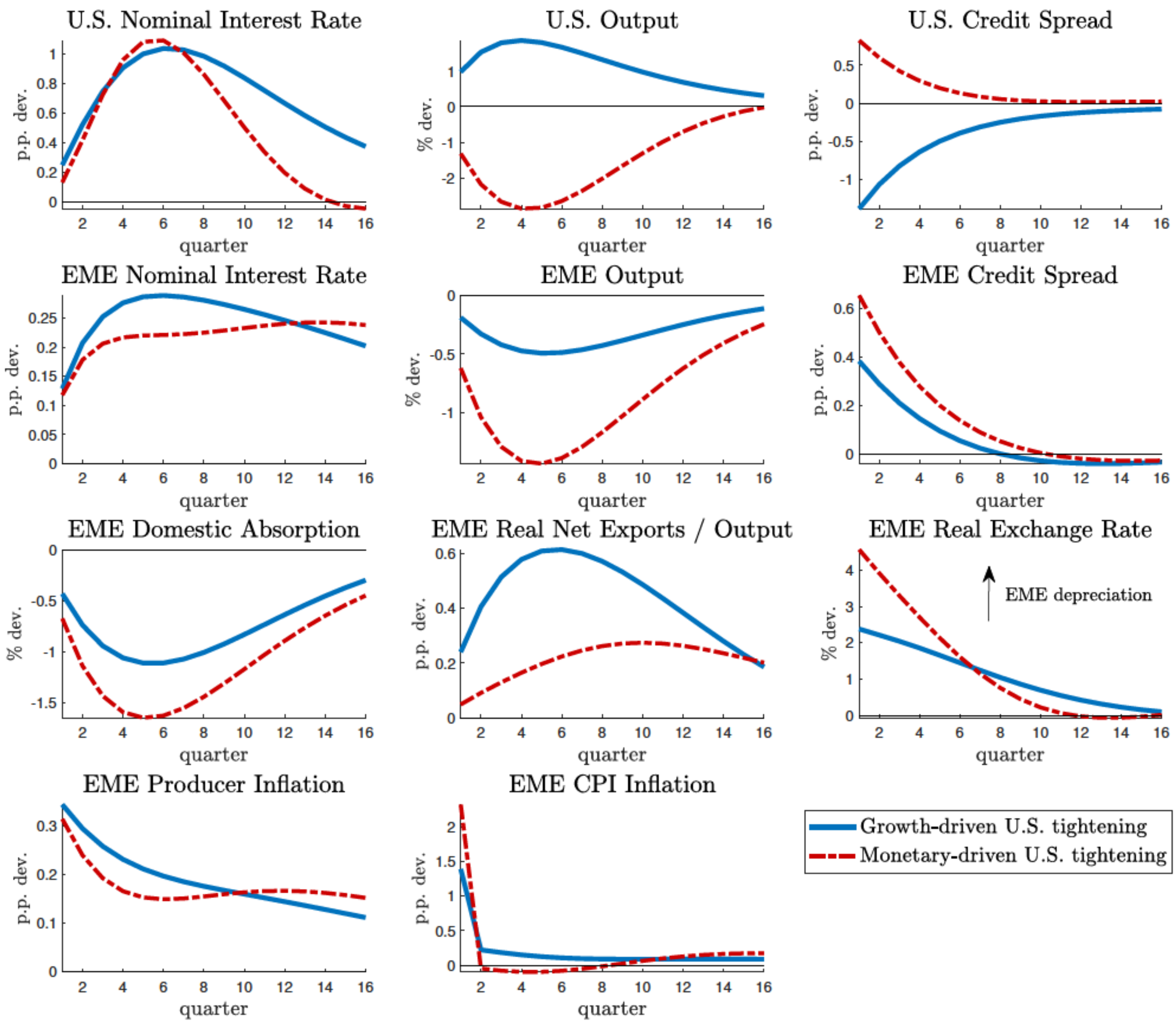
We now turn to the spillovers of a U.S. "growth" shock (to which U.S. monetary policy responds by tightening): an expansion in U.S. aggregate demand triggered by the preference shock $\varepsilon^*_{c,t}$, the effects of which are shown in Figure 3. We size the shock so that it leads to a rise in the U.S. nominal interest rate of 1 percentage point at the peak, which was the size of the previous exogenous shock to the FFR discussed above. Note that the interest rate reaches that level gradually, both due to persistence in the shock and to the rigidities in the model generating inertia. Thus, the shock is a useful way of capturing a situation of persistent U.S. economic strength, leading to a higher path of expected future policy rates. The key observation from the figure is that this "growth-driven" tightening does not unambiguously lead to a drop in EME GDP. In fact, absent vulnerabilities (the green dotted lines), GDP actually expands, and even with balance sheet mismatches alone, EME activity essentially does not respond in either direction. This situation arises because the positive spillover effects from U.S. demand (to which U.S. monetary policy is responding) largely offset the negative effects of the rise in interest rates. But when imperfectly-anchored inflation expectations are added, activity drops quite significantly. In all cases, though, credit spreads rise and EME currencies depreciate, and with the balance sheet friction turned on, the UIP premium always rises.

A final point from both figures 2 and 3 is that these results suggest a much worse macroeconomic tradeoff for the more vulnerable EMEs (those with weak balance sheets, DCP, and imperfectly-anchored inflation expectations) than for the less-vulnerable ones, as GDP and inflation (both producer and CPI) move in opposite directions for these countries. Unanchored inflation expectations contribute to the emergence of this tradeoff, causing the EME policy rate to react much more forcefully to the U.S. tightening.

Note that the growth shock just examined and the monetary shock studied previously induce different dynamics for the U.S. policy rate, with the former shock leading to a very transitory rise in the policy rate and the latter leading to a response that rises over time before the policy rate falls. We next turn to the effects of the persistent monetary shock $\overline{\varepsilon}^*_{r,t}$, which induces a path of the U.S. policy rate that is more comparable to the one triggered by a persistent expansion in U.S. demand. We set the coefficients of the AR(2) process of this shock to minimize the distance between the U.S. nominal rate path in the growth-driven case and that in the monetary-driven case (over the first 8 quarters). The idea is to capture a meaningful "hawkish" shift in the Fed's reaction function that market participants expect to last. In Figure 4, we contrast the effects of such a shock, in red, to those of a growth-driven tightening, in blue, for what we hereafter refer to as the "less-vulnerable" EMEs—those with strong balance sheets, well-anchored inflation expectations, and domestic-currency pricing of exports. As made clear by this figure, for this type of countries a U.S. tightening has opposite effects on activity depending on the tightening driver: A growth-driven one leads to an expansion, while a monetary-driven tightening leads to a contraction (about twice as large in absolute magnitude as the expansion in the growth-driven case). The third row offers insight into the mechanism driving the differing effects on activity: While domestic absorption drops in both cases, the growth-driven case features a sharp rise in EME net exports, accounting for the positive response of GDP (note that the GDP response is roughly the sum of the responses of absorption and net exports over GDP).

Next, in Figure 5 we turn to the same experiment, but now for "vulnerable" EMEs—those with weak balance sheets, imperfectly-anchored inflation expectations, and dollar pricing of exports. Both types of tightening now induce a contraction in activity, which is particularly sharp in the monetary-driven case. Activity contracts even in the "growth" shock case, because the financial vulnerabilities amplify the

Figure 5: More-vulnerable EME, growth- v. monetary-driven U.S. tightening



Note: Effects of a U.S. policy tightening driven by growth shock $\varepsilon^{*}_{c,t}$ (blue) and by a persistent monetary shock $\overline{\varepsilon}^{*}_{r,t}$ (red) on more-vulnerable EME.

negative effects of the U.S. interest rate—an effect that now more than offsets the positive effect from the favorable U.S. demand shock. The much sharper contraction in the latter case is both due to a sharper contraction in EME absorption—which occurs due to the more-adverse financial accelerator and because the monetary authority is forced to increase policy rates to fight inflationary pressures—and to a much lower expansion in net exports, which is itself driven by two factors: the fact that U.S. aggregate demand (and thus demand for EME goods) now contracts, and the fact that EME exports are priced in dollars, which limit competitiveness gains despite a large depreciation of the EME currency.

A final important point we highlight from Figures 4 and 5 is that the responses of EME credit spreads and exchange rates are consistent with the empirical effects identified by Hoek et al. (2022) from their event study using narrow windows around FOMC meetings: For a given degree of vulnerability, EME credit spreads rise by more, and EME currencies depreciate by more, when the U.S. tightening is monetary-driven than when it is growth-driven; and for a given source of tightening, credit spreads rise more, and currencies depreciate by more, for more-vulnerable EMEs than for less-vulnerable ones.

5 Spillovers from the 2022-23 U.S. tightening cycle

We now apply the model to the current juncture to document how less-vulnerable and more-vulnerable EMEs have behaved through the most recent U.S. tightening relative to what the model would predict, and to explore what insights can be gleaned from this exercise. The most recent U.S. monetary tightening cycle as of this writing—the one that started in 2022—has been unprecedented in both magnitude and speed, with a cumulative rise in the fed funds rate not seen in the previous 30 years (Figure 6, left panel). The right panel of the figure shows the massive shift over time in market expectations of the fed funds rate path, as implied by financial market quotes (specifically, overnight interest swaps): Between late 2021 and late 2023, the entire path shifted upward by over 4 percentage points, with the bulk of the move occurring during 2022.

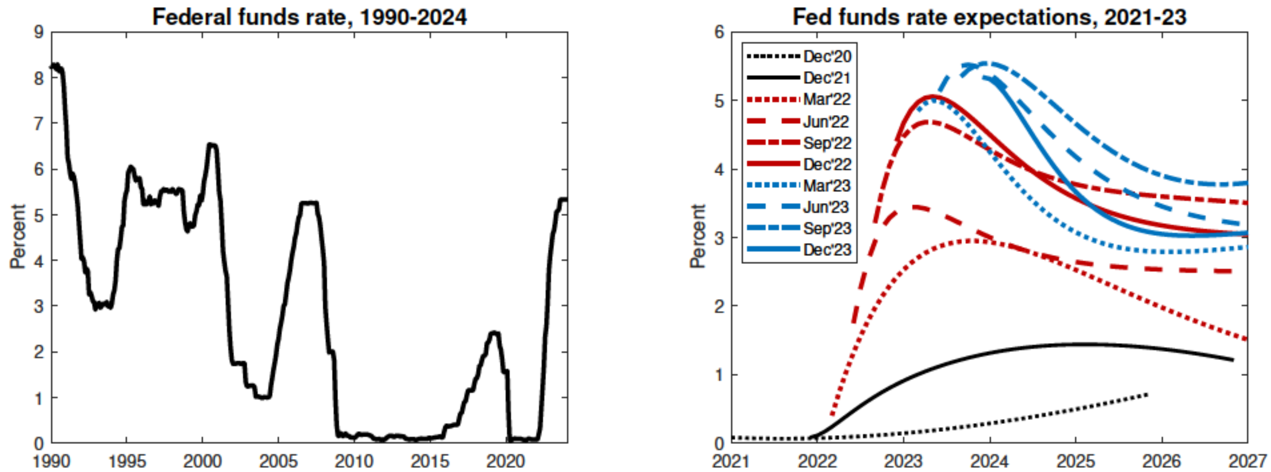
We next use the model to quantify the spillovers on EMEs with different degrees of vulnerability of the 2022-23 U.S. tightening, and compare the predictions against the actual evolution of EME corporate bond spreads, exchange rates, and GDP. In section 5.1 we condition only on the shift in market expectations of the fed funds rate over 2022 and 2023, and assume that the associated U.S. tightening was either fully growth-driven or fully monetary-driven. In section 5.2 we condition, in addition to the shift in the expected fed funds rate path, on the shift in private forecasters' expected path of U.S. GDP, which allows extracting a specific combination of growth and monetary shocks driving the tightening.

5.1 Two polar cases: Fully monetary-driven vs. fully growth-driven

We begin by envisioning, for illustrative purposes, two polar cases: One in which throughout this episode, the U.S. tightening was fully growth-driven, and another in which it was fully monetary-driven. We see these two polar cases as useful bounds to gauge a range of plausible spillover effects. For the growth-driven case, we numerically search for innovations to the U.S. growth aggregate demand shock, $\epsilon^*_{c,t}$, from $t =$2022:q1 through 2023:q4, to minimize the distance between the expected federal funds rate path in the model and in the data at each t, with the monetary shock $\varepsilon^*_{r,t}$ set to zero throughout. For the monetary-driven case, we then repeat the same exercise but searching over innovations to the persistent monetary shock $\overline{\varepsilon}^*_{r,t}$, this time setting the growth shock to zero.

Figure 7 shows the data and model-predicted expected FFR paths, as well as the paths of the shocks

Figure 6: Federal funds rate (FFR) and FFR expectations during 2022-23 tightening



Note: The left panel shows the level of the federal funds rate. The right panel shows market expectations of the future path of the fed funds rate implied by overnight interest swaps at each of the months indicated in the legend.

resulting from the matching exercise. Note that the model matches the data quite well: In both the growth-driven and monetary-driven cases, the model replicates the upward shift in the expected FFR path that occurred over the course of 2022. Key to the ability to match the data in the monetary-driven case is the AR(2) nature of the shock, which permits engineering a persistent upward shift in policy rate expectations.

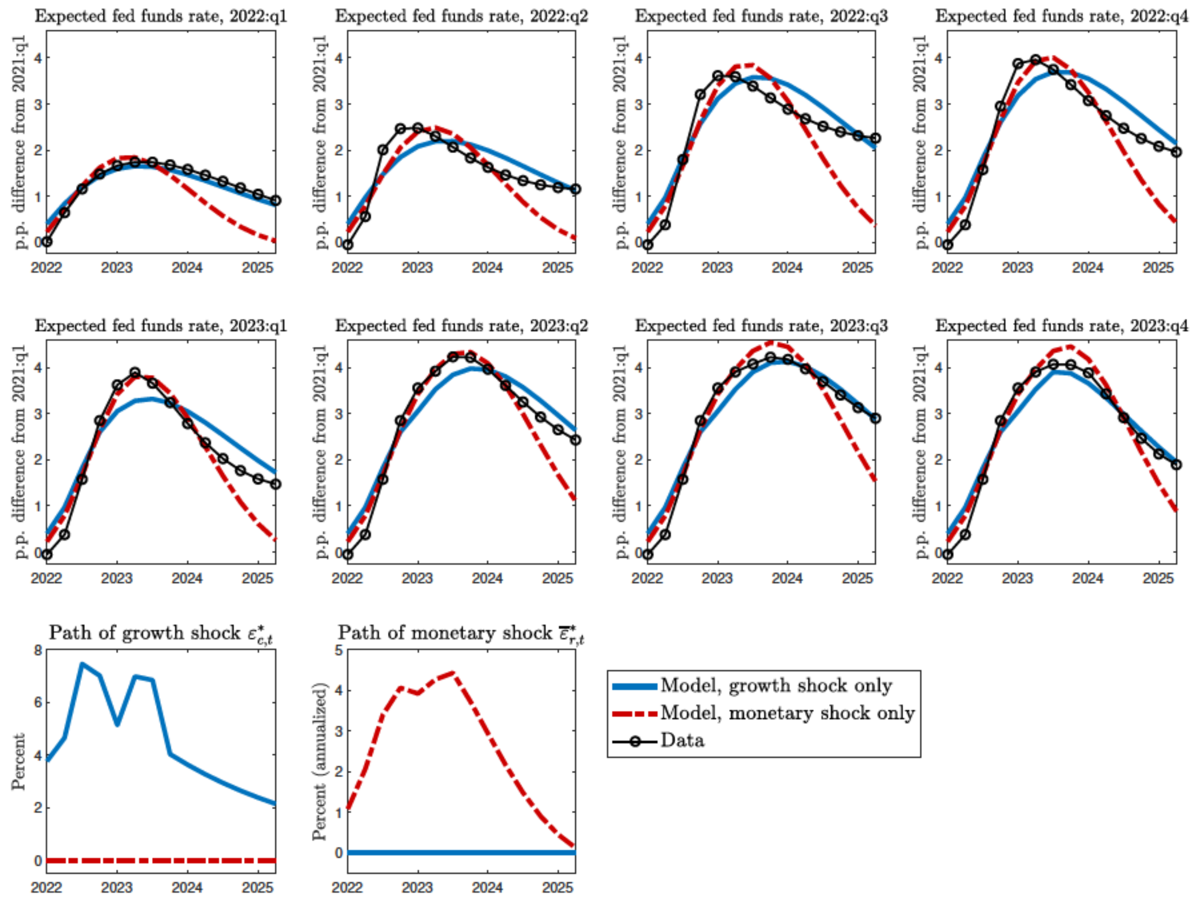
Moving to Figure 8 (and ignoring the green lines for the moment, to which we will return), the blue and red lines show the effects on less-vulnerable (left) and more-vulnerable (right) EME GDP, for the polar cases of only growth shocks and only monetary shocks, respectively. The key takeaway is that while for the less-vulnerable EMEs, the 2022 tightening would have mostly manageable effects—and might even have been beneficial to the extent that it was growth-driven, as the blue line in the left panel shows—for the more-vulnerable EMEs the effects would have been much more negative, and might have been very adverse (at negative 6 percent) in the case of a fully monetary-driven tightening.

These are polar cases, of course, and in reality it was most likely a combination of growth and monetary shocks that drove the U.S. tightening. Below we use the model to identify what that combination might have been.

5.2 More realistic case: Model-inferred mix of growth and monetary shocks

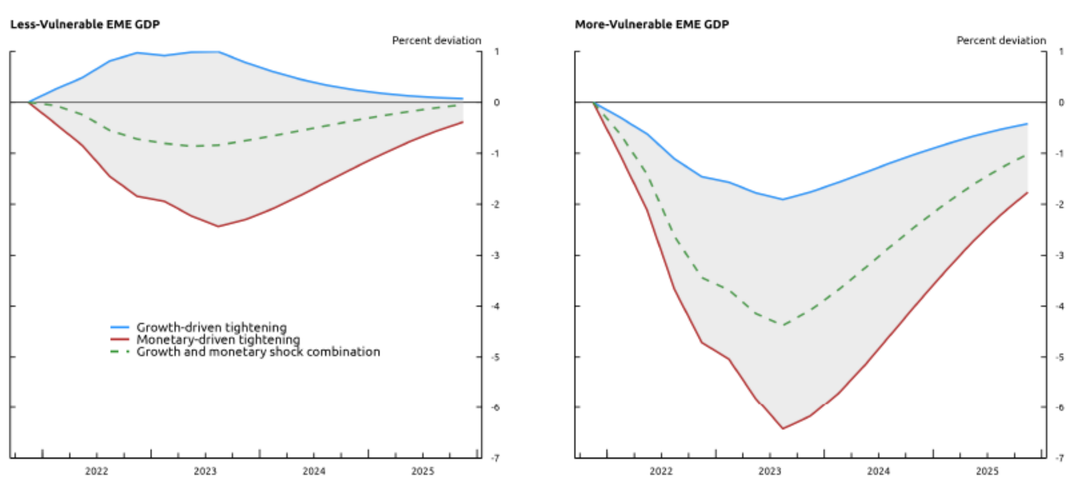
Here we use the model to infer a specific mix of growth and monetary shocks driving the U.S. tightening, assuming that these two shocks in the model were the only shocks driving the dynamics of the fed funds rate and U.S. GDP. The key observation allowing us to identify a specific mix of growth and monetary shocks is that these two shocks would drive U.S. GDP in opposite directions, as made clear by the upper

Figure 7: FFR expectations during 2022 tightening, data v. model



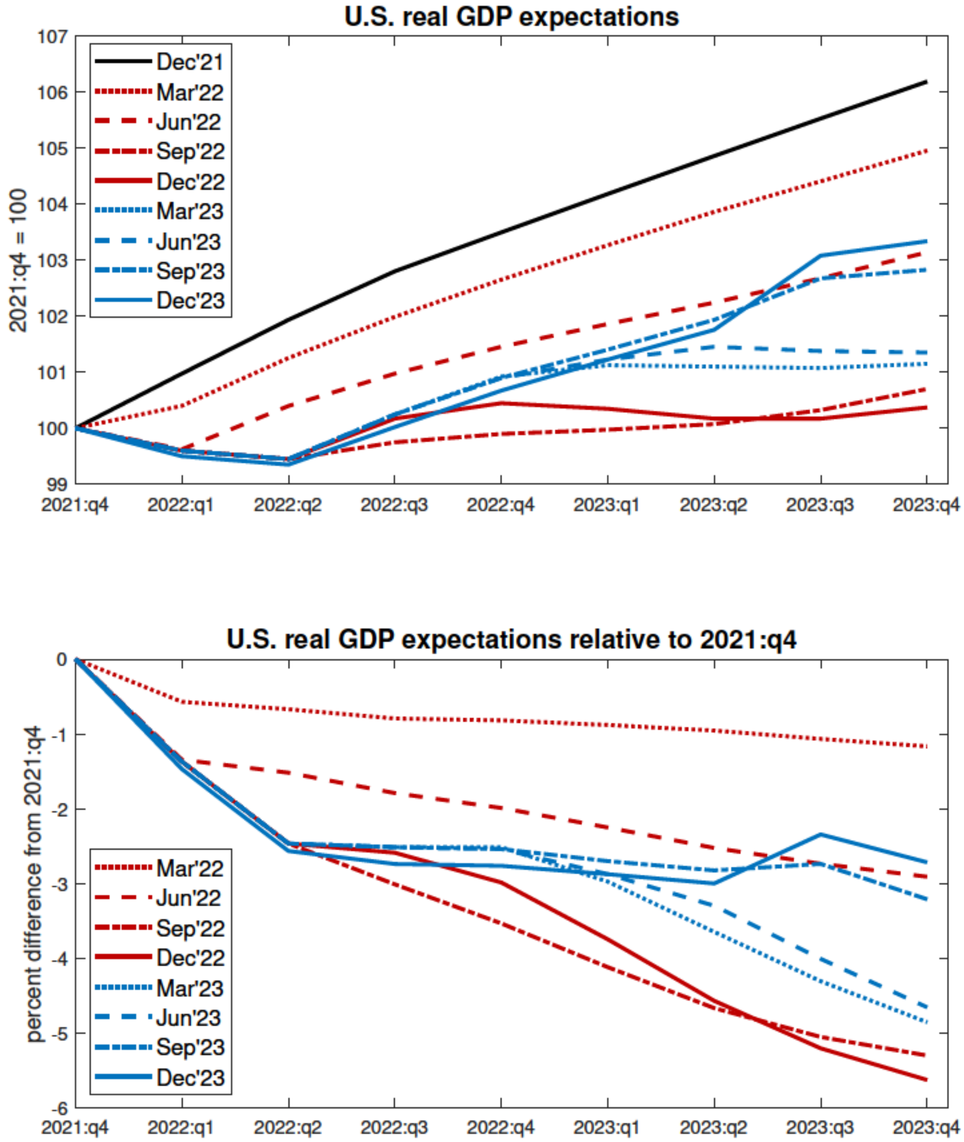
Note: The black circled lines show the fed funds rate expected paths from Figure 6 (in deviations from 2021:q1). The blue solid lines show the model-implied paths conditional on a U.S. growth shock. The red dash-dotted lines show the model-implied paths conditional on a U.S. monetary shock. The bottom two panels show the realized growth and monetary shocks, respectively.

Figure 8: Model-predicted Effects of 2022-23 U.S. tightening cycle on EME GDP



Note: The lines show the model-predicted effects on EME GDP of the 2022-23 U.S. tightening when the tightening is purely monetary-driven (red solid), when it is purely growth-driven (blue solid), and when it is the combination of growth and monetary shocks (green dashed).

Figure 9: U.S. GDP expectations during 2022 tightening



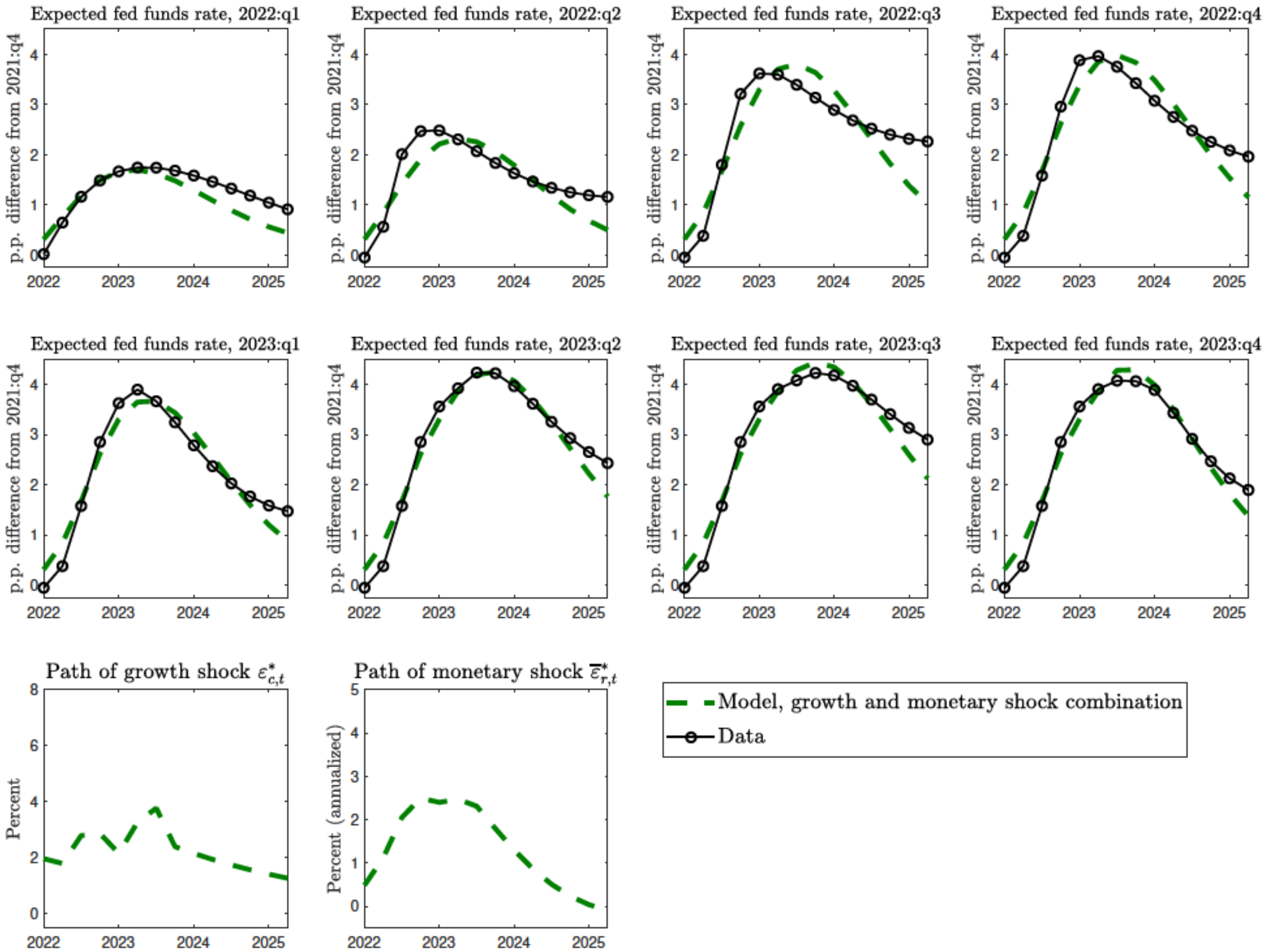
Note: U.S. real GDP forecasts from financial analysts. Source: Blue Chip Economic Indicators.

middle panel of Figure 4. Thus, if we have a measure of the shift in market participants' expectations of U.S. growth, then along with the expected path of the fed funds rate, we can infer at each point in time the specific growth and monetary shock combination driving the tightening.

Figure 9 shows one survey-based measure of U.S. quarterly growth expectations: it plots the path of U.S. GDP forecasted by financial analysts, obtained from Blue Chip Economic Indicators. As seen in the figure, this measure indicates progressive mark-downs to expected U.S. growth paths over much 2022, with some reversal of the expected growth paths starting in December 2022.

In this exercise, we now search for paths of both the growth and monetary shocks, $\epsilon^*_{c,t}$ and $\bar{\epsilon}^*_{r,t}$, to simultaneously minimize the distance between expected FFR paths in the model and in the data, and

Figure 10: FFR and expectations during 2022 tightening, data v. model

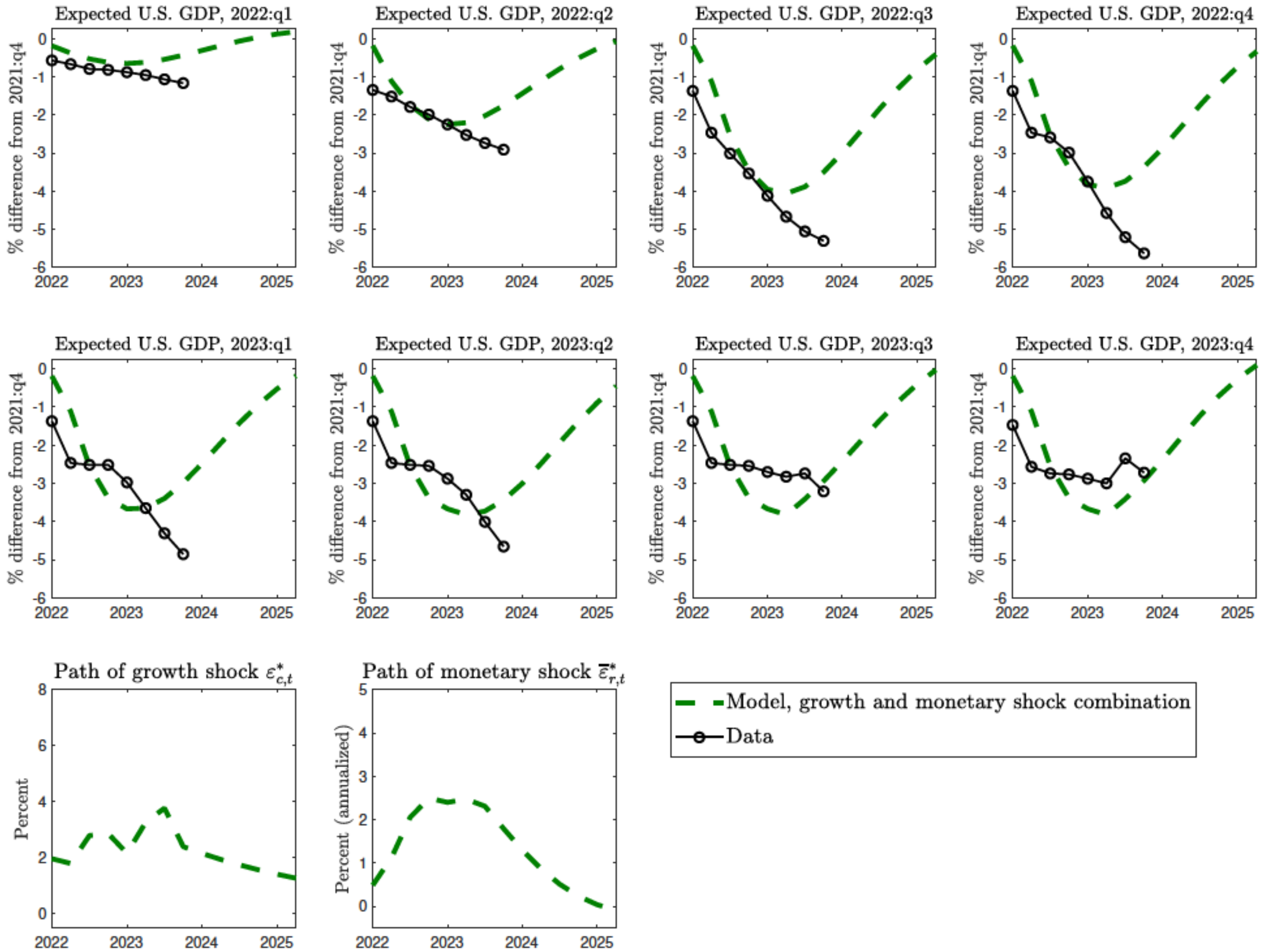


Note: The black circled lines show the fed funds rate expected paths from Figure 6 (in deviations from 2021:q1). The green dashed lines show the model-implied paths conditional on a combination of U.S. growth and monetary shocks.

between expected U.S. GDP paths in the model and in the data. Figures 10 and 11 shows the outcome of this exercise. As before, the match between model and data is good. Note that, as expected, both the monetary and growth shocks in this case, shown in the bottom row, are smaller than in the respective polar cases discussed in the previous section. To explore whether the tightening is deemed to have been more monetary- or growth- driven, Figure 12 shows the path of the growth shock in the case of a growth- and monetary-shock combination, relative to its size in the growth-only case. In 2022, this relative size is close to a third, indicating that the tightening was mostly monetary driven. Going into 2023, this relative size gradually rises and reaches almost 0.6, indicating that the U.S. tightening gradually turned to become relatively more growth-driven.

The dashed green line in Figure 8 shows the resulting EME GDP effects from the estimated combination of growth and monetary shocks. The resulting effects lie a little more than mid-way toward the purely monetary-driven case, reflecting that the tightening in 2022 was mostly monetary-driven according

Figure 11: U.S. GDP expectations during 2022 tightening, data v. model



Note: The black circled lines show the U.S. real GDP forecasts from Figure 9. The green dashed lines show the model-implied paths conditional on a combination of U.S. growth and monetary shocks.

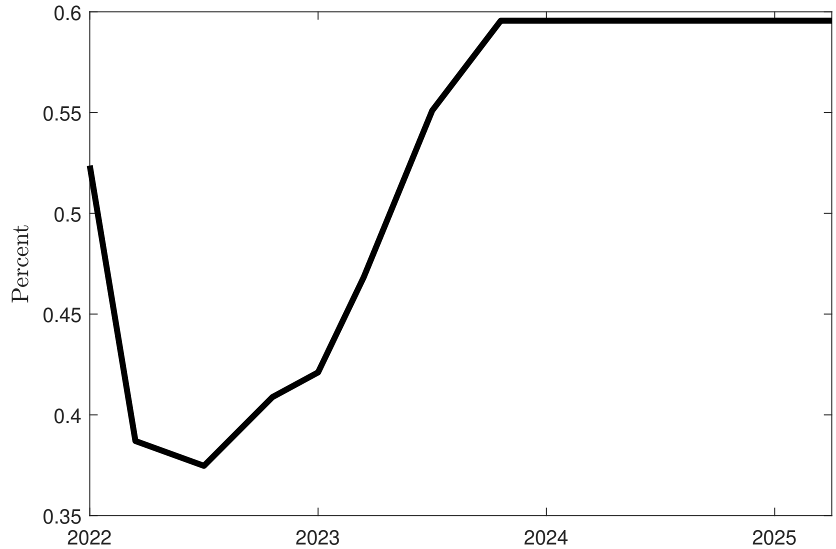
to the model.

5.3 Model predictions vs. realizations: Discussion

This section compares the model-predicted effects of the U.S. tightening on EMEs against the actual evolution of financial spreads, exchange rates, and real GDP and less- and more-vulnerable EMEs. The spirit of the exercise is to contrast the actual data against a model-based "counterfactual" in which only shocks originating in the U.S. were present, and to draw some conclusions from that contrast.

Figure 13 shows the actual evolution of EME corporate borrowing spreads (top row) and EME nominal exchange rates (bottom) fore less- and more-vulnerable EMEs (left and right columns, respectively). The figure contrasts the data with the model-implied paths, constructed by assuming that absent shocks, spreads and exchange rates would have remained fixed at their 2021:q4 level. The key observations from the figure are that for the less-vulnerable EMEs, the evolution of exchange rates is very close to the

Figure 12: Growth shock in growth-monetary combination relative to growth-only case



Note: The line shows the value of the growth shock $\varepsilon^*_{c,t}$ in the growth-monetary shock combination (the bottom left panel of Figure 11) divided by its size in the growth-only case (the blue solid line in the bottom left panel of Figure 7).

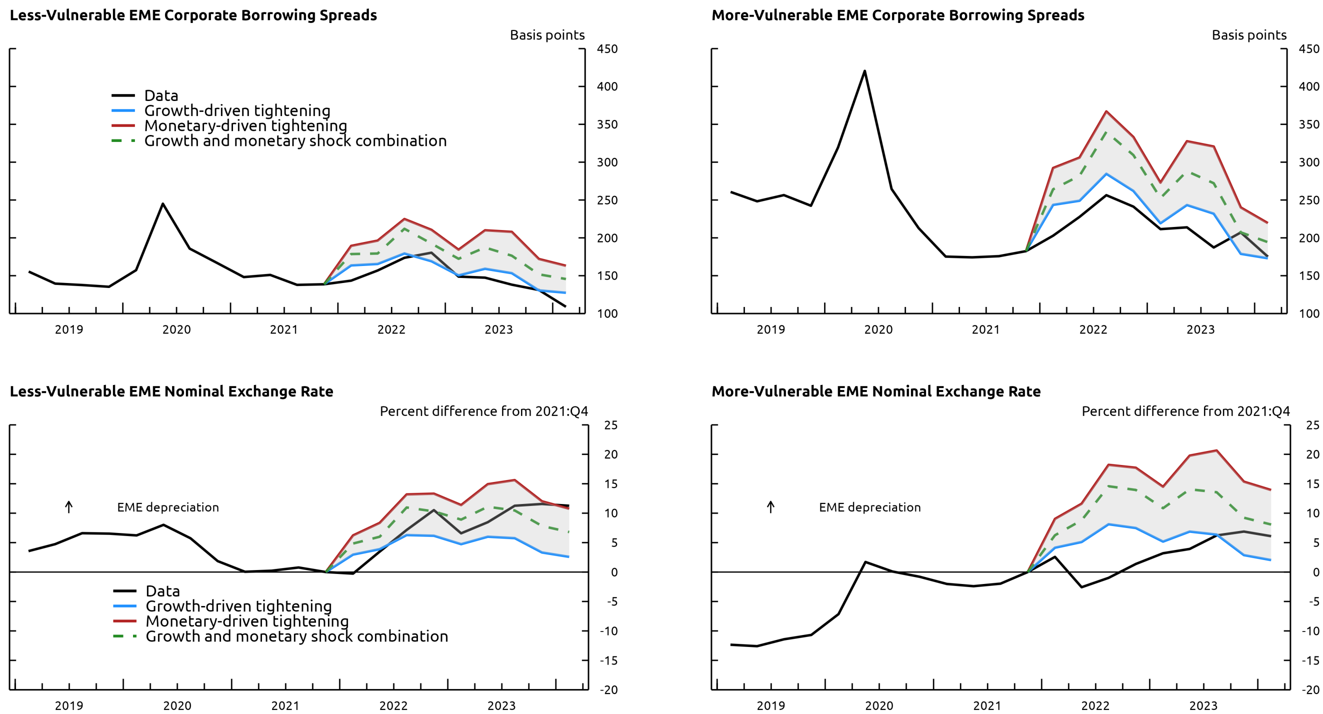
model-predicted effects, with these economies experiencing significant depreciation against the dollar; and the level of corporate spreads in the data is somewhat lower than, though still reasonably close to, the model-predicted path.

But in stark contrast, for the more-vulnerable EMEs, the degree of financial stress experienced since early 2022—measured as either increasing corporate spreads or depreciating currencies— has been far smaller than the model's prediction under the growth-monetary shock combination, and has in fact been even smaller than if the tightening had been purely growth driven. Observe, also, that the degree of depreciation experienced by the more-vulnerable EMEs has been smaller than experienced by the less-vulnerable ones. This fact stands in contrast with the historical norm: Generally, during times of market stress EMEs with greater vulnerabilities experience larger depreciations and overall worse financial outcomes than EMEs with stronger fundamentals.[18]

The broad conclusions from the evolution of financial variables carry over when considering the evolution of EME real GDP, in Figure 14. Here, we contrast the actual data against the model-predicted outcomes, where the latter are constructed by assuming that absent the U.S. shocks, EME GDP would have followed the path indicated by private-sector forecasts as of 2021:q4. The key observation here is, again, that the more-vulnerable EMEs have proved remarkably resilient: Actual GDP is generally above the model-implied path from the growth-monetary combination (the green dashed line), and by late 2023 is even above the case when the tightening is purely monetary-driven. In stark contrast, less-vulnerable EME GDP has underperformed, with the level of GDP lying below the monetary-driven case.

[18] See Ahmed et al. (2017).

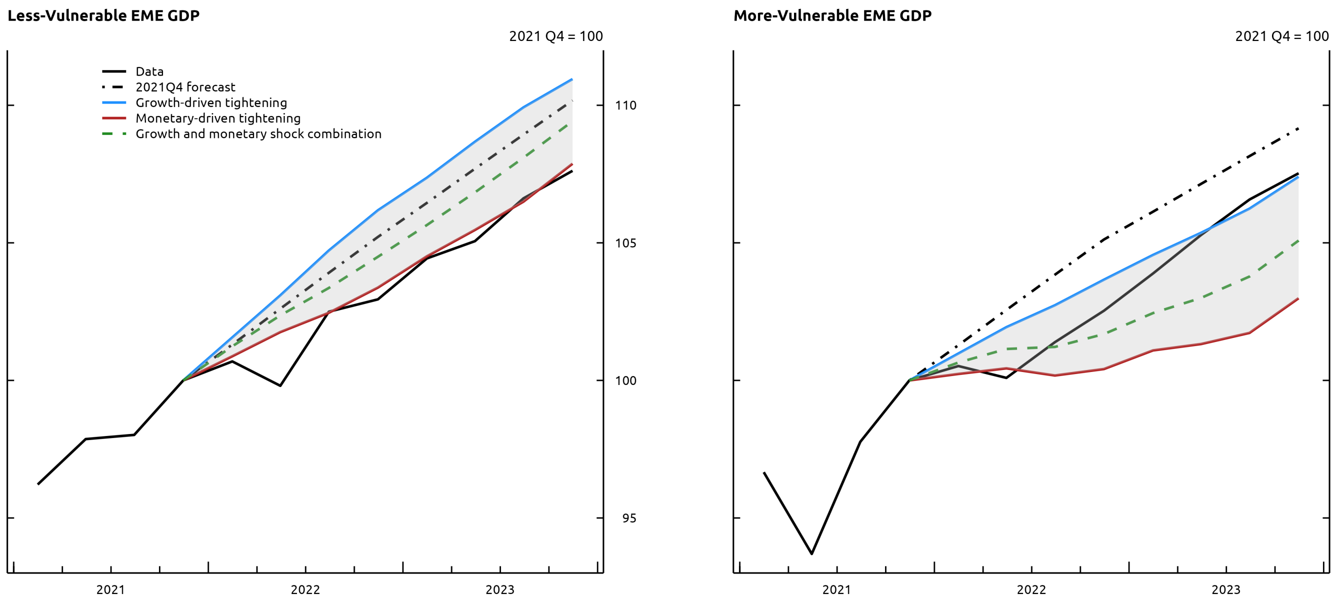
Figure 13: EME spreads and exchange rates, data and model



Note: EME corporate borrowing spreads (top row) and nominal exchange rates (bottom row) for less-vulnerable and more-vulnerable EMEs, left and right columns respectively. The black solid line shows the data. The colored lines show model simulations when the tightening is purely monetary-driven (red solid), when it is purely growth-driven (blue solid), and when it is the combination of growth and monetary shocks (green dashed). Corporate borrowing spreads are 5-year triple-B corporate bond spreads issued by corporations in Asian EMEs proxying less-vulnerable EMEs (left) and by corporations in Latin American EMEs proxying for more-vulnerable EMEs (right). Less-vulnerable EME exchange rates comprise China, Indonesia, Israel, Malaysia, South Korea, Taiwan, Thailand, and Vietnam, and the more-vulnerable group comprises Argentina, Brazil, Chile, Colombia, India, Mexico, Philippines, and Russia, weighted using GDP PPP weights.

We believe the resilience of the more-vulnerable EMEs reflects a number of factors. First, the sharp increases in oil and other commodity prices since 2022 likely benefited some of the more vulnerable EMEs, as several of them are commodity exporters. Second, several vulnerable EMEs increased their own policy rates early and significantly—generally much earlier than the U.S. and other advanced economies. These pre-emptive rate hikes may have contained capital outflows as advanced economies began tightening their own monetary policies, perhaps avoiding worse outcomes for EMEs. Finally, effective communication during 2022 and 2023 by advanced-economy central banks likely kept overall financial market volatility in check. Turning to the underperformance of the less-vulnerable EMEs, we hypothesize that these economies were likely hit particularly hard by the high commodity prices over this period. In addition, China's economic performance has generally been weak over the 2022-23 period, with significantly lower growth rates than in earlier periods. Many of the traditionally less-vulnerable Asian EMEs have also likely suffered a drag from this weakness in China over this period. Overall, these observations underscore that shocks besides those originating in the U.S. also play an important role in shaping macroeconomic

Figure 14: EME GDP, data and model



Note: EME GDP in the data (black solid) and as forecasted as of 2021:Q4 by financial analysts, obtained from Blue Chip Economic Indicators (black dash-dotted line). Colored lines show the model simulations when the tightening is purely monetary-driven (red solid), when it is purely growth-driven (blue solid), and when it is the combination of growth and monetary shocks (green dashed). Less- and more-vulnerable groups comprised of the same countries as in the exchange rate aggregates shown in Figure 13.

and financial outcomes in EMEs.

6 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 imperfectly anchored inflation 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, consistent with the evidence.

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 the absence of unhedged foreign-currency-denominated debt and well-anchored inflation expectations) prove to be the best form of insulation from foreign monetary policy shifts, especially if these shifts are driven by a 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 analyze the consequences for EMEs of the 2022 U.S. tightening through the lens of our model.

References

Ahmed, Shaghil, Brahima Coulibaly, and Andrei Zlate, "International financial spillovers to emerging market economies: How important are economic fundamentals?," *Journal of International Money and Finance*, 2017, *76*, 133–152.

Benigno, Gianluca and Pierpaolo Benigno, "Price stability in open economies," *The Review of Economic Studies*, 2003, *70* (4), 743–764.

Blanchard, Olivier, Christopher Erceg, and Jesper Linde, "Jump-Starting the Euro Area Recovery: Would a Rise in Core Fiscal Spending Help the Periphery?," in "NBER Macroeconomics Annual 2016, Volume 31," National Bureau of Economic Research, Inc, 2016, pp. 103–182.

Boivin, Jean, Michael T Kiley, and Frederic S Mishkin, "How has the monetary transmission mechanism evolved over time?," in "Handbook of monetary economics," Vol. 3, Elsevier, 2010, pp. 369–422.

Bordalo, Pedro, Nicola Gennaioli, Yueran Ma, and Andrei Shleifer, "Overreaction in macroeconomic expectations," *American Economic Review*, 2020, *110* (9), 2748–82.

Bowman, David, Juan M. Londono, and Horacio Sapriza, "U.S. unconventional monetary policy and transmission to emerging market economies," *Journal of International Money and Finance*, 2015, *55*, 27–59.

Bräuning, Falk and Victoria Ivashina, "US monetary policy and emerging market credit cycles," *Journal of Monetary Economics*, 2019.

Bruno, Valentina and Hyun Song Shin, "Capital flows and the risk-taking channel of monetary policy," *Journal of Monetary Economics*, 2015, *71* (C), 119–132.

Carrillo, Julio A., Rocio Elizondo, Cid Alonso Rodriguez-Perez, and Jessica Roldan-Pena, "What determines the neutral rate of interest in an emerging economy?," *Brookings,* October 22, 2017.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans, "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, February 2005, *113* (1), 1–45.

Chui, Michael, Emese Kuruc, and Philip Turner, "A new dimension to currency mismatches in the emerging markets - non-financial companies," BIS Working Papers 550, Bank for International Settlements March 2016.

Curcuru, Stephanie E., Steven B. Kamin, Canlin Li, and Marius del Giudice Rodriguez, "International Spillovers of Monetary Policy : Conventional Policy vs. Quantitative Easing," International Finance Discussion Papers 1234, Board of Governors of the Federal Reserve System (U.S.) August 2018.

Dedola, Luca, Giulia Rivolta, and Livio Stracca, "If the Fed sneezes, who catches a cold?," *Journal of International Economics*, 2017, *108*, S23–S41.

Degasperi, Riccardo, Seokki Simon Hong, and Giovanni Ricco, "The Global Transmission of U.S. Monetary Policy," Technical Report 2020.

di Giovanni, Julian, Sebnem Kalemli-Ozcan, Mehmet Fatih Ulu, and Yusuf Soner Baskaya, "International Spillovers and Local Credit Cycles," Working Paper 23149, National Bureau of Economic Research February 2017.

Erceg, Christopher, Christopher Gust, and David Lopez-Salido, *The Transmission of Domestic Shocks in Open Economies*, University of Chicago Press, June

Erceg, Christopher J., Dale W. Henderson, and Andrew T. Levin, "Optimal monetary policy with staggered wage and price contracts," *Journal of Monetary Economics*, 2000, *46* (2), 281–313.

Erceg, Christopher J, Luca Guerrieri, and Christopher Gust, "Expansionary fiscal shocks and the US trade deficit," *International Finance*, 2005, *8* (3), 363–397.

_ , _ , and _ , "SIGMA: A New Open Economy Model for Policy Analysis," *International Journal of Central Banking*, 2006.

Farhi, Emmanuel and Iván Werning, "Fiscal Unions," *American Economic Review*, December 2017, *107* (12), 3788–3834.

Gabaix, Xavier, "A Behavioral New Keynesian Model," *American Economic Review*, 2020, *110* (8), 2271–2327.

Gali, Jordi, *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and its Applications*, Princeton University Press, 2015.

_ and Tommaso Monacelli, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*, 2005, *72* (3), 707–734.

García-Schmidt, Mariana and Michael Woodford, "Are Low Interest Rates Deflationary? A Paradox of Perfect-Foresight Analysis," *American Economic Review*, January 2019, *109* (1), 86–120.

Gertler, Mark and Nobuhiro Kiyotaki, "Financial Intermediation and Credit Policy in Business Cycle Analysis," in Benjamin M. Friedman and Michael Woodford, eds., *Handbook of Monetary Economics*, Vol. 3, Elsevier, 2010, chapter 11, pp. 547–599.

_ **and Peter Karadi**, "Monetary policy surprises, credit costs, and economic activity," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 44–76.

Gilchrist, Simon and Egon Zakrajsek, "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 2012, *102* (4), 1692–1720.

Gopinath, Gita, Emine Boz, Camila Casas, Federico Diez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller, "Dominant Currency Paradigm," *NBER Working Paper*, 2018, (22943).

Hahm, Joon-Ho, Hyun Song Shin, and Kwanho Shin, "Noncore bank liabilities and financial vulnerability," *Journal of Money, Credit and Banking*, August 2013, *45*, 3–36.

Hoek, Jasper, Steve Kamin, and Emre Yoldas, "Are higher U.S. interest rates always bad news for emerging markets?," *Journal of International Economics*, 2022, *137*, 103585.

Holston, Kathryn, Thomas Laubach, and John C Williams, "Measuring the natural rate of interest: International trends and determinants," *Journal of International Economics*, 2017, *108*, S59–S75.

Hooper, Peter, Karen Johnson, and Jaime R Marquez, "Trade elasticities for the G-7 countries," 2000.

Iacoviello, Matteo and Gaston Navarro, "Foreign effects of higher U.S. interest rates," *Journal of International Money and Finance*, 2018.

Jarociński, Marek and Peter Karadi, "Deconstructing monetary policy surprises—the role of information shocks," *American Economic Journal: Macroeconomics*, 2020, *12* (2), 1–43.

Justiniano, Alejandro, Giorgio E Primiceri, and Andrea Tambalotti, "Investment shocks and business cycles," *Journal of Monetary Economics*, 2010, *57* (2), 132–145.

Kaminsky, Graciela L., Carmen M. Reinhart, and Carlos A. Végh, "When it rains, it pours: Procyclical capital flows and macroeconomic policies," *NBER Macroeconomics Annual*, 2004, *19*, 11–53.

Levin, Andrew T., Jeremy M. Piger, and Fabio M. Natalucci, "The macroeconomic effects of inflation targeting," *Review*, 2004, (jul), 51–80.

Miranda-Agrippino, Silvia and Hélene Rey, "U.S. Monetary Policy and the Global Financial Cycle," *The Review of Economic Studies*, 2020.

Nakamura, Emi and Jón Steinsson, "High-frequency identification of monetary non-neutrality: the information effect," *The Quarterly Journal of Economics*, 2018, *133* (3), 1283–1330.

Reifschneider, David, "Gauging the Ability of the FOMC to Respond to Future Recessions," 2016.

Rey, Helene, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," Working Paper 21162, National Bureau of Economic Research May 2015.

Taylor, John B., "Discretion versus policy rules in practice," in "Carnegie-Rochester Conference Series on Public Policy," Vol. 39 Elsevier 1993, pp. 195–214.

Özge Akinci and Albert Queralto, "Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets," *The Review of Financial Studies*, 10 2023, *37* (2), 309–355.

Appendix

A Proof of Proposition

Given the assumptions stated in the Proposition, the EME households' first-order conditions are

$$R^n_{t+1} = \beta \mathbb{E}_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \left(\frac{P_t}{P_{t+1}} \right) \right\}, \tag{A.1}$$

$$C_t^\sigma N_t^\varphi = \frac{W_t}{P_t}, \tag{A.2}$$

$$C_{D,t} = (1-\omega) \left(\frac{P_{D,t}}{P_t} \right)^{-\eta} C_t, \tag{A.3}$$

$$M_{C,t} = \omega \left(\frac{P_{M,t}}{P_t} \right)^{-\eta} C_t. \tag{A.4}$$

EME firms' price-setting and production is characterized by the conditions

$$P_{D,t}^{1-\epsilon} = \theta_p (e^{\overline{\pi}_t})^{1-\epsilon} + (1-\theta_p) \overline{P}_{D,t}^{1-\epsilon}, \tag{A.5}$$

$$\log(\overline{P}_{D,t}) + \sum_{j=1}^{\infty} \beta^j \theta_p^j \overline{\pi}_{t+j} = \log(\frac{\epsilon}{\epsilon - 1}) + (1-\beta\theta_p) \sum_{j=0}^{\infty} \beta^j \theta_p^j \log(W_{t+j}), \tag{A.6}$$

$$\overline{\pi}_t = \kappa \left(\pi_t - \mathbb{E}_{t-1} \left\{ \pi_t \right\} \right) + \phi \overline{\pi}_{t-1}, \tag{A.7}$$

$$\pi_t = \pi_{D,t} - \omega \Delta \tau_t, \tag{A.8}$$

$$Y_t = N_t, \tag{A.9}$$

where $\pi_t = \log(P_t/P_{t-1})$, $\pi_{D,t} = \log(P_{D,t}/P_{D,t-1})$, and $\tau_t \equiv \log(\mathcal{T}_t)$ where $\mathcal{T}_t \equiv P_{D,t}/P_{M,t}$ is the terms of trade. EME monetary policy follows

$$r^n_{t+1} = \phi_\pi \pi_{D,t}. \tag{A.10}$$

Conditions characterizing the foreign economy are analogous (with $\overline{\pi}_t = 0$ for all t and with the inclusion of the exogenous preference shifter $\varepsilon^*_{c,t}$ and the monetary shock $\varepsilon^*_{r,t}$):

$$R^{n*}_{t+1} = \beta \mathbb{E}_t \left\{ e^{\varepsilon^*_{c,t+1} - \varepsilon^*_{c,t}} \left(\frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \left(\frac{P^*_t}{P^*_{t+1}} \right) \right\}, \tag{A.11}$$

$$C_t^{*\sigma} N_t^{*\varphi} = \frac{W^*_t}{P^*_t}, \tag{A.12}$$

$$C^*_{D,t} = (1-\omega^*) \left(\frac{P^*_{D,t}}{P^*_t} \right)^{-\eta} C^*_t, \tag{A.13}$$

$$M^*_{C,t} = \omega^* \left(\frac{P^*_{M,t}}{P^*_t}\right)^{-\eta} C^*_t, \tag{A.14}$$

$$\tag{A.15}$$

$$P^{*1-\epsilon}_{D,t} = \theta_p + (1-\theta_p)\overline{P}^{*1-\epsilon}_{D,t}, \tag{A.16}$$

$$\log(\overline{P}^*_{D,t}) = \log(\frac{\epsilon}{\epsilon-1}) + (1-\beta\theta_p)\sum_{j=0}^{\infty}\beta^j\theta_p^j \log(W^*_{t+j}), \tag{A.17}$$

$$\pi^*_t = \pi^*_{D,t} + \omega^*\Delta\tau_t, \tag{A.18}$$

$$Y^*_t = N^*_t, \tag{A.19}$$

$$r^{n*}_{t+1} = \phi_\pi \pi^*_{D,t} + \varepsilon^*_{r,t}, \tag{A.20}$$

where we've used the fact that the terms of trade satisfy $\mathcal{T}_t = P^*_{M,t}/P^*_{D,t}$ given the PCP assumption.

The risk-sharing condition resulting from complete international financial markets is

$$(e^{\varepsilon^*_{c,t}})^{\frac{1}{\sigma}} C_t = \vartheta C^*_t \mathcal{S}_t^{-\frac{1}{\sigma}}, \tag{A.21}$$

with the real exchange rate $\mathcal{S}_t$ and the terms of trade $\mathcal{T}_t$ satisfying $\log(\mathcal{S}_t) = (1-\omega-\omega^*)\log(\mathcal{T}_t)$, and where the constant ϑ (determined by initial conditions) will be set to unity without loss of generality.

The market-clearing conditions for the home and foreign goods, respectively, are

$$Y_t = C_{D,t} + \frac{\mathcal{N}^*}{\mathcal{N}} M^*_{C,t}, \tag{A.22}$$

$$Y^*_t = C^*_{D,t} + \frac{\mathcal{N}}{\mathcal{N}^*} M_{C,t}. \tag{A.23}$$

We now make use of our approximation around a point in the parameter space satisfying $\mathcal{N}/\mathcal{N}^* \to 0$, $\omega^* \to 0$, $\frac{\mathcal{N}^*}{\mathcal{N}}\omega^* \to \omega$, which captures an extreme asymmetry in terms of size (with the EME being arbitrarily small relative to the U.S.) yet ensures balanced trade in steady state. It is straightforward to verify that these assumptions ensure the existence of a steady state in which all relative prices are unity and trade is balanced, and in which $C = C^* = Y = Y^*$. In that steady state, the parameter assumptions imply $C^*_D \to C^* = Y^*$, $\frac{\mathcal{N} M_C}{\mathcal{N}^* Y^*} \to 0$, and $\pi^*_t \to \pi^*_{D,t}$. Combining these conditions with the log-linearized versions of (A.11)-(A.20) and (A.23) and following standard steps, it is straightforward to verify that the foreign variables are governed by equations (60)-(62) in the main text.

Turning to the home economy (the EME), Log-linearizing (A.22) yields

$$\begin{aligned} y_t &= \frac{C_D}{Y} c_{d,t} + \frac{\mathcal{N}^*}{\mathcal{N}}\frac{M^*_C}{Y} m^*_{c,t} \\ &= (1-\omega)c_{d,t} + \frac{\mathcal{N}^*}{\mathcal{N}}\omega^* m^*_{c,t} \end{aligned}$$

$$
\begin{aligned}
&\rightarrow (1-\omega)c_{d,t} + \omega m^*_{c,t} \\
&= (1-\omega)c_t + \omega[-(2-\omega)\eta\tau_t + y^*_t], \qquad \text{(A.24)}
\end{aligned}
$$

as in (55). Following standard steps, log-linearizing and combining (A.1)-(A.3) and (A.5)-(A.6) yield (56) and (57). Combining the log-linearized risk-sharing condition (A.21) with the log-linearized Euler equations in each country yields the uncovered interest parity condition (63).

■

B Data Sources

Long-term inflation expectations for 20 EMEs and AEs are based on survey data of 6- to 10- year inflation forecasts for the period 1993-2019, obtained from Consensus Economics. Realized CPI inflation data are obtained from Haver Analytics. The complete list of countries as EMEs and AEs in Section 2 is as follows:

EMEs: Argentina, Brazil, Chile, Colombia, Czech Republic, Hungary, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Singapore, Slovakia, Taiwan, Thailand, Turkey, Ukraine.

AEs: Austria, Canada, New Zealand, Sweden, United Kingdom.

Data for the federal funds rate is obtained from FRED. Federal funds rate expectations are the average 1-month forward OIS rates based on a fitted Nelson-Siegel-Svensson curve (data obtained from Bloomberg). The survey-based measure of U.S. quarterly growth expectations, as measured by the path of U.S. GDP forecasted by financial analysts, are obtained from Blue Chip Economic Indicators.