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When the Fed Sneezes, the Cold is Transmitted by Trade

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Abstract

We investigate the global transmission of US monetary policy shocks. The existing literature finds that a US monetary contraction causes a contraction in economic activity not only in the US but also abroad. This sharply contradicts the traditional Mundell-Fleming view. Much of the existing literature refers to frictions in international financial markets as reasons for the failure of the traditional view. Instead, we argue that trade is key for understanding the transmission of US monetary policy shocks.

Keywords: Monetary policy spillovers, Trade channel, Small open economy DSGE models, Exchange rates.

JEL Classification: E44, E52, F31, F32, F41.

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1 Introduction

The dynamic effects of monetary policy shocks in the United States (US), ε_t^{mp} , have been studied extensively in US data. Estimates of the impact of these shocks have played a central role in the design of closed economy models (see, e.g., [Christiano et al. \(2005\)](#) and [Auclert et al. \(2020\)](#)). Increasingly, this methodology is being applied to the open economy setting with a similar impact on how we think about the open economy.

The classic Mundell-Fleming model suggests that after a US policy tightening, i.e., a jump in ε_t^{mp} , the US dollar appreciates and the consequent relative price effects shift production away from the US and towards other countries. Empirical analyses of the international effects of a jump in ε_t^{mp} suggest that, instead, output falls virtually everywhere. Reactions to this discovery can be loosely categorized according to the two sides of the balance of payments: the net international flow of financial capital (financial markets) and the net international flow of goods and services (trade). The recent literature has focused heavily on the role of financial markets (see, e.g., [Rey \(2015\)](#), [Kalemli-Özcan \(2019\)](#), [Miranda-Agrippino and Rey \(2020\)](#) and [Akinci and Queralto \(2024\)](#)). The idea is that a high US interest rate triggers a capital outflow from other countries toward the US. This outflow is amplified by a reduction in global risk appetite as well as adverse balance sheet effects for foreigners exposed to unhedged US dollar debt. All these factors are used to account for the fall in production that occurs in the rest of the world after a jump in ε_t^{mp} . For example, capital outflows from non-US countries deprive those countries of the resources needed to finance local investment, helping to drag down production.

Still, one observation seems hard to explain from a purely financial-market perspective: when ε_t^{mp} jumps, foreign exports drop precipitously. As long as production costs are primarily in local currency, then the dollar marginal cost of production for a non-US country falls with a depreciation, allowing exporters to charge lower dollar prices for their exports. This suggests that non-US countries' exports should rise after a US monetary tightening. In theory, it is possible to devise a financial market explanation of the fall in non-US exports after a jump in ε_t^{mp} . But our reading of the data suggests that such an explanation seems implausible, at least for the 2000s.

The observation about foreign exports naturally shifts attention to trade. One trade-based explanation is given in [Camara et al. \(2025\)](#), who suggest that the fall in foreigners' exports reflects a decline in the US demand for imports after a jump in ε_t^{mp} . [Gopinath et al. \(2020\)](#) argue for a different trade-based mechanism. They argue that much of world trade is conducted in dollar prices which are sticky over time (Dominant Currency Paradigm, DCP). Thus, if two non-US countries trade with each other and their currencies depreciate relative to the dollar, say because of a jump in ε_t^{mp} , it becomes more expensive in local currency units for each country to buy goods from the other. As a result, the exports of both countries go down in a way that has nothing directly to do with US imports. A related trade-based explanation is proposed by [Auclert et al. \(2021\)](#). They argue that if short-run elasticities of substitution between domestic and foreign inputs are low enough, then when non-US countries' currencies depreciate in the wake of a jump in ε_t^{mp} , their domestic production and GDP fall. If production and imports across large numbers of non-US countries fall then it is to be expected that exports between these countries go down too.

In this paper we summarize and extend the work of [Camara et al. \(2025\)](#). We decompose the response of the world economy to a jump in ε_t^{mp} into a part due to trade and a part due to financial markets. We capture the trade channel as what would happen to foreigners if only US demand for their exports fell and the US interest rate remained constant after a jump in ε_t^{mp} . We adopt the definition of the financial market channel used in [Auclert et al. \(2021\)](#) and [Camara et al. \(2025\)](#). This channel focuses on the US interest rate effect of a jump in ε_t^{mp} , holding US import demand constant. The total effect of a US monetary tightening is the sum of the

financial market channel and the trade channel. This additivity property reflects the linearity of the models used in our analysis.

We find that a jump in ε_t^{mp} mostly affects foreign countries via the trade channel. This suggests that the trade channel is the main mechanism by which a US monetary tightening is transmitted to the rest of the world. Although we do not fully include the DCP or the considerations of [Auclert et al. \(2021\)](#), we expect that including these factors would assign an even bigger role to the trade channel.

As in [Camara et al. \(2025\)](#), we use time series methods to compute the impact of [Bauer and Swanson \(2023b\)](#)'s estimate of ε_t^{mp} on the US economy, advanced economies (AE) and emerging market economies (EME).¹ To decompose the channels by which a US monetary contraction affects AEs and EMEs, we must perform counterfactual exercises on those economies. To this end, we estimate one representative small open economy model for the AEs and one for the EMEs. We do this by choosing model parameters so that model impulse responses (IRFs) match, as well as possible, the estimated IRFs to ε_t^{mp} obtained by time series methods. For this, we apply the Bayesian IRF matching procedure proposed in [Christiano et al. \(2010\)](#).² In our model analysis, the AEs and EMEs only trade with the US. Because there is no trade among the representative economies, or across our AEs and EMEs, we in effect abstract from the mechanisms in [Gopinath et al. \(2020\)](#) and [Auclert et al. \(2021\)](#).

In our model analysis, only a subset of the variables in the US VAR matter for the representative AE and EME: the US dollar interest rate, $R_{d,t}^*$, and the variables that shift the US demand for AE and EME exports (trade channel). We proxy $R_{d,t}^*$ by the nominally risk-free return for private borrowers constructed (and updated) by [Gilchrist and Zakrajšek \(2012\)](#). We define the *financial market channel* as the response of $R_{d,t}^*$ to ε_t^{mp} , zeroing out the responses to ε_t^{mp} of the variables that determine the demand for AE and EME exports. We define the *trade channel* as the impact on the AE and EME of the response to ε_t^{mp} of the variables that shift the demand for exports, zeroing out the response of $R_{d,t}^*$.

Our AE and EME models include the standard financial frictions, such as balance sheet effects and uncovered interest parity (UIP) wedges. With one exception these frictions play an important role in shaping both the financial and trade channels. The exception is that we tie shifts in risk appetite specifically to $R_{d,t}^*$. This choice maximizes the role played by the financial market channel and so does not undercut our fundamental conclusion that the trade channel is the dominant driver of the international transmission of a jump in ε_t^{mp} .

The paper is organized as follows. Section 2 discusses key time series facts, Section 3 sketches the AE and EME models. Section 4 explains our basis for concluding that the trade channel dominates the financial market channel. For additional details of the analysis, such as robustness considerations, see [\(Camara et al., 2025\)](#). Finally, Section 5 reports concluding thoughts.

2 Empirical Findings

We estimate IRFs using the [Bauer and Swanson \(2023a\)](#) proxy for monetary policy shocks, ε_t^{mp} . These high-frequency shocks control for information effects, which might otherwise bias the results (see, e.g., [Camara \(2025\)](#)). We refer to the [Bauer and Swanson \(2023a\)](#) estimate of the monetary policy shock as ε_t^{mp} even though their estimate only identifies ε_t^{mp} up to a scalar constant.³

¹[Camara et al. \(2025\)](#) document that our conclusions are robust to using the [Jarociński and Karadi \(2020\)](#) measure of ε_t^{mp} and to a variety of alternative strategies for estimating impulse responses.

²We used the version of this procedure implemented in Dynare, version 6.2.

³Specifically, let $\hat{\varepsilon}_t^{mp}$ denote the [Bauer and Swanson \(2023a\)](#) proxy for ε_t^{mp} . Then, we suppose that $\varepsilon_t^{mp} = \alpha \hat{\varepsilon}_t^{mp} + v_t$, where α is an unknown constant and v_t is uncorrelated with all structural shocks.

2.1 Results for US

We first describe the VAR model for the US and how ε_t^{mp} enters. We then turn to the estimated US impulse responses to ε_t^m .

2.1.1 US VAR

Let Y_t denote the vector of endogenous US variables in the VAR. All variables are in levels, and prices and quantities are expressed in log form. The p -lag VAR is expressed as follows:

$$Y_t = A(L)Y_{t-1} + C\varepsilon_t^{mp} + u_t, \quad (1)$$

where $E[u_t u_t'] = V$, and ε_t^{mp} , Y_{t-j} , $j > 0$, are assumed to be orthogonal to the VAR disturbances, u_t . Also, L denotes the lag operator and

$$A(L) = A_1 + A_2L + \dots + A_pL^{p-1}. \quad (2)$$

We estimate V , C , and the A_i 's using Bayesian methods with "Minnesota" priors. These priors suppose that all elements of Y_t are independent random walks. That is, the mean of the prior on A_1 is the identity matrix and the priors on A_i , $i > 1$, are zero matrices. In addition, under the priors, the means of the elements of C are zero. The prior density of $A_1, \dots, A_p, C$ conditional on V is normal, and the marginal density of V is inverse Wishart. So, the joint density of $V, A_1, \dots, A_p, C$ is normal inverse Wishart. In the results reported below we set $p = 12$. Results are insensitive to using smaller values of p .

The VAR is monthly and covers the period 2006–2019. This sample is chosen primarily because many of the EMEs in our sample are characterized by different monetary and fiscal regimes before 2000. Our measure of $R_{d,t}^*$ is the sum of the 2-year US Treasury bond rate plus the excess bond premium (EBP).⁴ The EBP is the excess of the interest rate paid by firms on loans over what the US Treasury pays, after adjusting for firm default risk. So, $R_{d,t}^*$ denotes the interest rate on risk free securities that do not offer the liquidity benefits associated with US Government debt. See [Camara et al. \(2025\)](#) for additional discussion of $R_{d,t}^*$. Because the monetary policy shock is only identified up to a scale factor, the absolute value of the [Bauer and Swanson \(2023a\)](#) shock has no interpretation. Only the relative magnitude of the IRFs of different variables to a monetary shock are identified.

Our benchmark US VAR includes nine variables that capture the financial, real, and trade dimensions of the US economy. The variables are $R_{d,t}^*$, an index of the dollar exchange rate,⁵ the PCE price index, real US GDP, real US consumption, real US investment, real US exports, real US imports, and an index of the dollar price of imports, excluding fuels. This list of variables is slightly different from those used in [Camara et al. \(2025\)](#). Where they overlap, the results are essentially the same. We work with a slightly different set of variables because we want to more fully explore the drivers of the fall in US imports than is reported in [Camara et al. \(2025\)](#).

2.1.2 Results for US VAR Analysis

Figure 1 reports the IRFs of US variables to a contractionary US monetary policy shock, a one-standard-deviation jump in ε_t^{mp} . The dark lines correspond to the posterior mean of the IRFs, while the dark and light shaded areas represent 68% and 90% posterior probability intervals, respectively.

⁴See [Gilchrist and Zakrajšek \(2012\)](#) for a detailed discussion of the EBP.

⁵The nominal dollar index measures the external value of the US dollar against a broad trade-weighted basket of currencies. As is conventional with trade-weighted exchange rates, an increase in the dollar index corresponds to an appreciation of the US exchange rate.

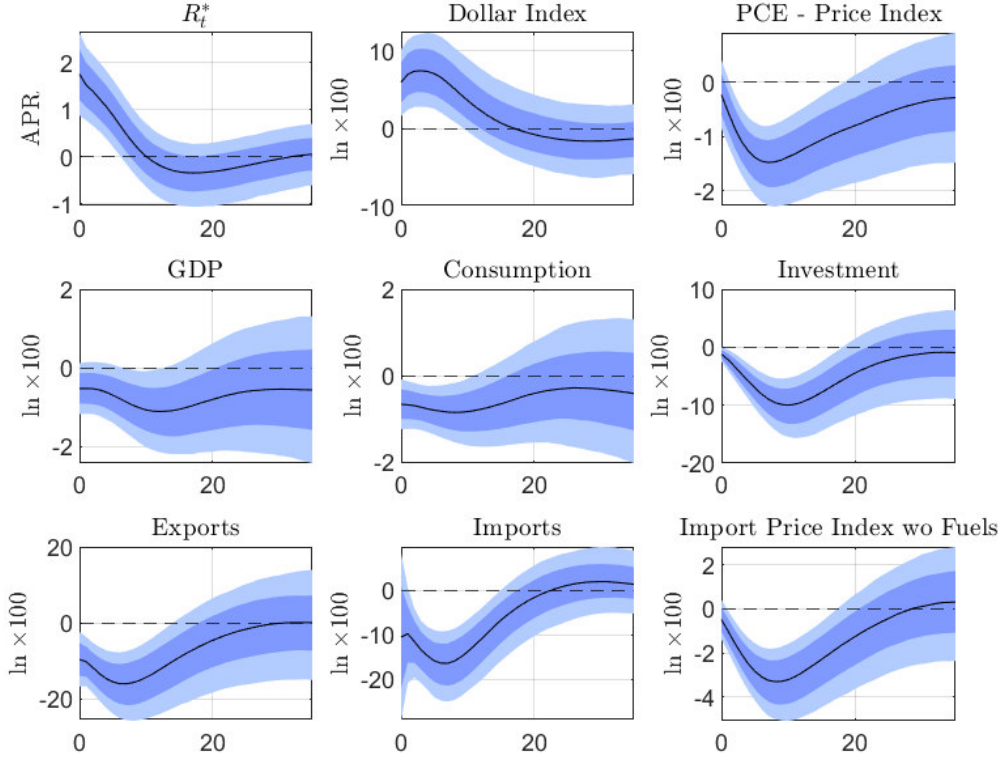


Figure 1: Benchmark US Results

Note: Response to a contractionary US monetary policy shock in the United States, i.e., a one-standard deviation jump in ε_t^{mp} constructed by [Bauer and Swanson \(2023a\)](#). Solid lines denote the posterior median responses, while the dark and light shaded areas represent 68% and 90% posterior probability intervals, respectively. The underlying VAR is estimated at a monthly frequency over the period 2006–2019 using a 12-lag, 9-variable specification. See the text for further discussion.

Six features of the figure are worth noting. First, the policy rate measure $R_{d,t}^*$ increases by about 170 basis points on impact and remains elevated for a little less than a year before returning to its unshocked path. Recall from our earlier discussion that the size of a shock is only identified up to a constant scale factor. So, in principle we could normalize the shock so that the jump in $R_{d,t}^*$ is 100 basis points or 25 basis points. Because of the linearity of the system, this would have no impact on the figures other than to change the scale of the vertical axis of each graph in Figure 1.

Second, the effect on the terms of trade of a monetary contraction is dominated by its impact on the nominal value of the dollar. The dollar index rises by close to 10 percent on impact and exhibits a persistent, hump-shaped response before gradually returning toward its unshocked path. The PCE index falls by an order of magnitude less. In particular, it falls by a maximum of 1-1.5 percent before ultimately returning to its unshocked path.⁶

⁶Let the terms of trade be denoted by P_t^x/P_t^f , where P_t^x and P_t^f denote the dollar price of exports from foreign countries to the US and P_t^f denotes the US price index. Let S_t denote the exchange rate: the amount of foreign currency needed to purchase one dollar. Suppose the marginal cost, in foreign currency units, of a foreign country's exports to the US is denoted by P_t and, for now, suppose P_t does not respond to ε_t^{mp} . Under competition, $P_t^x = P_t/S_t$, so that the terms of trade is written as $P_t/(S_t P_t^f)$. A US monetary contraction drives P_t^f down and S_t up. The fall in P_t^f is on the order of 1 percent and the rise in S_t is on the order of 10 percent. So, the move in terms

Third, real economic activity contracts in response to the shock. Real GDP declines on impact and reaches a trough of slightly more than 1 percent below baseline. Consumption and investment both fall, with investment falling substantially more in percentage terms. Interestingly, the impact of the shock on these variations extends over a longer period than the impact on $R_{d,t}^*$.

Fourth, exports and imports both decline strongly in response to the monetary tightening. They drop by somewhat more, in percent terms, than the decline in investment.

Fifth, the dollar price index of US imports falls significantly and twice as much as the PCE in percent terms. This fall in the dollar price of imports suggests that the fall in US imports is driven by a decrease in US demand due to the fall in consumption and investment. In particular, the fall in US imports does not appear to reflect a fall in the supply of foreign goods, say via the operation of a financial market channel.⁷ In the latter case we would expect to see the fall in US imports associated, counterfactually, with a rise in the dollar price of imports.

Sixth, the impact of a monetary shock on $R_{d,t}^*$ lasts less long than the impact on the other variables. For example, the impact on $R_{d,t}^*$ lasts for roughly a year while the impact on imports and investment is longer than a year. This suggests the presence of internal propagation mechanisms.

Generally, our results for the US are consistent with existing results. In particular, with a monetary contraction the interest rate, R_d^* rises and the US currency appreciates. This is associated with a fall in aggregate output, investment, consumption, and the price level. We stress here that US imports decline substantially in the wake of a US monetary contraction. This is consistent with the findings in [Ozhan \(2020\)](#), [Miranda-Agrippino and Ricco \(2021\)](#) and [Müller and Verner \(2024\)](#).

2.2 Response of Two Large US Trading Partners: Canada and Mexico

We begin our study of the foreign impact of a US monetary tightening by examining the effects of a jump in ε_t^{mp} on Canada and Mexico. This analysis works with two versions of the VAR in equation (1). The Canadian version adds three Canadian variables: GDP, exports and exports to non-US countries. The Mexican analysis simply replaces the Canadian variables with their Mexican counterparts. Canadian and Mexican results are indicated by CAN and MEX, respectively.

Figure 2 shows that Canadian real GDP declines persistently following the shock, though the effect is not large (for details about the VAR see the footnote to Figure 2). Canadian total exports fall significantly. The point estimates of the response of exports are similar, though the results for Canadian exports to non-US economies are less precise. The key result is that Canadian GDP falls and Canadian exports fall significantly. Finally, the US responses in Figure 2 are similar to what we reported in the benchmark VAR, which does not include Canadian data. This similarity is consistent with our assumption that the boomerang effects on the US of a monetary shock on foreign economies are small.

of trade is dominated by S_t . That the percent difference in the response of P_t^f and S_t is an order of magnitude is independent of the scale of ε_t^{mp} .

⁷The fall in foreign exports could reflect a financial channel in which the US credit crunch caused by the jump in ε_t^{mp} inflicts a credit crunch on foreign exporters. This could happen if foreign exporters require dollar credit to purchase critical US inputs to produce exports. Two examples of this supply crunch narrative can be found in, for example, [Christiano et al. \(2004\)](#) and [Braggion et al. \(2009\)](#).

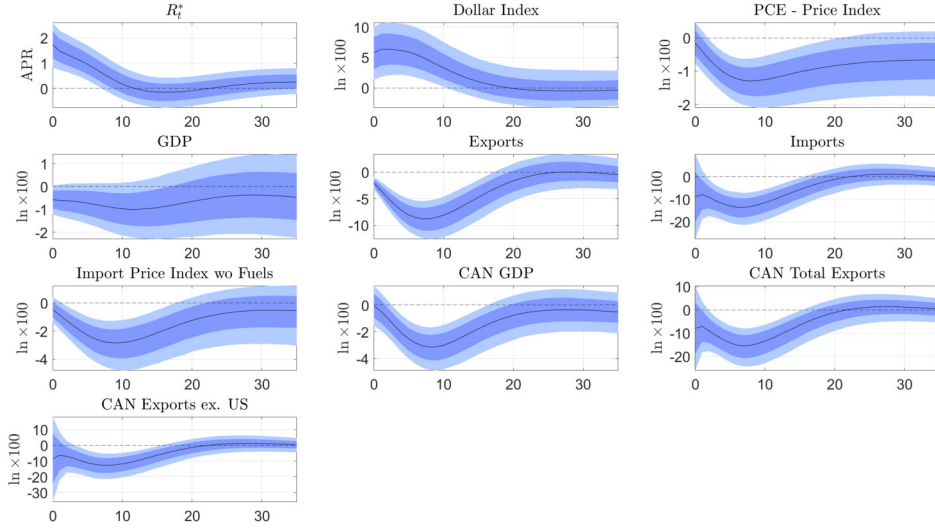


Figure 2: Impact of a US Monetary Policy Shock on the Canadian Economy

Note: Response of the Canadian economy to a jump in ε_t^m . The figure reports impulse responses from a VAR specification that augments the benchmark US VAR (equation (1)) with three Canadian variables: GDP, Total Exports and Canadian exports to non-US countries (CAN indicates Canada).

Next, we turn to the response of the Mexican economy to a US monetary contraction. The results are similar to what we found with Canadian data: Mexican GDP declines by as much as it does in Canada and exports fall significantly, whether we look at total exports or just exports to non-US countries.

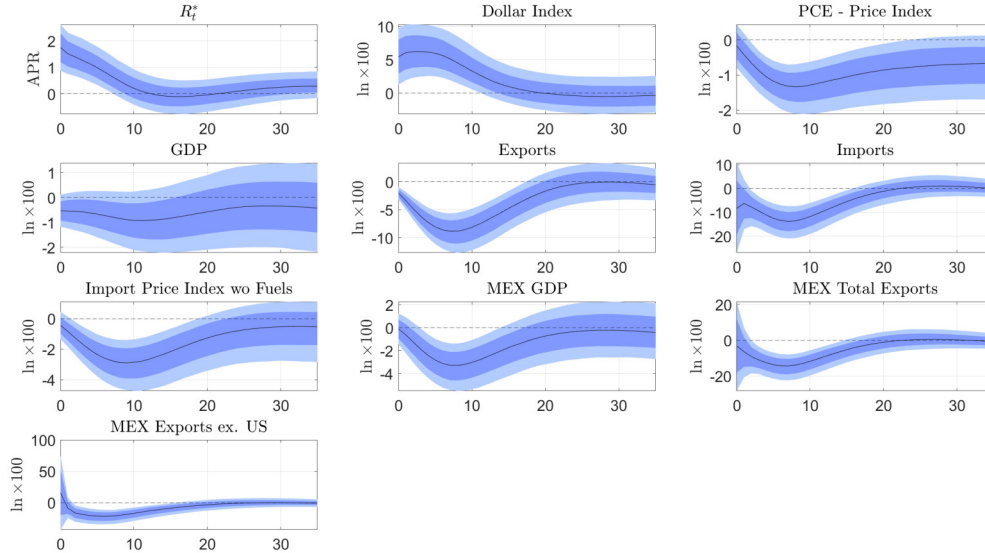


Figure 3: Impact of a US Monetary Policy Shock on the Mexican Economy

Note: The impulse responses reported in the figure correspond to those in Figure 2, except that CAN is replaced with MEX, where the latter corresponds to Mexico.

2.3 Estimated Response of Non-US Countries

We now consider the average response of two groups of economies. We use the same panel VAR approach as in [Camara et al. \(2025\)](#). Still, we summarize it here for completeness.

2.3.1 Panel VAR

Our VAR for the i^{th} non-US economy is

$$Y_{i,t} = A_1 Y_{i,t-1} + A_2 Y_{i,t-2} + C \varepsilon_t^{mp} + \varepsilon_{i,t}, \quad (3)$$

where

$$Y_{i,t} = \begin{bmatrix} \tilde{Y}_t \\ Y_t^i \end{bmatrix}, \quad (4)$$

and $\tilde{Y}_t$ denotes the 3×1 vector of US variables composed of GDP , R_d^* and PCE . As explained in [Camara et al. \(2025\)](#), when the US analysis in Section 2.1.2 was redone with a US 3-variable, 1-lag VAR the IRFs in GDP , R_d^* and PCE to the [Bauer and Swanson \(2023b\)](#) shock are very similar to what is reported in Figure 1.

Also, Y_t^i denotes an 8×1 vector of variables for country i : GDP ; nominal exchange rate (foreign currency per dollar); domestic monetary policy rate; consumer price index (CPI); gross private domestic investment; exports; imports; and the measure of Central Bank FX intervention, as a percent of GDP provided in [Adler et al. \(2024\)](#).⁸

When we estimate the system in equation (3) we do not zero out the top right 3×8 blocks in A_1 and A_2 , which govern feedback from movements in the foreign variables, Y_t^i , to the US variables, $\tilde{Y}_t$. This fact allows us to evaluate our assumption in the US VAR and in our model analysis that the rebound effect on the US from the foreign impact of US monetary policy shocks is small.

The panel VAR is structured as follows:

$$\begin{bmatrix} Y_{1,t} \\ Y_{2,t} \\ \vdots \\ Y_{N,t} \end{bmatrix} = \begin{bmatrix} A_1 & 0 & \cdots & 0 \\ 0 & A_1 & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & 0 & \cdots & A_1 \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ Y_{2,t-1} \\ \vdots \\ Y_{N,t-1} \end{bmatrix} + \begin{bmatrix} A_2 & 0 & \cdots & 0 \\ 0 & A_2 & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & 0 & \cdots & A_2 \end{bmatrix} \begin{bmatrix} Y_{1,t-2} \\ Y_{2,t-2} \\ \vdots \\ Y_{N,t-2} \end{bmatrix} + \begin{bmatrix} C \\ C \\ \vdots \\ C \end{bmatrix} \varepsilon_t^{mp} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \vdots \\ \varepsilon_{N,t} \end{bmatrix}, \quad (5)$$

where N denotes the number of countries and the dimension of C conforms with the dimension of $Y_{i,t}$. We apply a similar Bayesian method to estimate equation (5) as in the case of the US VAR in equation (1). The difference here is the zero restrictions in equation (5) as well as the assumption that A_1 , A_2 and C are the same across countries. In words, we impose that for each i , Y_t^i (a) responds only to the country's own lagged data and lagged data on the three US variables in $\tilde{Y}_t$, and (b) the responses are the same for all i 's among the AE's and for all i 's among the EME's.

We impose (a) and (b) in part to minimize the number of parameters to be estimated. Our effective data sample is short. As noted above, this is due only in part to data limitations. We think that the monetary and regulatory regimes in place, especially in the EMEs, were very different before the 2000s, and we exclude this data plus a few years to accommodate

⁸The measure constructed by [Adler et al. \(2024\)](#) is intended to capture changes in reserves that reflect active purchases and sales by Central Banks in the FX market. They are not simply changes in Central Bank FX reserves. The latter changes can reflect changes in market valuation and changes in earnings on the underlying assets. Other movements in Central Bank reserves are stripped from the measure of FX intervention. For example, reserves can change because banks must deposit a portion of their dollar liabilities with the Central Bank and these enter Central Bank reserves. [Adler et al. \(2024\)](#) also attempt to include Central Bank activity in futures markets in their measure of FX interventions.

a transition, from the analysis. We interpret our IRFs for the AE and EME countries as an average over the individual country responses, which is perhaps more reliably estimated than the individual responses. The evidence in [Camara \(2025\)](#) suggests that this interpretation is valid.

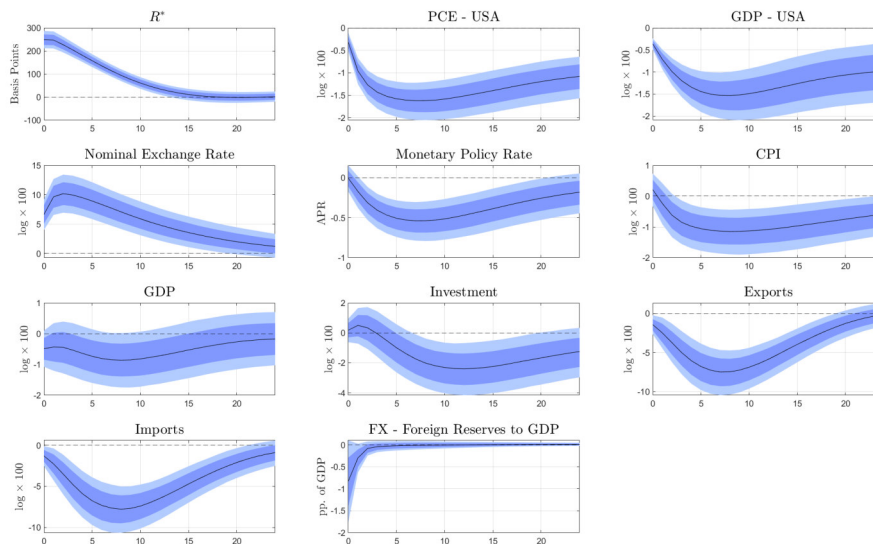
2.3.2 Impact on the Advanced and Emerging Market Economies

The core objective of this paper is to analyze the impact of a US monetary policy shock on Advanced Economies (AE) and Emerging Market Economies (EME).⁹ Our results are similar to what we found for Canada and Mexico, with one exception. We found that the decline in GDP in Canada (an AE) and Mexico (an EME) are roughly the same magnitude in percent terms. But, our panel analysis finds that the drop in EME output is larger than the drop in AE output. Still, the finding that GDP declines is robust. Also, the previous section's finding that exports drop by about 10 percent also happens across EMEs and AEs.

The results for AEs and EMEs are reported in Figures 4 and 5, respectively. In each figure, the first row displays the results for the US and the remaining rows display the results for the non-US economies.

We find that when monetary policy tightens GDP in the rest of the world contracts. The fall in EME output tends to be larger than the fall in AE output. These results in effect represent averages over all our countries. As we showed above Mexico and Canada fit the general pattern in that GDP and exports fall. However, the drop in GDP in these two countries is about equal. Note that the sign of the foreign monetary shock is different across AEs and EMEs. Still, the responses are very small compared with the US interest rate, which responds by 170 basis points. The AEs react to that US tightening by a modest reduction of 50 basis points in their policy rates and the EMEs react by increasing their policy rates by a modest 30 basis points.

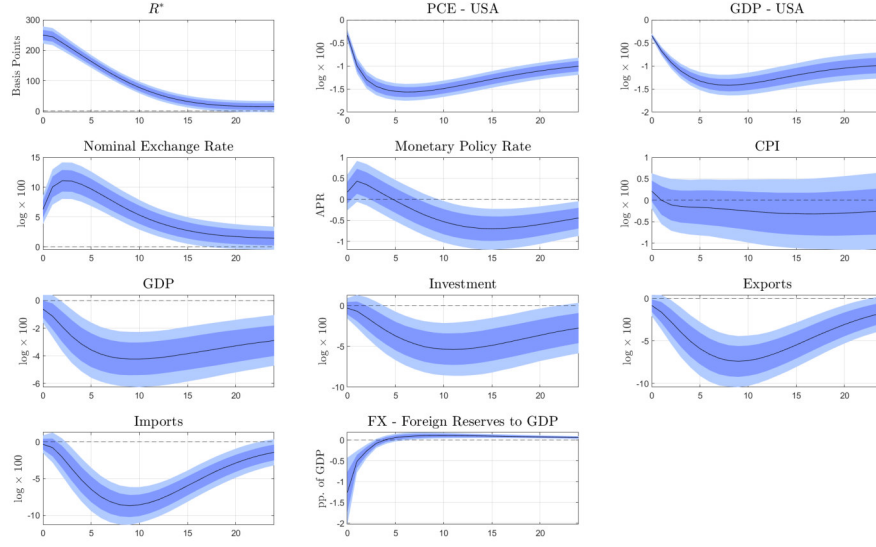
Figure 4: Impulse Responses: Advanced Economies (AE)



Note: The first row depicts the response of the US variables in the panel VAR the other rows depict the response of the panel of AE countries. For extensive robustness checks on these results see [Camara et al. \(2025\)](#), where we also use projection methods as well as the shocks computed by [Jarociński and Karadi \(2020\)](#).

⁹We use data on 10 advanced economies: Australia, Canada, UK, Germany, Israel, Japan, Korea, Norway, Switzerland, and Sweden. We use data on 14 emerging market economies: Brazil, Chile, Colombia, Hungary, India, Indonesia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey.

Figure 5: Impulse Responses: Emerging Market Economies (EME)



Note: see the note to Figure 4.

Our IRFs allow us to provide a novel characterization of the deviation from uncovered interest parity (UIP) implicit in our VARs. Under UIP, the expected nominal return on the domestic risk-free interest rate, R_d , should be equal to the expected nominal return on the foreign risk-free asset, adjusting for the expected change in the exchange rate:

$$r_{d,t} = r_{d,t}^* + E_t s_{t+1} - s_t, \quad (6)$$

or,

$$s_t = \Delta_t + E_t s_{t+1}, \quad \Delta_t \equiv r_{d,t}^* - r_{d,t},$$

where lower case letters mean the log of the corresponding upper case object. Let Δ_ℓ and s_ℓ denote the $t + \ell$ -period IRFs, $E_t \Delta_{t+\ell}$ and $E_t s_{t+\ell}$, to ε_t^m so that UIP implies:

$$s_\ell = \Delta_\ell + s_{\ell+1}, \quad (7)$$

for $\ell = 0, 1, \dots$. Note in Figures 4 and 5 that Δ_ℓ and s_ℓ appear to converge to their unshocked paths as $\ell \rightarrow \infty$. A monetary policy shock appears to leave these variables unaffected in the long run.¹⁰ After iterating on equation (7) and taking account the convergence properties of these variables, we obtain:

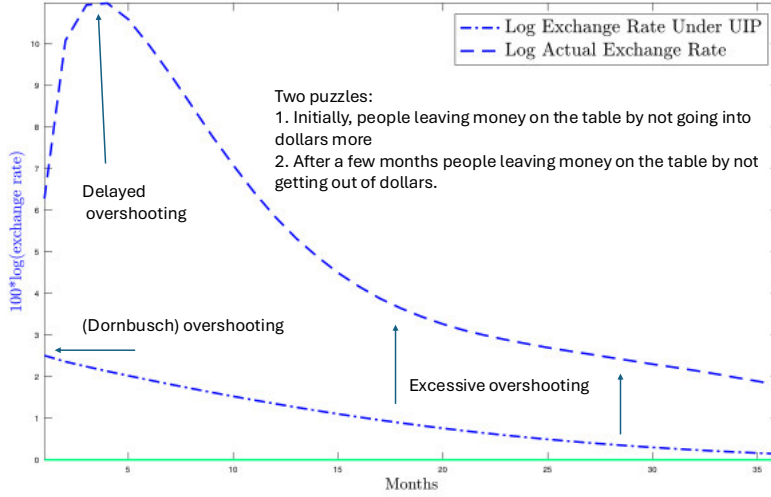
$$s_\ell^{UIP} = \sum_{j=0}^{\infty} \Delta_{\ell+j}. \quad (8)$$

According to equation (8) there is a connection between the exchange response ℓ periods after a monetary tightening and anticipated subsequent interest rate spreads. The connection is displayed in Figure 6. The dot-dashed line is the log exchange response expected under the UIP, as a function of the later evolution of the interest rate differentials, Δ . The path of $\log s_\ell^{UIP}$ displays the expected Dornbusch overshooting pattern. Note that the actual exchange rate responds very differently than what is implied by UIP. First, the overall response is far too strong ('excessive overshooting'). Second, the path exhibits the delayed overshooting pattern

¹⁰For extended discussion, see the Appendix of Camara et al. (2025).

discussed in the literature. In effect, relative to UIP the actual response of the exchange rate poses two puzzles: when the exchange rate depreciates people initially ‘leave money on the table’ by not transferring more local assets into dollars. Second, because the depreciation is so high and the exchange rate returns to zero, it must return faster than it does under the prediction of UIP. So, after a few months, people leave money on the table by not moving their financial capital out of the US and into the domestic economy.

Figure 6: Actual and UIP Predicted Response of EME Exchange Rate to Monetary Tightening



Note: The dashed line

shows the estimated response to the EME dollar exchange rate reported in the 2,1 panel of Figure 5. The dot-dashed line shows s_{ℓ}^{UIP} in equation (8), using the estimated IRF of the differential between the US interest rate response and the EME interest rate response.

3 Small Open Economy Model

We analyze the transmission of a contractionary US monetary policy shock to the rest of the world using the medium-scale New Keynesian small open economy (SOE) framework developed in our companion paper, [Camara et al. \(2025\)](#). The model is a streamlined version of [Adolfson et al. \(2007\)](#) and [Christiano et al. \(2011\)](#), augmented with three features designed to capture the global transmission of US monetary policy: (1) portfolio balance frictions that generate endogenous uncovered interest parity (UIP) deviations¹¹; (2) a version of the Dominant Currency Pricing (DCP) in trade [Gopinath et al. \(2020\)](#); and (3) frictions in which exchange rate changes have balance sheet effects ([Bernanke et al. \(1999\)](#), [Gertler et al. \(2007\)](#), [Castillo and Medina \(2021\)](#), [Dalgic \(2024\)](#)).

3.1 Households and Portfolio Balance Frictions

The economy is populated by a representative household that maximizes the expected discounted sum of utility from consumption and leisure, subject to a non-pecuniary cost of portfolio adjustment. A central feature of our framework is the deviation from the standard Uncovered Interest Parity (UIP) condition, motivated by the need to match the exchange rate dynamics discussed above.

We introduce these frictions through the household’s preferences, which include a term $-h_t(\Theta_t)$,

¹¹The UIP literature is very large. We follow the style in [Christiano et al. \(2011\)](#) and [Eichenbaum et al. \(2021\)](#).

where Θ_t denotes the share of financial wealth held in dollars. The cost function is quadratic, $h_t(\Theta_t) = \frac{\gamma}{2} (\Theta_t - \Upsilon_t)^2$, penalizing deviations from a time-varying target Υ_t .

The household's target share of dollar assets, Υ_t , evolves according to the following process:

$$\Upsilon_t = \Upsilon + \gamma_{R^*} (R_{d,t}^* - R^*) + \gamma_{\Theta} (\bar{\Theta}_t - \bar{\Theta}_{t-1}) + e_t^{\Upsilon}. \quad (9)$$

Here, Υ is the steady-state target. The term $\gamma_{R^*} > 0$ captures a “risk appetite” or “flight to safety” channel. When the US interest rate $R_{d,t}^*$ rises, households increase their preferred allocation of dollar assets for non-pecuniary reasons, effectively perceiving the dollar as safer or more desirable during periods of monetary tightening. This allows us to obtain the ‘excessive overshooting’ result documented in section 2.3.2. The term governed by $\gamma_{\Theta} < 0$ introduces portfolio inertia, representing adjustment costs or frictions that prevent households from instantly rebalancing their portfolios. This allows us to obtain the delayed overshooting result in section 2.3.2 as well our second UIP puzzle, that people seem to move their financial capital too slowly out of the US when the exchange rate eventually starts to appreciate after a US monetary tightening (see Figure 6). Finally, e_t^{Υ} represents an exogenous noise trader shock. We do not study the consequences of that shock here (we take this issue up in Camara et al. (2025)).

These preference specifications break the standard UIP condition. The analog of the condition in equation (6) is now:

$$E_t \Delta s_{t+1} + r_{d,t}^* + \Lambda_t = r_{d,t}, \quad (10)$$

where $\Lambda_t = \gamma(\Upsilon_t - \Theta_t)$ represents the endogenous risk premium. When the household's holding of dollars exceeds the target, the non-pecuniary return on dollars is negative, incentivizing people to sell dollar assets.

3.2 Exports, DCP and Import Channel

Consistent with the “Dominant Currency Paradigm” (Gopinath et al., 2020), we assume export prices are sticky in US dollars. A representative exporter sets prices subject to Calvo frictions, implying that exchange rate depreciations do not immediately pass through to lower export prices. As noted in the introduction, the full force of the DCP comes into play when non-US countries trade with each other. We do not allow that here because we do not let the AEs and EMEs trade with each other. We suspect that by limiting the force of the DCP, we are understating the importance of the trade channel.

US demand for domestic exports, X_t , is driven by the transitory component of US GDP, y_t^f :

$$X_t = \left(\frac{P_t^X}{P_t^f} \right)^{-\eta_f} \left[\left(\frac{y_t^f}{y^f} \right)^{\gamma_f} \mathcal{Z}_t \right] \quad (11)$$

where γ_f is the elasticity of exports to (scaled) foreign activity. This specification captures the direct quantity effect of a US contraction on the SOE's exports. The variable, $\mathcal{Z}_t$, is a trend term. Since we do not consider shocks to $\mathcal{Z}_t$, we do not say anything further about it. We set $\gamma_f > 1$ because the percent change in US imports is greater than the percent change in US GDP (compare panels 2,1 and 3,2 in Figure 1).

3.3 Financial Frictions and Balance Sheet Effects

To include financial frictions we incorporate an open-economy version of the Costly State Verification (CSV) framework (Bernanke et al., 1999). Entrepreneurs purchase capital using net worth and bank loans. Banks, in turn, finance these loans by issuing liabilities in both domestic currency (fraction ϕ) and foreign currency (fraction $1 - \phi$), following Castillo and Medina (2021).

In our model, when domestic residents need to borrow in foreign currency (i.e., ϕ is large) these borrowers' balance sheets are exposed to exchange rate fluctuations. In particular, when the US tightens monetary policy and the dollar appreciates, people abroad who borrowed in dollars suffer a balance sheet loss. In our estimation we assign $\phi = 0.99$ to the entrepreneurs in the AEs and $\phi = 0.5$ in the EMEs. In the analysis, the reason for the greater fall in GDP in EMEs relative AEs after a US monetary tightening is that the former are more exposed to exchange rate risk.

3.4 Policy

The domestic central bank follows a standard Taylor rule targeting domestic inflation, output, and the exchange rate. Additionally, the central bank utilizes a sterilized FX intervention rule, leaning against the wind to stabilize exchange rate fluctuations. This rule dictates that the central bank accumulates foreign reserves when the currency appreciates and sells them when it depreciates, thereby dampening volatility.

3.5 Foreign Sector and Shock Transmission

A key methodological contribution of our framework is the modeling of the foreign block (the US economy). Rather than assuming an exogenous process for the foreign interest rate in isolation, we capture the joint dynamics of US interest rates, output, and inflation. This approach ensures that the external shocks hitting the Small Open Economy are structurally consistent with the empirical evidence derived from our US VAR analysis.

Specifically, we model the evolution of the foreign economy vector, $\hat{Y}_t$, as a VAR(1) process:

$$\hat{Y}_t = A\hat{Y}_{t-1} + D\varepsilon_t^{mp}, \quad (12)$$

where ε_t^{mp} denotes the US monetary policy shock. The vector of foreign variables, expressed in deviations from steady state, is defined as:

$$\hat{Y}_t = \begin{pmatrix} \hat{\pi}_t^f \\ \hat{R}_t^* \\ \hat{y}_t^f \end{pmatrix} = \begin{pmatrix} \log(\pi_t^f / \pi^f) \\ R_{d,t}^* - R_d^* \\ \log(y_t^f / y^f) \end{pmatrix}. \quad (13)$$

Here, $\hat{\pi}_t^f$ represents US inflation (based on the PCE price index), $\hat{R}_t^*$ denotes the US nominal interest rate, and $\hat{y}_t^f$ corresponds to the transitory component of US GDP. Variables without a time subscript in equation (13) correspond to their steady state value.

The matrix A and vector, D , are constructed so that when equation (12) is hit in $t = 1$ by $\varepsilon_1^{mp} > 0$ and $\varepsilon_t^{mp} = 0$, $t > 0$, $\hat{Y}_0 = 0$, then $\hat{Y}_t$ for $t = 1, 2, \dots$ replicate, virtually exactly, IRFs estimated in the data using our US VAR (for a caveat, see subsection 3.6). By embedding this estimated structure into the SOE model, a US monetary policy shock ε_t^{mp} does not merely raise the risk-free rate $R_{d,t}^*$. Instead, it simultaneously triggers a contraction in US demand ($\hat{y}_t^f$) and perturbs foreign prices ($\hat{\pi}_t^f$) in a manner consistent with the data. This allows us to capture the full transmission mechanism of a monetary contraction via the financial market channel ($R_{d,t}^*$) and via the trade channel ($\hat{y}_t^f, \hat{\pi}_t^f$).

3.6 Parameter Estimation

We estimate the model parameters using the approximate Bayesian IRF matching approach developed in (Christiano et al., 2010). We implement this procedure using the code in version 6 of Dynare (see Adjemian et al. (2024)). The method selects SOE model parameters to minimize

the distance between the theoretical IRFs generated by the model and the empirical IRFs estimated in our VAR analysis (i.e., the results in the second two rows in each of Figures 4 and 5.

The estimation minimizes a weighted sum of squared deviations between the model and empirical IRFs. The weighting matrix is diagonal, with elements corresponding to the inverse of the sampling variance of the empirical estimators. This ensures that the estimation places higher weight on matching aspects of the data that are estimated with greater precision.

A challenge in our estimation is the frequency mismatch: our VAR is estimated at a monthly frequency to capture high-frequency financial dynamics, while the structural model is quarterly. We address this by choosing the matrices A and D to match a quarterly version of the IRFs in the US variables (see (Camara et al., 2025, page 75) for details).

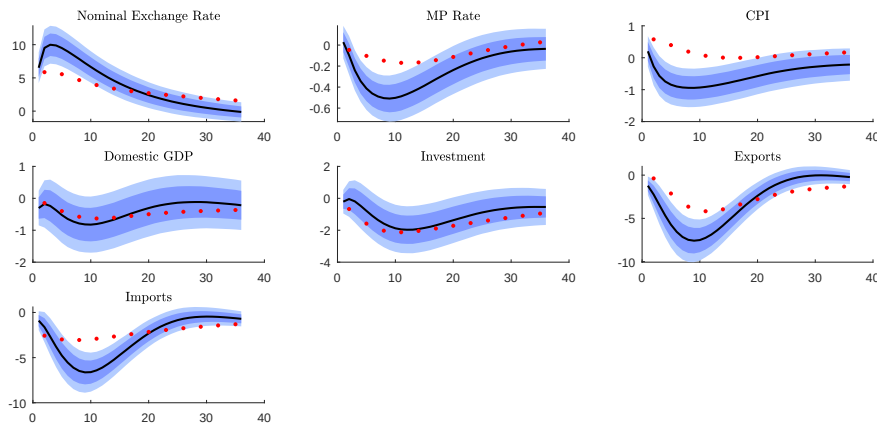
3.7 Model Fit

We now evaluate the ability of our estimated Small Open Economy models to account for the empirical IRFs derived from the VAR analysis.

Figure 7 displays the results for Advanced Economies (AE). The solid black lines and shaded regions represent the empirical VAR estimates (posterior mean and probability intervals), while the red dots represent the IRFs generated by the estimated structural model.

The model is generally successful at replicating the key empirical regularities of the transmission to AEs. Notably, it captures the contraction in real activity, matching the magnitude of the decline in GDP and the sharp, persistent drop in investment. Crucially for our hypothesis, the model tracks the trade dynamics remarkably well: both exports and imports exhibit the deep, U-shaped contraction observed in the data. The model has a hard time reproducing the gradual decline in the CPI, presumably because the data require a very big depreciation compared to the evolution of the $R_d^* - R$ spread.

Figure 7: AE Model Fit versus Empirical IRFs



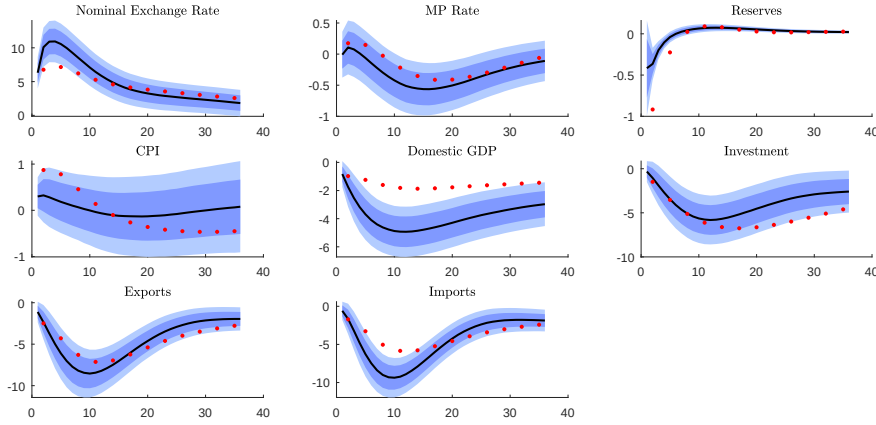
Notes: solid line reproduces the AE impulse responses in Figure 5. The impulse responses are quarterly and the responses of the model (the dots) are quarterly (see the text for a discussion of the time aggregation issue).

Turning to Emerging Market Economies (EME), Figure 8 presents the model fit. As documented

in the empirical section, EMEs experience a more severe contraction than AEs, a feature of the estimated IRFs. The model misses how much EME GDP drops relative to AE GDP.

The model also performs well in matching the financial variables. The estimated UIP frictions allow the model to replicate the large depreciation of the nominal exchange rate. In addition, the red dots indicate that the model gets a modest delayed depreciation. On the trade side, the model matches the magnitude of the export and import collapse, validating the role of the estimated export demand elasticities and the import channel in driving the downturn.

Figure 8: EME Model Fit versus Empirical IRF



Notes: see

notes to Figure 7 with appropriate adjustments for the fact that the IRFs in this figure correspond to the EMEs.

4 Decomposition of Channels

Foreign economies absorb the US monetary contraction through two distinct channels:

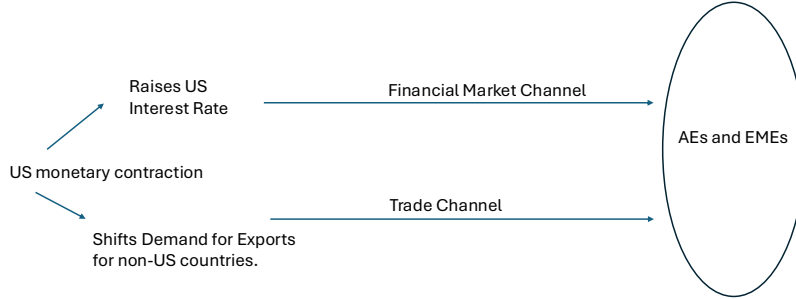
1. **Financial Market Channel:** The monetary tightening moves up R_d^* , triggering a portfolio shift toward the dollar, amplified by a fall in risk appetite and balance sheet effects. This channel is defined by zeroing out the shift in the demand for exports.¹²
2. **Trade Channel:** This channel zeros out the response of R_d^* and looks at the response of the AE and EME models to the perturbation in export demand only.

Because our VARs are linear and we adopt a linearization strategy for solving our small open economy model, the response of our models to a US monetary tightening is exactly the sum of the above two channels. In effect, we can imagine that a US monetary contraction launches two shocks to each of the AEs and EMEs: an export demand shock and an interest rate shock. This interpretation is summarized in Figure 9.

Figure 10 shows the decomposition of a US monetary contraction on the EMEs for our estimated model. The red line indicates the financial changes. It incorporates balance sheet effects and a decline in risk appetite, but zeros out US trade effects. Notice that the response of exports

¹²By a shift in demand for exports we mean the shift in foreign GDP and the price level, y_t^f, P_t^f in the demand curve in equation (11).

Figure 9: Decomposition of US Monetary Tightening into Two Shocks



Note: in our model a US monetary tightening affects the world in two ways: (1) it raises the interest rate, which triggers financial market effects and (2) it reduces US import demand, so that non-US countries see a decline in the demand for their exports. The total effect of a US monetary tightening is the sum of (1) and (2).

has a Mundell-Fleming flavor. Though prices of traded goods are sticky in dollars, they are not literally constant. So, exports expand in the financial channel.

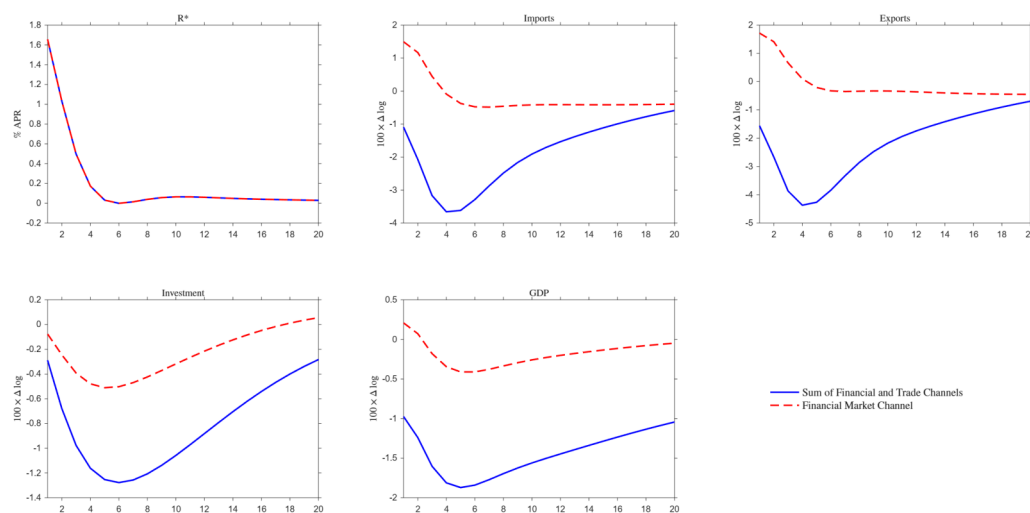
In the financial channel output falls, but by a relatively small amount compared to the data. The fall reflects two factors driving a fall in investment. First, the jump in R_d^* leads to portfolio decisions (augmented by a reduction in risk appetite) to move financial capital out of the country, reducing domestic investment. Second, balance sheet effects due to dollar exposure and the dollar appreciation reduces entrepreneurs' access to credit, thus accelerating the decline in investment.

Note that the combined financial and trade channels differ markedly from the financial channel alone. So, in the total response to a US monetary contraction, the decline in US imports plays the major role. For example, notice how an export rise in the financial market channel becomes an actual decline when trade is brought into the picture.

5 Conclusion

The literature has focused much attention on financial markets as the channel by which a US monetary tightening affects the rest of the world. Our results suggest that the reduction in US demand for goods and services is the larger of the two channels. We suspect that our analysis puts a lower bound on the importance of the trade channel because, as mentioned in the introduction, we have abstracted from the trade considerations in [Gopinath et al. \(2020\)](#) and [Auclert et al. \(2021\)](#). An interesting outstanding question is to investigate the relative importance of US imports versus the trade factors in [Gopinath et al. \(2020\)](#) and [Auclert et al. \(2021\)](#) in the transmission of monetary shocks.

Figure 10: Role of Trade Channel in Transmitting US Monetary Tightening to EMEs



Notes: The blue

line corresponds to the dotted line in Figure 8. That line depicts the full effects of a US monetary tightening, the sum of the financial and trade market channels. The red line corresponds to the financial market channel only. The sharp difference between blue and red lines indicates the importance of the trade channel in the overall impact of a US monetary contraction on the EME economies.

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