The Macroeconomic Consequences of Exchange Rate Depreciations

Masao Fukui — Boston University

Emi Nakamura — UC Berkeley

Jón Steinsson* — UC Berkeley

March 18, 2024

Abstract

We study the consequences of "regime-induced" exchange rate depreciations by comparing outcomes for peggers versus floaters to the US dollar in response to a dollar depreciation. Pegger currencies depreciate relative to floater currencies and these depreciations are strongly expansionary. The boom is not associated with an increase in net exports, or a fall in nominal interest rates in the pegger countries. This suggests that expenditure switching and domestic monetary policy are not the main drivers of the boom. We develop a financially driven exchange rate (FDX) model in which multiple shocks originating in the financial sector drive exchange rates and households and firms can borrow in foreign currencies. Following a depreciation, UIP deviations lower the costs of borrowing from abroad and stimulate the economy, as in the data. The model is consistent with (unconditional) exchange rate disconnect and the Mussa facts, even though exchange rates have large effects on the economy.

JEL Classification: F31, F41

*We thank Collin Jones for excellent research assistance. We thank Javier Bianchi, Louphou Coulibaly, Luca Fornaro, Rohan Kekre, Tarek Hassan, Ethan Ilzetzki, Oleg Itskhoki, Sebnem Kalemli-Ozcan, Matteo Maggiori, Enrique Mendoza, Dmitry Mukhin, Maurice Obstfeld, Michael Waugh and seminar participants at various institutions for helpful comments and discussions. We thank the Clausen Center at UC Berkeley, the Alfred P. Sloan Foundation, and the Smith Richardson Foundation for financial support.

1 Introduction

How does an exchange rate depreciation affect the economy? Is it expansionary? Is it contractionary? Or does it perhaps have little or no effect? Surprisingly, the answers to these questions are unclear. Simple textbook models imply that a depreciation is expansionary due to expenditure switching in goods markets (Dornbusch, 1980; Obstfeld and Rogoff, 1996). But there is a long literature discussing the theoretical possibility that exchange rate depreciations may be contractionary due to a contractionary real income effect (Diaz Alejandro, 1963; Cooper, 1969; Krugman and Taylor, 1978; Auclert et al., 2021b) or a contractionary balance sheet effect (Krugman, 1999; Aghion, Bacchetta, and Banerjee, 2001; Kalemli-Ozcan, Kamil, and Villegas-Sanchez, 2016).[1] Finally, there is a prominent literature in international macroeconomics that argues that exchange rates are largely disconnected from other macroeconomic aggregates (Meese and Rogoff, 1983; Baxter and Stockman, 1989; Flood and Rose, 1995; Obstfeld and Rogoff, 2000; Devereux and Engel, 2002; Itskhoki and Mukhin, 2021a). Lacking clear guidance from empirical evidence, there is precious little consensus.

These questions are difficult to answer because of the endogeneity of exchange rate movements. Consider a country that is hit by a negative shock. This may lead the exchange rate to depreciate and output growth to be unusually low. Using this type of variation to assess the effect of exchange rate depreciations on output will yield misleading results since the direct effect of the negative shock on the economy is a confound (which in this case would bias results towards finding that exchange rate depreciations are contractionary). Since all exchange rate changes happen for a reason, it is not clear that it is truly possible to measure the causal effect of an exchange rate depreciation.

Our approach to tackling this challenge is to compare outcomes for countries that peg their currency to the US dollar to outcomes in countries with currencies that float versus the US dollar when the US dollar exchange rate changes. A concrete example is useful. Since 2000, the South African rand has floated versus the US dollar, while the Egyptian pound has been pegged or has been on a crawling peg versus the US dollar. This has meant that when the US dollar depreciates relative to its main trading partners, the Egyptian pound (EGP) has tended to depreciate relative to the South African rand (ZAR). The question we ask is: How does this depreciation of EGP

[1] Bianchi and Coulibaly (2023) present a third type of model that can generate a contractionary devaluation. In their model, a devaluation reduces the value of collateral and thereby tightens borrowing constraints. A large literature has also considered how stabilization plans – i.e., the prevention of further depreciation – can be expansionary in high inflation countries (Dornbusch, 1982; Rodriguez, 1982; Calvo, 1986; Helpman and Razin, 1987; Mendoza and Uribe, 2000).

relative to ZAR affect macroeconomic outcomes in Egypt relative to South Africa?

Importantly, we are not using all variation in the exchange rate of the EGP and ZAR. We are only using a component of the variation in these exchange rates that arises because they have different pre-existing exchange rate regimes versus the US dollar (about 8% of the total variation in exchange rates in our sample). We refer to this variation as "regime-induced" variation in the exchange rate. Notice that this approach excludes all variation in exchange rates that arises from idiosyncratic shocks to each country (such as the bad shock discussed above) since such shocks do not move the US dollar exchange rate. We measure the US dollar exchange rate relative to 24 relatively advanced economies and exclude these countries from our baseline sample.

Our empirical results are easiest to interpret if the following assumption holds: pegs are not differentially exposed (relative to floats) to aggregate shocks that are correlated with the US dollar exchange rate. If this is true, the direct effects of the shocks that drive the US dollar exchange rate will affect pegs and floats symmetrically and will be absorbed by time fixed effects in our empirical specification. What is left is the "regime-induced" effect of the exchange rate of the pegs comoving with the US dollar.

The choice of exchange rate regime is, of course, an endogenous policy decision. So, considering deviations from the no-differential-exposure assumption is important. Perhaps the most likely scenario is that peggers to the US dollar may tend to be countries that share more shocks with the US than floaters (a standard assumption in the literature on optimal currency areas). A battery of robustness checks suggests this is unlikely to drive our results, which remain virtually unchanged after controlling for differential exposure to changes in US GDP, US monetary policy, the global financial cycle indicators, and commodity price fluctuations. Also, if pegs are differentially exposed to the same negative shocks that depreciate the US dollar, one might expect them to do poorly in the wake of a US dollar depreciation (but we find the opposite).[2]

There are relatively few "true floats" in our sample. Many of the countries that we classify as floats versus the US dollar are pegs to other currencies such as the euro. Since the euro floats versus the US dollar, currencies that peg to the euro float versus the US dollar. The choice of which currency a country pegs to in many cases has deep historical roots relating to colonial origins (e.g., the French franc zone in West Africa). We show that our pegs and floats are quite similar on observable characteristics, which lends credence to the view that they have similar exposure to macroeconomic shocks.

[2]If pegs are differentially exposed to positive shocks that depreciate the US dollar (e.g., productivity shocks) then the bias could go in the opposite direction. However, productivity shocks yield very little exchange rate variability in standard models. Moreover, controlling for US variables has little impact, as we discuss above.

Our main empirical finding is that regime-induced depreciations are strongly expansionary. Consider a case when the US dollar depreciates. This results in both the nominal and real exchange rates of pegging countries depreciating relative to floating countries. These depreciations are quite persistent. (They lasts roughly five years.) Output, consumption, and investment in pegging countries boom relative to floating countries. The boom builds gradually over several years and peaks after about five years. Quantitatively, our estimates imply that a 10% regime-induced depreciation results in a 5.5% increase in GDP over five years.

We consider the effects on a number of other macroeconomic outcomes. Two of these are particularly important for interpreting our results. First, we find that net exports fall in response to a regime-induced depreciation. This rules out an export-led boom due to expenditure switching as the main driver of our results. Second, our point estimates indicate that nominal interest rates rise in response to a regime-induced depreciation (these estimates are noisy). This is inconsistent with the depreciation resulting from looser monetary policy in pegging countries relative to floating countries. Together, these results rule out a large set of standard models that might be used to explain our results.

We present a financially driven exchange rate model (FDX model) that can match our empirical results. In this model, shocks emanating from the financial sector are important drivers of exchange rate volatility and financial frictions in international financial markets result in novel transmission mechanisms from these shocks to macroeconomic outcomes. Our model builds most directly on Itskhoki and Mukhin (2021a), but indirectly on a large prior literature that has developed financially driven exchange rate models. We augment Itskhoki and Mukhin's (2021a) model in two important ways: we allow households and firms to borrow and invest in foreign currency and we allow for more than one type of financial shock.

In our model, a depreciation of the US dollar driven by a financial shock (e.g., a UIP shock) makes the currencies of peggers "cheap" in the sense that expected future returns from investing in these currencies are higher than for floater currencies. (We show that this is indeed the case empirically in response to regime-induced exchange rate variation.) This return differential results in capital flows into pegging countries, which stimulates a domestic boom in these countries. For this to occur, the model must have two features. First, limits to arbitrage must be pervasive, i.e., there cannot be any "deep pocketed" investors that fully arbitrage away all return differentials. Second, households and firms must – directly or indirectly – be able to invest and borrow in foreign currency assets.

Our empirical results raise the following question: if regime-induced exchange rate depreciations have large stimulatory effects, why don't we see a strong unconditional correlation between exchange rates and output? It is well-known that the correlation of exchange rates with most macroeconomic aggregates is very low. Exchange rates are often said to be "disconnected" from macroeconomic aggregates. Furthermore, when countries shift from a fixed to a flexible exchange rate, this can lead to a dramatic change in the volatility of their real exchange rate (Mussa, 1986) apparently without having much of an effect on the volatility on output, consumption, and other macroeconomic outcomes (Baxter and Stockman, 1989; Flood and Rose, 1995; Itskhoki and Mukhin, 2021b). How can regime-induced depreciations have large effects, while exchanges rates are more generally disconnected from macroeconomic outcomes?

We show that our FDX model is simultaneously consistent with large effects of regime-induced depreciations, unconditional exchange rate disconnect, and the "Mussa facts" regarding changes in volatility when countries move from a peg to a float. The crucial ingredient to match all these facts simultaneously is that exchange rates be driven by more than one different type of financial shock. We consider two financial shocks. The first of these is a "UIP shock" where noise traders reduce demand for the home currency. In response to this shock, other agents trade against the noise traders and this results in a capital inflow into the home country and an associated boom. The second shock is a "capital flight" shock where home households and firms reduce demand for the home currency. This shock results in a capital outflow and a recession. The combination of these two shocks can then result in a low correlation between the exchange rate and output.

Similarly, moving from a floating exchange rate to a peg has two opposing effects on output volatility in our model. On the one hand, pegging eliminates the UIP shocks. This reduces output volatility. On the other hand, pegging makes the contractionary effects of capital flight shocks larger. This arises for two reasons. First, the peggers can no longer respond to an adverse capital flight shock by easing monetary policy. Second, peggers do not experience a UIP deviation after a capital flight shock since their exchange rate does not depreciate. This means that borrowing costs increase more for peggers after a capital flight shock than they would if these countries were floating. Since there are opposing effects, the overall effect of pegging on exchange rate volatility is ambiguous. Our model, thus, captures both the potentially destabilizing effects of flexible exchange rates articulated by Nurkse (1944, 1945) and the stabilizing role of flexible exchange rates articulated by Friedman (1953). For our calibration, the second effect is larger than the first and output volatility decreases when a country floats.

While it is crucial that we have two shocks driving exchange rate fluctuations, not just any two shocks will do. In standard models, most shocks generate a positive correlation between consumption and the real exchange rate (booms associated with depreciations). Empirically, however, exchange rates and consumption are mildly negatively correlated (Backus and Smith, 1993). Second, many shocks fail to generate appreciable volatility in the exchange rate. We need a shock that generates a negative correlation between consumption and the exchange rate and also generates high exchange rate volatility. The capital flight shock has these two important implications.

The tradeoffs a country faces in adopting a fixed versus flexible exchange rate look fundamentally different when viewed from the perspective of models in which financial shocks play a central role in driving the exchange rate. In traditional open economy models, the primary effect of pegging one's currency is for monetary policy: pegging to the US dollar implies a country must follow US interest rate policy. Our empirical findings suggest, however, that a first order consequence of pegging to the US dollar is that a country imports the financial shocks that drive the US exchange rate, while potentially eliminating home-grown financial shocks. The importance of this financial shock trade-off may greatly outstrip the importance the traditional monetary trilemma.

Related Literature. Our analysis relates to a literature that has sought to estimate the effect of changes in exchange rates on macroeconomics outcomes. Rodrik (2008) shows that an "undervaluation" of the real exchange rate correlates with GDP growth. Obstfeld and Zhou (2022) estimate the effect of changes in the US dollar exchange rate on a sample of 26 emerging market and developing countries from 1990-2019. They focus on the aggregate effect, but also find as we do that pegs are affected more by movements in the US dollar than floats. Eichengreen and Sachs (1985) and Bouscasse (2022) exploit the difference in the timing of the abandonment of the gold standard in the 1930s and find that depreciations are strongly expansionary.

Our empirical strategy relates to a strand of literature that explores heterogenous responses of macroeconomic outcomes by exchange rate regime. Tenreyro (2007); Barro and Tenreyro (2002) use regime induced volatility in exchange rate rates to study trade and the comovement of price and GDP across countries. Di Giovanni and Shambaugh (2008) and Cloyne et al. (2022) study the effect of anchor country monetary policy on peggers. Jordà, Schularick, and Taylor (2020) interact the exchange rate regime, capital account openness, and anchor currency's monetary policy to construct an instrumental variable for changes in a country's monetary policy based on the classic monetary trilemma. Broda (2004) assess the effects of terms of trade shocks on peggers versus floaters. Carare et al. (2022) assess the effect of a country's exchange rate regime for global demand shocks, while Cesa-Bianchi, Ferrero, and Rebucci (2018) consider global supply shocks. We investigate arguably the most direct consequence of choosing one exchange rate regime versus the other: differential exposure to movements in the anchor currency's exchange rate.

Our model draws heavily on Itskhoki and Mukhin (2021a) and indirectly on the pioneering work of Gabaix and Maggiori (2015). These papers in turn build on much earlier literature, e.g., Branson et al. (1970) and Kouri (1976). Papers emphasizing UIP shocks include Devereux and Engel (2002), Gourinchas and Tornell (2004), Kollmann (2005), Bacchetta and Wincoop (2006), and Eichenbaum, Johannsen, and Rebelo (2020). Also related is the literature on the carry trade (see, e.g., Burnside, Eichenbaum, and Rebelo, 2011). Our modeling of the capital flight shock builds on Bianchi and Lorenzoni (2021). Alternative models that generate similar shocks are developed by Kekre and Lenel (2021) and Engel and Wu (2023). These ideas, in turn, build on Calvo (1998). A growing empirical literature documents a strong association between financial market variables and exchange rates (Jiang, Krishnamurthy, and Lustig, 2018; Engel and Wu, 2023; Lilley et al., 2022; Jiang, Richmond, and Zhang, 2022). Our empirical results – when interpreted through the lens of our theoretical model – provide additional support for the view that the dominant driver of exchange rate fluctuations is financial shocks.

The paper proceeds as follows. Section 2 presents our empirical results. Section 3 lays out the model we used to interpret these results. Section 4 discusses the calibration of the model. Section 5 shows that the model can match our empirical results. Section 6 shows that our model augmented with capital flight shocks is consistent with unconditional exchange rate disconnect, the Backus-Smith correlation, and the Mussa facts.

2 New Evidence on the Effect of Exchange Rate Depreciations

The basic idea of our empirical approach is to compare outcomes in countries that peg their exchange rate to the US dollar to outcomes in countries with a currency that floats versus the US dollar when the US dollar exchange rate moves. We start this section by discussing how we measure movements in the US dollar exchange rate. Next, we discuss how we classify countries into pegs and floats. We then discuss our main empirical specification and the data we use, before presenting our empirical results.

2.1 US Dollar Nominal Effective Exchange Rate

Our sample is annual data over the period 1973 to 2019. When assessing the response of pegs and floats to movements in the US dollar exchange rate, we use a trade-weighted US exchange rate

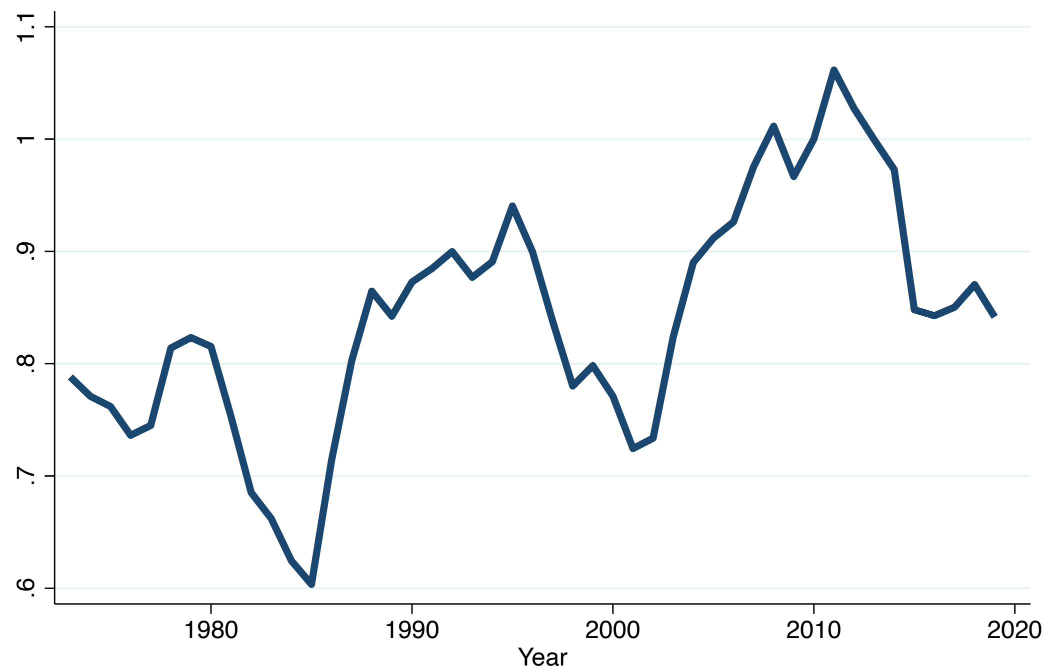


Figure 1: US Dollar Trade-Weighted Exchange Rate

Note: This figure plots the BIS's trade-weighted exchange rate of the US dollar against 24 countries. For a list of these countries, see footnote 3. Lower values indicate a more appreciated US dollar.

constructed by the Bank of International Settlements (BIS) relative to 24 countries.[3] We exclude these 24 countries from our sample of pegs and floats. We sometimes refer to this exchange rate as the nominal effective exchange rate of the US dollar. Figure 1 plots the evolution of this exchange rate over our sample period. We define the exchange rate as the domestic currency price of foreign currency. This implies that an increase in the exchange rate is a depreciation. The US dollar's exchange rate experienced several large swings during our sample period. Its value rose sharply in the early 1980s and fell sharply in the late 1980s. It rose in the late 1990s, and fell in the 2000s. It then rose, again, substantially in the 2010s.

2.2 Exchange Rate Regimes

Exchange rate classification is notoriously difficult. Many countries follow a policy that is neither a strict peg nor a free float and often de facto policy differs sharply from de jure policy. We classify the exchange rate regime for each country-by-year observation as either a peg or a float versus the US dollar based on Ilzetzki, Reinhart, and Rogoff's (2019) classification of exchange rate regimes.

[3]The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and United Kingdom.

They develop a "coarse" six-category classification, and a "fine" 15 category classification. These classifications attempt to provide a detailed breakdown of the spectrum of de facto policy from a strict peg to a free float. Their coarse categories are: 1) peg, 2) narrow band, 3) broad band and managed float, 4) freely floating, 5) freely falling, 6) dual market with missing parallel market data. We list the fine categories in Table A.2. Ilzetzki, Reinhart, and Rogoff also assign an anchor currency to each country-by-year observation. The anchor currency for most observations is the US dollar. A minority of observations have the euro, British pound, French franc, German mark, and other major currencies as anchors. (See appendix A for details.)

From our perspective, what matters is the extent to which currencies in different categories comove with the US dollar. We can assess this with the following regression

$$\Delta e_{i,t} = \alpha_i + \alpha_{r(i),t} + \sum_k \gamma_k \mathbb{I}_{i,t}(k) \times \Delta e_{USD,t} + \epsilon_{i,t}, \tag{1}$$

where $\Delta e_{i,t}$ denotes the log change in the exchange rate of country i from time $t-1$ to t, α_i denotes country fixed effects, $\alpha_{r(i),t}$ denotes region-by-time fixed effects, $\mathbb{I}_{i,t}(k)$ is an indicator for the exchange rate regime k of country i at time t, $\Delta e_{USD,t}$ denotes the log change in the US dollar effective exchange rate, and $\epsilon_{i,t}$ denotes unmodelled influences on the change in the exchange rate of country i at time t. The region-by-time fixed effects are for four regions: Europe, Americas, Africa, Asia/Oceania.

In this analysis, we define $\Delta e_{i,t}$ for all countries relative to *the same* currency (say the US dollar). This simplifies the exposition, since a perfect peg to the US dollar moves *exactly* one-for-one relative to a perfect USD float. The same holds (identically) if we define $\Delta e_{i,t}$ relative to any other currency, so long as it is the same across countries (due to the presence of time fixed effects). The level of the coefficients γ_k are determined by the omitted category (which we choose to be the free floats (category 13)). In section 2.6, in contrast, we use the trade-weighted exchange rate (with country-specific trade weights). In practice, both approaches yield similar yield similar results, as we describe below.

For country-by-year observations anchored to the US dollar, we define $\mathbb{I}_{i,t}(k)$ using Ilzetzki, Reinhart, and Rogoff's fine classification. We exclude observations from categories 14 (freely falling) and 15 (dual market/missing data). We assign country-by-year observations that Ilzetzki, Reinhart, and Rogoff assess as being anchored to a currency other than the US dollar (or to a basket) to one of three categories based on their coarse classification of these observations vis-a-vis that anchor. In particular, categories 13.1, 13.2, and 13.3 in Figure 2 are currency-by-year observations with an anchor other than the US dollar and which are classified in coarse categories 1 (peg), 2 (narrow band), and 3 (broad band and managed float), respectively. We exclude the 24 countries that the US dollar nominal effective exchange rate is defined relative to and restrict the sample to country-by-year observations for which real GDP data from the World Bank is available.

Figure 2 plots the γ_k coefficients from this regression along with 95% confidence intervals. The key conclusion that we draw from this figure is that Ilzetzki, Reinhart, and Rogoff's classification works. Currencies in categories on the left in the figure (the "hardest" pegs) depreciate strongly relative to currencies in category 13 ("free floats") when the USD depreciates. A second observation is that currencies that are anchored to countries other than the US dollar (categories 13.1, 13.2, and 13.3) behave quite similarly to the free floats (category 13). The reason for this is simply that the other anchor countries (mostly the euro and its predecessors) are for the most part free floats versus the US dollar. Countries that peg to these other anchors therefore also float versus the dollar.[4]

Interestingly, the degree to which the coefficients in Figure 2 fall as we move from left to right is quite modest for the first 12 categories. Even currencies that Ilzetzki, Reinhart, and Rogoff classify as managed floats comove by similar amounts with the US dollar at an annual frequency as currencies that they classify as very hard pegs. This suggests that "fear of floating" is pervasive (Calvo and Reinhart, 2002).

Based on these results, we classify observations into pegs and floats as follows. We classify observations in categories 1 through 8 in Figure 2 as pegs and observations in categories 13 - 13.3 as floats. We drop observations in categories 9 through 12 as well as observations in categories 14 (freely falling) and 15 (dual market/missing data). Categories 9 through 12 (coarse category 3) are intermediate categories that fit poorly in either the peg or float group. Our results are robust to handling these categories differently.[5]

We classify roughly half of our sample as floats (see Figure A.3 and Figure A.4 for the fraction of pegs in each region). Most of the countries that we classify as floats versus the US dollar are strongly linked to other currencies (categories 13.1, 13.2, and 13.3 above). For example, a number of West African countries peg to the euro (and before that the French franc), which floats relative to the US dollar. These currencies are classified as "floats" in our analysis. Therefore much of the

[4] Figure A.1 presents results separately for observations anchored to baskets (that include the US dollar) and for observations anchored to the South African rand, the Indian rupee, or the Singapore dollar – currencies that have not always floated freely relative to the US dollar. Figure A.2 presents results analogous to Figure 2 for Ilzetzki, Reinhart, and Rogoff's coarse categories.

[5] As robustness, we present results for both the case where we include these categories as pegs and the case where we include them as floats (see Figures A.17 and A.18 in the appendix). Both of these sets of results are similar to our baseline results.

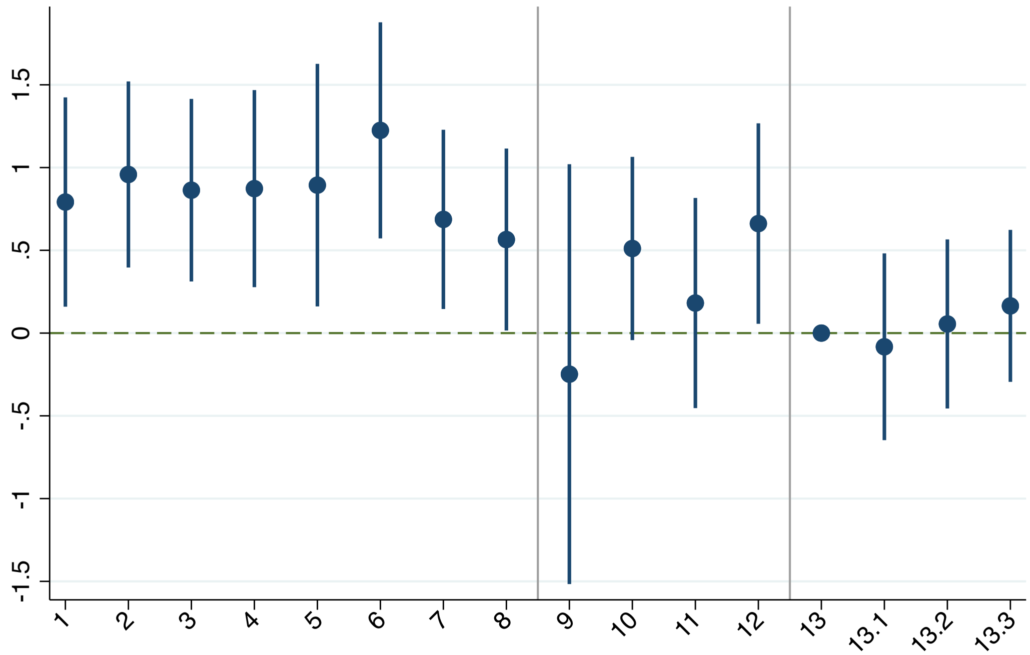


Figure 2: Comovement with US Dollar by Category

Note: This figure plots our estimates of the γ_k's from equation (1). These are estimates of the comovement of the exchange rate of currencies with different exchange rate regimes as classified by Ilzetzki, Reinhart, and Rogoff's (2019) fine classification. We normalize the γ_k for category 13 (freely floating and anchored to the US dollar) to zero. The vertical lines extending from each point estimate represent 95% confidence intervals. The two thin vertical lines denote the splits between categories we classify as pegs (1 through 8) and floats (13 through 13.3).

variation we exploit comes from which currency a country pegs to, rather than whether a country pegs or floats.

Our classification of observations into pegs and floats is likely far from perfect in that many of our pegs are not completely "hard" pegs and many of our floats are not completely "free" floats. However, a key insight is that while this issue may reduce the statistical power of our methodology, it is not a source of bias. As in any instrumental variables analysis, misclassification of pegs and floats will lead to a smaller differential response of pegs versus floats for *both* the exchange rate and other outcome variables. We are interested in the magnitude of the response of various outcome variables *relative to* the exchange rate. Since misclassification of pegs and floats leads both the numerator and the denominator in this ratio to be smaller, it is not necessary for the classification of regimes to be perfect. This is analogous to the idea that an instrument need not capture *all* the random variation, only a piece of it.

Table 1: How Do Pegs Differ from Floats

Variable	No Controls	Time FE	Region X Time FE
Log Population	-0.02	-0.09	0.74*
	(0.31)	(0.31)	(0.39)
Log Real GDP Per Capita	0.36	0.32	-0.17
	(0.22)	(0.22)	(0.23)
Export to GDP	-0.01	-0.01	0.00
	(0.04)	(0.04)	(0.04)
Import to GDP	-0.03	-0.03	-0.03
	(0.04)	(0.04)	(0.04)
Export Share to the US	0.04***	0.04***	-0.00
	(0.01)	(0.01)	(0.01)
Import Share to the US	0.05***	0.05***	0.00
	(0.01)	(0.01)	(0.00)
NFA to GDP	0.05	0.06	-0.10
	(0.18)	(0.19)	(0.26)
Inflation Rate (p.p.)	-0.89	-0.65	2.21***
	(1.51)	(1.41)	(0.69)
TBill Rate (p.p.)	1.01	0.89	2.86***
	(0.84)	(0.90)	(0.96)
Commodity Exports to GDP	0.05*	0.06**	0.04
	(0.03)	(0.03)	(0.03)
Commodity Imports to GDP	0.01	0.01	-0.01
	(0.02)	(0.02)	(0.02)

Note: The table reports regression coefficients for regressions of various country characteristics on an indicator variable for whether the country-by-year observation is a peg. The dependent variables are listed on the left. For each dependent variable we report results of a regression with no additional control variables, results when time fixed effects are included, and results when region-by-time fixed effects are included. Standard errors clustered by country are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

2.3 How Do Pegs Differ from Floats?

Our empirical results are simplest to interpret if the following identifying assumption holds: pegs are not differentially exposed (relative to floats) to shocks that are correlated with the US nominal effective exchange rate. We can assess the plausibility of this assumption by comparing observable characteristics of pegs and floats. Table 1 reports the average differences in various observable characteristics between pegs and floats. We estimate this difference by regressing the characteristics on an indicator variable for whether the country-by-year observation is a peg. In each case, we report unconditional differences (i.e., no other controls), differences conditional on time fixed effects, and differences conditional on region-by-time fixed effects.

Conditional on region-time fixed effects, pegs and floats are quite well balanced on most observable dimensions. The average difference in their real GDP per capita is not statistically significantly different from zero. They are roughly equally open economies on average, their export and import shares to the US are similar, as are their net foreign asset positions, and their exports and imports of commodities as a share of GDP are also similar.[6] The only observable differences conditional on region-time fixed effects are that pegs have somewhat higher inflation, somewhat higher short-term interest rates, and are larger in terms of population.[7]

2.4 Empirical Specification

We seek to estimate the differential response of various outcome variables in pegging countries versus floating countries at different horizons to a change in the US dollar exchange rate. For this purpose, we run the following regression:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \alpha_{r(i),t,h} + \beta_h \text{Peg}_{i,t} \times \Delta e_{USD,t} + \Gamma_h' \mathbf{X}_{i,t-1} + \gamma_h \text{Peg}_{i,t} + \epsilon_{i,t,h}, \tag{2}$$

where $y_{i,t+h}$ denotes an outcome variable in country i at time $t+h$, $\text{Peg}_{i,t}$ is an indicator for whether country i at time t is a peg, $\Delta e_{USD,t}$ denotes the log change in the US dollar nominal effective exchange rate from time $t-1$ to time t, $\alpha_{i,h}$ is a country fixed effect, $\alpha_{r(i),t,h}$ is a region-by-time fixed effect, $\mathbf{X}_{i,t-1}$ denotes additional control variables, and $\epsilon_{i,t,h}$ denotes unmodelled influences on the outcome variable. This type of empirical specification is often called a local projection (Jordà, 2005). The region-by-time fixed effects are for the following four regions: Europe, Americas, Africa, Asia/Oceania. The coefficient of interest is β_h. We run this regression on annual data for different horizons h.[8]

We report standard errors that are two-way clustered on time and country. We drop the largest and smallest 0.5% of observations for each outcome variable. This avoids our results being highly sensitive to extreme events such as severe wars (Iraq in 2004). We also drop country-by-year observations during which the country switches from being a peg to a float or vice versa and the

[6]This last result is based on a relatively coarse measure of commodity exports: the sum of agriculture and mining exports.

[7]This may, at first, seem to contradict the findings of Hassan, Mertens, and Zhang (2023), who document that large countries tend to float. The difference comes from the fact that we exclude 24 relatively advanced economies and our definition of floats include pegs to other currencies than the US dollar.

[8]An alternative approach would be to instrument for the local exchange rate with $\text{Peg}_{i,t} \times \Delta e_{USD,t}$. However, this would pre-suppose that the only channel through which the shocks that move the US dollar exchange rate affect peggers versus floaters is these countries' exchange rates. This might not be the case (e.g., interest rates might drive both exchange rates and affect the economy directly). Hence, we run direct regressions. However, if the exchange rate is truly the only channel through which changes in the exchange rate of the US dollar affect peggers versus floaters, our regressions with the nominal exchange rate as the outcome variable are akin to first stage regressions in an IV empirical strategy and our output regressions are akin to reduced from regressions. The IV estimate is then the ratio of the two.

following year.

2.5 Data

Our main data sources are the World Bank's World Development Indicators (WDI) database, the database of the United Nations Conference on Trade and Development (UNCTAD), and the International Financial Statistics (IFS) database of the International Monetary Fund (IMF). We use data on GDP, consumption, investment, exports, and imports from WDI, all measured in constant 2015 US dollars. We use data on export unit values, import unit values, and the terms of trade from UNCTAD. We use data on short term nominal interest rates and inflation from IFS. In addition to these sources, we use data on nominal and real effective exchange rates from Darvas (2012, 2021) (series NEER_65 and REER_65), data on the ratio of net foreign assets to GDP from the External Wealth of Nations Database (Lane and Milesi-Ferretti, 2018), the Bloomberg Commodity Price Index, and the capital account openness measures from Chinn and Ito (2008).

For the nominal interest rate, we choose among the T-bill rate, the policy rate, and the money market rate. For each country, we use the one of these series with the longest sample in the IFS database. We construct a measure of net exports from data on exports and imports. We construct a measure of the ex-post real interest rate from data on the nominal interest rate and inflation. Table A.3 in the appendix provides an overview of our data sources.

As we note above, all our data is annual and our sample period is 1973 to 2019. However, our panel data set is unbalanced and differs in size from variable to variable. One of the robustness exercises we do below is to rerun our empirical analysis on the largest sample for which we have all our main variables of interest available.

2.6 Empirical Results

Figure 3 plots our estimates of β_h for four outcome variables: the nominal effective exchange rate, the real effective exchange rate, real GDP, and consumption. For the nominal and real effective exchange rates, the dependent variable is the $h+1$-period change in the logarithm of the country's trade-weighted exchange rate (nominal or real). For GDP, the dependent variable is $(Y_{i,t+h} - Y_{i,t-1})/Y_{i,t-1}$ where $Y_{i,t}$ denotes the level of GDP in country i at time t. For consumption, the dependent variable is $(C_{i,t+h} - C_{i,t-1})/Y_{i,t-1}$, where $C_{i,t}$ denotes the level of consumption in country i at time t. The independent variable of interest $\Delta e_{US,t}$ is the change in the logarithm of the US dollar nominal effective exchange rate. We include three controls in addition to the

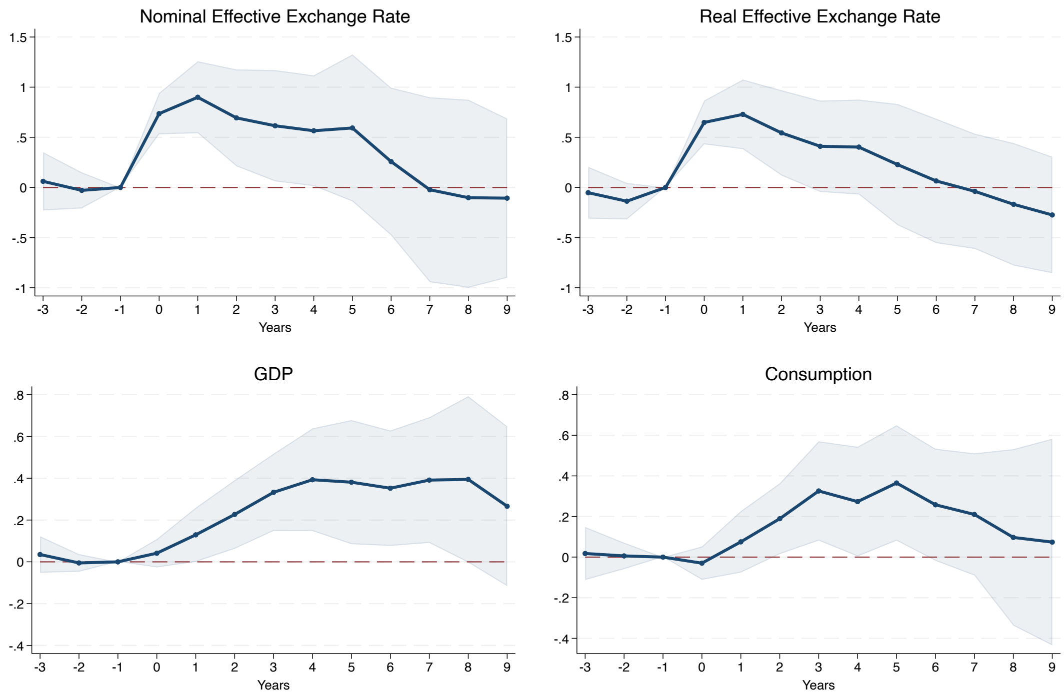


Figure 3: Response of Pegs vs. Floats for Exchange Rate, Output, and Consumption

Note: This figure plots the response of the nominal effective exchange rate, real effective exchange rate, real GDP, and consumption for pegs versus floats in response to a change in the US dollar exchange rate. For the exchange rates, the dependent variable is the change in the logarithm of the variable. For GDP, the dependent variable is the percentage change, while for consumption it is $(C_{i,t+h} - C_{i,t-1})/Y_{i,t-1}$. These are our estimates of β_h in equation (2) for different horizons h when these four variables are the outcome variables. These results are for the case with our baseline set of controls: one lag of the outcome variable, one lag of the treatment variable, and one lag of GDP growth. The shaded areas are 95% confidence intervals.

fixed effects: the lagged growth rate of the outcome variable, a lag of the treatment variable (more specifically, a lag of $\text{Peg}_{i,t} \times \Delta e_{USD,t}$ and $\text{Peg}_{i,t}$), and a lag of GDP growth.[9] Recall that we define the exchange rate as the domestic currency price of foreign currency, which implies that an increase in the exchange rate is a depreciation. The responses in Figure 3 should thus be interpreted as responses of pegs relative to floats to a 1% depreciation in the US dollar.

In response to a 1% depreciation of the US dollar, the trade-weighted nominal effective exchange rate of pegs depreciates by 0.74% relative to floats. This depreciation persists for a number of years, first rising slightly to 0.9% and then falling to about 0.6% in the 3-5 years after the US depreciation. The reason the response is not fully one-for-one is that our pegs are not perfectly hard pegs and our floats are not perfectly free floats. The real effective exchange rate of pegs depreciates by only slightly less relative to floats than the nominal effective exchange rate. The response of the real effective exchange rate is also persistent, although somewhat less persistent than the re-

[9]For the periods prior to the treatment period ($h < 0$), we include these controls at time $h - 1$.

sponse of the nominal exchange rate.[10] Table A.4 in the appendix shows that the regime-induced variation in exchange rates we use for identification represents roughly 8% of the total variation in exchange rates in our data.

The bottom two panels in Figure 3 show that the US dollar depreciation results in a gradual but quite substantial increase in GDP and consumption in pegger countries relative to floater countries. In response to a 1% US dollar depreciation, GDP eventually rises by about 0.4%. To get a better sense for the quantitative magnitude of the GDP response, note that these estimates imply that a 10% depreciation of the domestic currency results in a 5.5% increase in GDP over five years.[11] Recall that the consumption response we plot is the change in consumption as a fraction of time $t-1$ GDP. The consumption response peaks at almost 0.4% of GDP a few years after the depreciation.

Figure 4 presents results for investment, net exports, exports, and imports. All four variables are measured as a fraction of GDP. For example, the dependent variable for investment is $(I_{i,t+h} - I_{i,t-1})/Y_{i,t-1}$, where $I_{i,t}$ is the level of investment in country i at time t. The depreciation results in an increase in investment that is modest to begin with, but builds over time and reaches a maximum after five years. Exports increase one year after the depreciation but then fall back to zero for several years before increasing again. Contrary to the simple logic of expenditure switching, the depreciation results in an increase in imports that builds gradually over time. For several years, the increase in imports is larger than the increase in exports, which implies that net exports fall.

The left two panels of Figure 5 present the response of the short-term nominal interest rate and the CPI in pegger countries relative to floaters. For the CPI, the dependent variable is the change in the logarithm of the CPI. For the nominal interest rate, the dependent variable is the change in the level of the interest rate. The nominal interest rate rises modestly in response to the depreciation (by less than 0.1 percentage point in response to a 1% depreciation). The price level also increases, modestly at first, but more later on (by about 0.5% in response to a 1% depreciation).[12]

These results help distinguish between different possible underlying shocks that might be driving the variation in the US dollar exchange rate in our regressions. If loose monetary pol-

[10]Figure A.5 in the appendix compares the response of the trade-weighted nominal and real exchange rate (the baseline in this section) to the response of the nominal exchange rate to the US dollar. These yield similar responses of pegs versus floats to USD depreciations, although the exchange rate versus the USD is more persistent at long horizons.

[11] The GDP response is gradual and peaks after five years at 0.4. The average nominal exchange rate response is roughly 0.7 over the first five years. We get 5.5 as $10 \times 0.4 \div 0.7$.

[12]Figure A.7 presents results on the ex-post real interest rate that are implied by the responses of the nominal interest rate and prices in Figure 5. The response of the real interest rate fluctuates around zero and is statistically insignificant throughout.

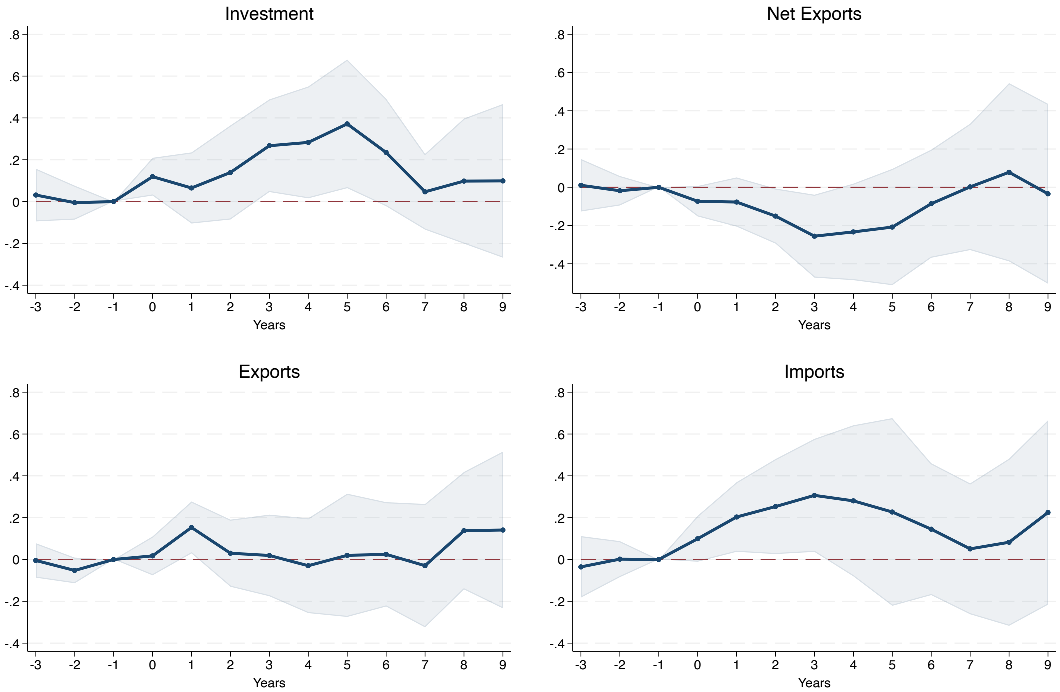


Figure 4: Response of Pegs vs. Floats for Investment and Trade

Note: This figure plots the response of investment, net exports, exports, and imports for pegs versus floats in response to a change in the US dollar exchange rate. All four variables are measured as a fraction of initial GDP (e.g., $(I_{i,t+h} - I_{i,t-1})/Y_{i,t-1}$ for investment). T hese are our estimates of β_h in equation (2) for different horizons h when these four variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

icy were the reason for the US dollar depreciation, we would expect to see a negative relative response of the nominal interest rate for pegs relative to floats (since pegs share US monetary policy more strongly). The fact that our estimated response for the nominal interest rate is positive, therefore, provides evidence against the notion that the US depreciations in our regressions are driven by monetary policy.[13] We develop this idea more fully in Section 5 below.

Put differently, the joint responses of nominal exchange rates and nominal interest rates show substantial ex-post deviations from uncovered interest parity (UIP). After the initial depreciation of pegs, their nominal exchange rates appreciate and their nominal interest rates are (if anything) higher than before (relative to floats). This implies that the return to holding assets denominated in the currencies of the pegs are higher ex-post than returns of assets denominated in floating currencies. Figure C.3 in the appendix shows this by plotting the impulse response of ex-post UIP

[13]Our empirical analysis cannot rule out the possibility that exchange rate changes are due to changes in expectation about far future nominal interest rates, $\ln(1 + i_{P,t+T}) - \ln(1 + i_{F,t+T})$ for T greater than 10 years. Such shocks are hard to distinguish from financial shocks. Chahrour et al. (2022) argue that far future fundamental shocks are the source of a substantial fraction of volatility in exchange rates. This finding contrasts the findings of Miyamoto, Nguyen, and Oh (2022) that the dominant drivers of the real exchange rate are largely orthogonal to macro aggregates.

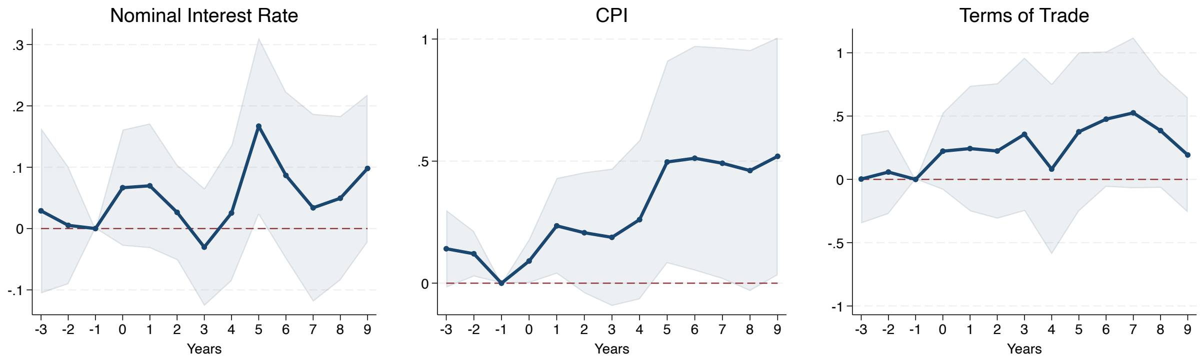


Figure 5: Response of Pegs vs. Floats for the Nominal Interest Rate, CPI, and Terms of Trade

Note: This figure plots the response of short term nominal interest rates, the CPI, and the terms of trade for pegs versus floats in response to a change in the US dollar exchange rate. For the nominal interest rate, the dependent variable is the level of the interest rate (i.e., 0.02 denotes 2%). For the CPI and the terms of trade, the dependent variables are the change in the logarithm of the variables. These are our estimates of β_h in equation (2) for different horizons h when these two variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

deviations of pegs relative to floats. The presence of these UIP deviations are at the core of the theoretical channel we propose in section 3 for why depreciations are expansionary in response to regime-induced exchange rate variation.

The right panel of Figure 5 presents the response of the terms of trade. The dependent variable, in this case, is the change in the logarithm of the terms of trade. We define the terms of trade as the price of exports divided by the price of imports (our data are unit values). We estimate that the terms of trade of peggers improves modestly relative to floaters at short horizons in response to the US dollar depreciation. Further out, the improvement in the terms of trade is larger (though statistically insignificant). In a world with sticky prices that are set in the producer's currency, the terms of trade would deteriorate in response to a depreciation (imports would become more expensive in domestic currency). With local currency pricing, however, a depreciation results in an improvement in the terms of trade. In a world with a dominant currency (e.g., import and export prices sticky in US dollars) the terms of trade would not respond to a change in the exchange rate. Figure A.6 in the appendix present our estimates of the response of export and import unit values. Measured in US dollars, the price of exports is little changed, while the price of imports falls modestly in pegging countries relative to floating countries in response to the US dollar depreciation.

Figure 6 presents the response of output by sector for pegs relative to floats. The dependent variable for these four sets of results is the change in the variable in question divided by initial GDP. For example, for the service sector, the dependent variable is $(Y^S_{i,t+h} - Y^S_{i,t-1})/Y_{i,t-1}$, where

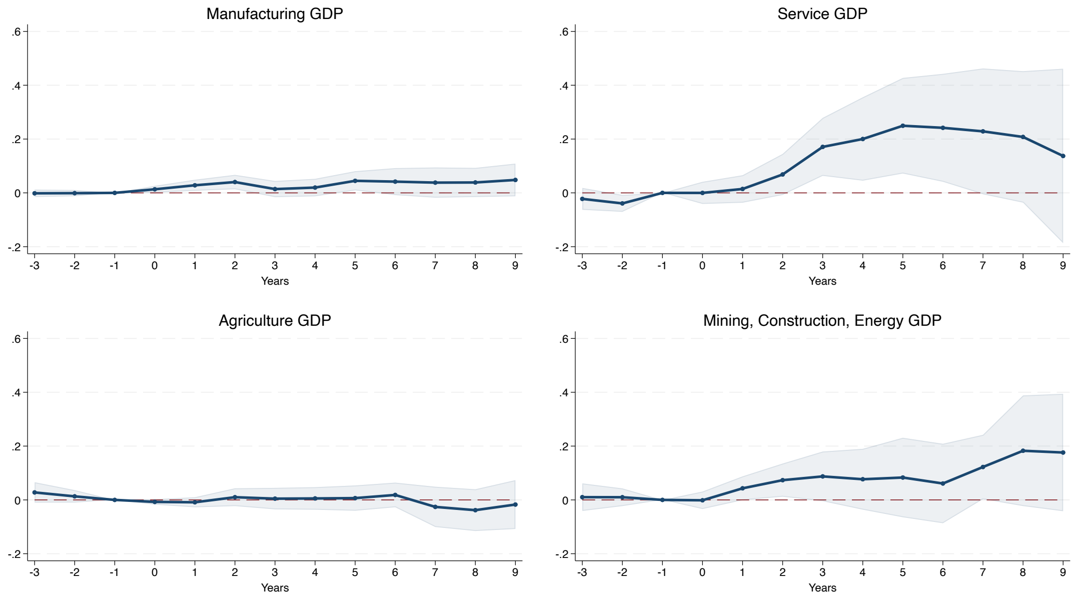


Figure 6: Response of Pegs vs. Floats by Sector

Note: This figure plots the response of output by sector for pegs versus floats in response to a change in the US dollar exchange rate. In all cases, the dependent variable is the change in the variable in question as a fraction of initial GDP. These are our estimates of β_h in equation (2) for different horizons h when these four variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

$Y^S_{i,t}$ is service sector output in country i at time t. Strikingly, the bulk of the response comes from the service sector. The response of manufacturing and agriculture are very close to zero. So is the response of the mining, construction, and energy sectors except for a boom at very long horizons. This pattern of responses suggests that the depreciation kicks off a domestic boom, as opposed to an export-led boom.

2.7 Heterogeneity by Openness and Time Period

Our finding that a regime-induced depreciation results in a fall in net exports indicates that capital is flowing into these countries. This raises the question whether our results differ by a country's capital account openness and openness to trade. Figure 7 re-estimates equation (2) for countries with above versus below-average capital account openness over the sample period when the country's data are available. Here we measure capital account openness by the Chinn-Ito index (Chinn and Ito, 2008). We find that the relative response of GDP is entirely driven by a set of countries with high capital account openness, despite the fact that the relative response of real exchange rates are similar. In contrast, the response of GDP is similar for countries with above versus below median levels of trade openness, as measured by the sum of exports and imports

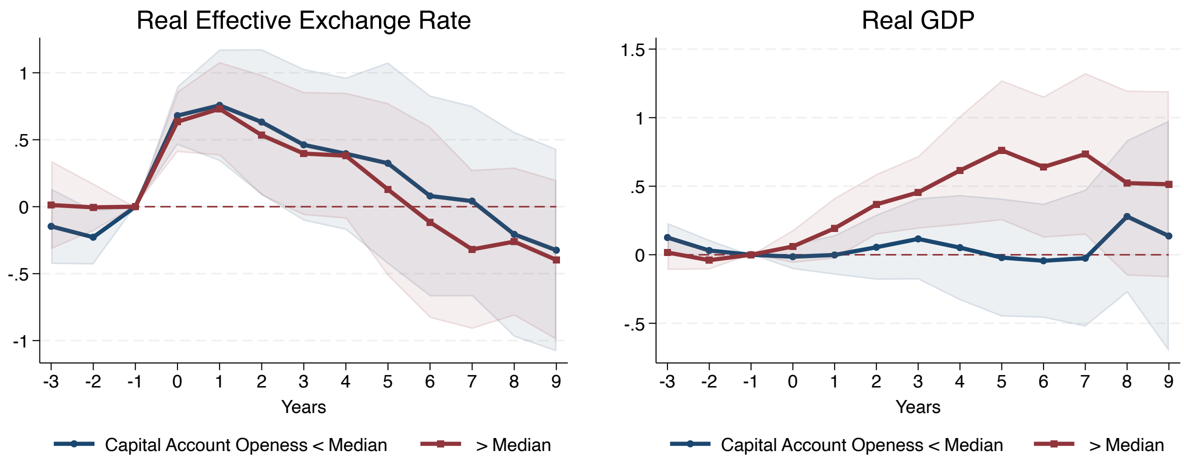


Figure 7: Heterogenous Response by Capital Account Openness

Note: This figure plots the response of the real exchange rate and output for pegs versus floats in response to a change in the US dollar exchange rate. We report this separately for countries with average capital account openness below versus above the median across countries. For the real exchange rates, the dependent variable is the change in its logarithm. For GDP, the dependent variable is a percentage change. These are our estimates of β_h in equation (2) for different horizons h when the variables described above are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

over GDP (see Figure A.8). The heterogeneity in the results by capital account openness, and the *lack* of heterogeneity by trade openness, are both consistent with the model we develop in Section 3. This model puts international capital flows at center stage. Figure A.9 splits the sample period into an early period (1973-1995) and a later period (1996-2019). We find similar responses in both periods.

2.8 The Plaza Accord

It is perhaps useful to have a concrete example of the stimulatory effects of exchange rate depreciations that we have documented in general terms in the preceding sections. The Plaza Accord of 1985 – named after the hotel where it was announced in New York City – provides such an example. The Plaza Accord was an agreement between France, Germany, Japan, the UK, and the US (G5 countries) to depreciate the US dollar. The announcement at the Plaza Hotel was a culmination of a larger policy shift by the Reagan administration regarding the dollar, which started when James Baker became Treasury Secretary in January 1985 (Frankel, 2015). This policy shift helped trigger a rapid depreciation of the US dollar. Here, we use this event as a case study of a regime-induced depreciation of pegs to the US dollar versus floats.

Figure 8 plots the evolution of the real exchange rate and real GDP for pegs versus floats against the USD in the years surrounding the Plaza Accord. The left panel shows that the real

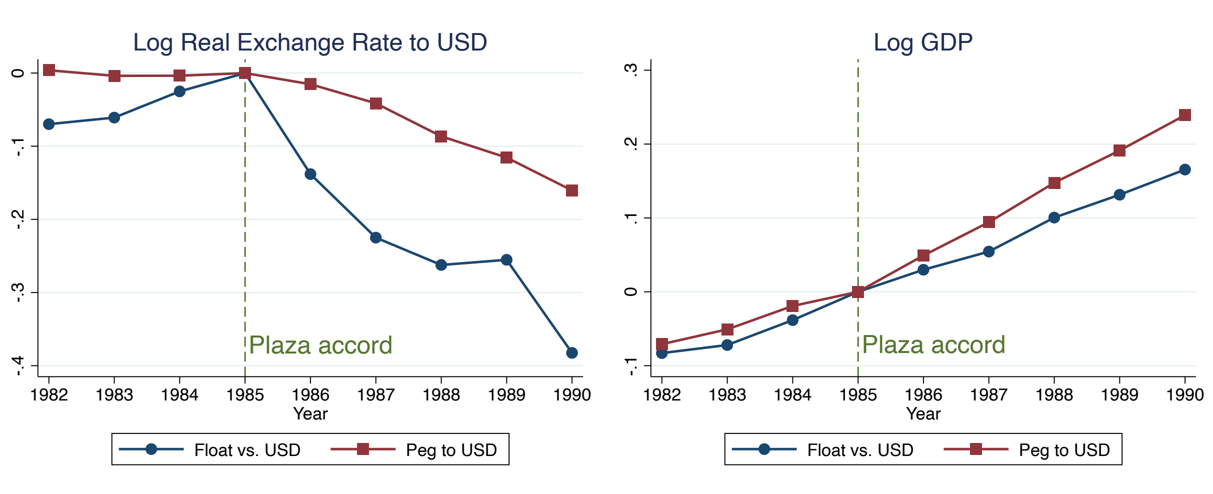


Figure 8: Case Study of the Plaza Accord

Note: The left figure plots the average of changes in the log real exchange rate relative to 1985 for countries that float and peg against the USD. The right panel is analogous for GDP. We exclude G5 countries and country-by-year observation with Ilzetzki, Reinhart, and Rogoff classification 14 and 15 from the sample in constructing the figure. We define countries that peg to USD in the same way as before: (Ilzetzki, Reinhart, and Rogoff classification 1-8 with anchor currency USD), while other countries are classified as floats versus the USD. Pegs and floats are defined in this figure based on their status in 1985.

exchange rate of floats appreciated relative to pegs following the Accord. The timing of the Accord was arguably orthogonal to macroeconomic conditions in the pegs versus floats in our sample (none of which were parties to the agreement). The right panel shows that GDP grew less quickly in the floats relative to the pegs in the years after the Accord. To quantify the response for this episode, we regress changes in real GDP and the real exchange rate starting in 1985 on a peg indicator for 1985. The differential response in the log real exchange rate in the first year is 12% (standard error of 2.7%) and difference in log GDP after five years is 7.4% (standard error 3.1%). This implies a GDP response to a 10% exchange rate depreciation of 6.2% ($\approx 7.4 \times 10 \div 12$), which roughly lines up with the estimates from our baseline empirical analysis.[14]

2.9 Robustness

We have explored a number of variations on our baseline specification. Results for twelve such variations are presented in Figures A.10-A.21. Figure A.10 presents results analogous to our baseline results except that we add interactions of contemporaneous values of US GDP growth, US inflation, and the change in the US T-bill rate with the peg indicator as controls. Adding these controls helps control for economic conditions in the United States (e.g., US monetary policy shocks).

[14] We also consider a regression where we include all time periods in our data set and country and time fixed effects to account for any country-specific growth differentials. According to this regression, a 10% initial depreciation is associated with an 8% increase in GDP after five years.

Figure A.11 adds an interaction of the change in the logarithm of commodity prices with the peg indicator as a control.[15] Figure A.12 adds an interaction of the change in the global factor in risky asset prices of Miranda-Agrippino and Rey (2015, 2020).[16] This addresses the concern that our results might be driven by peggers being systematically more exposed to global financial cycles, which are correlated with the movements in US dollar exchange rate. In all three cases, the results are very similar to our baseline result.

The region-by-time fixed effects in our baseline specification imply that the variation we use to identify our main results is within-region variation. Figure A.13 presents results for a case that is identical to our baseline specification except that the region-by-time fixed effects are replaced by time fixed effects. This allows us to exploit variation in exchange rate regimes not only within but also between continents. For example, in the baseline version, pegs in Latin America are not being compared with floats in Europe (this variation is absorbed by the region-by-time fixed effects). This specification yields similar point estimates, with smaller standard errors. One difference is that the response of net exports is less negative.

Figures A.14 and A.15 consider alternative sets of controls (no controls other than fixed effects and two lags of the outcome variable, the treatment variable, and GDP, respectively). Figure A.16 presents results where we drop the largest and smallest 1% of observations for each variable (instead of 0.5% in the baseline). Figures A.17 and A.18 consider alternative assumptions about how to categorize Ilzetzki, Reinhart, and Rogoff's coarse category 3 (included among floats or pegs, respectively, rather than dropped). Figure A.19 presents results for the case where we replace the BIS trade-weighted nominal effective exchange rate for the US dollar as our treatment variable with a US dollar exchange rate that is constructed using GDP weights for the same set of countries. Figure A.20 presents results for the case where we include the 24 countries that the US dollar nominal effective exchange rate is defined relative to in the sample of floats. In all of these cases, the responses are very similar to our baseline case.

Figure A.21 presents results for the largest sample where we have data on all nine of our main variables. In this case, the response of the nominal and real effective exchange rates is estimated to be more transient, although the standard errors are very large. The estimated response for output, consumption, investment, and net exports is similar to our baseline. The estimated response of the

[15] Since 2000, commodity prices have tended to comove negatively with the US dollar. This is less true before 2000 and is potentially spurious given the high persistence of both series— see Figure A.24 in the appendix. The correlation between the log-changes in the trade-weighted US dollar exchange rate and the log-change in the Bloomberg commodity price index is 0.22 before 2000 but 0.71 after 2000.

[16] We use the updated version of their standardized measure for the period of 1980-2019. We downloaded these data from Hélène Rey's website.

terms of trade is larger than in our baseline. The large standard errors arise because the sample size in this case is only about 20% the sample size in our baseline specification. The primary constraint here is the availability of the interest rate data.

Finally, one might ask whether either tourism or government expenditures are driving our results. Figure A.22 shows the response of tourist inflows and outflows in our baseline specification. Neither of them is statistically significantly different from zero. Figure A.23 shows the response of government expenditures. The response is positive but quantitatively small in magnitude.

3 An FDX Model of Pegs and Floats

To explain our empirical findings from Section 2, we introduce a model in which exchange rates are driven by financial shocks. We call this a financially driven exchange rate model, or FDX model for short. The core of the model is a relatively standard open economy New Keynesian model. To this we add financial frictions in international financial markets and shocks emanating from the financial sector. Our model builds most directly on Itskhoki and Mukhin (2021a), but indirectly on a substantial prior literature that has sought to introduce financial frictions and financial shocks to international macro models (e.g., Kouri, 1976; Gabaix and Maggiori, 2015).

Relative to the model in Itskhoki and Mukhin (2021a), we add two features. First, we allow households and firms to trade in foreign currency assets. This is important for explaining our empirical findings from Section 2. Our second important departure from Itskhoki and Mukhin (2021a) is to allow for a second financial shock that yields a different correlations between the exchange rate and output. This is important for jointly explaining our empirical findings from Section 2 and unconditional moments that have been emphasized in the open economy literature: exchange rate disconnect, the Backus-Smith correlation, and the Mussa facts. For expositional clarity, we delay introducing the second financial shock until Section 6.

3.1 Standard Open Economy New Keynesian Model Features

Consider an economy consisting of a continuum of small open economies, $i \in [0, 1]$. Each of these economies belongs to one of three regions, $i \in \{U, P, F\}$, where U is the United States with the US dollar as its currency, P is a monetary union consisting of a set of countries that peg their currency to the US dollar, and F is a monetary union consisting of a set of countries with a currency that floats versus the US dollar. The economies within each of these groups are identical. (This means that we model the US as a continuum of identical small economies in a monetary union.) We define the nominal exchange rate $\mathcal{E}_{jit}$ as the price of currency j in terms of currency i at time t. An increase of $\mathcal{E}_{jit}$ then represents a depreciation of currency i against currency j. Analogously, we define the real exchange rate as $Q_{jit} = \mathcal{E}_{jit} P_{jt} / P_{it}$, where P_{it} is the price level of the economy i.

The core features of our model are standard in the open economy New Keynesian literature. Households consume and supply labor. We assume that they have preferences that feature habit formation. This helps capture the hump-shaped impulse response of consumption. Household preferences over goods produced in the economy take a standard nested CES form with home bias. Labor unions set wages as in Erceg, Henderson, and Levin (2000). Firms produce goods using labor, capital, and intermediate inputs. They invest in capital subject to investment adjustment costs as in Christiano, Eichenbaum, and Evans (2005). Firms set prices as in Calvo (1983). We allow for prices to be set in any currency, i.e., we allow for any combination of producer currency pricing, local currency pricing, and dollar currency pricing. We relegate the detailed description of these standard parts of the model to Appendix B.1. When solving the model, we take a log-linear approximation around a symmetric deterministic steady state. We characterize the steady state in Appendix B.3.

3.2 Household and Firm Portfolio Choice

Households in each region invest in domestic equity and foreign currency bonds. Firms fund themselves by issuing domestic equity and foreign currency bonds. Since we abstract from domestic currency financial frictions, domestic equity and domestic bonds are identical assets from the households' perspective. We refer to these assets as domestic equity for brevity's sake. Likewise, the fact that we refer to foreign currency assets traded by households and firms as "bonds" is for brevity. These are meant to include foreign direct investment, portfolio investments in foreign equity, investment in foreign real estate, and other foreign investments, in addition to foreign borrowing and lending.

We denote the real return on domestic equity in country i between time t and $t+1$ by r_{it+1}. We denote the real return that households in country i earn when they invest in bonds from country $j \neq i$ by r_{ijt+1}. The gross real return on foreign currency bonds is then given by the foreign currency real return adjusted for the change in the real exchange rate:

$$(1 + r_{ijt+1}) \equiv (1 + r_{jt+1}) \frac{Q_{jit+1}}{Q_{jit}}. \tag{3}$$

All agents in the model that are able to trade assets internationally – including households and firms – face financial frictions that limit their ability to arbitrage away expected return differentials across currencies. In other words, no agent in the model is "deep pocketed" in the sense of being able to fully arbitrage away uncertain expected return differentials. This implies that uncovered interest parity (UIP) will not hold in the model and the expected return from investing domestically and abroad will not be equal ($\mathbb{E}_t(1+r_{it+1}) \neq \mathbb{E}_t(1+r_{ijt+1})$). The response of households and firms to these expected return differentials yields capital flows that are crucial to the workings of the model.

Households Households choose each period how large a fraction of their portfolio of assets to invest in domestic equity and foreign currency bonds. Since we solve the model only up to a first-order approximation around its deterministic steady state, the steady-state portfolio shares of households are indeterminate. We treat the steady state portfolio shares as primitives and calibrate them based on their counterparts in the real-world data. When shocks hit the world economy, the households adjust these portfolio shares with the objective of maximizing returns. However, the households incur adjustment costs when they deviate from the steady state portfolio shares. These adjustment costs limit the adjustment of the households' portfolio shares and, thus, limit the ability of households to arbitrage away expected return differentials.

Formally, the households seek to maximize:

$$\max_{\{s^h_{ijt}\}_{j\in[0,1]}} \mathbb{E}_t \left[\left(1 - \int_0^1 s^h_{ijt} dj\right) (1 + r_{it+1}) + \int_0^1 \left(s^h_{ijt}(1 + r_{ijt+1}) - \Phi^h_{ij}(s^h_{ijt}) \right) dj \right] \tag{4}$$

where s^h_{ijt} is the share of their portfolio that households in country i invest in bonds in country j at time t per unit measure of that country's size. Letting dj denote the measure of country j's size, $s^h_{ijt}dj$ corresponds to the portfolio share that households in country i invests in country j. The remaining share $1 - \int_0^1 s^h_{ijt}dj$ is held in domestic equity.[17] The households' portfolio adjustment costs per unit of asset take the form $\Phi^h_{ij}(s_{ijt}) = \frac{\Gamma^h}{2\bar{s}_{ij}}(s^h_{ijt} - \bar{s}_{ij})^2$, where $\bar{s}_{ij}$ denotes steady state portfolio shares. The adjustment costs are incurred in terms of final consumption goods. An underlying assumption here is that adjustment costs scale with household assets. With this, the portfolio problem is separable from the rest of the household problem. We denote the maximized value of the return on the household's portfolio as $1 + r^h_{it+1}$.[18] This is the return the household uses when

[17] We solve this portfolio problem assuming perfect foresight. Since we solve the model only up to a first-order approximation, the solution to the perfect foresight problem coincides with the first order approximation of the stochastic equilibrium (Boppart, Krusell, and Mitman, 2018).

[18] These adjustment costs are incurred in terms of the deviation from the steady state portfolio, rather than from the previous period's portfolio. We make this choice for tractability. This allows us to avoid keeping track of the

making its consumption-savings decision.

Solving the household's portfolio choice problem yields the following optimality condition:

$$s_{ijt}^h - \bar{s}_{ij} = \frac{\bar{s}_{ij}}{\Gamma^h} \left[\mathbb{E}_t(1 + r_{ijt+1}) - \mathbb{E}_t(1 + r_{it+1}) \right]. \tag{5}$$

Intuitively, this condition indicates that household "chase returns", i.e., when the expected return on foreign currency bonds is high relative to domestic equity they shift their portfolio towards foreign currency bonds. However, the degree to which they do this is limited by the adjustment cost. In particular, the parameter Γ^h governs the (inverse) elasticity of household demand for foreign currency bonds in response to changes in the returns on these bonds. In traditional open economy models without financial frictions, $\Gamma^h = 0$. In this case, even an arbitrarily small expected return differential between home and foreign assets generates arbitrarily large financial flows, arbitraging away any effect of financial shocks on the exchange rate. In contrast, the FDX model limits the size of these financial flows, allowing financial shocks to generate expected return differentials.

Firms Production firms finance their operations with a mix of domestic equity and foreign currency debt. They face an analogous portfolio problem to households. For analytical simplicity, we assume that the steady state foreign currency debt share of production firms is equal to the steady state foreign currency asset share of households. This implies that the net foreign currency position for each country is zero in the steady state. Lane and Shambaugh (2010) and Bénétrix, Lane, and Shambaugh (2015) document that it is common for countries to have large gross foreign currency asset and liability positions but small net foreign currency asset positions. For simplicity, we set steady state net foreign currency asset positions to zero.[19]

Production firms choose their portfolio of liabilities to minimize the total financing costs net of adjustment costs

$$\min_{\{s_{ijt}^f\}_{j \in [0,1]}} \mathbb{E}_t \left[\left(1 - \int s_{ijt}^f dj \right) (1 + r_{it+1}) + \int_0^1 \left\{ (1 + r_{ijt+1}) s_{ijt}^f + \Phi_{ij}^f(s_{ijt}^f) \right\} dj \right] \tag{6}$$

where s_{ijt}^f denotes the share of firm value financed via debt in currency j at time t per unit measure of that country's size. Similarly to households, $s_{ijt}^f dj$ corresponds to the share of firm value in country i financed via debt in currency j. The remaining share $1 - \int_0^1 s_{ijt}^f dj$ is financed with

distribution of portfolios.

[19]Christiano, Dalgic, and Nurbekyan (2021) present a model where such foreign currency positions arise endogenously as an efficient risk-sharing between households and firms.

domestic equity. The adjustment cost they incur when they adjust their portfolio of funding away from its steady state takes the form $\Phi^f_{ij}(s^f_{ijt}) = \frac{\Gamma^f}{2\bar{s}_{ij}}(s^f_{ijt} - \bar{s}_{ij})^2$, where $\bar{s}_{ij}$ is the steady state share of firm's value financed via debt in currency j. We denote the firms' minimized financing cost as $(1 + r^f_{it+1})$. This is the return firms use when they make investment decisions. Intuitively, production firms discount future earnings with a rate of return that reflects the rates of returns on the mix of financial instruments that they finance themselves with net of adjustment costs.

Solving the portfolio problem of the production firms yields the optimality condition

$$s^f_{ijt} - \bar{s}_{ij} = \frac{\bar{s}_{ij}}{\Gamma^f}\left[\mathbb{E}_t(1 + r_{ijt+1}) - \mathbb{E}_t(1 + r_{it+1})\right]. \tag{7}$$

Intuitively, firms shift their mix of funding away from foreign bonds when the expected return on foreign bonds from their perspective is high. As with households, the production firms are limited in their ability to switch away from expensive funding sources by the adjustment costs. In particular, the parameter Γ^f governs the (inverse) elasticity of firm demand for foreign currency bonds as a funding source with respect to the expected return on these bonds. See Appendix B.2.1 for a more detailed discussion of the financing decisions of production firms.

3.3 International Financial Market

In addition to households and firms, there are two other types of agents who trade assets internationally: noise traders and international bond arbitrageurs. Fluctuations in asset demand by noise traders are one source of exchange rate volatility and expected return differentials across countries. The international bond arbitrageurs trade against the noise traders, as do the households and firms. We next describe the behavior of the noise traders and international bond arbitrageurs.

Noise Traders and UIP Shocks Noise traders sell US bonds and use the proceeds to purchase bonds from countries $j \notin U$, and vice versa. There is a unit measure of such noise traders.[20] Their position in country j bonds is ψ_{jt}, where ψ_{jt} follows an AR(1) process:

$$\psi_{jt} = \rho^\psi \psi_{jt-1} + \epsilon^\psi_{jt}, \text{for } j \notin U. \tag{8}$$

We refer to the shock to this equation $\{\epsilon^\psi_{jt}\}$ as the "UIP shock" following Itskhoki and Mukhin (2021a). A positive shock to ψ_{jt} implies that the demand for country $j \in F$ bonds increases relative

[20]We normalize the measure to one without loss of generality since it is not distinguishable from the size of each trader's position.

to the demand for US bonds, resulting in a depreciation of the USD against currency $j \in F$.

International Bond Arbitrageurs International bond arbitrageurs engage in the currency carry trade by taking a long position of B^I_{Ujt} dollars in the bonds of floater country j and a short position of equal value in US bonds. Here B^I_{ijt} denotes a carry trade position in which the bond arbitrageurs borrow in currency i and invest in currency j. The unit in which this position is expressed is currency i. For each currency j, we assume that there is a measure one of international bond arbitrageurs specializing in the carry trade between that currency and US dollars. The nominal return on the carry trade position B^I_{Ujt} is $\tilde{R}_{Ujt+1} \equiv (1+i_{jt})\frac{\mathcal{E}_{jUt+1}}{\mathcal{E}_{jUt}} - (1+i_{Ut})$ per dollar invested, where i_{jt} is the nominal interest rate in country j at time t. The international bond arbitrageurs choose their portfolio to maximize the following CARA utility function over the real return on their portfolio expressed in US dollars:

$$\max_{B^I_{Ujt}} -\mathbb{E}_t \frac{1}{\gamma} \exp\left(-\gamma \left[\tilde{R}_{Ujt+1} \frac{1}{P_{Ut+1}} B^I_{Ujt}\right]\right)$$

In Appendix B.2.2 we show that the solution to this problem implies that the demand of international bond arbitrageurs for bonds from currency $j \in F$ is

$$B^I_{Ujt} = \frac{1}{\Gamma^B}[\ln(1+i_{jt}) - \ln(1+i_{Ut}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{jUt+1}]$$

up to a first-order approximation, where $\Gamma^B \equiv \gamma \text{var}(\Delta \ln \mathcal{E}_{jU})$, and $\text{var}(\Delta \ln \mathcal{E}_{Uj})$ is the steady state variance of the change in the logarithm of the nominal exchange rate.

Deviations from Uncovered Interest Parity Adding up the demand for bonds from currency $j \in F$ from international bond arbitrageurs, noise traders, households, and firms and setting this equal to the supply of such bonds (which is zero) yields the following equilibrium condition to a first order approximation around a symmetric steady state:

$$(1+i_{U,t}) = \mathbb{E}_t (1+i_{j,t}) \frac{\mathcal{E}_{jU,t+1}}{\mathcal{E}_{jU,t}} \exp(\Omega(\{NFA_{kt}\}_k, \psi_{jt})). \tag{9}$$

In this equation, the deviation from uncovered interest parity (UIP) is given by

$$\Omega(\{NFA_{kt}\}_k, \psi_{jt}) \equiv \Gamma \left[\left(1 - \int \bar{s}_{ji} di\right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di + \psi_{jt}\right], \tag{10}$$

where NFA_{jt} is the net foreign asset position of country j. The size of this term is determined by the size of noise trader demand ψ_{jt} and the parameters governing the strength of financial frictions for households, firms, and international bond arbitrageurs through the composite parameter $\Gamma \equiv 1/\left(\frac{1}{\Gamma^B} + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \int_{i \in \{P,U\}} (\bar{s}_{ji} + \bar{s}_{ij}) di\right)$, where $\bar{a}$ is steady state asset holdings (i.e., the capital stock). We derive this condition in Appendix B.2.3.

Equation (9) shows that the financial frictions in our model imply that uncovered interest parity (UIP) does not hold for floater countries. The expression for $\Omega(\{NFA_{kt}\}_k, \psi_{jt})$ lists the "sources" of UIP deviations. The last term represents demand from noise traders. The first two terms reflect the fact that the portfolio shares of households and firms are anchored at certain steady state values (i.e., it is costly for these agents to adjust their portfolio shares). This implies that when households and firms in a particular country build up foreign assets, this increases the demand for assets in the countries that their steady state portfolio of assets is biased towards. This will bid up the price of assets in these countries, and thereby reduce the expected returns on these assets.

In the wake of a noise trader shock, that drives down the expected return on domestic bonds relative to foreign bonds, international bond arbitrageurs, households, and firms sell domestic bonds and buy foreign bonds to take advantage of the expected return differential. If the combined response of these agents was strong enough, they would eliminate the return differential and UIP would hold. In our model, however, this profit-driven demand response is limited by financial frictions and the UIP deviation is not eliminated. The parameter, $1/\Gamma$, measures the aggregate strength of profit-driven trading in the international bond market. If Γ is small, international financial frictions are small and UIP deviations are small.[21]

In contrast to floaters, uncovered interest parity holds for peggers versus the US:

$$(1 + i_{Ut}) = \mathbb{E}_t (1 + i_{jt}) \frac{\mathcal{E}_{jUt+1}}{\mathcal{E}_{jUt}} \quad \text{for } j \in P \tag{11}$$

The reason is that there is no exchange rate risk between peggers and the US. Thus, even risk-averse arbitrageurs are willing to perfectly arbitrage any return differentials between bonds of peggers and the US.

[21]Regarding UIP deviations, Itskhoki and Muhkin's (2021a) model is a special case of our model with $\bar{s}_{ij} = 0$ for all j.

3.4 Monetary Regimes

The central banks in region F adjust nominal interest rates according to the following monetary policy rule:

$$\ln(1+i_{jt}) = \ln \bar{R} + \rho^m \ln(1+i_{jt-1}) + (1-\rho^m)\phi_\pi \pi_{jt} + \epsilon^m_{jt} \quad \text{for } j \in F, \tag{12}$$

where $\bar{R} \equiv 1/\beta$ is the steady state gross interest rate, $\rho^m \in [0,1)$ governs the degree of inertia in monetary policy, ϕ_π is the Taylor coefficient, and ϵ^m_{jt} is a monetary policy shock. The central bank in the US follows analogous monetary policy rule:

$$\ln(1+i_{Ut}) = \ln \bar{R} + \rho^m \ln(1+i_{Ut-1}) + (1-\rho^m)\phi_\pi \pi_{Ut} + \epsilon^m_{Ut}, \tag{13}$$

where $\pi_{Ut} \equiv \frac{1}{|U|}\int_{j\in U} \pi_{jt} dj$ is the average inflation rate in the US.

Central banks in region P fix the nominal exchange rate of their currency to the US dollar:

$$\mathcal{E}_{jUt} = \bar{\mathcal{E}}_{jU} \quad \text{for } j \in P. \tag{14}$$

Together with equation (11), this implies that interest rates in region P track the nominal interest rate in the US, $i_{jt} = i_{Ut}$ for $j \in P$.

We define the equilibrium of our model in Appendix B.1.3 and discuss our solution method in Appendix B.1.4.

4 Calibration

We assign standard values to most parameters of our model. We relegate a detailed discussion of these choices to Appendix B.4 and focus here on a few key parameters. We calibrate our model so that each period is a year, as in our empirical analysis. Our benchmark parametrization is to assume prices are sticky in local currency. We set the trade elasticity to $\eta = 1.5$, a relatively standard value in the international macroeconomics literature. We choose the openness parameter to match the average imports-to-GDP ratio in our sample of 40%. We set the size of the three countries in our model to approximate the GDP share of the US, countries that peg to the US, and countries that float versus the US in the data, averaged over our sample period. This results in $|U| = 0.3, |F| = 0.5, |P| = 0.2$.

In Section 5, we assume that the primary driver of the US dollar exchange rate is a US

UIP shock as argued by Itskhoki and Mukhin (2021a) and Eichenbaum, Johannsen, and Rebelo (2020).[22] We show in Section 5.2 that monetary and productivity shocks yield counterfactual implications about the effects of regime-driven depreciations. In Section 6, we show that a different financial shock – which we call a "capital flight shock" – can also match the effects of regime-driven depreciations, and that a two-shock model fits important unconditional moments of the data better. For simplicity, we assume that all shocks in the model have the same persistence and set this persistence parameter to $\rho = 0.89$. This is the same shock persistence as is assumed in Itskhoki and Mukhin (2021a) (0.97 at a quarterly frequency).

We set the steady state net foreign asset position of each country to zero. We assume that the steady state gross foreign currency portfolio share is the same in all countries and denote this by $\bar{s}$. The remaining portfolio share, $1 - \bar{s}$, is held in domestic equity in steady state. This assumption implies that the steady state bilateral portfolio shares per unit measure of country j's size are

$$\bar{s}_{ij} = \begin{cases} \frac{\bar{s}}{|U|+|P|} & \text{for } i \in F, j \in \{U, P\} \\ 0 & \text{for } i, j \in F, j \neq i. \end{cases} \qquad \bar{s}_{ij} = \begin{cases} \frac{\bar{s}}{|F|} & \text{for } i \in \{P, U\}, j \in F \\ 0 & \text{for } i, j \in \{P, U\}, j \neq i. \end{cases} . \tag{15}$$

The portfolio share that country i invests or borrows in currency j is given by $\bar{s}_{ij}dj$. This ensures that the steady state total foreign currency share is equal to $\int_0^1 \bar{s}_{ij}dj = \bar{s}$ in all countries. We set $\bar{s} = 0.24$ to match the average value of gross foreign currency assets in our sample. We first compute total assets held by a country as the sum of domestic stock market capitalization and foreign assets, where we obtain the stock market capitalization from the World Bank World Federation of Exchanges database and foreign assets from Bénétrix, Lane, and Shambaugh (2015). Then we compute the fraction of assets held in foreign currency that a country floats against, $\bar{s}$, by dividing the foreign currency assets by the total assets. Specifically, for a country pegging to USD, we compute the fraction of non-USD currency assets. For a country floating against USD, we compute the fraction of USD currency assets.[23]

UIP deviations resulting from movements in net foreign asset positions are governed by Γ in our model. We set Γ to a small value ($\Gamma = 0.001$) following Itskhoki and Mukhin (2021a). This implies that UIP deviations resulting from movements in net foreign asset positions are small in our model. Even with a small Γ, UIP shocks can have large effects if their variance is sufficiently large.

[22] Formally, we consider a shock to ϵ_{jt}^{ψ} for all $j \in F$, which increases noise trader demand for floater country bonds relative to US bonds ($\psi_{jt} = \psi_{Ft} > 0$ for all $j \in F$). We refer to this as a US UIP shock.

[23] Using household-level micro data, Drenik, Pereira, and Perez (2018) document that 70% of household assets in Uruguay are denominated in foreign currencies.

We choose the slopes of the price and wage Phillips curves, κ_p and κ_w (or equivalently, the rigidity of prices and the wages), and the habit parameter, h, to best fit our empirical impulse responses. This yields small values for κ_p and κ_w (i.e., quite flat price and wage Phillips curves), indicating that a substantial amount of price and wage rigidity is needed to match our evidence. It yields a relatively large value for h, indicating that a substantial amount of habit formation is need to match the hump-shaped nature of our impulse responses for consumption and output. See Appendix B.4 for the formal description of the procedure.

5 Regime-Driven Depreciations: Model vs. Data

In Section 2 we demonstrate that regime-driven exchange rate depreciations lead to macroeconomic booms. We also highlight a number of features of these booms that make them difficult to match using standard models: net exports fall implying that the booms are not export led, and nominal interest rates do not seem to fall (if anything they rise) implying that the booms do not arise from easy monetary policy. Here we show that our FDX model can match these impulse responses.

5.1 Impulse Responses

Figures 9 and 10 plot the impulse responses of key variables to a regime-induced depreciation in the data and in the model. For the model, we plot responses of peggers relative to floaters after a US UIP shock that leads the US dollar to depreciate.[24] We see that the model matches the main features of the responses in the data. The model generates a large boom in output, consumption, and investment in response to the regime-induced depreciation. The response is hump-shaped and very persistent, as in the data.

The boom does not arise from loose monetary policy in the pegging countries. Interest rates in the pegger countries actually rise somewhat relative to interest rates in the floater countries in the model as in the data. This reflects the fact that the boom is inflationary in the pegger countries, which leads monetary policy to tighten. Net exports fall in the model as in the data. This contrasts with traditional open economy models in which a regime-induced depreciation leads net exports to rise due to expenditure switching in goods markets. In our model, the expenditure switching

[24] This corresponds to the coefficient on the peg interacted with the US exchange rate that we emphasize in Section 2 (up to sampling error). When computing impulse response functions, we set the size of the initial US UIP shock, ϵ^{ψ}_{U0}, to match the initial response of the relative nominal exchange rates of peggers and floaters.

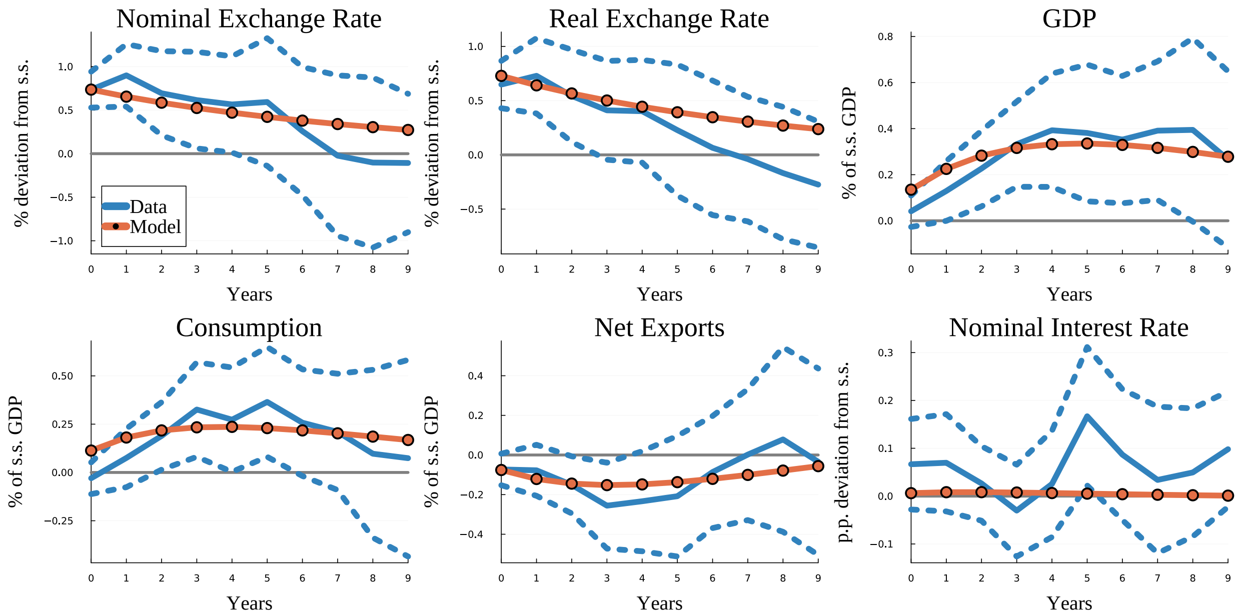


Figure 9: Model Fit: Main Variables

Note: This figure plots the response of peggers relative to floaters to a US UIP shock in the model and in the data. The dashed lines represent the 95% confidence interval in the data.

channel is operational, but it is dominated by a foreign credit channel pushing in the opposite direction.

International capital flows are the key channel through which a regime-induced exchange rate depreciation stimulates the economies of peggers in our model. A depreciation of the peggers' currency driven by a US UIP shock makes it cheap for households and firms in the pegging countries to borrow in foreign currency. It also increases the expected returns of foreigners from investing in the pegging countries. Households and firms in both the pegging countries and elsewhere thus have an incentive to bring money into the pegging countries. This stimulates consumption and investment (and thus imports).

To see why a US UIP shock makes foreign borrowing cheap in pegger countries, it is useful to consider the response of the rate firms in pegging countries can finance themselves with to such a shock. To a first order, this can be written as

$$d\ln(1+r^{f}_{it+1}) = d\ln(1+r_{it+1}) - \bar{s}d\Omega(\{NFA_{kt}\}_k, \psi_{Ft}), \tag{16}$$

which we obtain as a first-order approximation of equation (6) after substituting in equations (3), (9), and (15). The same equation can be derived for $d\ln(1+r^{h}_{it})$. The change in the cost of borrowing in domestic currency is $d\ln(1+r_{it+1})$. For peggers, this turns out to be positive in equilibrium

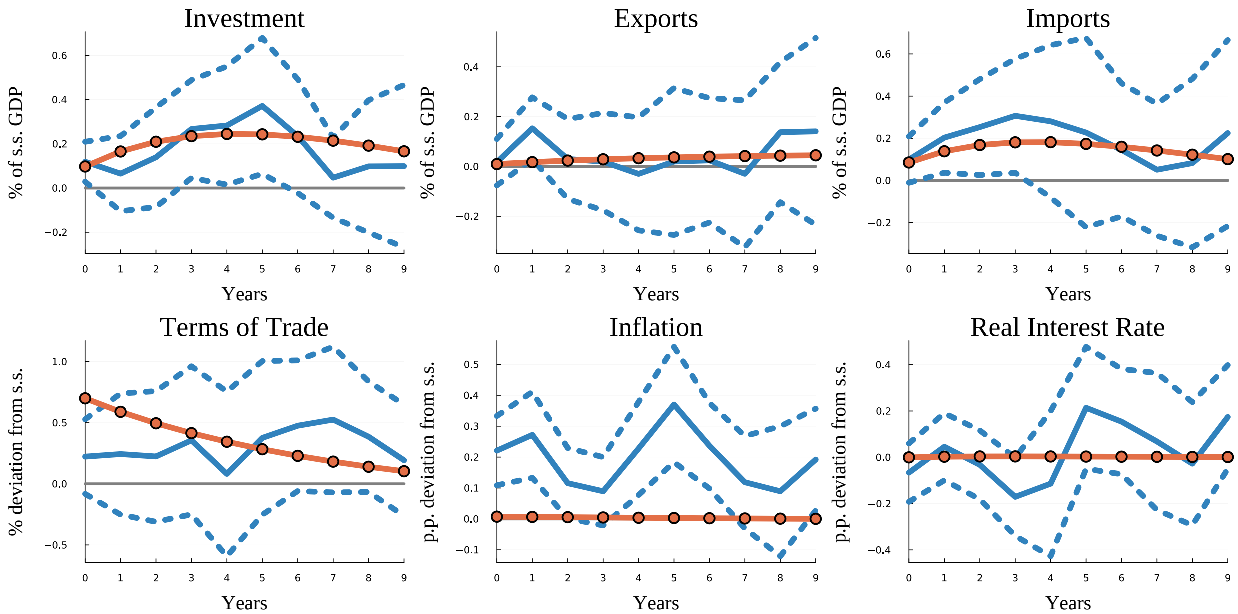


Figure 10: Model Fit: Additional Variables

Note: This figure plots the response of peggers relative to floaters to a US UIP shock in the model and in the data. The dashed lines represent the 95% confidence interval in the data.

because inflation increases and monetary policy responds to the higher inflation. The change in the cost of borrowing in foreign currency, however, differs from $d \ln(1 + r_{it+1})$ by $d\Omega(\{NFA_{kt}\}_k, \psi_{Ft})$ (the change in the UIP deviation): $d \ln(1 + r_{ijt}) = d \ln(1 + r_{it}) - d\Omega(\{NFA_{kt}\}_k, \psi_{Ft})$. After a depreciation caused by a US UIP shock (higher ψ_{Ft} and hence higher $d\Omega$), this UIP deviation is negative for peggers, which means that for them the cost of borrowing abroad falls. Figure C.3 plots the impulse response of the ex-post UIP deviation for peggers in the model and compares it to the data. In the data there is a substantial ex-post UIP deviation after regime-induced changes in the exchange rate. Our model generates a similar but smaller UIP deviation.

Intuitively, the domestic currency of peggers is cheap due to a shift in noise trader demand away from US dollar assets. In real terms, the domestic currency is expected to appreciate more than UIP implies. Conversely, the currency of floaters is expected to depreciate in real terms more than UIP implies. This means that borrowing abroad is cheap for households and firms in the pegger countries. As long as households and firms finance themselves partly in foreign currency (i.e., $\bar{s} > 0$), they will respond to this shift by borrowing from abroad (relative to their prior positions). Likewise, foreign agents will perceive a high expected return from investing in the pegging countries and will shift their portfolios accordingly. This capital inflow will finance increased consumption and investment in pegger countries and result in these economies running

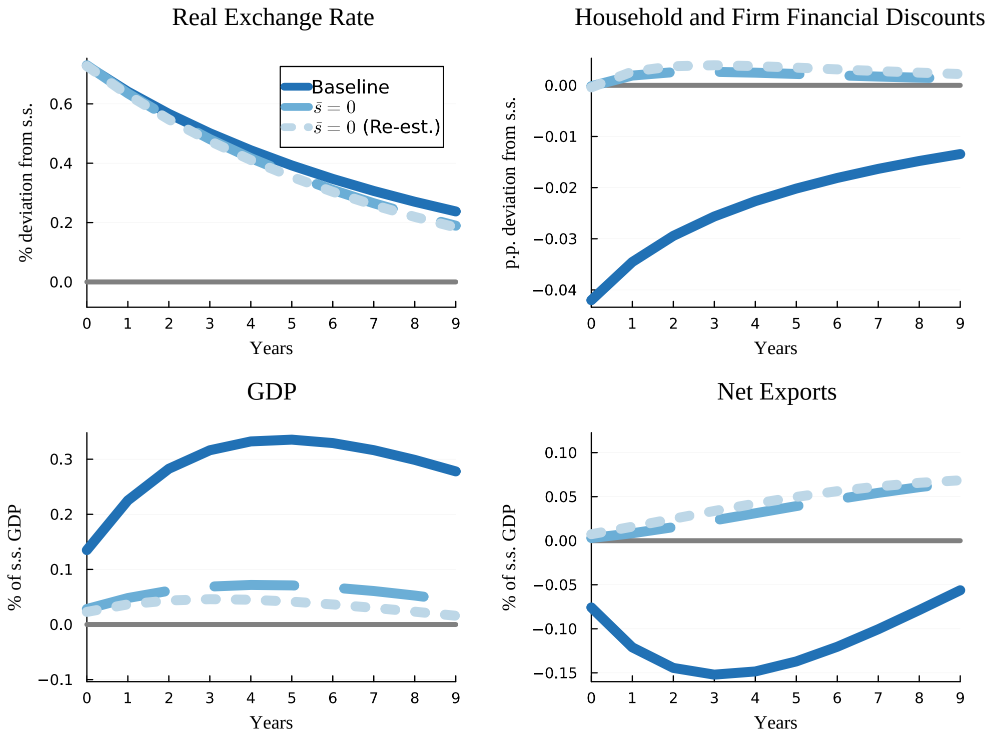


Figure 11: Comparison with a Model without Foreign Credit Channel

Note: The figure plots the response of peggers relative to floaters to a US UIP shock for the baseline model and version of the model with $\bar{s} = 0$. For the model with $\bar{s} = 0$, we plot results for two cases: 1) a case with $\{\kappa_p, \kappa_w, h\}$ unchanged, 2) a case where $\{\kappa_p, \kappa_w, h\}$ is re-estimated. Household and firm financial discounts refer to r^h_{it} and r^f_{it}.

a trade deficit (i.e., net exports will fall).[25]

Figure 11 demonstrates the importance of the foreign currency portfolio share $\bar{s}$ in our model, by comparing the impulse responses in our baseline case of $\bar{s} > 0$ with a case of $\bar{s} = 0$ (no foreign currency investing by households and firms). The boom in output is an order of magnitude smaller with $\bar{s} = 0$ than it is in our baseline case (bottom-left panel). The reason for this is that households and firms do not experience a decline in borrowing costs associated with the regime-induced depreciation when $\bar{s} = 0$ (top-right panel).[26] The small boom that remains in the $\bar{s} = 0$ case is driven by an increase in net exports that occurs for standard expenditure switching reasons (bottom-right panel).[27]

[25]In thinking about equation (16), it is important to keep in mind that we assume that firms (and households) face adjustment costs to their portfolio shares (not their positions). Since their portfolio shares are set optimally in the steady state, the change in their cost of funds that results from the change in their portfolio share after the shock is a second order term.

[26]Borrowing costs actually increase slightly due to tighter domestic monetary policy when $\bar{s} = 0$.

[27]We keep Γ unchanged when we set $\bar{s} = 0$. This can be thought of as a slight recalibration of the other components of Γ.

The foreign credit channel ($\bar{s} > 0$) is what distinguishes our analysis from the analysis in Itskhoki and Mukhin (2021a). In Itskhoki and Mukhin (2021a), households and firms do not have access to foreign currency borrowing (or investing). Their model is thus similar to our model when we set $\bar{s} = 0$. In this case, the exchange rate is largely disconnected from real outcomes in response to UIP shocks. This is much less true when $\bar{s} > 0$. Empirically, large gross foreign currency positions are a prominent feature of the data, suggesting that the $\bar{s} > 0$ case is more realistic.

5.2 Robustness and Extensions

Shocks Driving US Dollar We have so far assumed in this section that US UIP shocks drive movements in the US exchange rate. Table 2 considers other potential drivers of US dollar exchange rate fluctuations. In particular, Table 2 considers US productivity shocks and US monetary policy shocks in addition to our baseline results with US UIP shocks. In the data, the response of interest rates to a regime-induced depreciation is small. Our model matches this when US dollar exchange rate movements are driven by US UIP shocks.[28] This is also consistent with the fact that US dollar depreciations are only mildly correlated with US interest rates.[29]

In sharp contrast, when US dollar exchange rate movements are driven by either US monetary or productivity shocks the nominal interest rate in pegging countries falls substantially relative to the nominal interest rate in floating countries when the US dollar depreciates. In the monetary shock case, this arises because interest rates in the pegging countries must track US interest rates to maintain the peg. They thus fall relative to interest rates in floating countries. In the productivity shock case, the direct effect of the shock on peggers and floaters is identical and is therefore differenced out when we consider relative responses. The asymmetric effect arises from the US monetary policy response to the productivity shock. Interest rates in the pegging countries will track the US interest rate response to the productivity shock, while interest rates in the floating country will not. This same logic applies to many other potential sources of variation in the US dollar exchange rate.

An important point to emphasize is that, conditional on matching the joint behavior of nominal interest rate and nominal exchange rate, the choice of which shock drives the US dollar exchange

[28]Jiang, Richmond, and Zhang (2022) argue movements in asset demand, which UIP shocks are meant to capture, explain a large fraction of USD exchange rates behavior over the period of 2011-2019.

[29]The correlation between changes in the nominal interest rate and the changes in log USD effective exchange rate is 0.12. On average the US dollar appreciates when interest rates fall: the opposite direction from what you might expect if uncovered interest rate parity were driving exchange rates.

Table 2: Alternative Shocks Driving USD

	Impact Response		5Y Average Response	
	e	i	e	i
Data	0.74	0.07	0.70	0.03
Model				
US UIP Shock	0.74	0.01	0.59	0.01
US Monetary Policy Shock	0.74	-0.41	0.26	-0.14
US Technology Shock	0.74	-0.72	-0.97	-0.87

Note: This table shows the impulse response of the log of the nominal effective exchange rate (e) and the nominal interest rate (i) of peggers relative to floaters. Impact response indicates the response at $h = 0$, while the 5Y average response is the average of the response at horizons $h = 0$ through $h = 4$. The top row of the table shows our empirical estimates for these responses. The remaining rows show the simulated impulse response in our model in response to the shock listed to the left in that row. We choose the size of each shock such that the impact response of the nominal effective exchange rate matches the impact response in the data.

rate is not important. The reason for this is that the peggers and floaters are identical except for their monetary regime. This means that the differential effect of regime-induced exchange rate changes must come through a combination of the exchange rate and the nominal interest rate (i.e., monetary policy). As a consequence, any combination of shocks will induce the same impulse responses for peggers versus floaters as long as they match the path of the relative response of the nominal exchange rate and the nominal interest rate that we have estimated. This implies that our conclusions should carry over to richer models where UIP deviations are endogenous to economic fundamentals, for example, due to currency risk premia (Hassan and Zhang, 2021, and the references therein), term premia (Gourinchas, Ray, and Vayanos, 2022), or liquidity premium (Bianchi, Bigio, and Engel, 2021; Devereux, Engel, and Wu, 2022).

Alternative Models without a Foreign Credit Channel Table 3 presents results for a wide range of calibrations without a foreign credit channel (i.e., with $\bar{s} = 0$). Here we focus on the response of output and net exports. We see from this table that none of these models is able to fit our impulse responses (even qualitatively). We consider a model with producer currency pricing, a model with dominant currency pricing, a model with a low trade elasticity, and a model with hand-to-mouth households. None of these models absent a foreign credit channel can jointly explain a large positive GDP response and a fall in net exports in response to regime-induced depreciation. Without an off-setting foreign credit channel, expenditure switching in the goods market yields positive comovement between output and net exports in all of these models.

Table 3: Models without Foreign Credit Channel

5Y Average Response of:	Fixed Parameters *GDP*	Fixed Parameters *NX*	Re-estimated *GDP*	Re-estimated *NX*
Data	0.22	-0.16	0.22	-0.16
Baseline Model	0.26	-0.13	0.26	-0.13
Models with $\bar{s} = 0$				
(a) Benchmark	0.06	0.02	0.04	0.02
(b) PCP	0.33	0.68	0.35	0.58
(c) DCP	0.19	0.31	0.21	0.28
(d) Low η	0.05	0.00	0.05	0.00
(e) Hand-to-Mouth	0.07	0.01	0.07	0.01

Note: The table shows the response of the log GDP and the ratio of net exports to GDP averaged over horizons $h = 0$ through $h = 4$. The response is for peggers relative to floaters to a US UIP shock. Columns "Fixed Parameters" use the parameter estimates in the Panel B of table B.1. Columns "Re-estimated" re-estimate Θ. Row "Benchmark" uses our baseline parameter values from table B.1. Appendix B.6 describes the "PCP" and "DCP" calibration. "Low η" sets $\eta = 1.0$ instead of $\eta = 1.5$. Appendix B.8 describes the model with hand-to-mouth agents.

Price and Wage Rigidity In addition to a foreign credit channel, our model needs strong Keynesian features to fit the data. We estimate fairly flat slopes of both the price and the wage Phillips curves, reflecting a combination of nominal rigidity and unmodeled strategic complementarity in price setting. We show in Appendix B.5 that without a large degree of nominal rigidity, our model is not able to generate the magnitude of the booms we observe in the data, because of a large endogenous real interest rate response.[30] Habit formation in consumption plays the conventional role of explaining the delays we observe in the consumption response to regime-driven depreciations.[31]

Alternative Pricing Regimes In our baseline calibration, we assume that firms price in local currency (LCP). In Appendix B.6, we present results under producer currency pricing (PCP) and dominant currency pricing (DCP). In these alternative cases, the fit of the model to the data for net exports and the terms of trade deteriorates substantially. In both of these alternative cases, net exports increase. This is because the expenditure switching force is stronger under these pricing regimes. Moreover, the model with DCP predicts almost no response in the terms of trade, while

[30] Itskhoki and Mukhin (2021a) argue that price rigidity is not important to fit a certain set of unconditional moments of exchange rate and real variables. We are trying to fit a wider range of facts – particularly the effects we estimate of regime-driven depreciations.

[31] There are various other potential microfoundations for such delayed responses, including household's inattention to movements in financial markets or doubts about attention and responsiveness of others, as formalized by Angeletos and Huo (2021).

the model with PCP predicts a substantial deterioration in the terms of trade.[32] In the data, the terms of trade actually improve somewhat.

Non-Tradables and Tradables Recall that Figure 6 shows that most of the increase in GDP comes from the service sector, which is largely non-tradable, as opposed to the manufacturing or agricultural sectors, which are tradable. In Appendix B.7, we extend our baseline model to a two sector model featuring tradable and non-tradable sectors. We find that, consistent with our results, the increase in GDP is almost entirely driven by the non-tradable sector. The response of GDP in the tradable sector is small. The intuition for this is simply that a domestic boom drives an increase in consumption and investment, but much of the needed increase in production of tradeables comes from abroad.

Heterogenous agents In our baseline model, all households have access to financial markets. Since the boom resulting from a regime-induced depreciation in our model is driven by foreign credit, one might conjecture that the boom would be weaker if some households did not have access to financial markets. In Appendix B.8, we extend our baseline model to allow for the presence of hand-to-mouth households who do not have access to financial markets. We find that the response of consumption and GDP are virtually unchanged in the presence of hand-to-mouth households. The reason for this is closely related to the argument in Werning (2015). While hand-to-mouth households do not directly respond to the movements in financial market variables, they instead react more to the indirect effect of an increase in labor income. The net effect is ambiguous.[33]

6 Exchange Rate Disconnect, Backus-Smith and the Mussa Facts

Our evidence on the large real effects of regime-induced depreciations might, at first blush, seem to contradict well known unconditional facts about the exchange rate, including exchange rate disconnect, the Backus-Smith correlation, and the Mussa facts. If depreciations cause booms and exchange rate are so volatile, why isn't there a strong unconditional correlation between exchange rate depreciations and booms? In this section, we show that this apparent contradiction is a mirage arising from the distinction between conditional and unconditional moments. If exchange rates

[32] As shown by Auclert et al. (2021b), the model with DCP is isomorphic to, and therefore can alternatively be interpreted as, the commodity exporter model of Schmitt-Grohé and Uribe (2016).

[33] Since our benchmark parametrization assumes local currency pricing, the real income channel emphasized in Auclert et al. (2021b) is muted.

respond to several different shocks that each results in a different conditional correlation between the exchange rate and output, the unconditional correlation between the exchange rate and output can be small.

To demonstrate this, we introduce a second shock, which we refer to as a "capital flight" shock (Bianchi and Lorenzoni, 2021). This shock might alternatively be termed a "flight to safety" shock. It is similar to the "safety" shock in Kekre and Lenel (2021) and also similar to the "sudden stop" shocks of Calvo (1998). The capital flight shock has two characteristics that are crucial to matching the unconditional moments: it generates large exchange rate volatility and it generates the opposite correlation between output and the exchange rate from our UIP shock. Intuitively, a negative UIP shock is a time when noise traders get "spooked" and reduce demand for a currency. In this case households and firms trade against the noise traders and capital flows into the country. In contrast, a negative capital flight shock is a time when all investors in a region get spooked and reduce demand for a currency. In this case, capital flows out of the country.

6.1 An FDX Model with Capital Flight Shocks

We model the capital flight shocks as arising from financial intermediation: households and firms have access to foreign currency bonds only through banks. This introduces a stochastic wedge between the return agents in country i earn when they invest in country j bonds and the return agents in country j earn from investing in these bonds. We denote this intermediation wedge as ζ_{it}. The intermediation wedge implies that equation (3) in our earlier model becomes

$$(1 + r_{ijt+1}) \equiv (1 + r_{jt+1}) \frac{Q_{jit+1}}{Q_{jit}} \exp(\zeta_{it}) \tag{17}$$

When $\zeta_{it} = 0$, households and firms face the foreign real interest rate adjusted for the real exchange rate as in our earlier model. Here, we assume that the intermediation wedge follows an AR(1) process:

$$\zeta_{it} = \rho^{\zeta} \zeta_{it-1} + \epsilon^{\zeta}_{it}. \tag{18}$$

We refer to $\{\epsilon^{\zeta}_{it}\}$ as capital flight shocks. We provide a microfoundation for the intermediation wedge in Appendix B.9 based on Bianchi and Lorenzoni (2021). The micro-foundation introduces financial constraints to banks. Stochastic shocks to the tightness of these financial constraints yield the shock ζ_{it}.

Capital flight shocks lead to UIP deviations as we show in Appendix B.2.3. With capital flight shocks, UIP deviations are given by

$$\begin{aligned}\Omega\big(\{NFA_{kt}\}_k, \psi_{jt}, \{\zeta_{kt}\}_k\big) \equiv \Gamma\Big[&\big(1 - \textstyle\int \bar{s}_{ji}di\big)\, NFA_{jt} + \textstyle\int \bar{s}_{ij} NFA_{it} di \\ &+ \psi_{jt} + m^{\zeta}\left(- \textstyle\int \bar{s}_{ji} di \zeta_{jt} + \textstyle\int \bar{s}_{ij}\zeta_{it} di\right)\Big],\end{aligned} \tag{19}$$

where $m^{\zeta} \equiv \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right]\frac{\bar{a}}{\beta}$. It is the last term on the right hand side that arises because of the capital flight shocks: when it becomes more costly to borrow in foreign currency due to the capital flight shock (a high ζ_{jt}), agents borrow more in domestic currency, which decreases demand for domestic currency and depreciates the domestic exchange rate. Equation (19) replaces equation (10), and equation (17) replaces equation (3). The rest of the model is unchanged.

The capital flight shock affects the economy differently from the UIP shock. This can be illustrated by considering a first order approximation of the rate at which firms finance themselves in a floating country $i \in F$. (A similar condition holds for the rate of return households in this country have access to when saving.) We can use equation (17) to derive

$$d\ln(1 + r^f_{it+1}) = d\ln(1 + r_{it+1}) + \bar{s}\zeta_{it} + \bar{s}d\Omega(\{NFA_{kt}\}_k, \psi_{it}, \{\zeta_{kt}\}_k), \tag{20}$$

which is the counterpart of equation (16) in our earlier model.[34]

Notice that the capital flight shock affects firm borrowing costs through two channels – i.e., shows up in two places on the right hand side of equation (20) – while the UIP shock only affects firm borrowing costs through one of these two channels. First, the capital flight shock affects firm borrowing costs directly (second term on the right hand side of equation (20)). This captures the fact that a bad capital flight shock (positive ζ_{it}) increases firm borrowing costs (when $\bar{s} > 0$) by increasing the intermediation wedge firms must pay on foreign borrowing. The second channel operates in the same way as a UIP shock: it depreciates the exchange rate in a way that results in a UIP deviation going forward. This lowers the cost of firm borrowing.

Intuitively, UIP shocks only affect the relative demand for home versus foreign bonds, not the total demand for bonds: noise traders buy foreign bonds in exchange for the same amount of home bonds. Such a shift in the relative demand for home versus foreign bonds by noise traders results in a change in the relative price of home and foreign bonds (i.e., a change in the exchange rate). In contrast, capital flight shocks increase the demand for foreign bonds without decreasing

[34]Equation (16) is for a pegging country, while this equation is for a floating country.

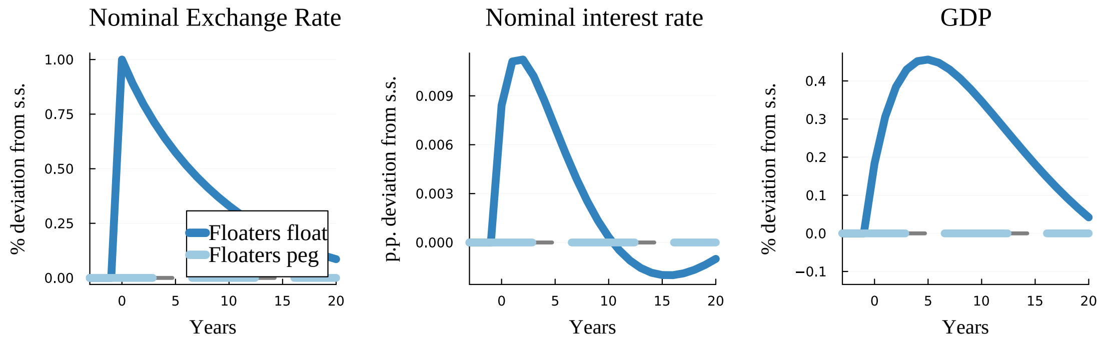
the demand for home bonds, since households and firms have access to a higher rate of return on foreign bonds. Therefore capital flight shocks not only increase the relative demand for foreign bonds (and hence depreciate the home exchange rate), but also increase overall saving and thus reduce aggregate demand. In this sense, one can think of the capital flight shock as a combination of a UIP shock and an aggregate demand (discount factor) shock in the home country.

We choose the parameter m^{ζ} – which governs the degree to which the capital flight shock induces fluctuations in the exchange rate – to match the unconditional correlation between output and the real exchange rate. We set the persistence of capital flight shocks equal to the persistence of other shocks, $\rho^{\zeta} = 0.89$.

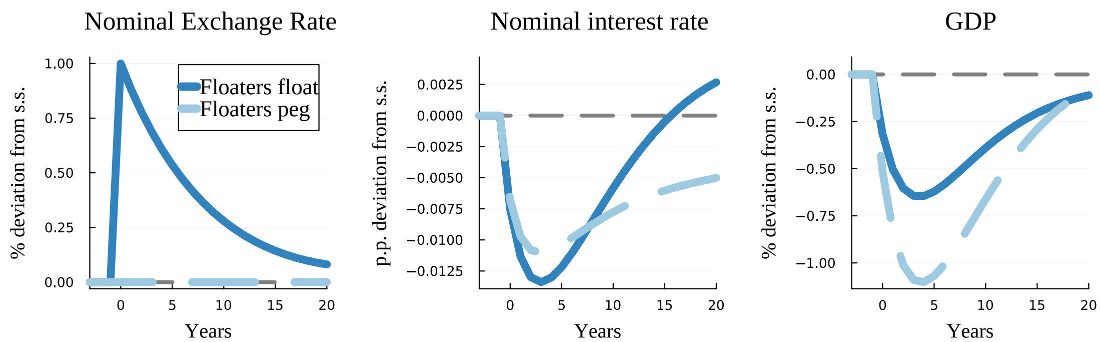
Impulse Responses Figure 12 contrasts the response of the economy to a UIP shock and a capital flight shock. Panel (a) plots responses to a UIP shock, while panel (b) plots responses to a capital flight shock. In both panels, the shock hits the floater region. The solid and dashed lines in the figure plot responses for two cases: a case where the currency of the floater region floats versus the US dollar (solid lines), and a case where the currency of the floater region pegs versus the US dollar (dashed lines). In the second case, all countries are pegged to the US dollar. We calibrate these two shocks such that the initial response of the nominal exchange rate is a depreciation of the same size in the case where the floater currencies float (solid lines / left panels).

Consider first the solid lines. The responses of the nominal interest rate (middle panels) and output (right panels) are sharply different for the two shocks. In the case of the UIP shock, output and the nominal interest rate increase. The UIP shock to the floater currency is isomorphic to the regime-induced depreciation we consider earlier in the paper. This causes a boom, which leads to an endogenous increase in the nominal interest rate. In sharp contrast, the capital flight shock results in output and the nominal interest rate falling. In this case, the depreciation arises from an increase in the intermediation wedge that the floating countries face (i.e., capital flight). This leads households and firms to consume and invest less, which causes output to fall. Interest rates fall endogenously as a consequence.

Next consider the dashed lines. If the floater region pegs, the UIP shock has no effect on either the exchange rate or the real economy. International arbitrageurs (and the central banks) fully arbitrage away the shock. This is not the case for the capital flight shock. In fact, the capital flight shock generates a larger recession when the countries that are hit by it are pegged than when they float. This occurs for two reasons. First, floaters that are hit by a capital flight shock can respond to the shock by easing monetary policy (this is what the monetary policy rule we specify implies they



(a) Impulse Response to a UIP Shock



(b) Impulse Response to a Capital Flight Shock

Figure 12: Impulse Responses to a UIP and a Capital Flight Shock

Note: Panels (a) and (b) plot the impulse response to a UIP shock and a capital flight shock, respectively. The darker solid line shows the response of the floater countries when the shock hits these countries. The lighted dashed line shows a case where these countries peg their exchange rate to the US dollar and they are hit by UIP and capital flight shocks. In this case, all countries are pegged to the US dollar. The shock size is normalized so that the nominal exchange rate depreciates by 1% upon impact in the floating case.

will do). When they peg, they cannot respond in this way.[35] Second, if they peg, their exchange rate does not depreciate in response to an adverse capital flight shock. This means that they do not experience a UIP deviation. Their borrowing costs therefore increase even more than if they were floating. This also contributes to a more severe recession. These differences demonstrate the role of the exchange rate as an endogenous stabilizer (Friedman, 1953).

Regime-Induced Depreciations with Capital Flight Shocks In our analysis of regime-induced depreciations in Section 5, we assume for simplicity that the US dollar exchange rate is driven by US UIP shocks. In Appendix B.10, we show that the facts we document about regime-induced depreciations in Section 2 can just as well be matched assuming that the US dollar exchange rate

[35]The nominal interest rate falls even when the countries hit by the shock peg because the US reacts to the capital flight shock due to negative spillovers from the shock on US economy. Recall that in this experiment we are shocking the entire floater region. So, the shock is not "small."

is driven by US capital flight shocks (which in this case may more naturally be thought of as flight to safety shocks). The response of the economy to UIP shocks and capital flight shocks differs as we emphasize above. But this difference is "differenced out" when we consider regime-induced depreciations since in that case we are comparing the response of pegs and floats to a US shock.

6.2 Exchange Rate Disconnect and the Backus-Smith Correlation

A large empirical literature demonstrates that – at least unconditionally – exchange rates are largely disconnected from other macroeconomic aggregates (Meese and Rogoff, 1983; Baxter and Stockman, 1989; Flood and Rose, 1995; Obstfeld and Rogoff, 2000; Devereux and Engel, 2002; Itskhoki and Mukhin, 2021a). Related to this, exchange rates are mildly negatively correlated with consumption in the data, as opposed to strongly positively correlated as in traditional open economy macroeconomic models (Backus and Smith, 1993). Table 4 demonstrates these facts in our sample. Nominal and real exchange rates of floating countries are three to four times more volatile than GDP and consumption (i.e., they are largely "disconnected").[36] Moreover, real exchange rates are mildly negatively correlated with both GDP and consumption.

Model vs. Data Table 5 assesses the ability of our FDX model to match these facts. The data column reproduces the results for floaters from Table 4. Column (1) presents results for the floater countries in our FDX model when economic fluctuations are caused by a combination of UIP and capital flight shocks. Column (2) presents results when economic fluctuations are caused by UIP and productivity shocks. Columns (3)-(6) present results when economic fluctuations are caused by a single shock: UIP shocks, capital flight shocks, productivity shocks, and monetary shocks, respectively. In columns (1) and (2), we choose the volatility of the two shocks to target the volatility of the nominal exchange rate and GDP in the data. In columns (3)-(6), we choose the volatility of the shock to match the volatility of GDP in the data. Column (7) presents the same set of results when economic fluctuations are cause by UIP and productivity shocks but $\bar{s}$ is set to zero. Recall that our model with $\bar{s} = 0$ is similar to the model in Itskhoki and Mukhin (2021a).

Only the model with both UIP and capital flight shocks fits the small negative correlation

[36] We include a larger set of countries than earlier work, which has largely focused on OECD countries. The sample used in Table 4 includes both the countries that we estimate our impulse responses for in Section 2 and the United States and the 24 relatively advanced countries that we exclude from the analysis in Section 2. In this analysis, we divide countries into pegs and floats in a somewhat different way than in Section 2 since the focus is not on pegging versus the US but rather pegging in general. We define country-year observations in Ilzetzki, Reinhart, and Rogoff's coarse categories 1 and 2 (fine categories 1 through 8) as pegs and those in coarse categories 3 and 4 (fine categories 9 through 13) as floats. As before, we exclude fine categories 14 (freely falling) and 15 (dual market / missing data).

Table 4: Exchange Rate and Macroeconomic Volatility in the Data

	Peg vs. Float (Post-1973)		Pre- and Post-1973	
	Peg	Float	Pre-1973	Post-1973
A. Volatility				
std(ΔNER)	0.082	0.114	0.070	0.090
std(ΔRER)	0.069	0.091	0.058	0.075
std(ΔGDP)	0.044	0.037	0.046	0.042
std(ΔC)	0.048	0.042	0.044	0.047
std(ΔNX)	0.039	0.032	0.034	0.038
std($\Delta(1+i)$)	0.030	0.031	0.012	0.030
B. Correlation				
corr($\Delta RER, \Delta NER$)	0.553	0.712	0.592	0.601
corr($\Delta RER, \Delta GDP$)	-0.045	-0.068	-0.042	-0.051
corr($\Delta RER, \Delta C$)	-0.069	-0.137	-0.017	-0.088
corr($\Delta RER, \Delta NX$)	0.040	0.213	0.146	0.093
corr($\Delta RER, \Delta(1+i)$)	0.171	0.130	-0.134	0.150

Note: The table reports the standard deviation and correlations of real and nominal effective exchange rates, GDP, consumption, net exports to GDP ratio, and nominal interest rate for each subsample. All variables are in logs except for net exports, which are relative to GDP. The sample contains all countries in our dataset (including the US and the 24 relatively advanced economies we use to define the US exchange rate earlier in the paper). See footnote 36 for more detail on the sample and the definition of pegs and floats. The third and forth columns split the sample by year as opposed to by exchange rate regime. For each variable (e.g., ΔNER), we drop outlying observations (the top and bottom 0.5%) when computing these moments.

between the real exchange rate and both GDP and consumption.[37] The model with a combination of UIP and productivity shocks fails to do so, and the model with any single shock also fails to do so. The intuition for this is simple. As we demonstrate in Figure 12, the UIP and capital flight shocks generate opposite correlations between the exchange rate and GDP. A model with only UIP shocks generates a strong positive correlation between the real exchange rate and GDP, while a model with only capital flight shocks generates a strong negative correlation (columns (3) and (4)). The combination of these two shock can thus generate a small negative unconditional correlation. Productivity and monetary shocks also yield strong positive correlations (columns (5) and (6)).[38]

Productivity shocks alone generate very little volatility in the real exchange rate when their volatility is chosen to match the volatility of real GDP. Combining capital flight shocks and either

[37] Table C.1 presents a variance decomposition for the model with UIP and capital flight shock.

[38] This analysis shares a similar perspective to recent work by Mullen and Woo (2022). Like us, Mullen and Woo (2022) introduce multiple shocks as drivers of exchange rate and show that a combination of trade cost shocks, UIP shocks, and a model with a dynamic trade elasticity can successfully replicate the unconditional moments of the US data. Our work differs in that we place emphasis on the financial channel and on matching conditional moments.

Table 5: Exchange Rate Disconnect

	Data	Model						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		(ψ,ζ) Baseline	(ψ,A)	ψ	ζ	A	m	(ψ,A) $\bar{s}=0$
A. Volatility								
std(ΔNER)	0.114	0.114	0.114	0.141	0.093	0.006	0.075	0.114
std(ΔRER)	0.091	0.113	0.113	0.140	0.093	0.005	0.075	0.114
std(ΔGDP)	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
std(ΔC)	0.042	0.045	0.030	0.036	0.049	0.017	0.035	0.018
std(ΔNX)	0.032	0.016	0.022	0.022	0.009	0.021	0.010	0.022
std($\Delta(1+i)$)	0.031	0.001	0.002	0.001	0.001	0.004	0.085	0.004
B. Correlation								
corr($\Delta RER, \Delta NER$)	0.712	1.000	1.000	1.000	1.000	0.781	1.000	0.999
corr($\Delta RER, \Delta GDP$)	-0.068	-0.068	0.504	0.607	-0.710	0.878	0.720	0.123
corr($\Delta RER, \Delta C$)	-0.137	-0.121	0.665	0.699	-0.693	0.674	0.759	-0.093
corr($\Delta RER, \Delta NX$)	0.213	-0.297	-0.501	-0.629	0.421	0.910	-0.718	0.003
corr($\Delta RER, \Delta(1+i)$)	0.130	0.206	0.355	0.849	-0.739	-0.930	-1.000	0.166

Note: The table shows the volatility and correlation of macro variables in the data, and in the model in response to various shocks. The data column reproduces the second column of Table 4. All series except for net exports (NX) are in logs. Net exports (NX) are expressed as a fraction of GDP. Column (1) considers UIP (ψ) and capital flight (ζ) shocks. Column (2) considers UIP (ψ) and TFP (A) shocks. Column (3) considers UIP (ψ) shocks only. Column (4) considers capital flight (ζ) shocks only. Column (5) considers TFP (A) shocks only. Column (6) considers monetary policy shocks (m) only. Column (7) considers UIP (ψ) and TFP (A) shocks in a model where households and firms do not have direct access to foreign bonds ($\bar{s}=0$). In columns (1), (2), and (7), we choose the volatility of shocks to match the volatility of GDP and the volatility of the nominal exchange rate. In columns (3)-(6), we match the volatility of GDP.

productivity shocks or monetary policy shocks can match the small negative correlation of the exchange rate with output and consumption (Backus-Smith correlation). However, since productivity shocks generate little exchange rate volatility, the combination of productivity shocks and capital flight shocks that matches the Backus-Smith correlation and the volatility of the exchange rate yields a volatility of GDP that is much too high. A combination of monetary shocks and capital flight shocks that matches the Backus-Smith correlation generates a counterfactually negative correlation between the exchange rate and the nominal interest rate.

Itskhoki and Mukhin (2021a) fit some of the facts in Table 5 using a model with productivity and UIP shocks but where exchange rates have very modest effects on the real economy. Column (7) of Table 5 reproduces similar results for our model with $\bar{s}=0$. This calibration is, however, inconsistent with our empirical findings regarding the substantial real effects of regime-induced depreciations as we discuss in Section 5.1. In Itskhoki and Mukhin's model, the key mechanism behind the model's ability to match the Backus-Smith correlation is that an exchange rate depreciation causes real interest rates to increase because monetary policy responds to inflation associated with imported intermediates. This increase in real interest rates causes consumption to decline, despite output increasing (due to expenditure switching). In our model, both output and consumption have the same (small negative) correlation with the real exchange rate, whereas in their model, these correlations have opposite signs. In the data, the real exchange rate has a small negative correlation with both output and consumption.

6.3 Mussa Facts

Mussa (1986) drew attention to the fact that the volatility of the real exchange rate rose substantially when the Bretton Woods system of fixed exchange rates broke down in 1973. Table 4 demonstrates this fact in our sample. Comparing columns 3 and 4 of this table reveals a large increase in the volatility of both the nominal and real exchange rates after 1973.[39] Comparing columns 1 and 2 of Table 4 shows, furthermore, that the volatility of both the nominal and real exchange rate are substantially larger for floats than pegs after 1973.

Earlier work has pointed out that the large change in the volatility of the real exchange rate in 1973 was not accompanied by substantial changes in the volatility of other real outcomes such as GDP and consumption (Baxter and Stockman, 1989; Flood and Rose, 1995; Itskhoki and Mukhin, 2021b). This can be seen in Table 4 for our sample. Table 4 also shows that the volatility of output and consumption is not lower for pegs than for floats after 1973 despite pegs having substantially lower volatility of the real exchange rate. In fact, the volatility of output is somewhat higher for pegs than for floats after 1973 and somewhat higher before 1973 than after 1973.

These facts might be seen to constitute a conundrum. Why does higher exchange rate volatility not translate into higher volatility of output and consumption in these cases? One answer is that pegs and floats may differ in other ways and the period after 1973 may differ from the period before 1973 in other ways. Ignoring this omitted variables explanation, one might be tempted to conclude that these facts imply that exchange rates are disconnected from other macro aggregates. But our result on large responses to regime-induced depreciations is hard to square with exchange rates not mattering for macro aggregates.

Our model with UIP shocks and capital flight shocks provides a different explanation. In this model, pegging the exchange rate has two effects on output volatility. On the one hand, pegging

[39] It is important to note that the discontinuity in the volatility of the real exchange rate is starker for G7 countries than for the countries we focus on in our analysis. Also, it is less stark when one focuses on trade-weighted exchange rates, a point emphasized by Petracchi (2022).

Table 6: Mussa Facts

	(ψ,ζ)		ψ only		ζ only		(ψ,A)	
	Float	Peg	Float	Peg	Float	Peg	Float	Peg
std(ΔNER)	0.114	0.000	0.088	0.000	0.073	0.000	0.114	0.000
std(ΔRER)	0.113	0.001	0.087	0.000	0.073	0.001	0.113	0.002
std(ΔGDP)	0.037	0.049	0.023	0.000	0.029	0.049	0.037	0.016
std(ΔC)	0.045	0.057	0.022	0.000	0.039	0.057	0.030	0.008
std(ΔNX)	0.016	0.016	0.014	0.000	0.007	0.016	0.022	0.014
std($\Delta(1+i)$)	0.001	0.001	0.001	0.000	0.001	0.001	0.002	0.001

Note: The table shows the volatility of macro variables of countries in region F in the model under a floating exchange rate regime and under a fixed exchange rate regime. All variables except for net exports (NX) are in logs. The net export is expressed as a fraction of steady state GDP. The first two columns consider UIP (ψ) and capital flight (ζ) shocks. The third and forth columns consider UIP (ψ) shocks only. The fifth and sixth columns consider capital flight (ζ) shocks only. The seventh and eighth columns consider UIP (ψ) and TFP (A) shocks.

reduces output volatility by eliminating UIP shocks. One the other hand, pegging increases output volatility by tying the hands of policy makers in the face of capital flight shocks. As we demonstrated in Figure 12, capital flight shocks cause larger output fluctuations when countries peg than when they float. This is because pegging prevents them from engaging in stabilizing monetary policy in the face of capital flight shocks and also prevents the capital flight itself from generating a stabilizing depreciation. Whether output volatility increases or decreases in our model when a country exogenously shifts from floating to pegging depends on the relative size of these two opposing forces.

Table 6 compares these forces quantitatively in our model, by comparing the volatility of the exchange rate and real macroeconomic variables for floats versus pegs.[40] In the first two columns of Table 6, we do this for the same calibration as we use in column (1) of Table 5. In this case, pegging reduces the volatility of the real exchange rate by a factor of 20. In contrast, the volatility of GDP and consumption increase slightly. This prediction lines up well with the data. In contrast, the model with only UIP shocks or with a combination of UIP and productivity shocks cannot match these facts.

6.4 Cross-Country Heterogeneity

The model we develop in this section matches unconditional statistics averaged across the many countries in our sample. Countries differ, however. Figure 13 plots one interesting dimension of this heterogeneity: the country-wise correlation between real exchange rates and net exports

[40] Specifically, we compare the cases where the F countries float vs. peg.

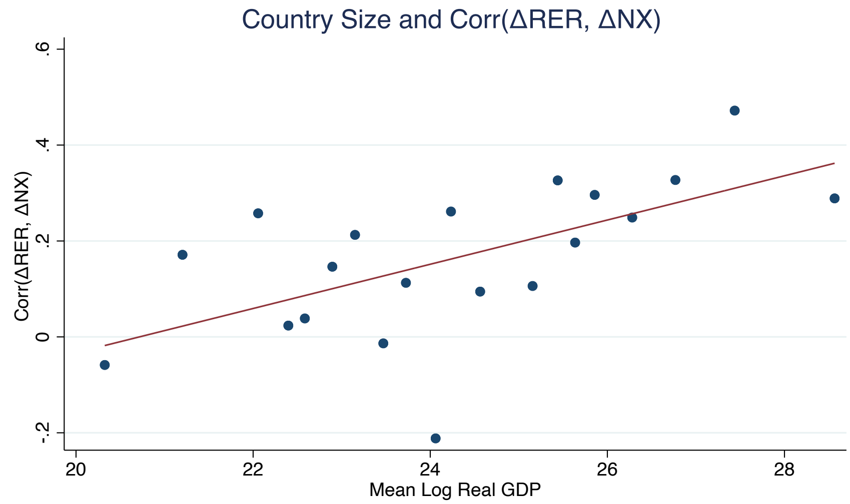


Figure 13: The Correlation between Real Exchange Rates and Net Exports by Country Size

Note: The figure plots the country-wise correlation between log changes in real exchange rates and changes in net exports over GDP as a function of mean log real GDP over the sample period. The figure is a binned-scatter plot with 20 bins. The red line denotes a linear fit. The slope is 0.044 with standard error of 0.010.

against mean log real GDP over the sample period. The figure shows that while the correlation is close to zero for small countries (the bulk of our sample) it is non-zero for large countries. The high correlation for large countries has been emphasized by Alessandria and Choi (2021).[41]

Our FDX model with both UIP shocks and capital flight shocks provides a straightforward way of fitting this pattern if we allow capital flight shocks to play a larger role in bigger countries. Figure C.2 demonstrates that varying the relative importance of the capital flight shocks results in the correlation between the real exchange rate and net exports varying.[42] Of course, this leaves open the question of *why* capital flight shocks might be relatively more important in larger countries, a question we leave for future research.

7 Conclusion

We estimate the effects of "regime-induced depreciations" on macroeconomic outcomes. Our main conclusion is that regime-induced depreciations cause large booms. Interestingly, net exports fall and nominal interest rates rise in response to such depreciations. These conditional

[41] The coefficient in an OLS regression of correlation between real exchange rates and net exports on mean log real GDP is 0.044 with standard error 0.010.

[42] Additionally, the Backus-Smith correlation is more negative for larger countries in the data (see Figure C.1 in the appendix). This is again consistent with the idea that capital flight shocks are relatively more important in larger countries.

statistics provide valuable discipline on models of how exchange rate depreciations affect the economy. Traditional open economy models, which emphasize expenditure switching effects and monetary policy cannot explain our empirical results. We develop a ”financially driven exchange rate” model (FDX model) to explain these facts. In this model, regime-induced depreciations cause an inflow of foreign credit that results in a boom with net exports falling and nominal interest rates rising. Despite regime-induced depreciations having a large causal effect on macroeconomy, a two-shock version of our model with both UIP shocks and capital flight shocks can explain exchange rate disconnect, the Backus-Smith correlation, and the Mussa facts.

References

AGHION, P., P. BACCHETTA, AND A. BANERJEE (2001): "Currency Crises and Monetary Policy in an Economy with Credit Constraints," *European Economic Review*, 45, 1121–1150.

ALESSANDRIA, G. AND H. CHOI (2021): "The Dynamics of the US Trade Balance and Real Exchange Rate: The J Curve and Trade Costs?" *Journal of International Economics*, 132, 103511.

ANGELETOS, G.-M. AND Z. HUO (2021): "Myopia and Anchoring," *American Economic Review*, 111, 1166–1200.

AUCLERT, A., B. BARDÓCZY, M. ROGNLIE, AND L. STRAUB (2021a): "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models," *Econometrica*, 89, 2375–2408.

AUCLERT, A., M. ROGLNIE, M. SOUCHIER, AND L. STRAUB (2021b): "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing Up the Real Income Channel," NBER Working Paper No. 28872.

BACCHETTA, P. AND E. V. WINCOOP (2006): "Can Information Heterogeneity Explain the Exchange Rate Determination Puzzle," *American Economic Review*, 96, 552–574.

BACKUS, D. K. AND G. W. SMITH (1993): "Consumption and Real Exchange Rates in Dynamic Economies with Non-Traded Goods," *Journal of International Economics*, 35, 297–316.

BARRO, R. AND S. TENREYRO (2002): "Economic Effects of Currency Unions," *Economic Inquiry*, 45, 1–23.

BAXTER, M. AND A. C. STOCKMAN (1989): "Business Cycles and the Real Exchange Rate Regime: Some International Evidence," *Journal of Monetary Economics*, 23, 377–400.

BÉNÉTRIX, A. S., P. R. LANE, AND J. C. SHAMBAUGH (2015): "International Currency Exposures, Valuation Effects and the Global Financial Crisis," *Journal of International Economics*, 96, S98–S109.

BIANCHI, J., S. BIGIO, AND C. ENGEL (2021): "Scrambling for dollars: International liquidity, banks and exchange rates," Tech. rep., National Bureau of Economic Research.

BIANCHI, J. AND L. COULIBALY (2023): "A Theory of Fear of Floating," NBER Working Paper No. 30897.

BIANCHI, J. AND G. LORENZONI (2021): "The Prudential Use of Capital Controls and Foreign Currency Reserves," NBER Working Paper No. 29476.

BOEHM, C. E., A. A. LEVCHENKO, AND N. PANDALAI-NAYAR (2023): "The Long and Short (Run) of Trade Elasticities," *American Economic Review*, 113, 861–905.

BOPPART, T., P. KRUSELL, AND K. MITMAN (2018): "Exploiting MIT Shocks in Heterogeneous-Agent Economies: The Impulse Response as a Numerical Derivative," *Journal of Economic Dynamics and Control*, 89, 68–92.

BOUSCASSE, P. (2022): "Canst Thou Beggar Thy Neighbour? Evidence from the 1930s," Working Paper, Cambridge University.

BRANSON, W. H., L. KRAUSE, J. KAREKEN, AND W. SALANT (1970): "Monetary Policy and the New View of International Capital Movements," *Brookings Papers on Economic Activity*, 1970, 235–270.

BRODA, C. (2004): "Terms of Trade and Exchange Rate Regimes in Developing Countries," *Journal* *of International Economics*, 63, 31–58.

BURNSIDE, C., M. EICHENBAUM, AND S. REBELO (2011): "Carry Trade and Momentum in Currency Markets," *Annual Review of Financial Economics*, 3, 511–535.

CALVO, G. A. (1983): "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383–398.

——— (1986): "Temporary Stabilization: Predetermined Exchange Rates," *Journal of Political Economy*, 94, 1319–1329.

——— (1998): "Capital Flows and Capital-Market Crises: The Simple Economics of Sudden Stops," *Journal of Applied Economics*, 1, 35–54.

CALVO, G. A. AND C. M. REINHART (2002): "Fear of Floating," *Quarterly Journal of Economics*, 117, 379–408.

CAMPBELL, J. Y. AND L. M. VICEIRA (2002): *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*, Oxford, UK: Oxford University Press.

CARARE, A., C. DE RESENDE, A. T. LEVIN, AND C. ZHANG (2022): "Do Monetary Policy Frameworks Matter in Low-Income Countries?" *IMF Economic Review*, 1–25.

CESA-BIANCHI, A., A. FERRERO, AND A. REBUCCI (2018): "International Credit Supply Shocks," *Journal of International Economics*, 112, 219–237.

CHAHROUR, R., V. CORMUN, P. DE LEO, P. GUERRON-QUINTANA, AND R. VALCHEV (2022): "Exchange Rate Disconnect Redux," Working Paper, Boston College.

CHARI, V. V., P. J. KEHOE, AND E. R. MCGRATTAN (2002): "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?" *Review of Economic Studies*, 69, 533–563.

CHINN, M. D. AND H. ITO (2008): "A New Measure of Financial Openness," *Journal of Comparative Policy Analysis*, 10, 309–322.

CHRISTIANO, L., H. DALGIC, AND A. NURBEKYAN (2021): "Financial Dollarization in Emerging Markets: Efficient Risk Sharing or Prescription for Disaster?" NBER Working Paper No. 29034.

CHRISTIANO, L. J., M. EICHENBAUM, AND C. L. EVANS (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113, 1–45.

CLOYNE, J., P. HÜRTGEN, AND A. M. TAYLOR (2022): "Global Monetary and Financial Spillovers: Evidence From a New Measure of Bundesbank Policy Shocks," NBER Working Paper No. 30485.

COOPER, R. N. (1969): "Currency Devaluation in Developing Countries: A Cross-Sectional Assessment," Discussion Paper No. 72, Economic Growth Center, Yale University.

DARVAS, Z. (2012): "Real Effective Exchange Rates for 178 Countries: A New Database," Bruegel Working Paper 2012/06.

——— (2021): "Timely Measurement of Real Effective Exchange Rates," Bruegel Working Paper 2021/15.

DEVEREUX, M. B. AND C. ENGEL (2002): "Exchange Rate Pass-Through, Exchange Rate Volatility, and Exchange Rate Disconnect," *Journal of Monetary Economics*, 49, 913–940.

DEVEREUX, M. B., C. M. ENGEL, AND S. P. Y. WU (2022): "Collateral advantage: Exchange rates, capital flows, and global cycles," *Capital Flows, and Global Cycles (September 6, 2022)*.

DI GIOVANNI, J. AND J. C. SHAMBAUGH (2008): "The Impact of Foreign Interest Rates on the

Economy: The Role of the Exchange Rate Regime," *Journal of International Economics*, 74, 341–361.

DIAZ ALEJANDRO, C. F. (1963): "A Note on the Impact of Devaluation and the Redistributive Effect," *Journal of Political Economy*, 71, 577–580.

DORNBUSCH, R. (1980): *Open Economy Macroeconomics*, New York, NY: Basic Books.

——— (1982): "Stabilization Policies in Developing Countries: What Have We Learned," *World Development*, 10, 701–708.

DRENIK, A., G. PEREIRA, AND D. J. PEREZ (2018): "Wealth Redistribution After Exchange Rate Devaluations," *AEA Papers and Proceedings*, 108, 552–56.

EICHENBAUM, M. S., B. K. JOHANNSEN, AND S. REBELO (2020): "Monetary Policy and the Predictability of Nominal Exchange Rates," *Review of Economic Studies*, 88, 192–228.

EICHENGREEN, B. AND J. SACHS (1985): "Exchange Rates and Economic Recovery in the 1930s," *Journal of Economic History*, 45, 925–946.

ENGEL, C. AND S. P. Y. WU (2023): "Liquidity and Exchange Rates: An Empirical Investigation," *Review of Economic Studies*, forthcoming.

ERCEG, C. J., D. W. HENDERSON, AND A. T. LEVIN (2000): "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics*, 46, 281–313.

FEENSTRA, R. C., R. INKLAAR, AND M. P. TIMMER (2015): "The Next Generation of the Penn World Table," *American Economic Review*, 105, 3150–82.

FLOOD, R. P. AND A. K. ROSE (1995): "Fixing Exchange Rates: A Virtual Quest for Fundamentals," *Journal of Monetary Economics*, 36, 3–37.

FRANKEL, J. (2015): "The Plaza Accord, 30 Years Later," NBER Working Paper No. 21813.

FRIEDMAN, M. (1953): *The Case for Flexible Exchange Rates*, Chicago, IL: Chicago University Press, 157–203.

GABAIX, X. AND M. MAGGIORI (2015): "International Liquidity and Exchange Rate Dynamics," *Quarterly Journal of Economics*, 130, 1369–1420.

GOURINCHAS, P.-O., W. D. RAY, AND D. VAYANOS (2022): "A Preferred-Habitat Model of Term Premia, Exchange Rates, and Monetary Policy Spillovers," NBER Working Paper No. 29875.

GOURINCHAS, P.-O. AND A. TORNELL (2004): "Exchange Rate Puzzles and Distorted Beliefs," *Journal of International Economics*, 64, 303–333.

HANSEN, L. P. AND T. J. SARGENT (2011): "Robustness and Ambiguity in Continuous Time," *Journal of Economic Theory*, 146, 1195–1223.

HASSAN, T. A., T. M. MERTENS, AND T. ZHANG (2023): "A risk-based theory of exchange rate stabilization," *The Review of Economic Studies*, 90, 879–911.

HASSAN, T. A. AND T. ZHANG (2021): "The Economics of Currency Risk," *Annual Review of Economics*, 13, 281–307.

HELPMAN, E. AND A. RAZIN (1987): "Exchange Rate Management: Intertemporal Tradeoffs," *American Economic Review*, 77, 107–123.

ILZETZKI, E., C. M. REINHART, AND K. S. ROGOFF (2019): "Exchange Arrangements Entering the Twenty-First Century: Which Anchor Will Hold?" *Quarterly Journal of Economics*, 134, 599–646.

ITSKHOKI, O. AND D. MUKHIN (2021a): "Exchange Rate Disconnect in General Equilibrium," *Journal of Political Economy*, 129, 2183–2232.

——— (2021b): "Mussa Puzzle Redux," NBER Working Paper No. 28950.

JIANG, Z., A. KRISHNAMURTHY, AND H. LUSTIG (2018): "Foreign Safe Asset Demand for US Treasurys and the Dollar," *AEA Papers and Proceedings*, 108, 537–41.

JIANG, Z., R. J. RICHMOND, AND T. ZHANG (2022): "Understanding the Strength of the Dollar," NBER Working Paper No. 30558.

JORDÀ, Ò. (2005): "Estimation and Inference of Impulse Responses by Local Projections," *American Economic Review*, 95, 161–182.

JORDÀ, Ò., M. SCHULARICK, AND A. M. TAYLOR (2020): "The Effects of Quasi-Random Monetary Experiments," *Journal of Monetary Economics*, 112, 22–40.

KALEMLI-OZCAN, S., H. KAMIL, AND C. VILLEGAS-SANCHEZ (2016): "What Hinders Investment in the Aftermath of Financial Crises: Insolvent Firms or Illiquid Banks," *Review of Economics and Statistics*, 98, 756–769.

KEKRE, R. AND M. LENEL (2021): "The Flight to Safety and International Risk Sharing," NBER Working Paper No. 29238.

KOLLMANN, R. (2005): "Macroeconomic Effects of Nominal Exchange Rate Regimes: New Insights into the Role of Price Dynamics," *Journal of International Money and Finance*, 24, 275–292.

KOURI, P. J. (1976): "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run: A Monetary Approach," *The Scandinavian Journal of Economics*, 280–304.

KRUGMAN, P. (1999): "Balance Sheets, the Transfer Problem, and Financial Crises," *International Tax and Public Finance*, 6, 459–472.

KRUGMAN, P. AND L. TAYLOR (1978): "Contractionary Effects of Devaluation," *Journal of International Economics*, 8, 445–456.

LANE, P. AND G. M. MILESI-FERRETTI (2018): "The External Wealth of Nationa Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis," *IMF Economic Review*, 66, 189–222.

LANE, P. R. AND J. C. SHAMBAUGH (2010): "Financial Exchange Rates and International Currency Exposures," *American Economic Review*, 100, 518–40.

LILLEY, A., M. MAGGIORI, B. NEIMAN, AND J. SCHREGER (2022): "Exchange Rate Reconnect," *Review of Economics and Statistics*, 104, 845–855.

MEESE, R. A. AND K. ROGOFF (1983): "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics*, 14, 3–24.

MENDOZA, E. G. AND M. URIBE (2000): "Devaluation Risk and the Business-Cycle Implications of Exchange-Rate Management," *Carnegie-Rochester Conference Series on Public Policy*, 53, 239–296.

MIRANDA-AGRIPPINO, S. AND H. REY (2015): *World asset markets and the global financial cycle*, National Bureau of Economic Research Cambridge, MA.

——— (2020): "US monetary policy and the global financial cycle," *The Review of Economic Studies*, 87, 2754–2776.

MIYAMOTO, W., T. L. NGUYEN, AND H. OH (2022): "In Search of Dominant Drivers of the Real

Exchange Rate," *Review of Economics and Statistics*, forthcoming.

MULLEN, M. M. AND S. K. WOO (2022): "Real Exchange Rate and Net Trade Dynamics: Financial and Trade Shocks," Working Paper, University of Rochester.

MUSSA, M. (1986): "Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications," *Carnegie-Rochester Conference Series on Public policy*, 25, 117–214.

NURKSE, R. (1944): *International Currency Experience: Lessons of the Interwar Period*, Geneva, Switzerland: League of Nations.

——— (1945): "Conditions of International Monetary Equilibrium," Essays in International Finance No. 45, Princeton University.

OBSTFELD, M. AND K. ROGOFF (1996): *Foundations of International Macroeconomics*, Cambridge, MA: MIT Press.

——— (2000): "Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" *NBER Macroeconomics Annual*, 15, 339–390.

OBSTFELD, M. AND H. ZHOU (2022): "The Global Dollar Cycle," *Brookings Papers on Economic Analysis*, 2022, forthcoming.

PETRACCHI, C. (2022): "The Mussa Puzzle: A Generalization," *European Economic Review*, 149, 104222.

RODRIGUEZ, C. A. (1982): "The Argentine Stabilization Plan of December 20th," *World Development*, 10, 801–711.

RODRIK, D. (2008): "The Real Exchange Rate and Economic Growth," *Brookings Papers on Economic Activity*, 2008, 365–412.

SCHMITT-GROHÉ, S. AND M. URIBE (2016): "Downward nominal wage rigidity, currency pegs, and involuntary unemployment," *Journal of Political Economy*, 124, 1466–1514.

SMETS, F. AND R. WOUTERS (2007): "Shocks and Frictions in US business Cycles: A Bayesian DSGE Approach," *American Economic Review*, 97, 586–606.

TAYLOR, J. B. (1993): "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 39, 195–214.

TENREYRO, S. (2007): "On the Trade Impact of Nominal Exchange Rate Volatility," *Journal of Development Economics*, 82, 485–508.

WERNING, I. (2015): "Incomplete Markets and Aggregate Demand," NBER Working Paper No. 21448.

Appendix

A Empirical Appendix

A.1 Details on Exchange Rate Regime Classification

Table A.1 lists of anchor currencies for the country-year observations that we classify as floats. A large majority of our sample of floats have European currencies as their anchor currencies. Other anchor currencies include the South African rand (ZAR), Australian dollar (AUD), Indian rupee (INR), and Singapore dollar (SGD). Ilzetzki et al. (2019) classify a few countries as anchoring to a basket of currencies (USD-EUR, USD-AUD) or the SDR.

One may be concerned that countries anchoring to a basket of currencies that include the US dollar, or to a currency that may be weakly pegged to the US dollar (e.g., ZAR, INR, SGD) should be classified as pegs to the US dollar rather than floats against the US dollar. Our choice is based on the empirical observation that the comovement of these currencies with the US dollar is similar to that of other categories that we classify as floats. Figure A.1 presents results analogous to Figure 2 but with separate categories for (i) observations anchored to ZAR, INR, SGD and (ii) observations anchored to a basket of USD and EUR or USD and AUD. The figure shows that the currencies of these two groups of countries behave extremely similar to freely floating countries (category 13) in terms of comovement with the U.S. dollar.

Additionally, an important point to note in this context is that the choice of how to categorize these observations affects the strength of the "first stage" in our analysis (the strength of the differential effect of the change in the USD on the exchange rate of pegs versus floats). Misclassification of exchange rate regimes will weaken the statistical power of the "first stage" of our analysis but does bias our results. To be concrete, if our exchange rate regimes contain substantial noise, a change in the USD will lead to little effect on the relative trade-weighted exchange rate of peggers versus floaters (classified according to our measure). But Figure 3 shows that this is not the case.

Table A.1: Anchor Currencies of Floats Sample

Anchor currency	Observations
AUD	117
BEF	1
BRL	5
DEM	124
EUR	771
FRF	430
GBP	54
INR	71
ITL	2
PTE	24
RUB	65
SDR	72
SGD	46
TRL	5
USD	36
USD-AUD	68
USD-EUR	107
ZAR	204
n.a.	32

Note: The table lists the anchor currencies of our floats sample based on Ilzetzki, Reinhart, and Rogoff (2019). We only include samples with GDP data.

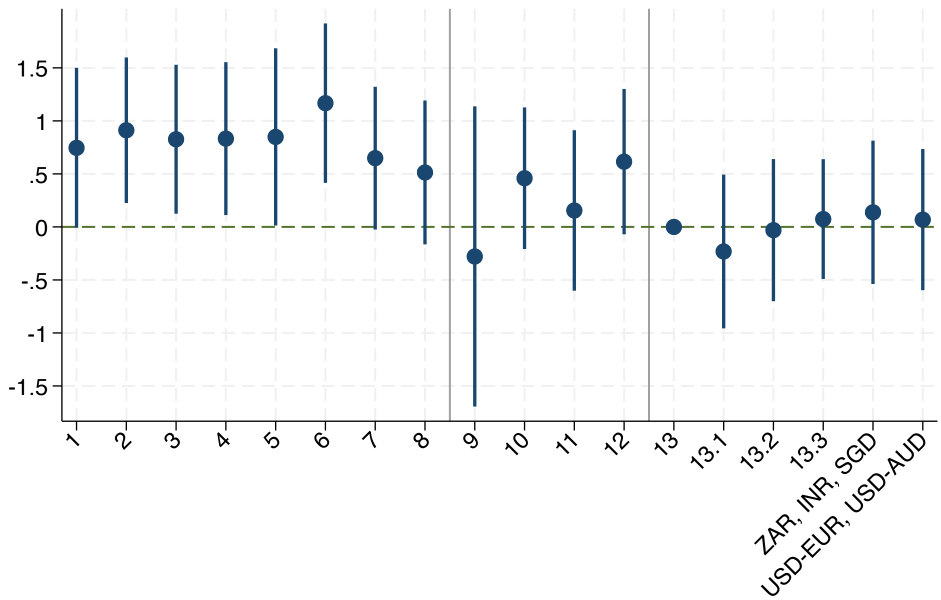


Figure A.1: Comovement with US Dollar by Category with Extra Categories

Note: This figure plots our estimates of the γ_k's from Equation (1) that is analogous to Figure 2 but we include dummies for two separate categories: pegs to ZAR, INR, or SGD and pegs to USD-EUR or USD-AUD.

A.2 Additional Figures and Tables

Table A.2: Ilzetzki, Reinhart, and Rogoff's (2019) Exchange Rate Regime Classification

Fine Code	Coarse Code	Description
1	1	No separate legal tender or currency union
2	1	Pre announced peg or currency board
3	1	Pre announced horizontal band that is narrower than or equal to ±2%
4	1	De facto Peg
5	2	Pre announced crawling peg; de facto moving band narrower than or equal to ±1%
6	2	Pre announced crawling band that is narrower than or equal to ±2% or de facto horizontal band that is narrower than or equal to ±2%
7	2	De facto crawling peg
8	2	De facto crawling band that is narrower than or equal to ±2%
9	3	Pre announced crawling band that is wider than or equal to ±2%
10	3	De facto crawling band that is narrower than or equal to ±5%
11	3	Moving band that is narrower than or equal to ±2%
12	3	De facto moving band ±5% / Managed floating
13	4	Freely floating
13.1	4.1	Other anchor and course classification 1 to that anchor
13.2	4.2	Other anchor and course classification 2 to that anchor
13.3	4.3	Other anchor and course classification 3 to that anchor

Note: The table lists the exchange rate regime classification of Ilzetzki, Reinhart, and Rogoff (2019). The table excludes two categories: "freely falling" and "dual market with missing parallel market data." The bottom three rows are three categories we create in our analysis.

Table A.3: Data Series and Sources

Variable	Source	Observations	Countries
Nominal effective exchange rate	Darvas (2021)	5012	149
Real effective exchange rate	Darvas (2021)	4905	149
Exchange rate to USD	IFS	4997	150
GDP	WDI	4975	158
Consumption	WDI	3244	137
Investment	WDI	3220	136
Export	WDI	3319	142
Import	WDI	3319	142
Net Exports	Constructed	3319	142
Nominal Interest Rate	IFS	2409	98
CPI	IFS	4462	153
Ex-post Real Interest Rate	Constructed	2139	92
Export Unit Value	UNCTAD	3831	158
Import Unit Value	UNCTAD	3697	158
Terms of Trade	Constructed	3697	158
Manufacturing GDP	WDI	3773	146
Service GDP	WDI	3899	148
Agriculture GDP	WDI	4184	151
Mining, Construction, Energy GDP	WDI	3643	144

Note: This table lists the variables and data sources we use. Column 3 presents the number of observations in our baseline sample. Column 4 presents the number of countries in our baseline sample.

Table A.4: Share of Variation that is Regime Induced

Horizon, h	Adjusted R^2	
	Including Peg Variables	Dropping Peg Variables
0	0.38	0.30
1	0.33	0.28
2	0.32	0.29
3	0.35	0.30
4	0.38	0.32
5	0.41	0.35
6	0.43	0.37
7	0.46	0.39
8	0.49	0.40
9	0.52	0.39

Note: The table reports adjusted R^2 from regression (2) for each horizon h, where the outcome variable is the log nominal effective exchange rate. The columns "Including Peg Variables" correspond to our baseline specification where $\text{Peg}_{i,t}$ and its interaction with $\Delta e_{US,t}$ as well as their lags are included. The columns "Dropping Peg Variables' correspond to the one where they are removed from the explanatory variables.

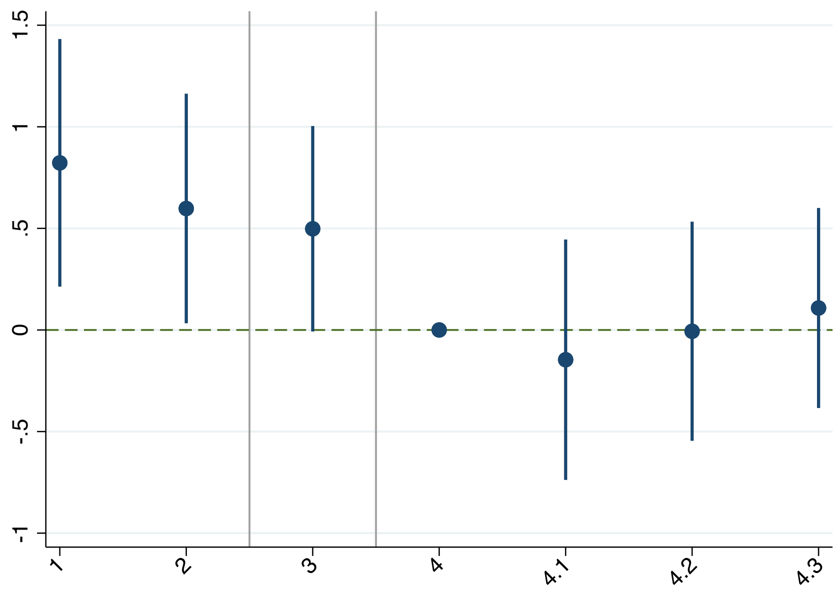


Figure A.2: Comovement with US Dollar by Category

Note: This figure plots our estimates of the γ_k's from Equation (1). These are estimates of the comovement of the exchange rate of currencies with different exchange rate regimes as classified by Ilzetzki, Reinhart, and Rogoff's (2019) coarse classification. We normalize the γ_k for category 4 (freely floating and anchored to the US dollar) to be zero. Categories 4.1 through 4.3 are currencies anchored to other currencies than the US dollar and classified in coarse categories 1 through 3, respectively, relative to their anchor currency. The vertical lines denotes the splits between categories we classify as pegs (1 and 2) and floats (4 through 4.3).

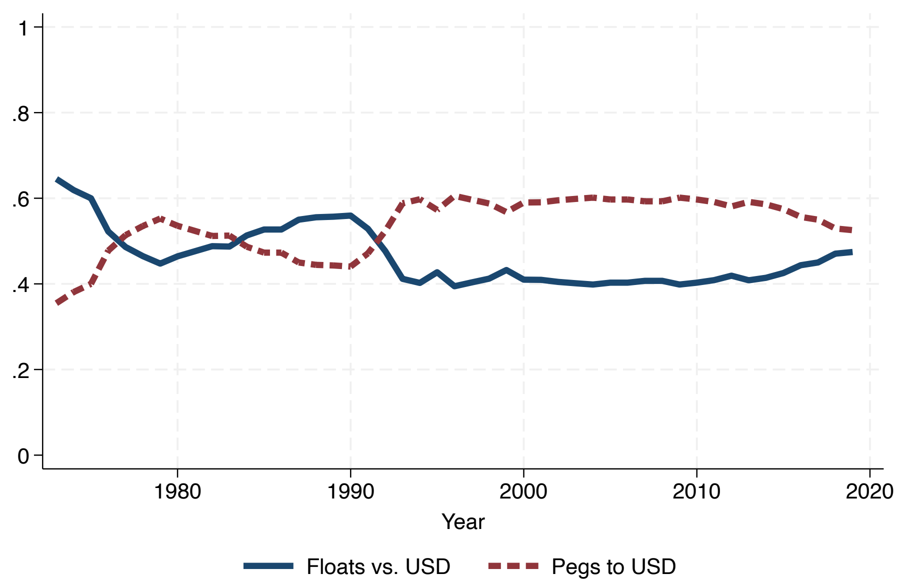


Figure A.3: Pegs and Floats over Time

Note: This figure plots the faction of countries that we classify as pegs and floats over time among observations where GDP data is available.

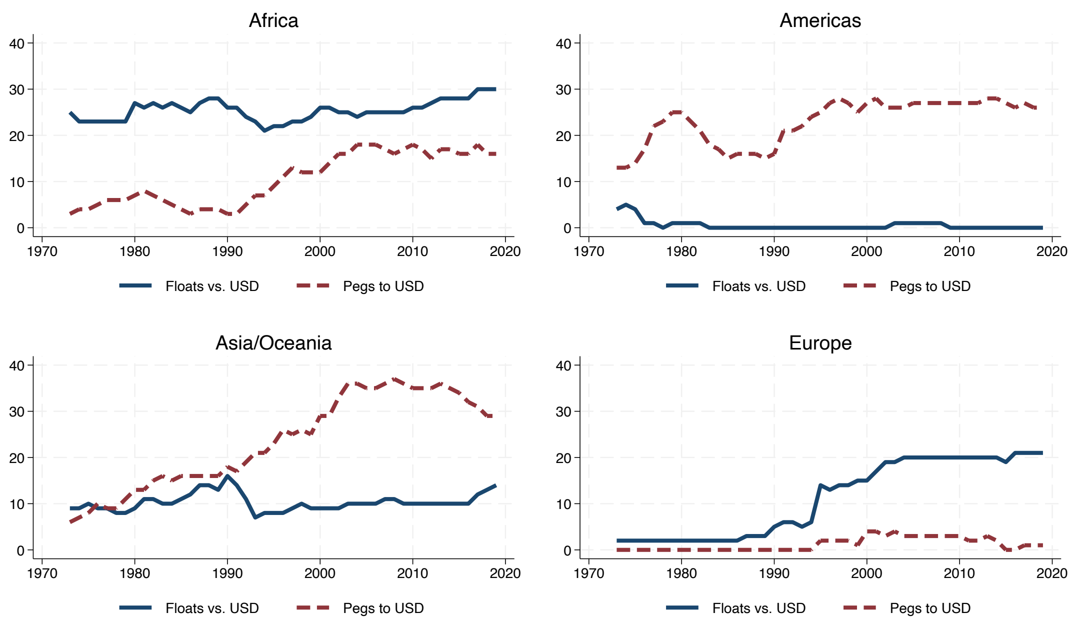


Figure A.4: Exchange Rate Regimes over Time by Region

Note: This figure plots the number of countries that we classify as pegs and floats over time by region. We only include samples where GDP data is available. The number of countries in Europe is small before 1990 because we exclude the 24 countries that we define the US dollar exchange rate against most of which are in Europe.

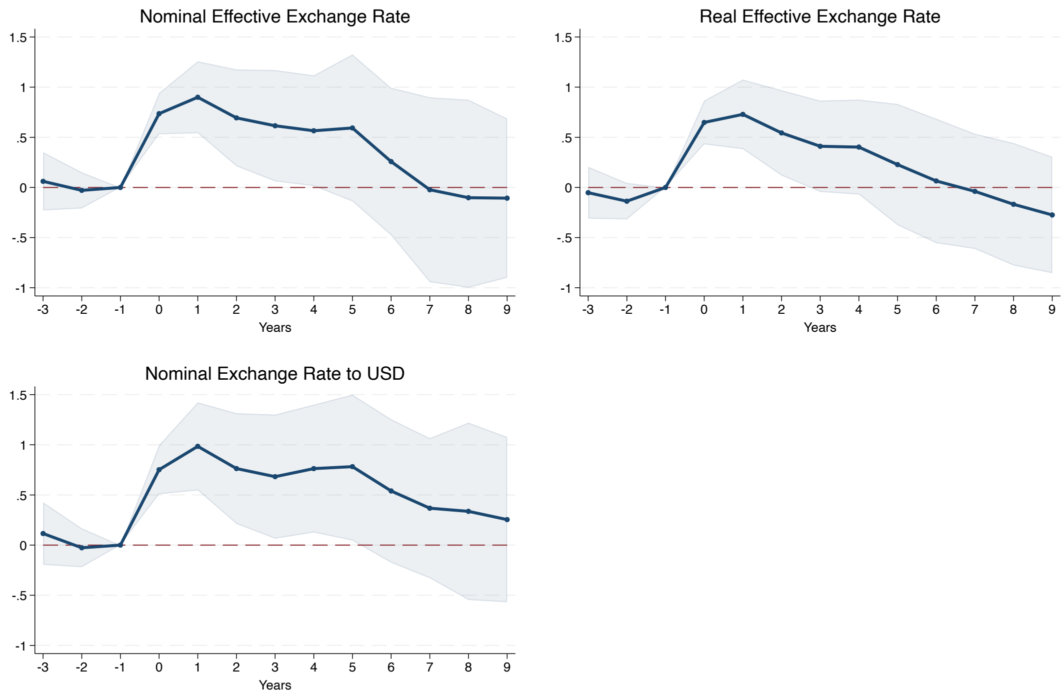


Figure A.5: Response of US Dollar Exchange Rate for Pegs vs. Floats

Note: This figure plots the response of the nominal effective exchange rate, real effective exchange rate, and country i's US dollar exchange rate for pegs versus floats in response to a change in the US dollar nominal effective exchange rate. In all three cases the dependent variable is the change in the logarithm of the variable. These are our estimates of β_h in Equation (2) for different horizons h when these three variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

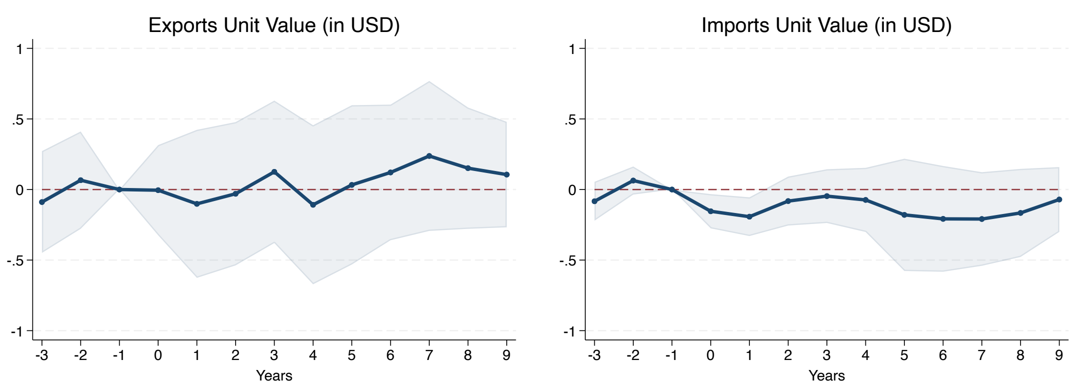


Figure A.6: Response of Pegs vs. Floats for Export and Import Prices

Note: This figure plots the response of export and import unit values in US dollars for pegs versus floats in response to a change in the US dollar exchange rate. For both variables, the dependent variable is the change in the logarithm of the variable. These are our estimates of β_h in Equation (2) for different horizons h when these two variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

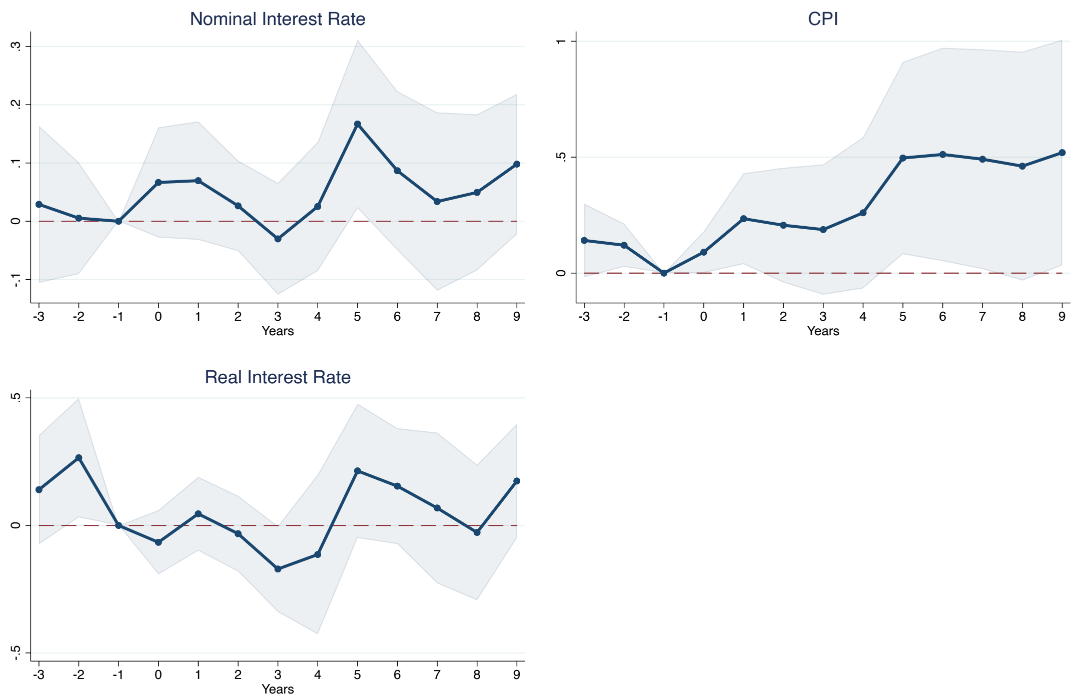


Figure A.7: Response of Interest Rates and Prices for Pegs vs. Floats

Note: This figure plots the response of the short term nominal interest rate, the CPI, and the ex-post real interest rate for pegs versus floats in response to a change in the US dollar nominal effective exchange rate. For the CPI, the dependent variable is the change in the logarithm of the CPI. For the nominal and real interest rates, the dependent variable is the variable in levels (i.e., 0.02 denotes 2%). These are our estimates of β_h in Equation (2) for different horizons h when these three variables are the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

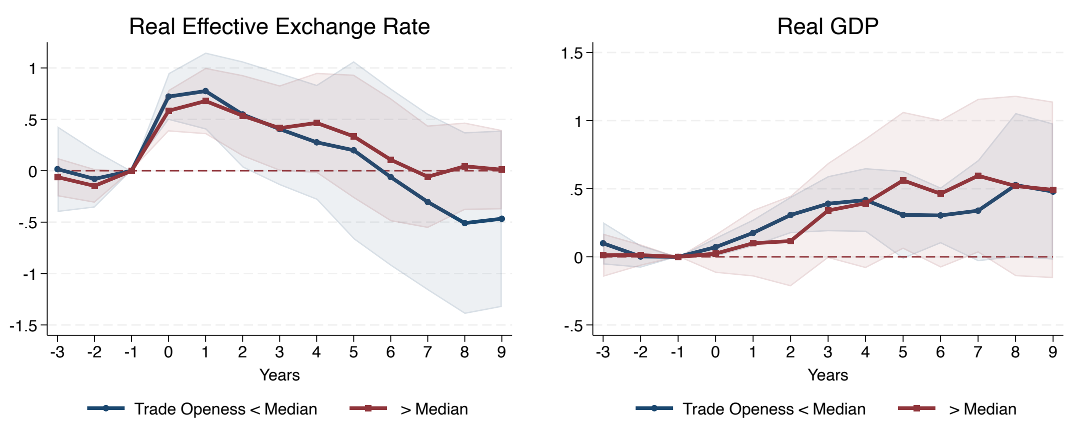


Figure A.8: Response of Pegs vs. Floats by Trade Openness

Note: This figure plots the response of real exchange rate and GDP for pegs versus floats in response to a change in the US dollar exchange rate. We estimate these responses separately for the sample of countries with an average trade openness below median and above median. We measure the average trade openness of a country as the sum of exports and imports divided by GDP, averaged over our sample period. For the real exchange rates, the dependent variable is the change in the logarithm of the variable. For GDP, the dependent variable is the percentage change. These are our estimates of β_h in Equation (2) for different horizons h. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

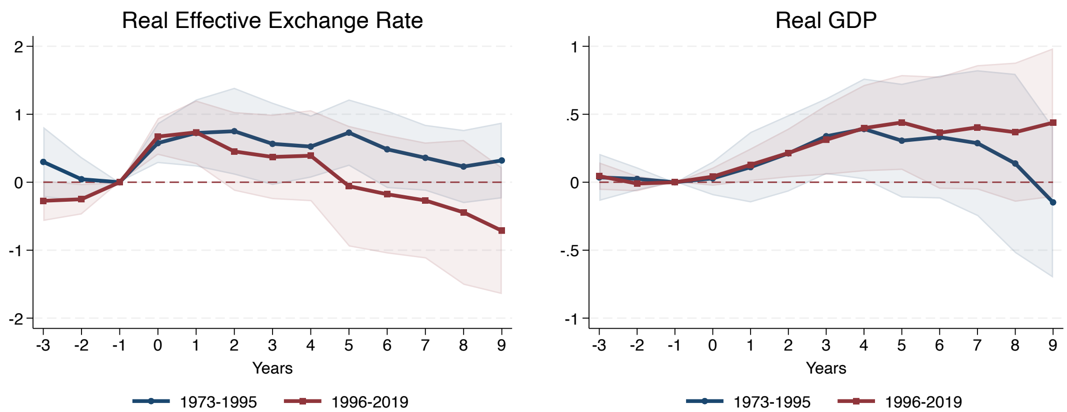


Figure A.9: Response of Pegs vs. Floats by Sample Period

Note: This figure plots the response of real exchange rate and GDP for pegs versus floats in response to a change in the US dollar exchange rate. We estimate these responses separately for the first and the second half of our sample period. For the real exchange rates, the dependent variable is the change in the logarithm of the variable. For GDP, the dependent variable is the percentage change. These are our estimates of β_h in Equation (2) for different horizons h. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

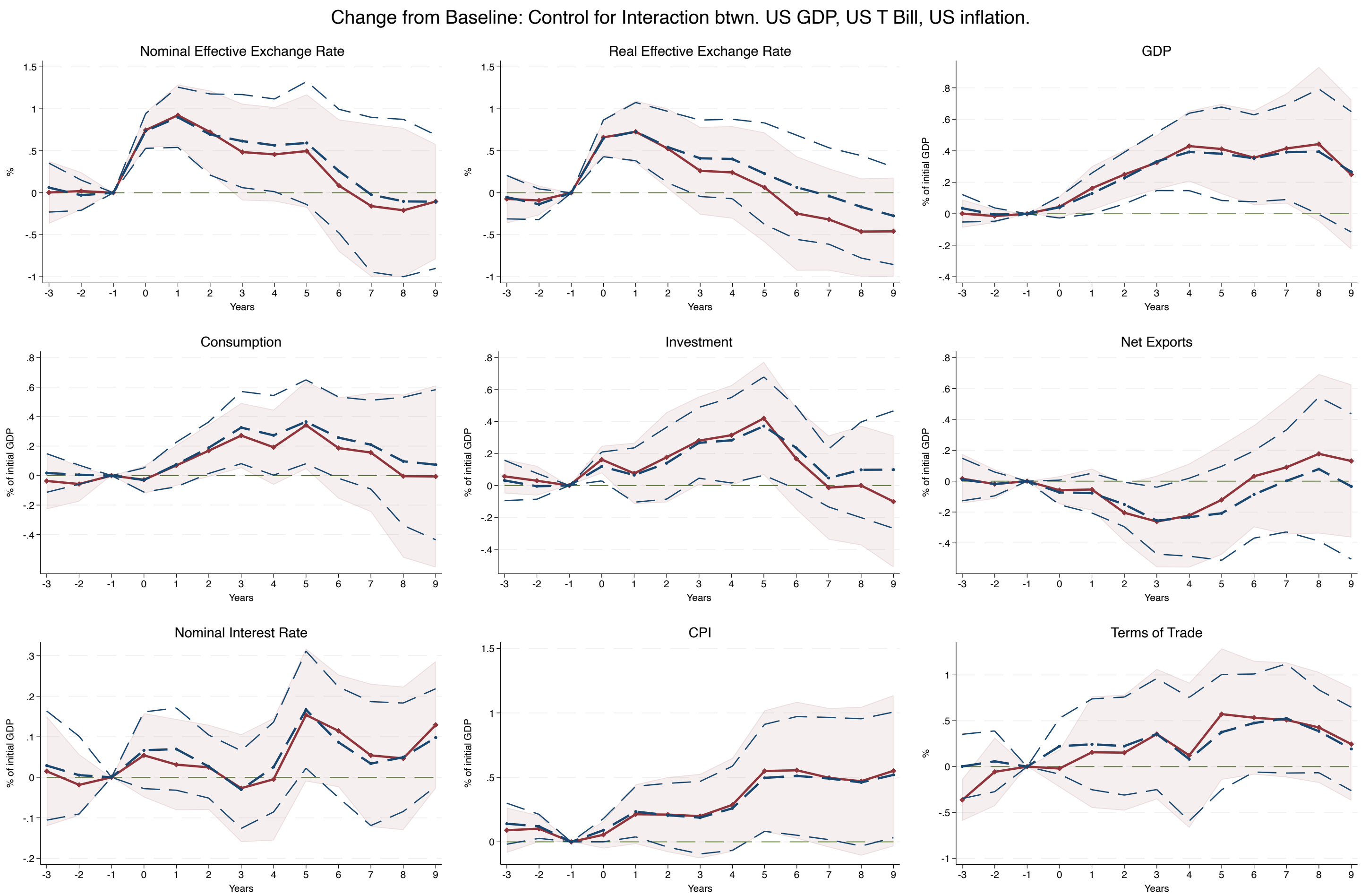


Figure A.10: Responses with Added US Controls

Note: This figure plots responses for a specification analogous to our baseline specification except that we add the interaction of contemporaneous US GDP growth, US inflation, and the US T-bill rate with the peg indicator variable as controls (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

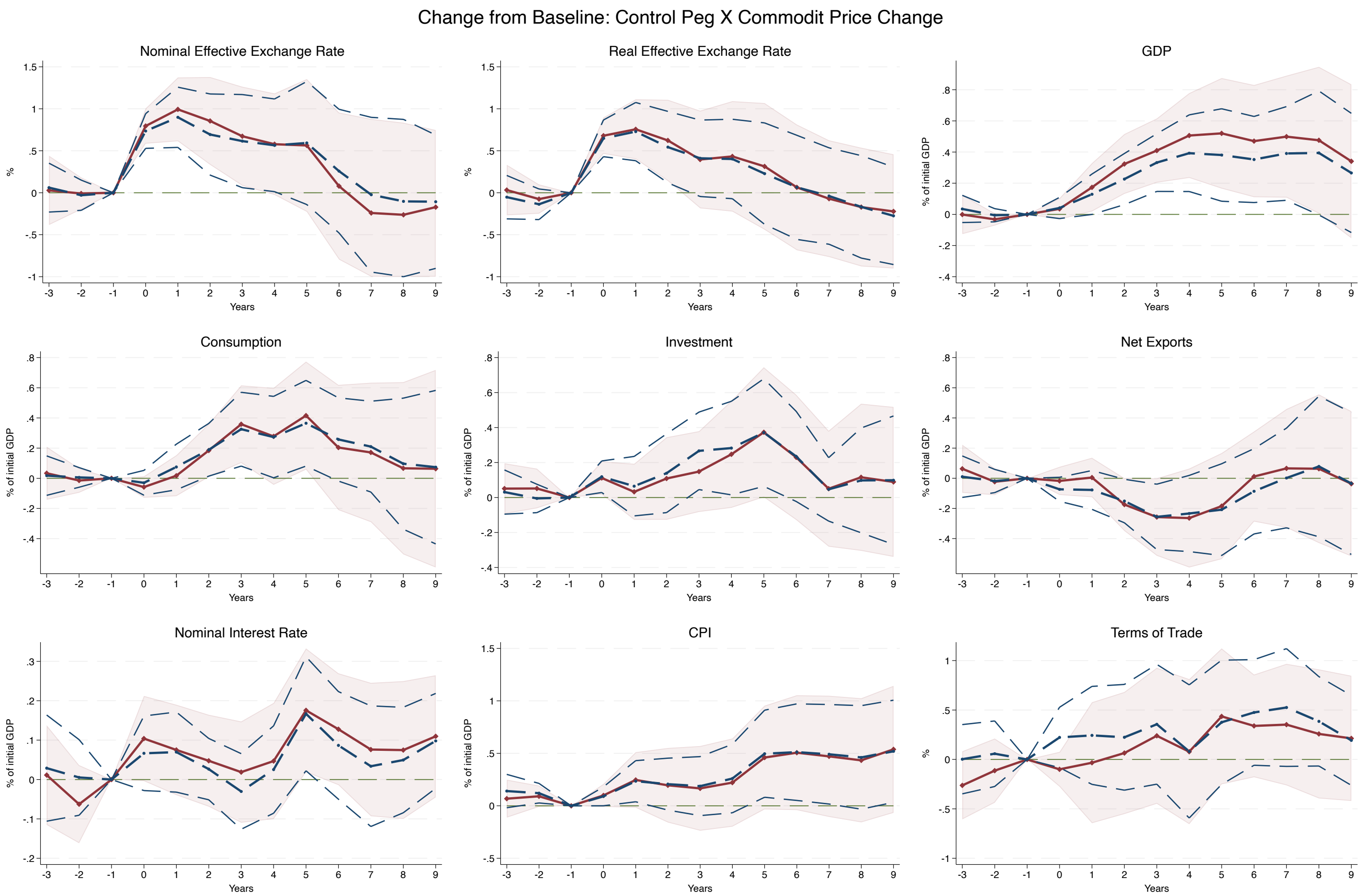


Figure A.11: Responses with Added Commodity Price Controls

Note: This figure plots responses for a specification analogous to our baseline specification except that we add the following control: log changes in commodity price index interacted with the peg indicator variable (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

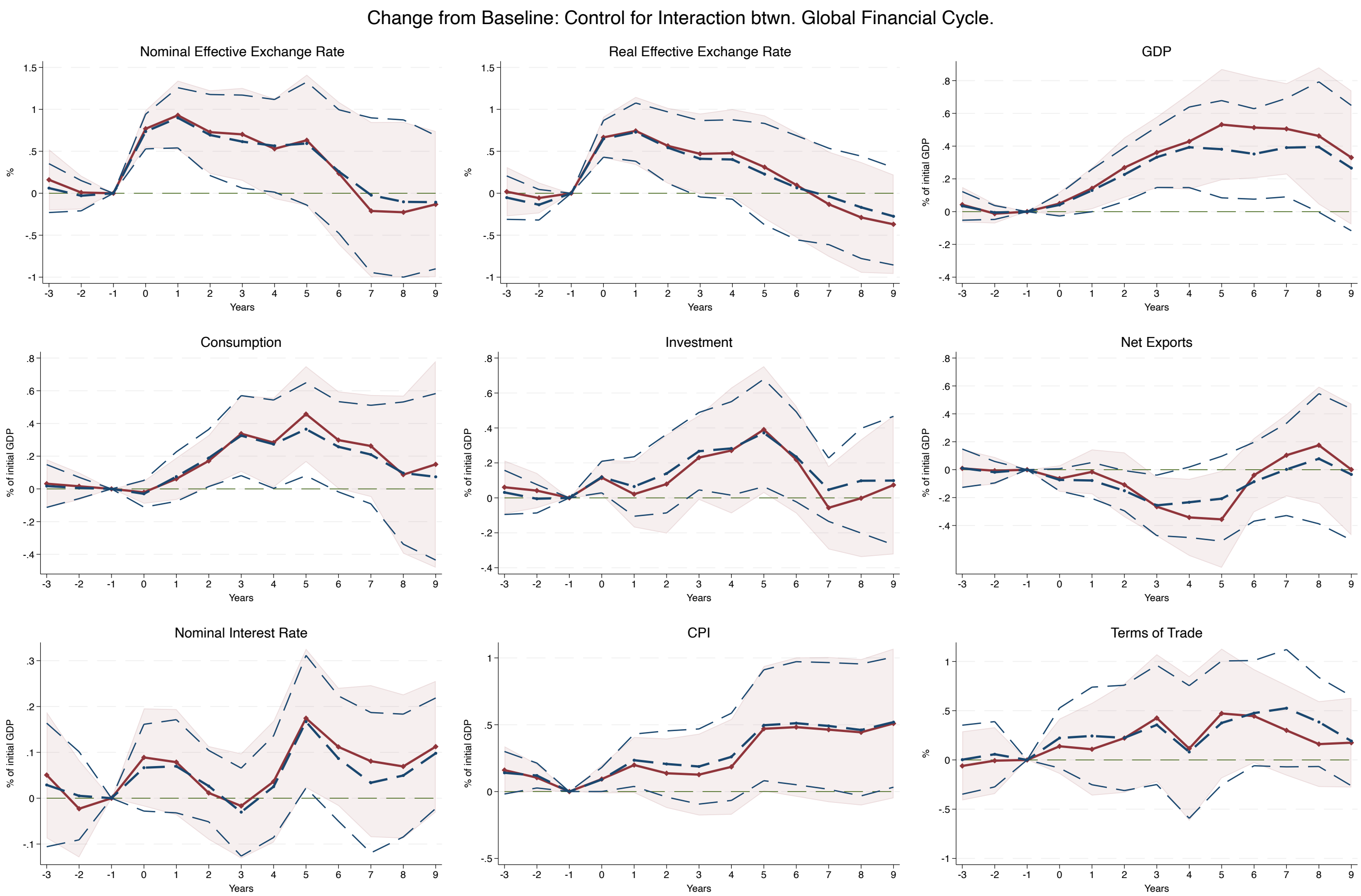


Figure A.12: Responses with Added Global Financial Cycles Controls

Note: This figure plots responses for a specification analogous to our baseline specification except that we add the following control: changes in Global Financial Cycle measure by Miranda-Agrippino and Rey (2015, 2020) interacted with the peg indicator variable (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

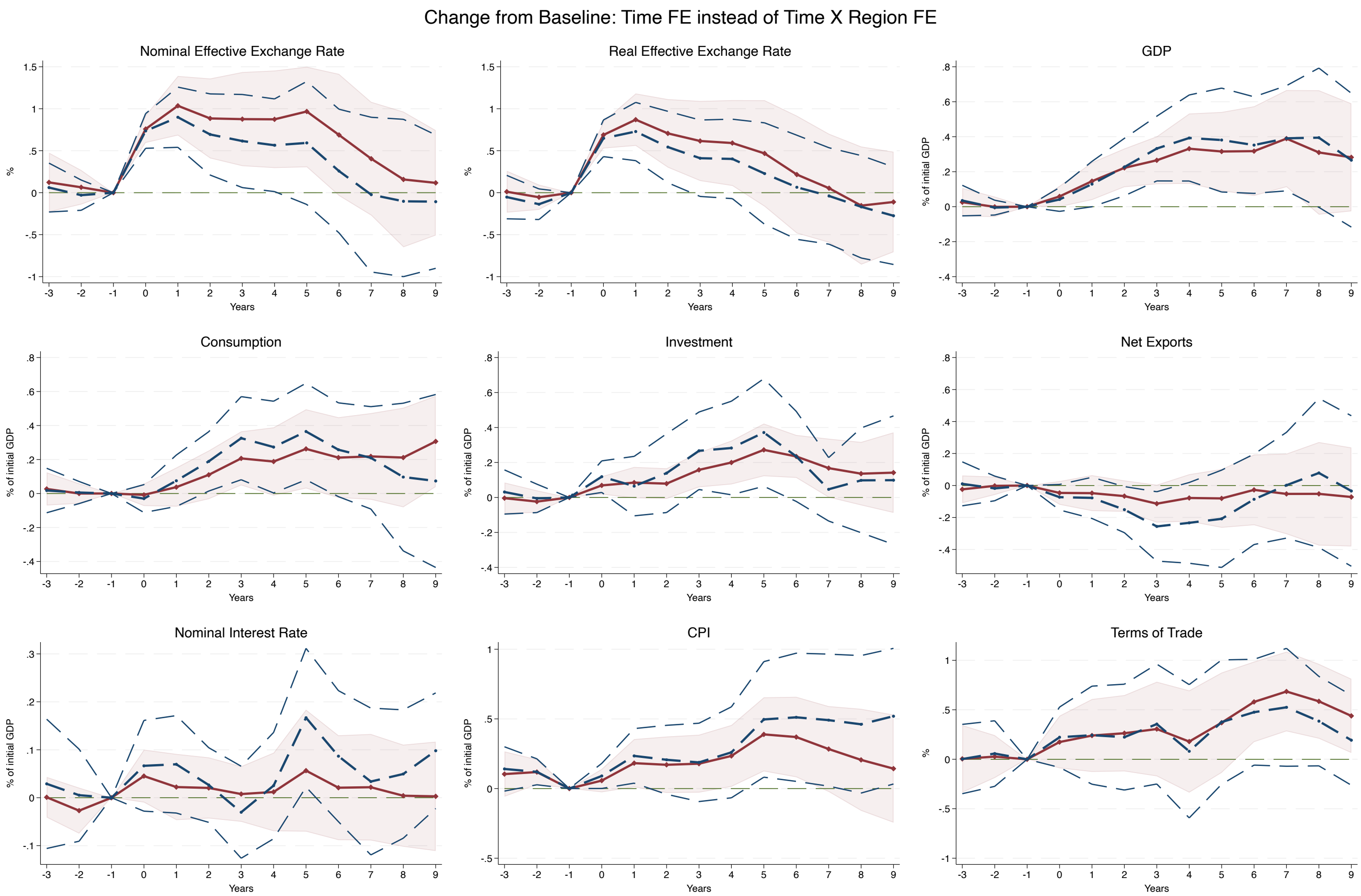


Figure A.13: Responses with Time Fixed Effects

Note: This figure plots responses for a specification analogous to our baseline specification except that region-by-time fixed effects have been replaced by time fixed effects (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

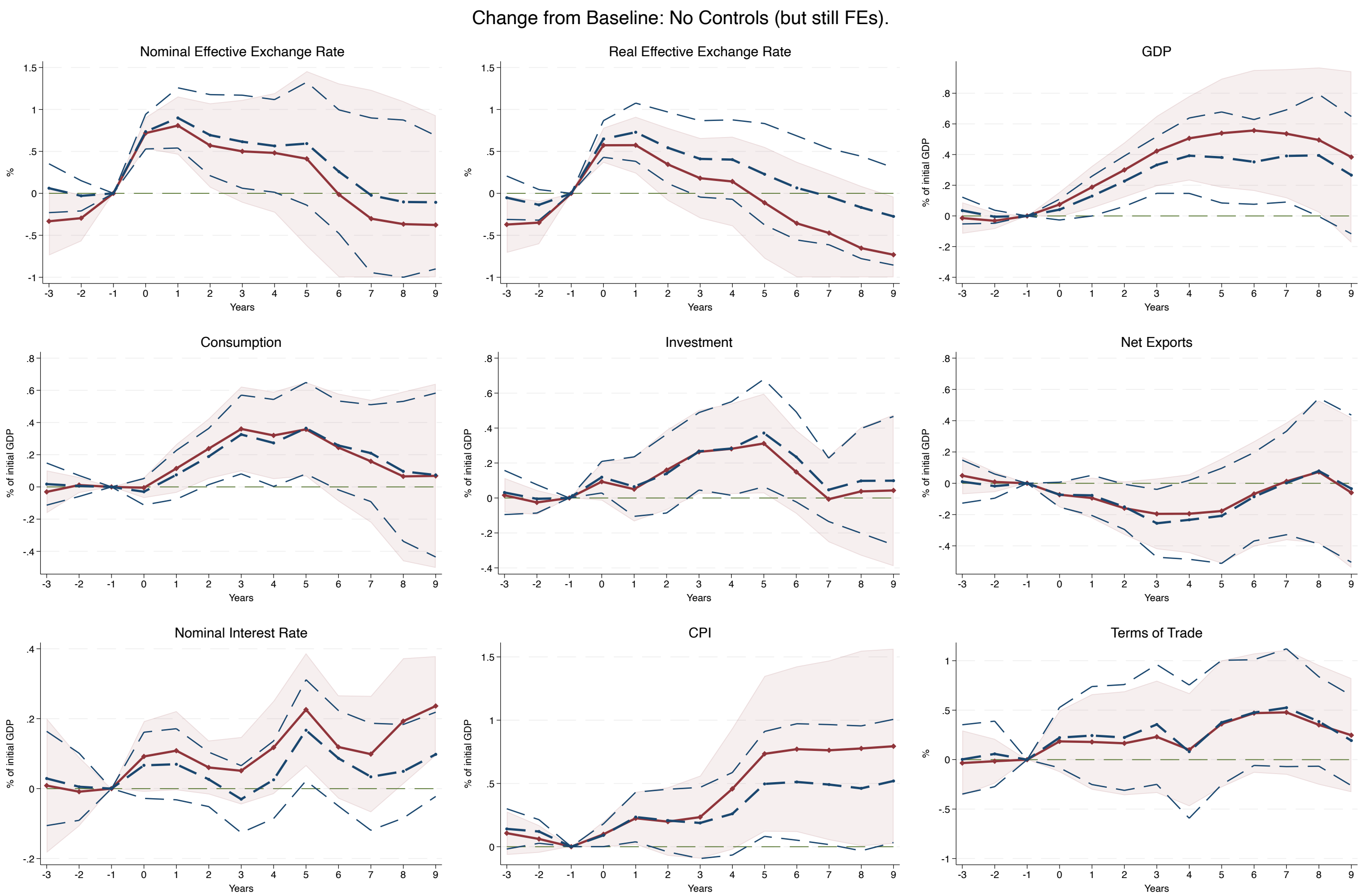


Figure A.14: Responses with No Controls Other than Fixed Effects

Note: This figure plots responses for a specification analogous to our baseline specification except that no controls are included other than fixed effects (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

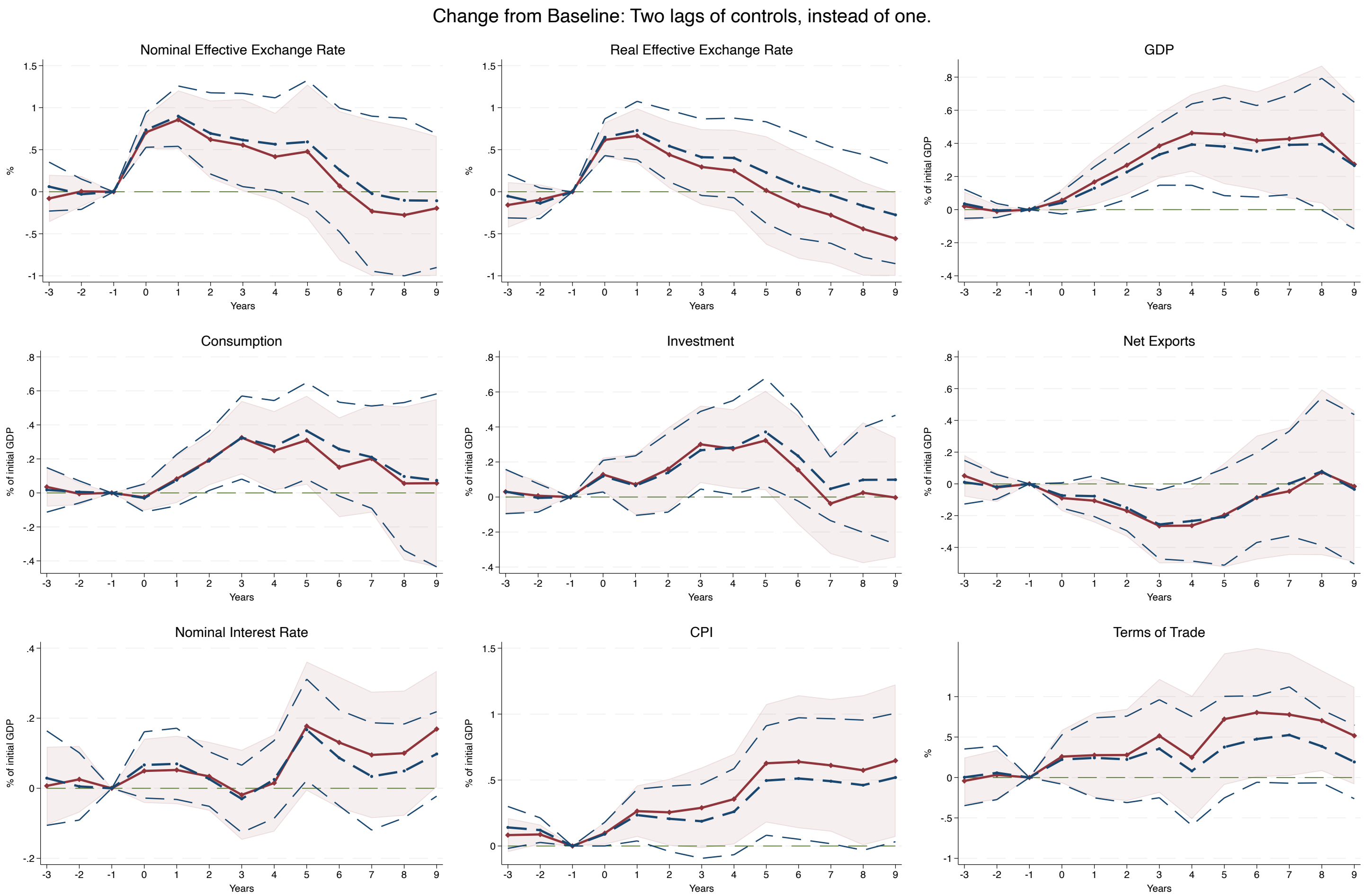


Figure A.15: Responses with Two Lags of Controls

Note: This figure plots responses for a specification analogous to our baseline specification except that two lags of controls are included (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

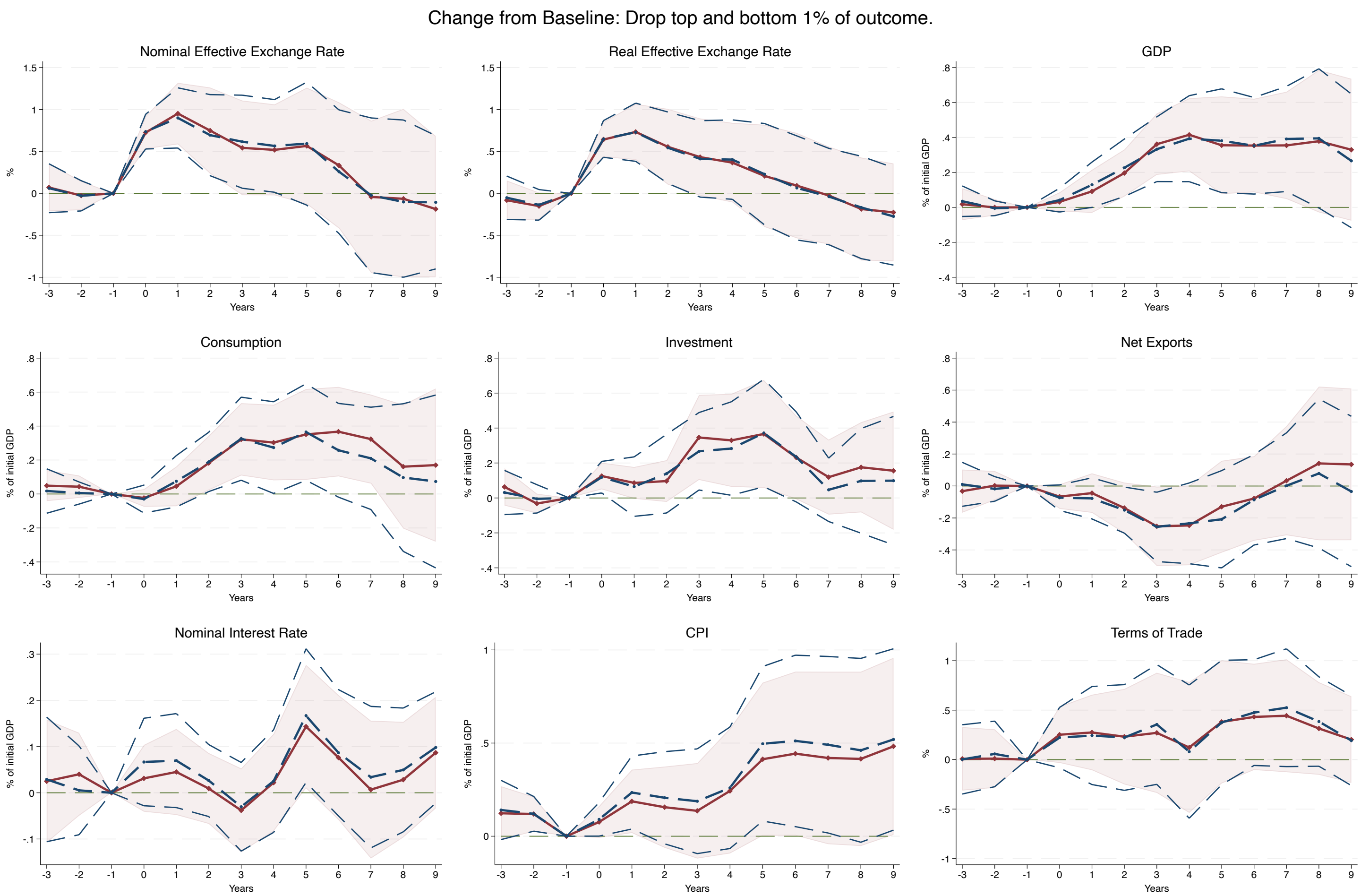


Figure A.16: Responses when Top and Bottom 1% of Observations are Dropped

Note: This figure plots responses for a specification analogous to our baseline specification except that we drop the top and bottom 1% of observations (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

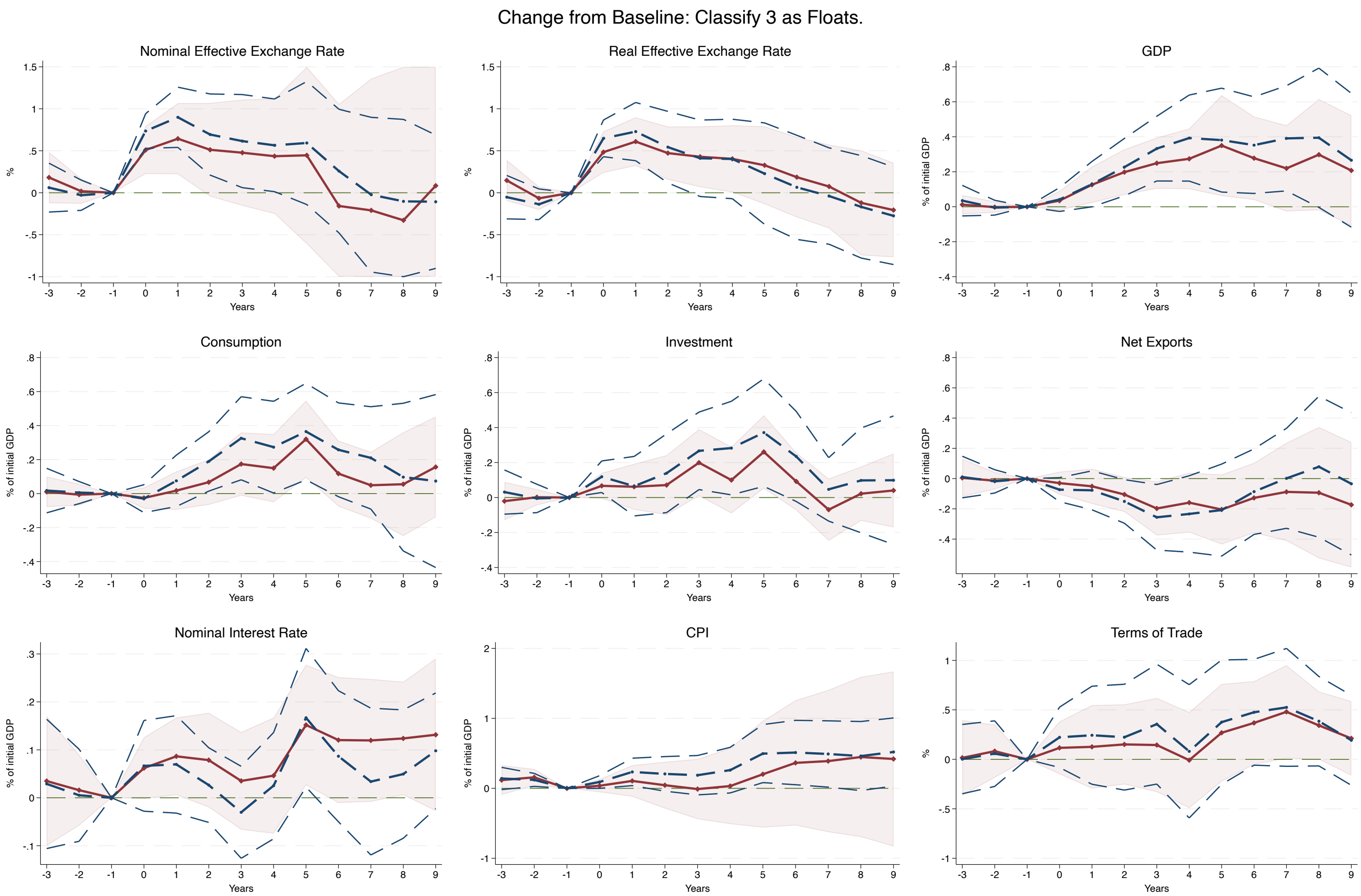


Figure A.17: Responses with Coarse Category 3 Included as Floats

Note: This figure plots responses for a specification analogous to our baseline specification except that we include observations in Ilzetzki, Reinhart, and Rogoff's coarse category 3 as Floats (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

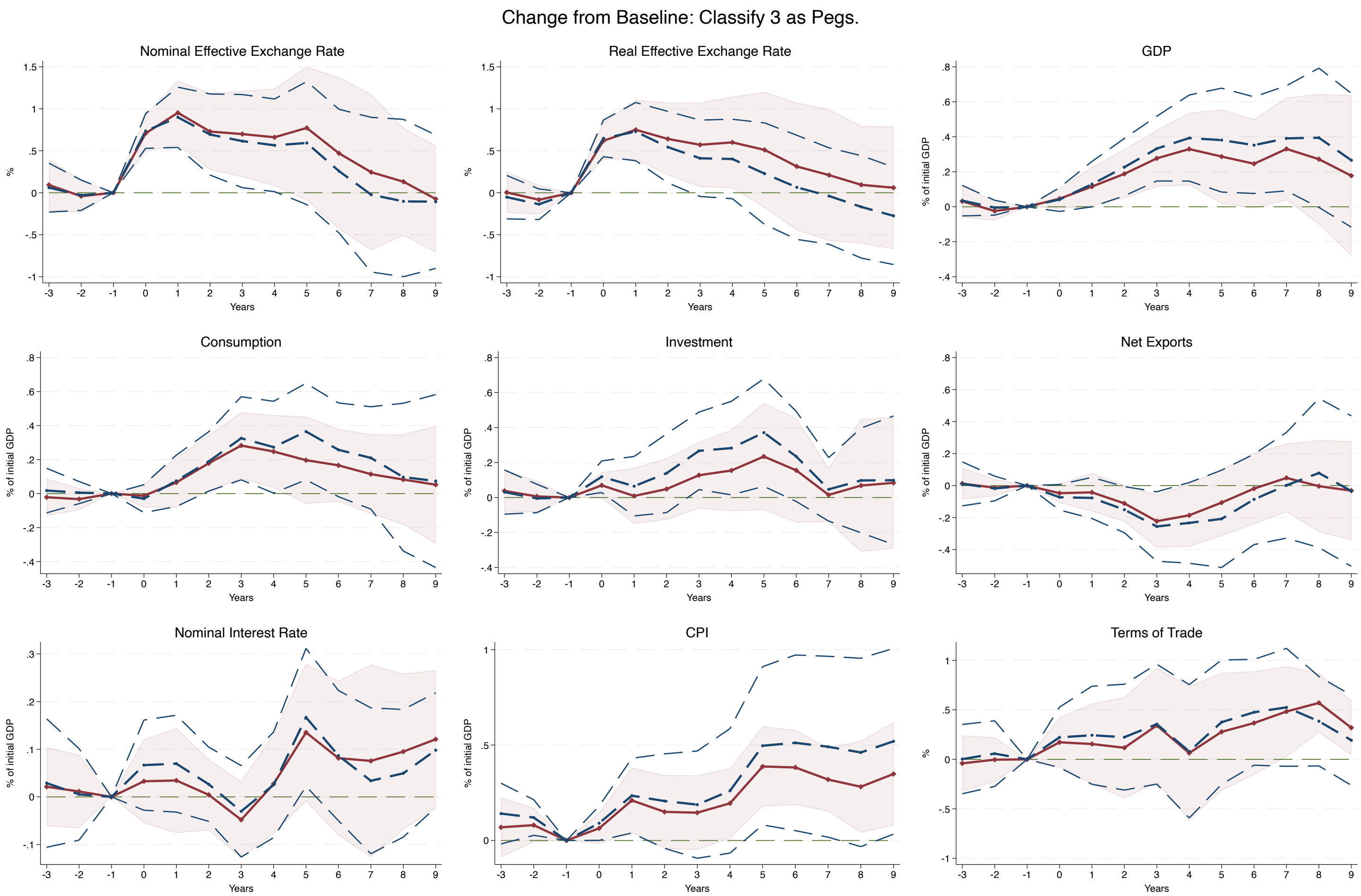


Figure A.18: Responses with Coarse Category 3 Included as Pegs

Note: This figure plots responses for a specification analogous to our baseline specification except that we include observations in Ilzetzki, Reinhart, and Rogoff's coarse category 3 as pegs (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

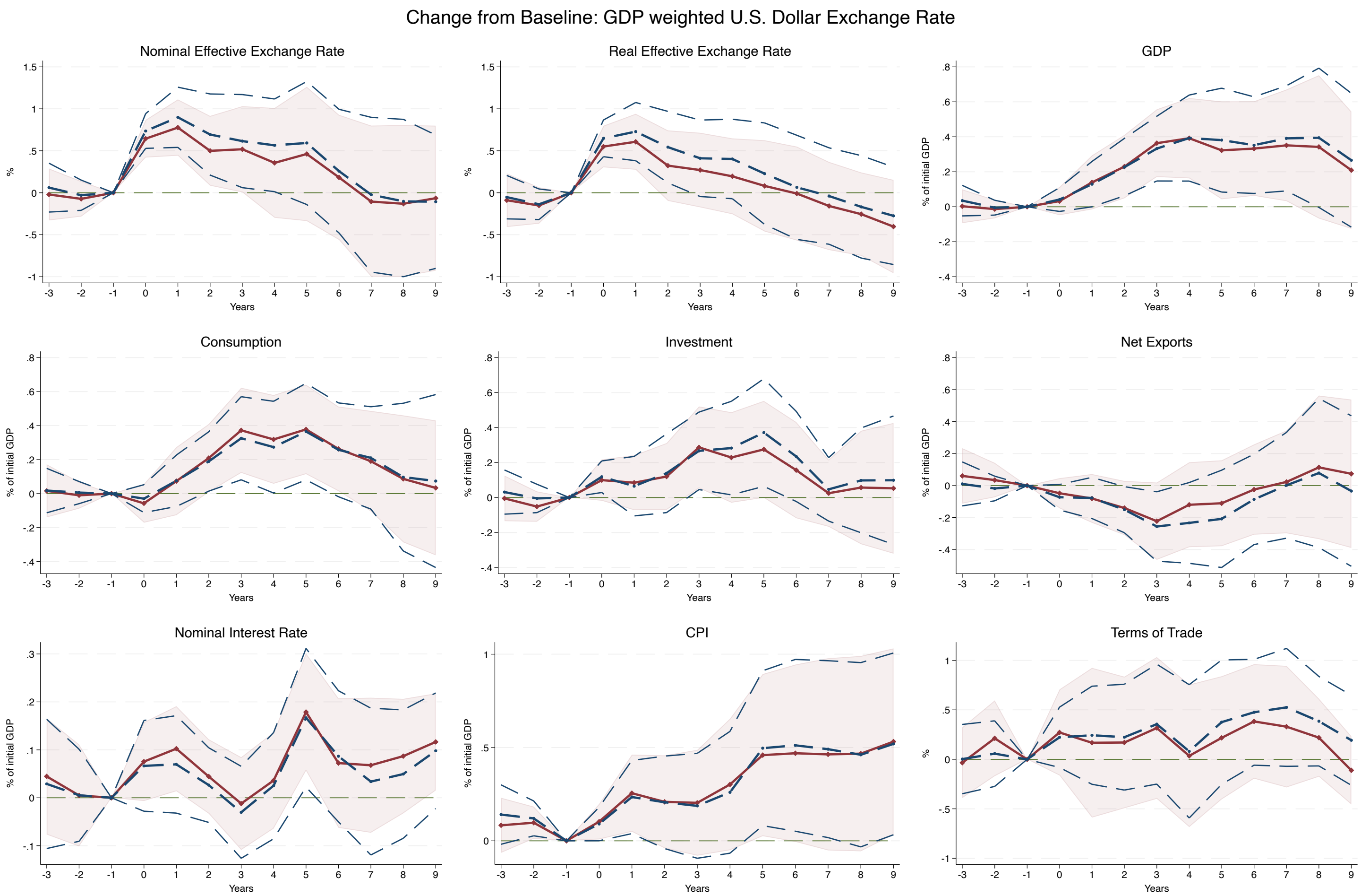


Figure A.19: Responses with a GDP-Weighted US Dollar Exchange Rate

Note: This figure plots responses for a specification analogous to our baseline specification except that the US dollar exchange rate is constructed using GDP weights rather than trade weights (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

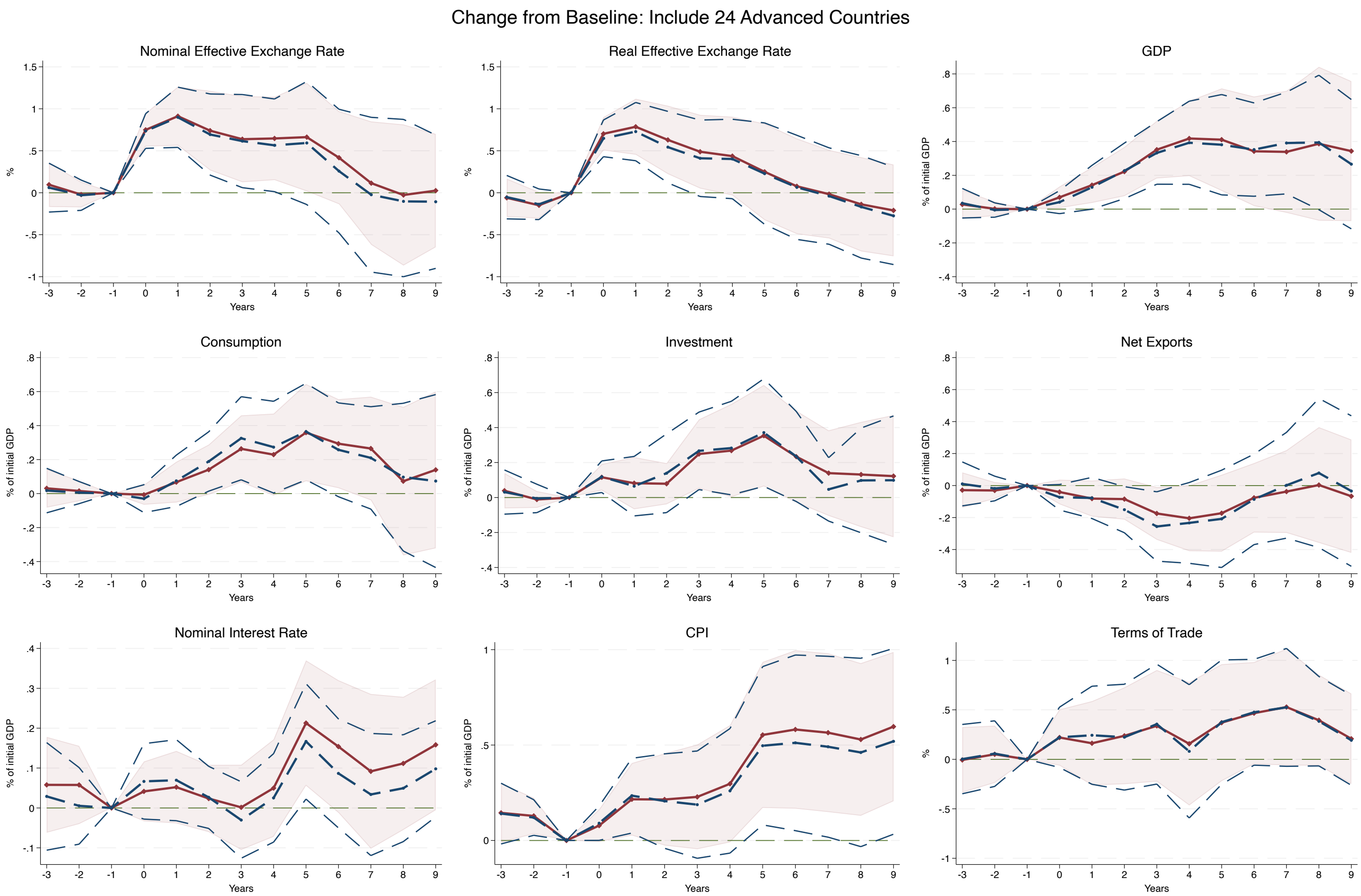


Figure A.20: Responses Including 24 "Advanced" Countries

Note: This figure plots responses for a specification analogous to our baseline specification except that we include the 24 countries that the BIS US trade-weighted exchange rate is defined relative to (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

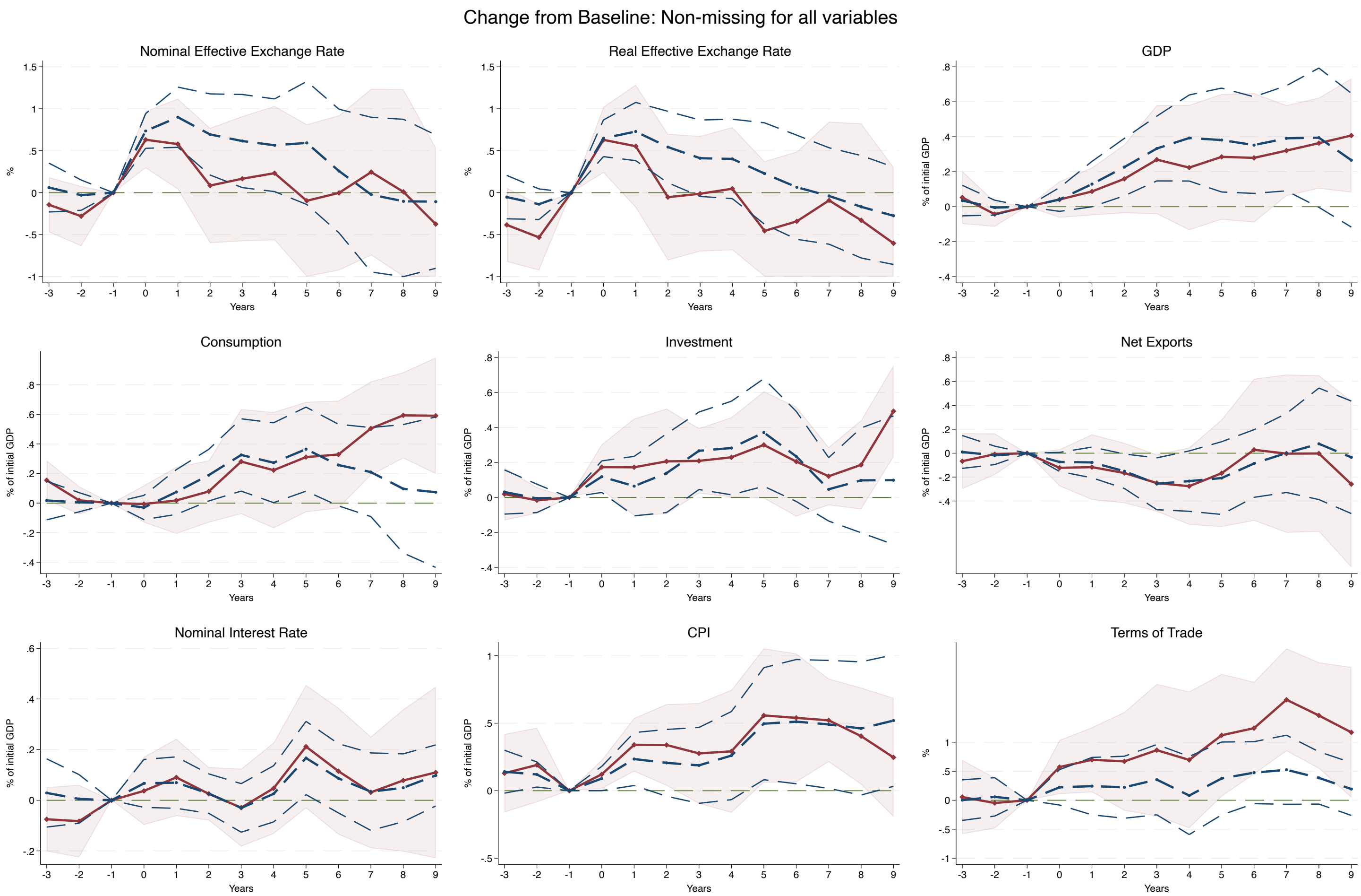


Figure A.21: Responses with Same Sample for All Variables

Note: This figure plots responses for a specification analogous to our baseline specification except that we estimate it on the largest sample where we have all nine variables (red diamonds). We also plot the baseline responses for comparison (blue circles). The shaded areas and broken lines are 95% confidence intervals.

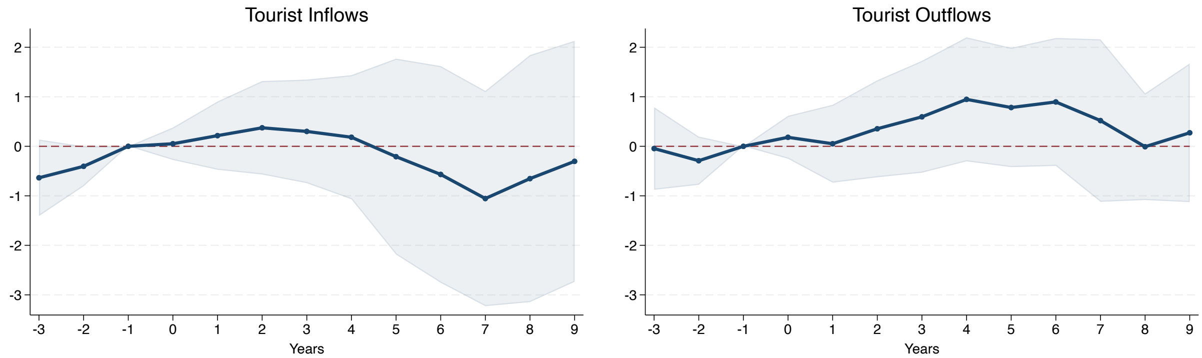


Figure A.22: Responses of Tourist Inflows and Outflows

Note: This figure plots the response of tourist inflows and outflows for pegs versus floats in response to a change in the US dollar exchange rate. The dependent variables are the change in the logarithm of the variable. These are our estimates of β_h in Equation (2) for different horizons h. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals. We obtain data for tourists flow from World Bank's World Tourism Organization, Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files.

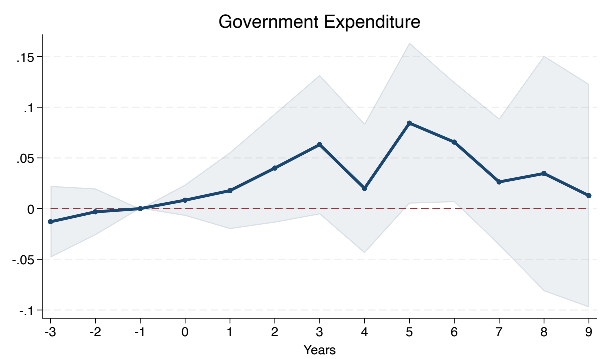


Figure A.23: Responses of Government Expenditure

Note: This figure plots the response of government purchases for pegs versus floats in response to a regime-driven change in the US dollar exchange rate. The dependent variable is $(G_{i,t+h} - G_{i,t-1})/Y_{i,t-1}$, where Y denotes GDP and G denotes government purchases, both of which are expressed in constant 2015 US Dollars. The data is from World Bank World World Development Indicators. These are our estimates of β_h in Equation (2) for different horizons h when the variable described above is the outcome variables. These results are for the case with our baseline set of controls. The shaded areas are 95% confidence intervals.

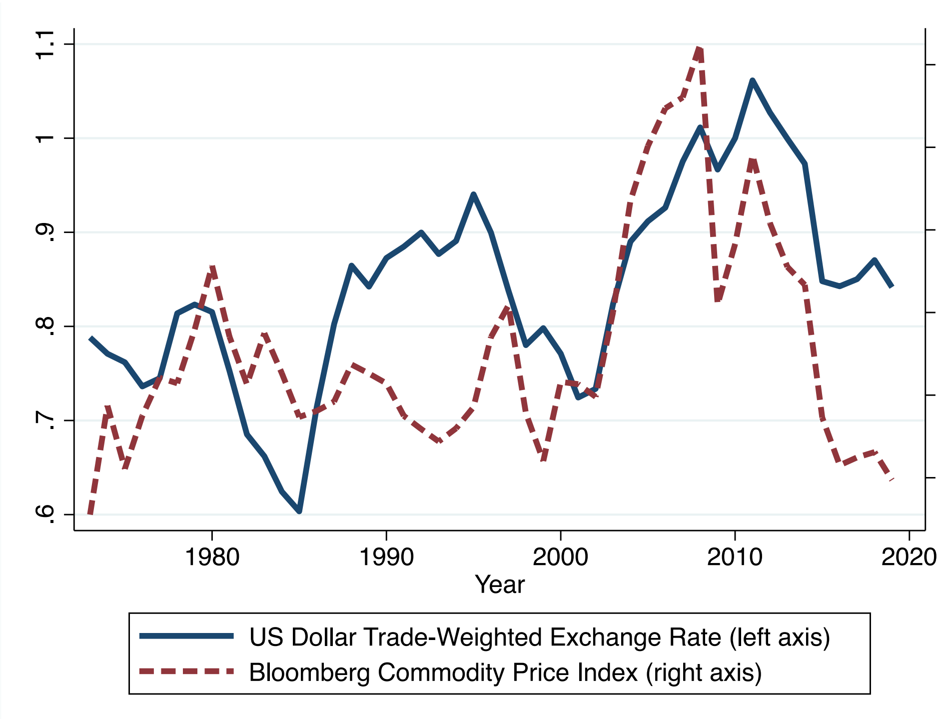


Figure A.24: US Dollar Trade-Weighted Exchange Rate and Commodity Price Index

Note: This figure plots the BIS's trade-weighted exchange rate of the US dollar against 24 countries and the Bloomberg Commodity Index. Lower values indicate a more appreciated US dollar.

B Theory Appendix

B.1 Standard Open-Economy New Keynesian Model Features

Here, we describe the features that our model shares with standard open economy New Keynesian models without financial frictions. If we set the adjustment costs in the portfolio problem of the households and the firms in our model to zero (see the description of these portfolio problems in Section 3 of the main text), our model becomes a standard open economy New Keynesian models without financial frictions in which UIP holds for all currency pairs.

B.1.1 Households

There is a unit measure of identical households in each economy. These households derive utility from consumption and disutility from labor. They maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_{it} - hC_{it-1}) - \chi(n_{it}) \right], \tag{B.1}$$

where C_{it} denotes consumption of households from country i at time t of a composite of home and foreign goods discussed below, n_{it} denotes labor supplied by households in country i at time t, β is the households' subjective discount factor, h is a parameter governing the strength of their habit formation in consumption,

$$u(C_{it} - hC_{it-1}) = \frac{(C_{it} - hC_{it-1})^{1-\sigma}}{1-\sigma}, \qquad \chi(n_{it}) = \frac{n_{it}^{1+\nu}}{1+\nu},$$

where σ is inversely related to the household's intertemporal elastiticy of substitution, and ν is the inverse of the Frisch elasticity of labor supply.

The composite consumption good C_{it} is a constant elasticity of substitution (CES) basket of goods produced in different countries

$$C_{it} = \left((1-\alpha)^{1/\eta} (c_{iit})^{\frac{\eta-1}{\eta}} + \alpha^{1/\eta} \int_0^1 (c_{jit})^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}},$$

where c_{jit} denotes the consumption by household in country i of a basket of goods produced in country j, $\alpha \in [0, 1]$ determines the weight on foreign goods in C_{it}, and $\eta > 0$ is the elasticity of substitution between goods from different countries. The index c_{jit} is a CES basket of a continuum of varieties $c_{jit}(v)$ produced in country j:

$$c_{jit} = \left(\int_0^1 \left(c_{jit}(v)\right)^{\frac{\epsilon_p - 1}{\epsilon_p}} dv \right)^{\frac{\epsilon_p}{\epsilon_p - 1}},$$

where the elasticity of substitution across goods produced by country j is $\epsilon_p > 1$.

Households in country i maximize utility subject to the following budget constraint:

$$C_{it} + a_{it} = a_{it-1}(1 + r_{it}^h) + (1 - \tau_i^n) W_{it} N_{it} / P_{it} + T_{it}, \tag{B.2}$$

where a_{it} denotes the value of the portfolio of assets that households purchase in period t, r_{it}^h is the real return on the portfolio that households purchased in period $t-1$, W_{it} is an index of the wages the households earn for supplying labor at time t, N_{it} is the composite index of labor services the households supply to firms (described below), P_{it} is the price level in country i at time t, τ_i^n is a time-invariant labor income tax imposed by the government, and T_{it} denotes transfers received from the government. We introduce the labor income tax to offset steady state markup distortions due to union power in the labor market.

Households in country i optimally trade off consumption today versus consumption in the future. This gives rise to the following consumption Euler equation

$$MU_{it} = \mathbb{E}_t[(1 + r_{it+1}^h) MU_{it+1}], \tag{B.3}$$

where

$$MU_{it} = u'(C_{it} - hC_{it-1}) - \beta h u'(C_{it+1} - hC_{it}) \tag{B.4}$$

is the marginal utility from increasing consumption by one unit today.

Households optimally choose how much to consume of goods from each country. This choice gives rise to a demand function given by

$$c_{jit} = \begin{cases} \alpha \left(\frac{p_{jit}}{P_{it}} \right)^{-\eta} C_{it} & \text{for } j \neq i \\ (1 - \alpha) \left(\frac{p_{jit}}{P_{it}} \right)^{-\eta} C_{it} & \text{for } j = i \end{cases}$$

where p_{jit} is the price index of goods consumed in country i that were produced in country j. The households furthermore optimally choose how much of each variety to consume among the varieties produced in each country. This choice gives rise to a demand function given by

$$c_{jit}(v) = \left(\frac{p_{jit}(\nu)}{p_{jit}}\right)^{-\epsilon_p} c_{jit}.$$

Cost minimization by households implies that

$$p_{jit} \equiv \left[\int_0^1 p_{jit}(v)^{1-\epsilon_p} dv\right]^{1/(1-\epsilon_p)} \tag{B.5}$$

and

$$P_{it} = \left((1-\alpha)(p_{iit})^{1-\eta} + \alpha \int_0^1 (p_{jit})^{1-\eta} dj\right)^{1/(1-\eta)}. \tag{B.6}$$

Labor Unions Households supply labor through a continuum of labor unions, $\ell \in [0,1]$. Each union converts household labor n_{it} into labor services of a specialized type $N_{it}(\ell)$. (Total household labor supply n_{it} is the simple integral of $N_{it}(\ell)$ over ℓ.) The labor types $N_{it}(\ell)$ enter the production function of firms through the CES basket

$$N_{it} = \left(\int_0^1 (N_{it}(\ell))^{\frac{\epsilon_w - 1}{\epsilon_w}} d\ell\right)^{\frac{\epsilon_w}{\epsilon_w - 1}},$$

where $\epsilon_w > 1$ is the elasticity of substitution between the labor types in production. Cost minimization by firms results in each union facing a downward sloping demand curve for its labor services

$$N_{it}(\ell) = \left(\frac{W_{it}(\ell)}{W_{it}}\right)^{-\epsilon_w} N_{it}, \quad \text{where} \quad W_{it} = \left(\int_0^1 W_{it}(\ell)^{1-\epsilon_w} d\ell\right)^{1/(1-\epsilon_w)},$$

$W_{it}(\ell)$ denotes the nominal wage for labor of type ℓ, and W_{it} denotes the nominal wage index for economy i.

Each labor union chooses the wage $W_{it}(\ell)$ to maximize household utility. Each period there is a constant probability $1 - \delta_w$ that union ℓ can reoptimize its wage, as in Erceg, Henderson, and Levin (2000). The union then supplies all labor that is demanded at this wage. This implies that in periods when it is able to reoptimize the wage, union ℓ chooses $\{W_{it}(\ell), N_{it}(\ell)\}$ to maximize

$$\sum_{s=0}^{\infty} (\beta\delta_w)^{s-t} \left[(u(C_{is} - hC_{is-1}) - \chi(n_{is}))\right] \qquad \text{where} \qquad n_{is} = \int_0^1 N_{is}(\ell) d\ell$$

subject to

$$N_{is}(\ell) = \left(\frac{W_{it}(\ell)}{W_{is}}\right)^{-\epsilon_w} N_{is},$$

$$C_{it} + a_{it+1} = a_{it}(1 + r^r_{it}) + (1 - \tau^n_i) \int_0^1 W_{it}(\ell) N_{it}(\ell) d\ell / P_{it} + T_{it},$$

where the wage index is given by

$$W_{it} = \left(\int_0^1 W_{it}(\ell)^{1-\epsilon_w} d\ell\right)^{1/(1-\epsilon_w)}. \tag{B.7}$$

Optimal wage setting then implies that

$$\sum_{s=0}^{\infty} (\beta\delta_w)^{s-t} \left(\chi'(n_{is})\epsilon_w \frac{N_{is}}{W_{is}} \left(\frac{W_{it}(\ell)}{W_{is}}\right)^{-\epsilon_w - 1} + \frac{\lambda_{is}(1-\tau^n_i)}{P_{is}} \left(N_{is}(\ell) - W_{it}(\ell)\epsilon_w \frac{N_{is}}{W_{is}} \left(\frac{W_{it}(\ell)}{W_{is}}\right)^{-\epsilon_w - 1}\right)\right) = 0,$$

where λ_{is} is the Lagrange multiplier on the budget constraint. Household optimization implies $\lambda_{is} = MU_{is}$. We can rewrite the above expression as

$$W_{it}(\ell) = \frac{\sum_{s=t} (\beta\delta_w)^{s-t} N_{is}(\ell) MU_{is}(1-\tau^n_i) \frac{\epsilon_w}{\epsilon_w - 1} \frac{\chi'(n_{is})}{MU_{is}}}{\sum_{s=t} (\beta\delta_w)^{s-t} N_{is}(\ell) MU_{is}(1-\tau^n_i) \left(\frac{1}{P_s}\right)}. \tag{B.8}$$

Log-linearizing this last equation around a steady state with no inflation yields

$$\hat{W}_{it}(\ell) = (1 - \beta\delta_w) \sum_{s=t} (\beta\delta_w)^{s-t} \left(\hat{P}_s - \widehat{MU}_{is} + \nu \hat{N}_{is}\right), \tag{B.9}$$

where the hatted variables denote log-deviations from steady state of the corresponding hatless variables. Notice that $\hat{n}_{it} = \int_0^1 \hat{N}_{it}(\ell) d\ell = \hat{N}_{it}$.

Log-linearization of the wage index in equation (B.7) yields

$$\hat{W}_{it} = \delta_w \hat{W}_{it-1} + (1 - \delta_w) \hat{W}_{it}(\ell). \tag{B.10}$$

Combining equations (B.9) and (B.10), we obtain the New Keynesian Wage Phillips Curve:

$$\pi^w_{it} = \kappa_w \ln\left(\frac{(N_{it})^\nu}{MU_{it} W_{it} / P_{it}}\right) + \beta \mathbb{E}_t \pi^w_{it+1}, \tag{B.11}$$

where $\pi^w_{it} \equiv W_{it}/W_{it-1} - 1$ is wage inflation in country i at time t and $\kappa_w \equiv (1 - \delta_w)(1 - \beta\delta_w)/\delta_w$.

B.1.2 Firms

There are two types of firms in the economy: production firms and price-setting firms. We describe these in turn.

Production Firms In each country, there are a continuum of ex-ante identical production firms. These firms produce a homogeneous country-specific good and sell this good to local price-setting firms in a competitive country-specific wholesale market at a price p_{it}^{mc} that is equal to their marginal cost of production. The production firms in country i operate the following Cobb-Douglas technology:

$$Y_{it} = A_{it}(K_{it}^{\varkappa} N_{it}^{1-\varkappa})^{1-\omega} X_{it}^{\omega}, \tag{B.12}$$

where A_{it} denotes aggregate productivity, K_{it} denotes capital, X_{it} denotes intermediate inputs, and $\varkappa$ and ω are parameters. The intermediate inputs consist of the same CES basket of goods as the households in country i consume. Aggregate productivity is stochastic and follows an AR(1) process in logarithms:

$$\ln A_{it} = \rho^A \ln A_{it-1} + \epsilon_{it}^A. \tag{B.13}$$

Production firms own the capital they use. Their capital stock evolves as follows:

$$K_{it+1} = K_{it}(1 - \delta_k) + I_{it}, \tag{B.14}$$

where I_{it} denotes investment and δ_k is the fraction of the existing capital stock that depreciates each period. The investment good I_{it} consists of the same CES basket of goods as C_{it} and X_{it}. Investment is subject to investment adjustment costs, $S(I_{it}/I_{it-1}) = \frac{\phi_I}{2}(I_{it}/I_{it-1} - 1)^2$. We assume that the production firms own a diversified portfolio of price-setting firms.

The real earnings of production firms are given by

$$D_{it} = \frac{1}{P_{it}}\left[p_{it}^{mc} Y_{it} - P_{it} I_{it}\left(1 + S\left(\frac{I_{it}}{I_{it-1}}\right)\right) - W_{it} N_{it} - P_{it} X_{it} + \Pi_{it}^p\right], \tag{B.15}$$

where Π_{it}^p denotes the profits the production firms earn from their ownership of the portfolio of price-setting firms – which is equal to the average profit of price-setting firms in each period. The production firms choose a sequence for $\{I_{it}, X_{it}, N_{it}, K_{it+1}\}$ as well as individual types of labor and varieties of investment and intermediate inputs to maximize their value

$$V_{it} = D_{it} + \mathbb{E}_t \sum_{s=t}^{\infty} \frac{1}{\prod_{k=0}^{t}(1 + r_{ik+1}^f)} D_{is+1}, \tag{B.16}$$

where r_{it+1}^f is their discount rate between period t and period $t+1$.

The firms' problem can be written recursively as

$$\begin{aligned} V_{it}(K_{it}, I_{it-1}) = \max_{I_{i,t}, K_{it+1}, N_{it}, X_{it}} \frac{1}{P_{it}} \Big\{ & p_{it}^{mc} A_{it} (K_{it}^{\varkappa} N_{it}^{1-\varkappa})^{1-\omega} (X_{it})^{\omega} - W_{it} N_{it} - P_{it} X_{it} \\ & - P_{it} I_{it} \left(1 + S\left(\frac{I_{it}}{I_{it-1}}\right)\right) \Big\} + \mathbb{E}_t \frac{1}{1 + r_{it+1}^f} V_{it+1}^k (K_{it+1}, I_{it}) \\ \text{s.t.} \quad K_{it+1} = (1 - \delta_k) K_{it} + I_{it}. & \end{aligned}$$

The first order conditions with respect to $I_{i,t}$ is

$$\begin{aligned} \left(1 + S\left(\frac{I_{it}}{I_{it-1}}\right)\right) + S'\left(\frac{I_{it}}{I_{it-1}}\right) \frac{I_{it}}{I_{it-1}} & \\ = \mathbb{E}_t \frac{1}{(1 + r_{it+1}^f)} & \left[\frac{\partial V_{it+1}(K_{it+1}, I_{it})}{\partial I_{it}} + \frac{\partial V_{it+1}(K_{it+1}, I_{it})}{\partial K_{it+1}} \right]. \end{aligned}$$

The envelope conditions for I_{it-1} and K_{it} are

$$\begin{aligned} \frac{\partial V_{it}(K_{it}, I_{it-1})}{\partial I_{it-1}} &= S'\left(\frac{I_{it}}{I_{it-1}}\right) \frac{(I_{it})^2}{(I_{it-1})^2} \\ \frac{\partial V_{it}(K_{it}, I_{it-1})}{\partial K_{it}} &= \frac{(1-\omega)\varkappa p_{it}^{mc} A_{it} (K_{it}^{\varkappa} N_{it}^{1-\varkappa})^{1-\omega} (X_{it})^{\omega} / K_{it+1}}{P_{it}} \\ & \quad + \mathbb{E}_t \frac{1 - \delta_k}{(1 + r_{it+1}^f)} \frac{\partial V_{it+1}(K_{it+1}, I_{it})}{\partial K_{it+1}} \end{aligned}$$

Defining "marginal Q" as $\mathcal{J}_{it} \equiv \partial V_{it}(K_{it}, I_{it-1}) / \partial K_{it}$, the above conditions simplify to

$$1 + S\left(\frac{I_{it}}{I_{it-1}}\right) + S'\left(\frac{I_{it}}{I_{it-1}}\right) \frac{I_{it}}{I_{it-1}} = \mathbb{E}_t \left[\frac{1}{1 + r_{it+1}^f} \left(S'\left(\frac{I_{it+1}}{I_{it}}\right) \frac{(I_{it+1})^2}{(I_{it})^2} + \mathcal{J}_{it+1} \right) \right] \tag{B.17}$$

$$\mathcal{J}_{it} = \frac{(1-\omega)\varkappa p_{it}^{mc} Y_{it} / K_{it}}{P_{it}} + \mathbb{E}_t \left[\frac{1 - \delta_k}{1 + r_{it+1}^f} \mathcal{J}_{it+1} \right]. \tag{B.18}$$

Optimal choice of N_{it} and X_{it} satisfies the following first-order conditions:

$$W_{it}N_{it} = (1-\omega)(1-\varkappa)p_{it}^{mc}Y_{it}, \qquad \text{and} \qquad P_{it}X_{it} = \omega p_{it}^{mc}Y_{it}. \tag{B.19}$$

Price-setting Firms. Price-setting firms in country i purchase local goods from production firms and differentiate them. Each price-setting firm is then a monopoly supplier of their brand or variety. They purchase goods at a price $p_{it}^{mc}(1-\tau_i^p)$, where τ_i^p is a time-invariant tax imposed by the government to offset the steady state markup distortion of the price-setting firms.

The price-setting firms sell their varieties both domestically and abroad. They must decide at which price to sell. They face pricing frictions which imply that they can only reoptimize the price of their varieties with a probability $1-\delta_p$ each period, as in Calvo (1983). When selling domestically, they set prices in the domestic currency. When selling abroad, a fraction $\theta_{ij}^k \in [0,1]$ of price-setting firms in country i selling to country j set prices in currency k. The fractions θ_{ij}^k determine how prevalent producer currency pricing (PCP), local currency pricing (LCP), and dominant currency pricing (DCP) are in the economy.

Consider the problem of a price-setting firm selling variety v from country i to country j with its price for these sales set in currency k. The optimal reset price solves

$$\max_{p_{ijt}^k(v),\{y_{ijs}^k(v)\}_{s=t}^{\infty}} \sum_{s=t}^{\infty} M_{is}(\delta_p)^{s-t}(\mathcal{E}_{kis}p_{ijt}^k(v)y_{ijs}^k(v) - (1-\tau_i^r)p_{is}^{mc}y_{ijs}^k(v)) \tag{B.20}$$

$$\text{s.t.} \quad y_{ijs}^k(v) = \left(\frac{p_{ijt}^k(v)}{p_{ijs}}\right)^{-\epsilon_p} Z_{ijs}, \tag{B.21}$$

where $Z_{ijs} \equiv C_{ijs} + X_{ijs} + I_{ijs}$ is the total demand for goods from country i in country j and $M_{i,s}$ is the nominal discount factor in country i between period t and period s. The nominal discount factor $M_{i,s}$ is defined as $M_{i,s} \equiv \prod_{\varsigma=t}^{s} 1/(1+i_{i\varsigma})$, where $i_{i\varsigma}$ is the nominal interest rate in country i at time ς.

Differentiation with respect to $p_{ijt}(v)$ yields the optimality condition

$$\sum_{s=t}^{\infty} M_{i,s}(\delta_p)^{s-t}\left(\mathcal{E}_{kis}p_{ijt}^k(v)y_{ijs}^k(v) - \frac{\epsilon_p}{(\epsilon_p-1)}(1-\tau_i^r)p_{is}^{mc}y_{ijs}^k(v)\right) = 0. \tag{B.22}$$

Linearizing this equation and combining it with a log-linear approximation of equation (B.5) – i.e., $\hat{p}_{ij,t} = (1-\delta_p)\hat{p}_{ij,t}(v) + \delta_p\hat{p}_{ij,t-1}$ – yields a Phillips curve for prices of goods produced in country

i and sold in country j that are denominated in currency k:

$$\hat{\pi}^k_{ijt} = (1 - \beta\delta_p)\frac{\delta_p}{1-\delta_p}\left(\hat{p}^{mc}_{it} - \hat{p}^k_{ijt} - \hat{\mathcal{E}}_{kit}\right) + \beta\hat{\pi}^k_{ijt+1}, \tag{B.23}$$

where $\pi^k_{ijt} \equiv p^k_{ijt}/p^k_{ijt-1} - 1$.

We next derive a Phillips curve for the prices of all goods produced in country i and sold to country j. This is a weighted average of equation (B.23) across currencies of denomination k using the weights θ^k_{ij}. When we take this weighted average, we denominate all prices in the currency of the destination country. This yields

$$\pi_{ijt} - \sum_k \theta^k_{ij}\Delta\ln\mathcal{E}_{kjt} = \kappa_p \ln\left(\frac{p^{mc}_{it}}{p_{ijt}}\mathcal{E}_{ijt}\right) + \beta\mathbb{E}_t\left[\pi_{ijt+1} - \sum_k \theta^k_{ij}\Delta\ln\mathcal{E}_{kjt+1}\right], \tag{B.24}$$

where $\pi_{ijt} \equiv p_{ijt}/p_{ijt-1} - 1$ and $\kappa_p \equiv (1-\beta\delta_p)(1-\delta_p)/\delta_p$. Aggregate inflation in country j is given by

$$\pi_{jt} = \alpha\pi_{jjt} + (1-\alpha)\int_0^1 \pi_{ijt} di.$$

The average nominal profits of price-setting firms are, to a first-order approximation,

$$\Pi^p_{it} = \left[\ln(p_{iit}y_{iit}) - \ln\left(p^{mc}_{it}y_{iit}\right)\right]\bar{p}_{ii}\bar{y}_{ii} + \int_0^1 \left[\ln(\mathcal{E}_{ijt}p_{ijt}y_{ijt}) - \ln\left(p^{mc}_{it}y_{ijt}\right)\right]\bar{p}_{ij}\bar{y}_{ij}dj, \tag{B.25}$$

where $\bar{p}_{ij}\bar{y}_{ij}$ is the steady state revenue of country i selling to country j, and

$$y_{ijt} = \begin{cases} (1-\alpha)\left(\frac{p_{iit}}{P_{it}}\right)^{-\eta}(C_{it} + I_{it} + X_{it}) & \text{for } i = j \\ \alpha\left(\frac{p_{ijt}}{P_{jt}}\right)^{-\eta}(C_{jt} + I_{jt} + X_{jt}) & \text{for } i \neq j \end{cases} \tag{B.26}$$

As described above, we assume that production firms own a diversified portfolio of price-setting firms and that the profits of price-setting firms therefore accrue as dividends to the production firms. We make this assumption for convenience, since it avoids us having to keep track of multiple asset prices in each economy.

B.1.3 Equilibrium Definition

In each country, the government sets the steady state labor and product market taxes to offset the steady state markup distortions,

$$(1-\tau_i^n) = \mu_w, \quad (1-\tau_i^p) = 1/\mu^p, \quad T_{it} = \tau_i^n W_{it} N_{it}/P_{it} + \tau_i^p p_{it}^{mc} Y_{it}/P_{it}, \tag{B.27}$$

where $\mu_w \equiv \frac{\epsilon_w}{\epsilon_w - 1}$ and $\mu_p \equiv \frac{\epsilon_p}{\epsilon_p - 1}$ are wage and price markups, respectively.

The goods market clearing condition is, to a first-order,

$$Y_{it} = (1-\alpha)\left(\frac{p_{iit}}{P_{it}}\right)^{-\eta}(C_{it} + I_{it} + X_{it}) + \alpha \int_0^1 \left(\frac{p_{ijt}}{P_{jt}}\right)^{-\eta}(C_{jt} + I_{jt} + X_{jt})dj. \tag{B.28}$$

We define the equilibrium of this economy as follows. Given a sequence of monetary, technology, UIP shocks, $\{\epsilon_{it}^m, \epsilon_{it}^A, \epsilon_{it}^\psi\}$, initial prices, $\{p_{ij,-1}, W_{i,-1}, \mathcal{E}_{i,-1}\}$, and the initial capital stock and investment, $\{K_{i,0}, \ I_{i,-1}\}$, the equilibrium consists of the path of allocations $\{C_{it}, MU_{it}Y_{it}, I_{it}, X_{it}, y_{ijt}, s_{ijt}^h, s_{it}^f, N_{it}, K_{it}, a_{it}, D_{it}, \Pi_{it}^p\}$, the path of shock processes, $\{A_{it}, \psi_{it}\}$, the path of prices $\{p_{ijt}, \mathcal{E}_{ijt}, Q_{ijt}, P_{it}, W_{it}, i_{it}, r_{it+1}, r_{ijt+1}, r_{it+1}^h, r_{it+1}^f, \mathcal{J}_{it}, p_{it}^{mc}, \pi_{ijt}, \pi_{it}, \pi_{it}^w, V_{it}\}$, the path of taxes $\{\tau_i^p, \tau_i^n, T_{it}\}$ such that equations (4)-(12), (B.2), (B.3), (B.4), (B.6), (B.11), (B.12), (B.13), (B.14), (B.15), (B.17), (B.18), (B.19), (B.24), (B.25), (B.26), (B.27), and (B.28) as well as the following accounting equations hold: $\pi_{it}^w = W_{it}/W_{it-1} - 1$, $\pi_{ijt} = p_{ijt}/p_{ijt-1} - 1$, $\pi_{it} = P_{it}/P_{it-1} - 1$.

B.1.4 Solution Method

We compute the impulse response of the economy to a shock as follows. Starting from the deterministic and symmetric steady state, we solve for the first-order approximation of the perfect-foresight equilibrium in response to the shock in sequence space (Boppart et al., 2018). This is equivalent to the first-order approximation of the stochastic equilibrium. We truncate the transition path at 100 years and assume that the economy returns to the steady state. Given the impulse responses to the various shocks in the model, we compute the second moments of the model using analytical second moments, as in, for example, Auclert, Bardóczy, Rognlie, and Straub (2021a).

B.2 Model Derivations

B.2.1 Capital Structure of Goods-Producing Firms

Consider a firm in country i with a sequence of corporate earnings $\{D_{it}\}$ that issues a sequence $\{b_{ijt}\}$ of debt in currency $j \neq i$. Apart from issuing foreign debt, the firm is financed with domestic equity. The share of firm's ex-dividend value financed via debt from currency j per unit measure of country j's size is denoted s_{ijt}. The firm's leverage is then given by $\frac{1}{1-\int s^f_{ij} dj}$ and total firm ex-dividend value can be written as $\frac{1}{1-\int s^f_{ij} dj} v_{it}$, where v_{it} is the ex-dividend value of the firm's equity. Using this notation, the debt the firm issues in currency j is $b_{ijt} = \frac{s^f_{ijt}}{1-\int s^f_{ijt} dj} v_{it}$. We assume that the firm's debt structure is sticky in the sense that the firm incurs adjustment costs when its debt structure deviates from a steady state. For mathematical simplicity, we assume that the adjustment cost is incurred in the following period and is proportional to total firm value: $\frac{1}{1-\int s^f_{ij} dj} v_{it} \Phi^f_{ij}(s^f_{ijt})$, where $\Phi^f_{ij}(s^f_{ijt}) = \frac{\Gamma^f}{2\bar{s}_{ij}}(s^f_{ijt} - \bar{s}_{ij})^2$.

The firm chooses its debt structure $\{s^f_{ijt}\}$ to maximize the sum of ex-dividend equity value and the current dividend at $t = 0$:

$$V_{i0} \equiv D_{i0} + \int b_{ij0} dj + v_{i0} \tag{B.29}$$

$$\begin{aligned} &= D_{i0} + \int \frac{s^f_{ij0}}{1-\int s^f_{ij0} dj} v_{i0} dj \\ &\quad + \mathbb{E}_0 \sum_{t=0}^{\infty} \frac{1}{\prod_{k=0}^{t}(1+r_{ik+1})} \left[D_{it+1} - \int \frac{(1+r_{ijt+1}) s^f_{ijt} + \Phi^f_{ij}(s^f_{ijt})}{1-\int s^f_{ijt} dj} v_{it} dj + \int \frac{s^f_{ijt+1}}{1-\int s^f_{ijt+1} dj} v_{it} dj \right], \end{aligned} \tag{B.30}$$

where the last two terms in the square bracket represent the repayment of last period's foreign debt with interest and the payment of last period's adjustment costs (second-to-last term) and the funds received from issuing new debt (last term).

The solution to the above problem is equivalent to that of the following period-by-period portfolio choice problem that is analogous to the households' problem:

$$\min_{s^f_{ijt}} \left(1 - \int s^f_{ijt} dj\right)(1 + r_{it+1}) + \int \left(s^f_{ijt}(1 + r_{ijt+1}) - \Phi^f_{ij}(s^f_{ijt})\right) dj \tag{B.31}$$

The first-order optimality condition for s^f_{ijt} is then given by

$$s^f_{ijt} = \bar{s}_{ij} - \bar{s}_{ij}\frac{1}{\Gamma^f}\mathbb{E}_t[(1+r_{ijt+1}) - (1+r_{it+1})]. \tag{B.32}$$

Let's next simplify (B.30). The definition of v_{i0} implies that

$$v_{i0} = \mathbb{E}_0\frac{1}{1+r_{i1}}\left[D_{i1} - \int \frac{(1+r_{ij1})s^f_{ij0} + \Phi^f_{ij}(s^f_{ij0})}{1-\int s^f_{ij0}dj}v_{i0}dj + \int b_{ij1}dj + v_{i1}\right].$$

This equation says that the firm's ex-dividend equity value at $t=0$ is equal to the discounted sum of dividends at $t=1$ (the sum of the first three terms) and the ex-dividend equity value at $t=1$ (the last term). Solving for v_{i0} gives

$$v_{i0} = \mathbb{E}_0\frac{1-\int s^f_{ij0}dj}{\left((1+r_{i1})(1-\int s^f_{ij0}dj) + \int\left\{(1+r_{ij1})s^f_{ij0} + \Phi^f_{ij}(s^f_{ij0})\right\}dj\right)}\left[D_{i1} + \int b_{ij1}dj + v_{i1}\right].$$

Notice also that

$$\int b_{ij0}dj = \frac{\int s^f_{ij0}dj}{1-\int s^f_{ij0}dj}v_{i0}.$$

Substituting these last two equations back into (B.29), we obtain

$$\begin{aligned}
V_{i0} &= D_{i0} + \frac{1}{1-\int s^f_{ij0}dj}v_{i0} \\
&= D_{i0} + \frac{1}{\left((1+r_{i1})(1-\int s^f_{ij0}dj) + \int\left\{(1+r_{ij1})s^f_{ij0} + \Phi^f_{ij}(s^f_{ij0})\right\}dj\right)}\left[D_{i1} + \int b_{ij1}dj + v_{i1}\right].
\end{aligned}$$

Following the same steps as above to solve for v_{i1} and substituting the resulting expression into the above equation eliminates $\{b_{ij1}\}$. This process can then be repeated for for $t = 2, 3, \ldots$. This allows us to express the firm's value as

$$V_{i0} = D_{i0} + \sum_{t=0}^{\infty}\frac{1}{\prod_{k=0}^{t}(1+r^f_{ik+1})}D_{it+1}, \tag{B.33}$$

where

$$(1+r^f_{it+1}) \equiv (1+r_{it+1})\left(1-\int s^f_{ijt}dj\right) + \int\left\{(1+r_{ijt+1})s^f_{ijt} + \Phi^f_{ij}(s^f_{ijt})\right\}dj$$

is the firm's discount rates.

B.2.2 International Bond Arbitrageurs

The model we adopt for international bond arbitrageurs builds on Itskhoki and Mukhin (2021a). For each currency j, we assume that there is a unit measure of international bond arbitrageurs engaging in the carry trade between currency j and USD. These bond traders take a long position of B^I_{Ujt} dollars in bonds from country j and a short position of equal value in US bonds. The nominal return from such a carry trade is $\tilde{R}_{Ujt+1} \equiv (1+i_{jt})\frac{\mathcal{E}_{jUt+1}}{\mathcal{E}_{jUt}} - (1+i_{Ut})$ per dollar invested. We assume that the international bond arbitrageurs seek to maximize the CARA utility function of the real return on this carry trade expressed in US dollars:

$$\max_{B^I_{Ujt}} -\frac{1}{\gamma} \exp\left(-\gamma \left[\tilde{R}_{Ujt+1} \frac{1}{P_{U,t+1}} B^I_{Ujt}\right]\right).$$

We can rewrite the above problem as

$$\max_{B^I_{Ujt}} -\frac{1}{\gamma} \exp\left(-\gamma \left[(1-\exp(\tilde{r}_{Ujt+1}))\exp(\pi_{Ut+1})\frac{B^I_{Ujt}}{P_{Ut}}\right]\right), \tag{B.34}$$

where $\tilde{r}_{Ujt+1} \equiv \ln(1+i_{jt}) - \ln(1+i_{Ut}) - \Delta \ln \mathcal{E}_{jUt+1}$ and $\pi_{Ut+1} = P_{Ut+1}/P_{Ut} - 1$. As in Campbell and Viceira (2002) and Itskhoki and Mukhin (2021a), we approximate the portfolio problem of the international bond arbitrageurs as the time interval gets short so that $(\tilde{r}_{Ujt+1}, \pi_{Ut+1})$ corresponds to the increment of the following diffusion process

$$\begin{pmatrix} d\mathcal{R}_{Ujt+1} \\ d\mathcal{P}_{Ut+1} \end{pmatrix} = \begin{bmatrix} \mu_R \\ \mu_\pi \end{bmatrix} dt + \begin{bmatrix} \sigma_e^2 & \sigma_{e\pi} \\ \sigma'_{e\pi} & \sigma_\pi^2 \end{bmatrix} d\mathbf{Z}_t,$$

where $\mu_R \equiv \mathbb{E}\tilde{r}_{Ujt+1}$ is mean return from carry trade, $\mu_\pi \equiv \mathbb{E}[\pi_{Ut+1}]$ is the mean US inflation rate, $\sigma_e^2 \equiv \text{var}(\tilde{r}_{Ujt+1}) = \text{var}(\Delta \ln \mathcal{E}_{jUt+1})$, $\sigma_{e\pi} \equiv [\text{cov}(\tilde{r}_{Uj,t+1}, \pi_{t+1})]_j$, and $\sigma_\pi^2 = \text{var}(\pi_{Ut+1})$ are the set of second moments.

Applying Ito's lemma, we can rewrite the objective function in (B.34) as follows

$$
\begin{aligned}
&-\frac{1}{\gamma}\exp\left(-\gamma\frac{1}{P_{Ut}}\left[(1-\exp(d\mathcal{R}_{Ujt+1}))\exp(d\mathcal{P}_{U,t+1})B^I_{jUt}\right]\right) \\
=&-\frac{1}{\gamma}\exp\left(-\gamma\frac{1}{P_{Ut}}\left[(-d\mathcal{R}_{Ujt+1}+\frac{1}{2}(d\mathcal{R}_{Ujt+1})^2+d\mathcal{R}_{Ujt+1}d\mathcal{P}_{Ut+1})B^I_{Ujt}\right]\right) \\
=&-\frac{1}{\gamma}\exp\left(\left(\gamma\frac{1}{P_{U,t}}B^I_{Ujt}(\mu_R+\frac{1}{2}\sigma_e^2+\sigma_{e\pi})-\frac{\gamma^2}{2}\frac{1}{(P_{Ut})^2}\sigma_e^2(B^I_{Ujt})^2\right)dt\right).
\end{aligned}
$$

Therefore, the optimal portfolio problem collapses to a standard mean variance portfolio problem. The optimal carry trade position is then given by

$$
B^I_{Ujt}/P_{Ut}=\frac{1}{\gamma\sigma_e^2}(\mu_R+\frac{1}{2}\sigma_e^2+\sigma_{e\pi}).
$$

We log-linearize the above condition around our steady state equilibrium where shocks are small and $P_{UT}=1$. But we also proportionally increase risk aversion, γ, so that $\gamma\sigma_e^2$ remains the same, as in Hansen and Sargent (2011). The terms σ_e^2 and $\sigma_{e\pi}$ go to zero as shocks become small. Therefore the log-linearized condition around a steady state with $P_{Ut}=1$ is

$$
B^I_{Ujt}=\frac{1}{\Gamma^B}[\ln(1+i_{jt})-\ln(1+i_{Ut})+\mathbb{E}_t\Delta\ln\mathcal{E}_{jUt+1}],
$$

where $\Gamma^B\equiv\gamma\sigma_e^2$.

B.2.3 Equilibrium in the International Bond Market

Here, we provide a general derivation that applies to both the model in Section 3 and the model in Section 6. To recover the results for the model in Section 3, simply set $\zeta_{it}=0$ for all i,t. The demand for currency j bonds from households and firms is

$$
B_{jt}=\left(1-\int s^h_{jit}di\right)a_{jt}-\left(1-\int s^f_{jit}di\right)\tilde{V}_{jt}+\int s^h_{ijt}a_{it}di-\int s^f_{ijt}\tilde{V}_{it}di.
$$

where $\tilde{V}_{jt}$ denotes the value of the firm in country j excluding their current-period dividend. The first term is the portion of the asset position of households in country j that is invested in domestic assets. Some of the household's domestic assets are equity in domestic firms as opposed to domestic bonds. The second term subtracts this amount – which is equal to the portion of firm value financed domestically. The third and fourth terms represent demand for bonds in country j from foreign households and firms, respectively.

A first-order approximation of the last equation yields ($x \approx \bar{x} + \nabla x$)

$$\begin{aligned}\nabla B_{jt} = &-\int \nabla s^h_{jit} di \bar{a} + \left(1 - \int \bar{s}_{ji} di\right) \nabla a_{jt} + \int \nabla s^f_{jit} \bar{a} di + \left(1 - \int \bar{s}_{ji} di\right) \nabla \tilde{V}_{jt} \\ &+ \int \nabla s^h_{ijt} di \bar{a} + \left(1 - \int \bar{s}_{ij} di\right) \nabla a_{jt} - \int \nabla s^f_{ijt} \bar{a} di + \int \bar{s}_{ij} \nabla \tilde{V}_{it} di,\end{aligned} \tag{B.35}$$

where $\bar{a}$ denotes steady state households' wealth (which also corresponds to steady state firm value excluding current dividend, $\tilde{V}_{jt}$). First-order approximations of equations (5) and (7) give

$$\begin{aligned}\nabla s^h_{ijt} &= \bar{s}_{ij} \frac{1}{\beta \Gamma^h} \left[\nabla \ln(1 + r_{ijt+1}) - \nabla \ln(1 + r_{it})\right] \\ &= \bar{s}_{ij} \frac{1}{\beta \Gamma^h} \left[\nabla \ln(1 + i_{jt}) - \nabla \ln(1 + i_{it}) + \mathbb{E}_t \Delta \nabla \ln \mathcal{E}_{jit+1} - \nabla \zeta_{jt}\right] \end{aligned} \tag{B.36}$$

$$\begin{aligned}\nabla s^f_{ijt} &= -\bar{s}_{ij} \frac{1}{\beta \Gamma^f} \left[\nabla \ln(1 + r_{ijt+1}) - \nabla \ln(1 + r_{it})\right] \\ &= -\bar{s}_{ij} \frac{1}{\beta \Gamma^f} \left[\nabla \ln(1 + i_{jt}) - \nabla \ln(1 + i_{it}) + \mathbb{E}_t \Delta \nabla \ln \mathcal{E}_{jit+1} - \nabla \zeta_{jt}\right], \end{aligned} \tag{B.37}$$

where we have used equation (17) in the second line of each equation.

Substituting equations (B.36) and (B.37) into equation (B.35), we can approximately write $B_{jt} \approx \nabla B_{jt}$ as

$$\begin{aligned}B_{jt} &= \left(1 - \int \bar{s}_{ji} di\right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di \\ &\quad + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \int \bar{s}_{ji} (\ln(1 + i_{j,t}) - \ln(1 + i_{i,t}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{ji,t+1} - \zeta_{jt}) di \\ &\quad + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \int \bar{s}_{ij} (\ln(1 + i_{j,t}) - \ln(1 + i_{i,t}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{ji,t+1} + \zeta_{it}) di \\ &= \left(1 - \int \bar{s}_{ji} di\right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di \\ &\quad + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \int_{i \in \{P,U\}} (\bar{s}_{ji} + \bar{s}_{ij}) (\ln(1 + i_{j,t}) - \ln(1 + i_{U,t}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{jU,t+1}) di \\ &\quad + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \left(-\int \bar{s}_{ji} di \zeta_{jt} + \int \bar{s}_{ij} \zeta_{it} di\right)\end{aligned}$$

where $NFA_{jt} \equiv a_{jt} - \tilde{V}_{jt}$, and we have used the fact that all floaters are identical and the economies in P peg their exchange rates to U.

Since the noise traders' position in currency j bonds is ψ_{jt}, total bond demand for country $j \in F$ is $B^I_{Ujt} + B_{jt} + n\psi_{jt}$. These bonds are in zero net supply. This implies that the market clearing condition for these bonds is given by

$$
\begin{aligned}
0 = &\left(1 - \int \bar{s}_{ji} di\right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di \\
&+ \left(\frac{1}{\Gamma^B} + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \int_{i \in \{P,U\}} (\bar{s}_{ji} + \bar{s}_{ij}) di\right) \left(\ln(1 + i_{j,t}) - \ln(1 + i_{U,t}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{jU,t+1}\right) \\
&+ \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f}\right] \frac{\bar{a}}{\beta} \left(-\int \bar{s}_{ji} di \zeta_{jt} + \int \bar{s}_{ij} \zeta_{it} di\right) + \psi_{jt}.
\end{aligned}
$$

This is the same equation as equations (9) and (10) in Section 3 (when $\zeta_{jt} = 0$) and equation (19) in Section 6 of the main text.

B.3 Steady State Characterization

In the symmetric steady state, the net foreign asset position in all countries is zero, $NFA_i = 0$. We normalize price index and exchange rates in all countries to one: $P_i = \mathcal{E}_{ij} = 1$. The aggregate variables $\{Y_i, X_i, C_i, I_i, K_i, N_i, r_i\}$ then solve

$$
\begin{aligned}
Y_i &= C_i + I_i + X_i, \\
Y &= A_i (K_i)^{\varkappa} (X_i)^{\omega} (N_i)^{1-\varkappa-\omega}, \\
X_i &= \omega Y_i, \\
(r_i + \delta) K_i &= \varkappa Y_i, \\
(N_i)^{\nu} (C_i - h C_i)^{\sigma} &= (1 - \omega - \varkappa) Y_i, \\
I_i &= \delta K_i, \\
r_i &= 1/\beta - 1,
\end{aligned}
$$

where we have imposed the fact that government subsidies offset the steady state product and labor markups.

B.4 Calibration Details

Panel A of Table B.1 lists the parameters that we calibrate externally. We set the discount factor to $\beta = 0.96$, which implies a steady state annual real interest rate of 4%. We set the curvature of the consumption utility function σ to 0.5.[43] We set the Frisch elasticity of labor supply $1/\nu$ to 0.5. The

[43]With habit formation, the elasticity of intertemporal substitution (EIS) around the steady state in our model is given by $\frac{1-h}{1+h+h^2} \frac{1}{\sigma}$. At our estimate value of habit, the EIS is 0.57, a relatively standard value in the macroeconomics literature.

Table B.1: Calibration of Parameters

Parameter	Description	Value	Note/Source
A. Externally Assigned Parameters			
β	Discount factor	0.96	Annual interest rate 4%
σ	Curvature in consumption utility	0.5	Standard
$1/\nu$	Frisch elasticity	0.5	Standard
ω	Intermediate inputs share	0.5	Itskhoki and Mukhin (2021a)
α	Openness	0.2	Imports-to-GDP ratio 40%
$\varkappa$	Capital share in value-added	0.43	Investment-to-GDP ratio 22%
δ_k	Capital depreciation rate	0.04	Penn World Table 10.0
ϕ_I	Investment adjustment cost	2.0	Christiano et al. (2005)
ϕ_π	Taylor coefficient	1.5	Standard
ρ_m	Monetary policy inertia	0.43	Smets and Wouters (2007)
η	Trade elasticity	1.5	Standard
$\bar{s}$	Foreign currency assets & liabilities	0.24	Bénétrix et al. (2015)
ρ	Shock persistence	0.89	Itskhoki and Mukhin (2021a)
$\{\theta_{ij}^k\}$	Pricing regime	See text	LCP
Γ	Bond demand inverse elasticity	0.001	Itskhoki and Mukhin (2021a)
B. Estimated Parameters			
κ_p	Price Phillips curve slope	0.005	(0.003)
κ_w	Wage Phillips curve slope	0.003	(0.002)
h	Habit	0.719	(0.048)

Note: Panel A of the table lists the parameters are externally assigned along with the values we assign for them. Panel B of the table lists the parameters we estimate along with our estimates. Standard errors are reported in parentheses.

annual capital depreciation rate is set to $\delta_k = 0.04$, based on the average value in the Penn World Table version 10.0 (Feenstra, Inklaar, and Timmer, 2015). We set the share of intermediate inputs in gross output to 50%, $\omega = 0.5$, following Itskhoki and Mukhin (2021a). The share of capital in value added is set to 43% to match a steady state investment-to-GDP ratio of 22%, which is the average value in our sample. We set the investment adjustment cost parameter to $\phi_I = 2.0$, which is in the middle of estimates provided by Christiano, Eichenbaum, and Evans (2005).

We set the coefficient on inflation in the monetary policy rule to $\phi_\pi = 1.5$ as suggested by Taylor (1993). Monetary policy inertia is set to $\rho_m = 0.43$, to match the estimate of 0.81 at the quarterly frequency obtained by Smets and Wouters (2007). The elasticity of substitution between goods produced in different countries is set to $\eta = 1.5$, following a large literature in international macro (e.g., Chari, Kehoe, and McGrattan, 2002). This value is also consistent with the medium-run (5-10 year) estimates in Boehm, Levchenko, and Pandalai-Nayar (2023). As described in the main texts, we set the size of each region as follows: $|U| = 0.3, |F| = 0.5, |P| = 0.2$. We choose the openness parameter, α, to match the average imports-to-GDP ratio in our sample of 40%. Since the imports-to-GDP ratio in the steady state of our model is $\alpha/(1-\omega)$, this implies $\alpha = 0.4 \times 0.5 = 0.2$. As mentioned in the main text, our benchmark parametrization is to assume that all prices are set in local currency: for all i, $\theta_{ij}^k = 1$ for $k = j$ and $\theta_{ij}^k = 0$ for $k \neq j$.

We choose the remaining parameters – the price and wage Phillips curves, κ_p and κ_w, (or equivalently, the rigidity of prices and the wages, δ_p and δ_w), and the habit parameter, h – to best fit our estimated impulse responses. More specifically, we set these parameters $\Theta \equiv (\kappa_p, \kappa_w, h)$ at the solution to the following problem:

$$\hat{\Theta} = \arg\min_{\Theta} \; (IRF(\Theta) - IRF)'\Sigma^{-1}(IRF(\Theta) - IRF), \tag{B.38}$$

where IRF denotes a vector of the estimated relative impulse response functions of the trade-weighted nominal and real exchange rates, GDP, consumption, investment, exports, imports, inflation, nominal interest rates, and the terms of trade. For each of these variables, we include ten elements of the impulse response ($h = 0$ to $h = 9$). $IRF(\Theta)$ is the simulated model counterpart of IRF in response to a US UIP shock, which is as function of Θ. We set the weighting matrix Σ to be an identity matrix. When computing the IRF, we always set the size of the initial US UIP shock, ϵ_{U0}^{ψ}, to match the initial response of the relative nominal exchange rates. We report standard errors of our estimates of Θ using the asymptotic covariance matrix of $\hat{\Theta}$: $\hat{V} = \frac{\partial IRF(\hat{\Theta})}{\partial \Theta}'\Sigma^{-1}\frac{\partial IRF(\hat{\Theta})}{\partial \Theta}$, where $\frac{\partial IRF(\hat{\Theta})}{\partial \Theta}$ is the Jacobian of the list of impulse responses evaluated at $\Theta = \hat{\Theta}$. Our parameter estimates are listed in Panel B of Table B.1.

B.5 Varying Price and Wage Stickiness

Our baseline estimate of the price and wage rigidity parameters in our model are $\delta_p = 0.87$ and $\delta_w = 0.95$ (see Table B.1). This is a considerable degree of rigidity. Figure B.1 presents results for the case where we halve both δ_p and δ_w and contrast these results with our benchmark case. We see that the response of GDP is substantially smaller with less nominal rigidity. The reason for this is that with less nominal rigidity, the depreciation leads inflation to increase sharply, which triggers a large monetary policy response. As a consequence, real rates increase sharply, which dampens the booms in GDP. Additionally, the real exchange rate is less volatile and less persistent with less nominal rigidity. This result can be avoided by assuming sufficiently responsive monetary policy that stabilizes inflation, as shown by Itskhoki and Mukhin (2021a). However, with even more

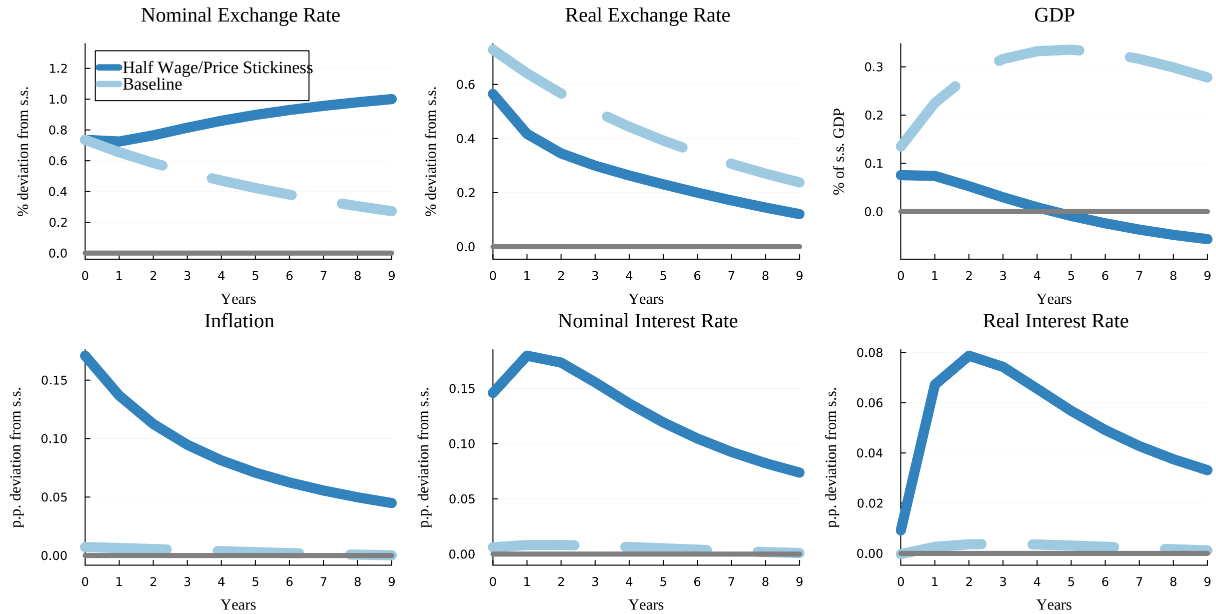


Figure B.1: Varying Price/Wage Stickiness

Note: This figure plots the impulse response of peggers relative to floaters in response to a US UIP shock for different price and wage stickiness parameters. The dark blue solid line is the case where we halved the size of δ_p and δ_w from our baseline estimates, while the light-blue dashed line uses our baseline parameters.

responsive monetary policy, the boom in GDP will be even weaker.

B.6 Alternative Pricing Regimes

In the benchmark parameterization, we have assumed that firms price in local currency (LCP). Here, we explore two other commonly assumed pricing regimes: producer currency pricing (PCP) and dominant currency pricing (DCP). PCP corresponds to the following case:

$$\theta_{ij}^{k} = \begin{cases} 1 & \text{if } k = i \\ 0 & \text{otherwise.} \end{cases}$$

The DCP corresponds to the following case:

$$\theta_{ij}^{k} = \begin{cases} 1 & \text{if } k = USD \text{ and } i \neq j \\ 1 & \text{if } k = j \text{ and } i = j \\ 0 & \text{otherwise.} \end{cases}$$

Figure B.2 shows results on net exports and the terms of trade for these two cases in addition to our baseline case. We plot the response of these variable in pegging countries relative to floating

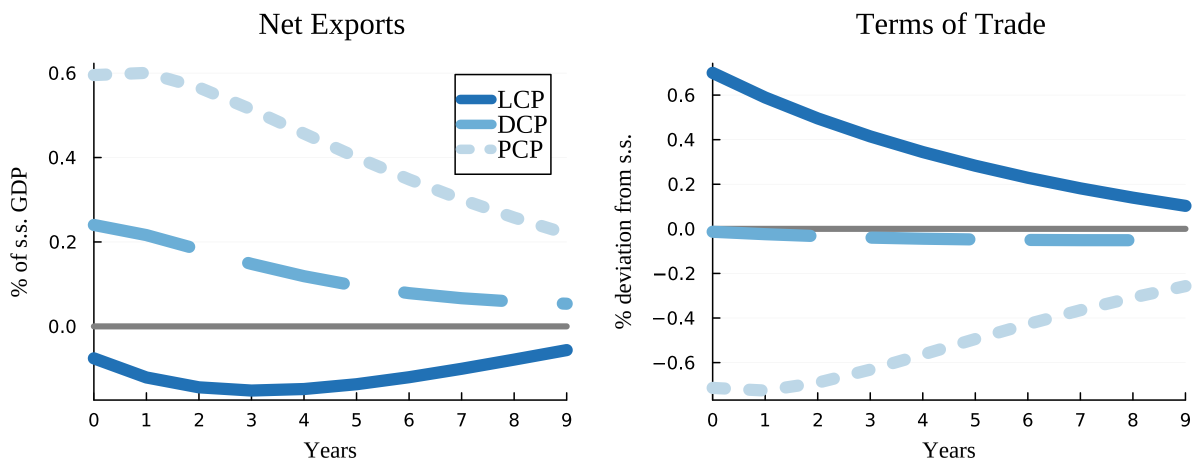


Figure B.2: Alternative Pricing Regimes

Note: This figure plots the response of net exports and the terms of trade for peggers relative to floaters in response to a US UIP shock for different pricing regimes.

countries after a US UIP shock. In the left panel, we see that with PCP and DCP net exports increase in pegging countries. This contrasts with our empirical results and our baseline LCP case in the model. The reason for the difference is that there is more expenditure switching under these alternative pricing regimes. In the right panel, the terms of trade response little with DCP, while the model generates a substantial deterioration in the terms of trade with PCP. In the data, we observe a mild improvement in terms of trade, which the model with LCP fits. For both net exports and the terms of trade, the model fits best when we assume LCP.

B.7 Tradable and Non-tradable Sectors

Consider an extension of our baseline model to a case with a tradable sector and a non-tradable sector. Both tradable and non-tradable goods are produced with the same technology as in equation (B.12), and factors are freely mobile across sectors. The aggregate consumption basket is given by

$$C_{it} = \left((1-\varsigma)^{1/\iota}(C_{it}^{NT})^{\frac{\iota-1}{\iota}} + \varsigma^{1/\iota}(C_{it}^{T})^{\frac{\iota-1}{\iota}}\right), \tag{B.39}$$

where $\iota > 0$ is the elasticity of substitution between tradable and nontradable sectors, and $\varsigma \in [0,1]$ governs the share of tradable goods in the consumption basket. Tradable consumption is in turn a CES basket of goods from different countries

$$C_{it}^{T} = \left((1-\alpha)^{1/\eta}(c_{iit})^{\frac{\eta-1}{\eta}} + \alpha^{1/\eta}\int_0^1 (c_{jit})^{\frac{\eta-1}{\eta}} dj\right)^{\frac{\eta}{\eta-1}}. \tag{B.40}$$

As in the baseline model, $\{c_{jit}^T\}$ and C_{it}^{NT} are all CES baskets of a continuum of varieties $v \in [0,1]$ with elasticity of substitution $\epsilon_p > 1$:

$$c_{jit} = \left(\int_0^1 (c_{jit}(v))^{\frac{\epsilon_p - 1}{\epsilon_p}} dv\right)^{\frac{\epsilon_p}{\epsilon_p - 1}}, \quad C_{it}^{NT} = \left(\int_0^1 (C_{it}^{NT}(v))^{\frac{\epsilon_p - 1}{\epsilon_p}} dv\right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$$

The price index for aggregate consumption is given by

$$P_{it} = \left((1-\varsigma)(P_{it}^{NT})^{1-\iota} + \varsigma(P_{it}^{T})^{1-\iota}\right)^{1/(1-\iota)}, \tag{B.41}$$

$$P_i^T = \left((1-\alpha)(p_{iit})^{1-\eta} + \alpha \int (p_{jit})^{1-\eta} dj\right)^{1/(1-\eta)}, \tag{B.42}$$

$$P_{it}^{NT} = p_{iit}, \tag{B.43}$$

where the last equation follows from the fact that factors are freely mobile across sectors, and therefore, the price index of non-tradable goods are equal to the price index of tradable goods produced domestically. Note that we assume that both the non-tradable goods and tradable goods sold domestically are priced in domestic currency.

We assume that both the intermediate inputs and the investment goods have the same nested CES structure as consumption. Therefore, the bilateral goods trade flows are given by

$$y_{ijt} = \begin{cases} \left[(1-\alpha)\varsigma\left(\frac{p_{iit}}{P_{it}^T}\right)^{-\eta}\left(\frac{P_{it}^T}{P_{it}}\right)^{-\iota} + (1-\varsigma)\left(\frac{p_{iit}}{P_{it}}\right)^{-\iota}\right](C_{it} + X_{it} + I_{it}) & \text{for } i = j \\ \alpha\varsigma\left(\frac{p_{ijt}}{P_{jt}^T}\right)^{-\eta}\left(\frac{P_{jt}^T}{P_{jt}}\right)^{-\iota}(C_{jt} + I_{jt} + X_{jt}) & \text{for } i \neq j \end{cases} \tag{B.44}$$

The market clearing condition for each country i's goods is

$$\begin{aligned} Y_i = &\left[(1-\alpha)\varsigma\left(\frac{p_{iit}}{P_{it}^T}\right)^{-\eta}\left(\frac{P_{it}^T}{P_{it}}\right)^{-\iota} + (1-\varsigma)\left(\frac{p_{iit}}{P_{it}}\right)^{-\iota}\right](C_{it} + X_{it} + I_{it}) \\ &+ \int_0^1 \alpha\varsigma\left(\frac{p_{ijt}}{P_{jt}^T}\right)^{-\eta}\left(\frac{P_{jt}^T}{P_{jt}}\right)^{-\iota}(C_{jt} + X_{jt} + I_{jt})dj. \end{aligned} \tag{B.45}$$

The equilibrium definition of this economy modifies the definition in Section B.1.3 by replacing equations (B.6) with (B.41)-(B.43), (B.26) with (B.44), and (B.28) with (B.45).

We calibrate this economy as follows. We first set the elasticity of substitution between tradable and non-tradable goods to $\iota = 1$. We then set $\varsigma = 0.5$ to match the average share of the service sector in GDP in our sample, which is 50%. Since the imports-to-GDP ratio in this model is $\varsigma\alpha/(1-$

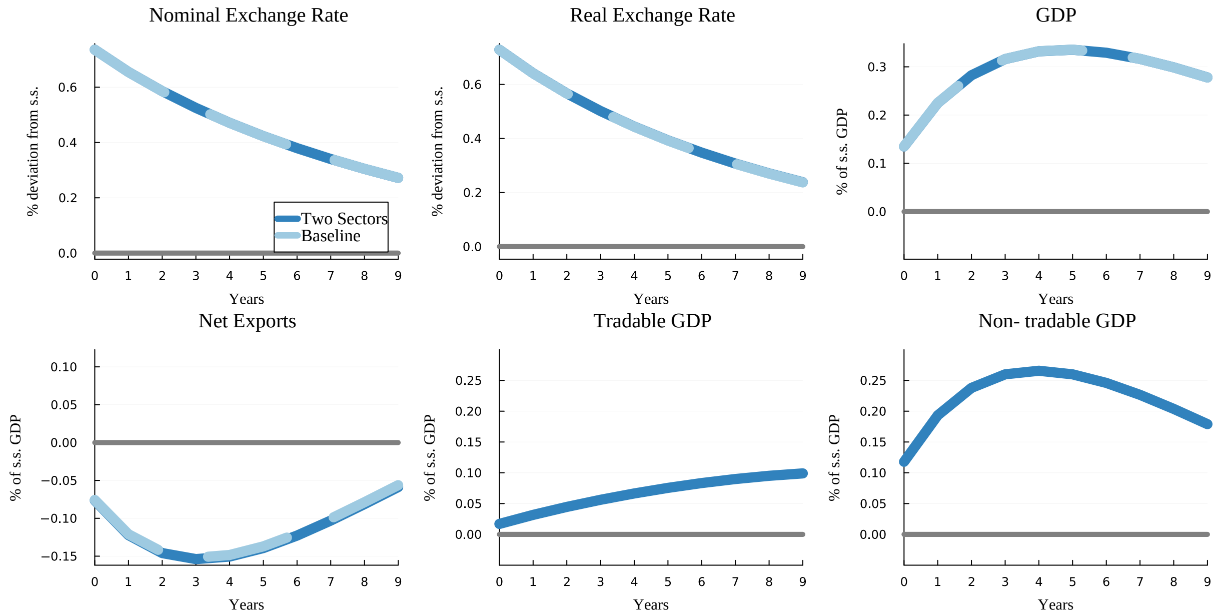


Figure B.3: Tradable and Non-tradable Sectors

Note: This figure plots impulse responses of peggers relative to floaters in response to a US UIP shock for the baseline model (dashed line) and the two-sectors model (solid line).

ω), we re-calibrate the value of openness to $\alpha = 0.4$ to match the same imports-to-GDP ratio of 40%. Other parameters are unchanged.

Figure B.3 plots the impulse response of peggers relative to floaters in response to a US UIP shock in this model. We find that extending the model to two sectors barely changes the behavior of aggregate variables. Looking at the response of sectoral output, we find that the increase in GDP is almost entirely driven by the non-tradable sector.

B.8 Hand-to-Mouth Households

Consider an extension of our baseline model in which some households live hand-to-mouth, i.e., consume their labor income period-by-period. More specifically, assume that a fraction φ^{HtM} of households in each country do not have access to financial markets. Their budget constraint is therefore,

$$C_{it}^{HtM} = (1 - \tau_i^n) W_{it} N_{it} / P_{it} + T_{it}. \tag{B.46}$$

The remaining fraction of households – which we refer to as permanent income households – solve the same problem as in the baseline model. We denote their consumption as C_{it}^r. Their consumption Euler equation is

$$MU_{it}^{r} = \mathbb{E}_t(1 + r_{it+1}^{p})MU_{it+1}^{r}, \tag{B.47}$$

where the marginal utility from a unit increase in consumption is

$$MU_{it}^{r} = u'(C_{it}^{r} - hC_{it-1}^{r}) - \beta h u'(C_{it+1}^{r} - hC_{it}^{r}).$$

Analogously, the marginal utility of hand-to-mouth households is

$$MU_{it}^{HtM} = u'(C_{it}^{HtM} - hC_{it-1}^{HtM}) - \beta h u'(C_{it+1}^{HtM} - hC_{it}^{HtM}).$$

The labor union now maximizes a weighted average of the two types of households' utility function:

$$\sum_{s=0}^{\infty}(\beta\delta_w)^{s-t}\left[\varphi^{HtM}(u(C_{is}^{HtM} - hC_{is-1}^{HtM}) - \chi(n_{is})) + (1-\varphi^{HtM})(u(C_{is}^{r} - hC_{is-1}^{r}) - \chi(n_{is}))\right],$$

subject to

$$\begin{aligned}
n_{is} &= \int_0^1 N_{is}(\ell)d\ell \\
N_{is}(\ell) &= \left(\frac{W_{it}(\ell)}{W_{is}}\right)^{-\epsilon_w} N_{is} \\
C_{it}^{r} + a_{it} &= a_{it-1}(1 + r_{it}^{h}) + (1-\tau_i^{n})\int_0^1 W_{it}(\ell)N_{it}(\ell)d\ell/P_{it} + T_{it} \\
C_{it}^{HtM} &= (1-\tau_i^{n})\int_0^1 W_{it}(\ell)N_{it}(\ell)d\ell/P_{it} + T_{it}.
\end{aligned}$$

Solving the above and taking a first-order approximation around the steady state yields the following New Keynesian wage Phillips Curve:

$$\hat{\pi}_{it}^{w} = \kappa_w\left(\hat{P}_{it} - \widehat{MU}_{it} + \nu\hat{n}_{it} - \hat{W}_{it}\right) + \beta\hat{\pi}_{i,t+1}^{w}, \tag{B.48}$$

where

$$\widehat{MU}_{is} = \Lambda_i^{HtM}\widehat{MU}_{is}^{HtM} + (1-\Lambda_i^{HtM})\widehat{MU}_{is}^{r}$$

is the weighted average of the log-changes in marginal utility from a unit increase in consumption

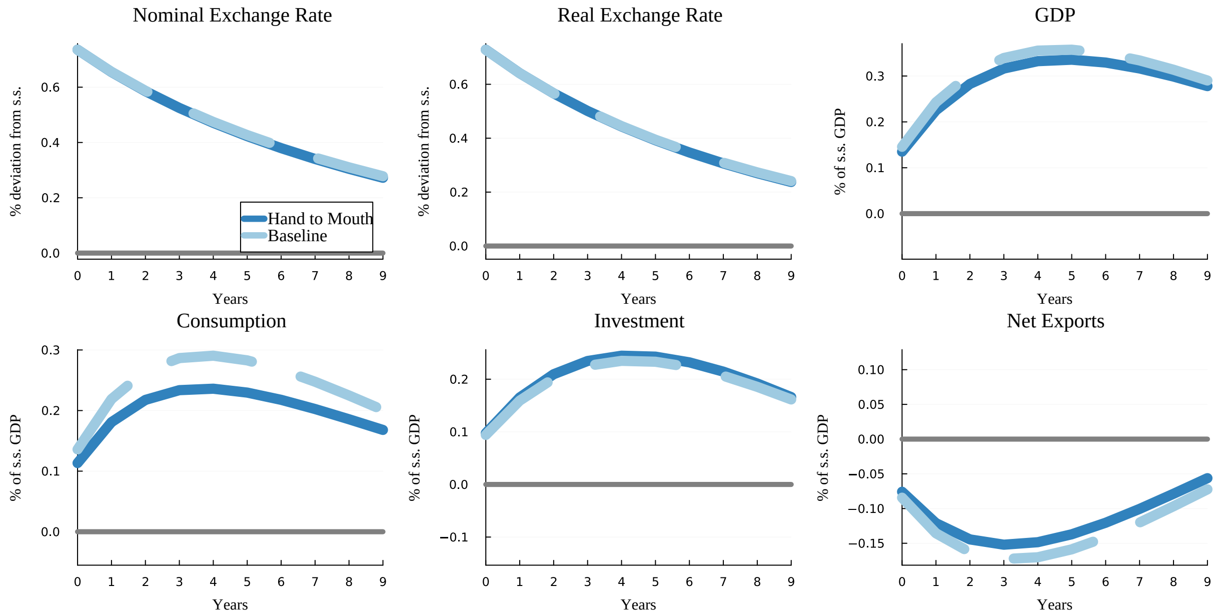


Figure B.4: Hand-to-Mouth Agents

Note: This figure plots impulse responses of peggers relative to floaters in response to a US UIP shock for the baseline model (dashed line) and the model with hand-to-mouth agents (solid line).

between the two types of households, and the weight is given by the steady state share of marginal utility: $\Lambda_i^{HtM} = \frac{\varphi^{HtM} MU_i^{HtM}}{\varphi^{HtM} MU_i^{HtM} + (1-\varphi^{HtM}) MU_i^r}$.

Aggregate consumption is given by

$$C_{it} = \varphi^{HtM} C_{it}^{HtM} + (1 - \varphi^{HtM}) C_{it}^r. \tag{B.49}$$

The equilibrium definition for this economy modifies the definition in Section B.1.3 by replacing equations (B.3) with (B.47), (B.46), and (B.49), and (B.11) with (B.48).

We set the share of hand-to-mouth agents to be 30%, $\varphi^{HtM} = 0.3$. The rest of parameters are unchanged. Figure B.4 shows the response to a US UIP shock for this economy. We find that, if anything, the presence of hand-to-mouth agents amplifies the response of consumption, but dampens the response of investment. The response of GDP is nearly unchanged.

B.9 Microfoundations of the Capital Flight Shock

As explained in the main text, banks intermediate foreign currency bonds between households and firms and the international financial market. We assume that these banks face a constraint on the amount of intermediation they can engage in: $b_{ijt} \leq \bar{b}_{it}$, where b_{ijt} is the net issuance of foreign bonds of currency j in country i, and $\bar{b}_{it}$ is the intermediation constraint of the bank. The bank solves,

$$\max_{b_{ijt}} (1+r_{ijt+1})b_{ijt} - (1+r_{jt})\frac{Q_{jit+1}}{Q_{jit}}b_{ijt}$$
$$\text{s.t.} \quad b_{ijt} \le \bar{b}_{it}.$$

A Lagrangian for this problem is

$$\max_{b_{ijt}} (1+r_{ijt+1})b_{ijt} - (1+r_{jt})\frac{Q_{jit+1}}{Q_{jit}}b_{ijt} + \tilde{\zeta}_{it}(\bar{b}_{it} - b_{ijt}),$$

where $\tilde{\zeta}_{it}$ is the Lagrangian multiplier on the borrowing constraint. The bank's optimality condition is then given by

$$(1+r_{ijt+1}) = (1+r_{jt})\frac{Q_{jit+1}}{Q_{jit}} + \tilde{\zeta}_{it} \tag{B.50}$$

Defining $\zeta_{it} = \frac{1}{\beta}\tilde{\zeta}_{it}$, equation (B.50) is equivalent to equation (17) to a first-order approximation around the symmetric steady state.

B.10 Regime-Induced Depreciations with Capital Flight Shocks

Table B.2 and Figure B.5 present results that are directly analogous to Table 2 and Figure 9, respectively, for the case where variation in the US exchange rate results from US capital flight shocks rather than US UIP shocks. These responses use the same calibration as we used in Section 5. The results with US capital flight shocks are very similar to the results with US UIP shocks. In other words, we can match our empirical responses to regime-induced exchange rate variation with either US UIP shocks or US capital flight shocks, or any combination of these shocks.

Responses of the world economy to a US capital flight shock do differ from the response to a US UIP shock. But these differences are due to the direct effects of the shock. These direct effects (i.e., effects that do not run through the exchange rate) are "differenced out" in our analysis of regime-induced depreciations, which compare outcomes between pegs and floats. These conditional moments are, in this sense, not sensitive to the choice of shocks driving the exchange rate in our model.

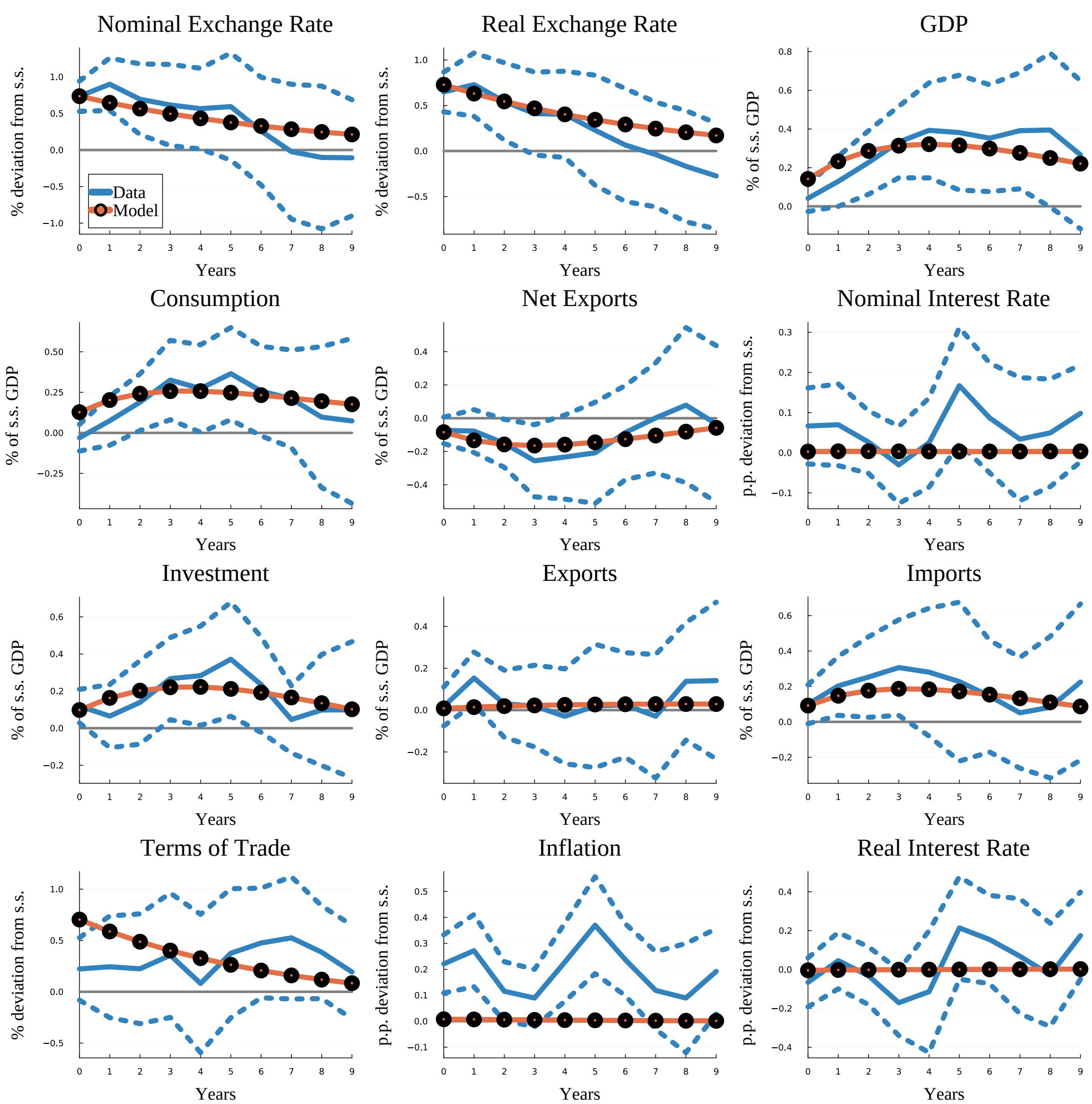


Figure B.5: Model Fit: US Capital Flight Shock

Note: This figure plots the response of peggers relative to floaters to a US capital flight shock in the model and in the data. The dashed lines represent the 95% confidence interval in the data.

Table B.2: Regime-Induced Depreciation

	Impact Response		5Y Average Response	
	e	i	e	i
Data	0.74	0.07	0.70	0.03
Model				
US UIP Shock	0.74	0.01	0.59	0.01
US Capital Flight Shock	0.74	0.00	0.57	0.00
US Monetary Policy Shock	0.74	-0.41	0.26	-0.14
US Technology Shock	0.74	-0.72	-0.97	-0.87

Note: This table reports the impulse response of the log of the nominal effective exchange rate (e) and the nominal interest rate (i) of peggers relative to floaters. Impact response indicates the response at $h = 0$, while the 5Y average response is the average of the response at horizons $h = 0$ through $h = 4$. The top row of the table shows our empirical estimates for these responses. The remaining rows show the simulated impulse response in our model in response to the shock listed to the left in that row. We choose the size of each shock such that the impact response of the nominal effective exchange rate matches the impact response in the data.

C Additional Figures and Tables

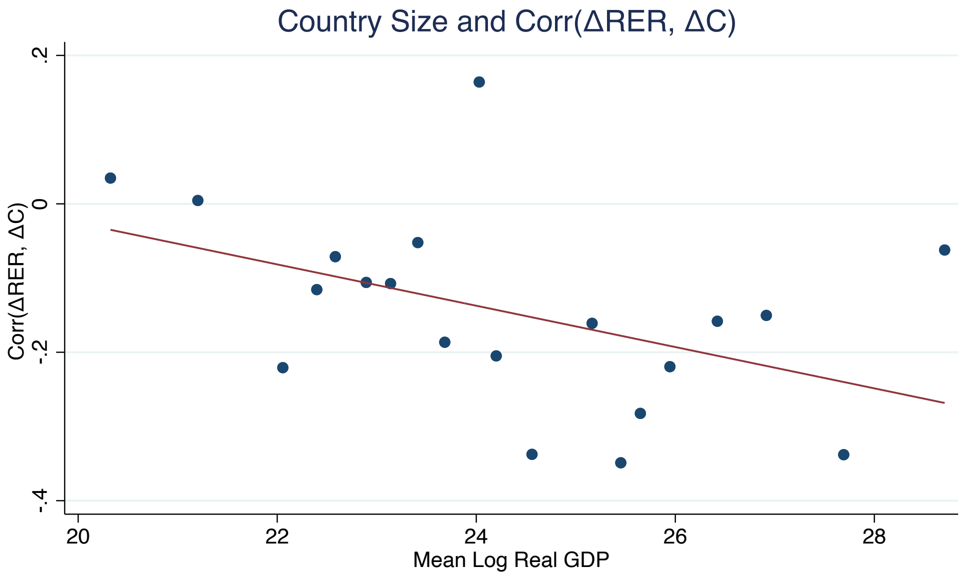


Figure C.1: The Correlation between Real Exchange Rates and Consumption by Country Size

Note: The figure plots the country-wise correlation between the log change in consumption and the log change in the real exchange rate as a function of mean log real GDP over the sample period. The figure is a binned-scatter plot with 20 bins. The red line denotes the linear fit. The slope is -0.028 with standard error of 0.010.

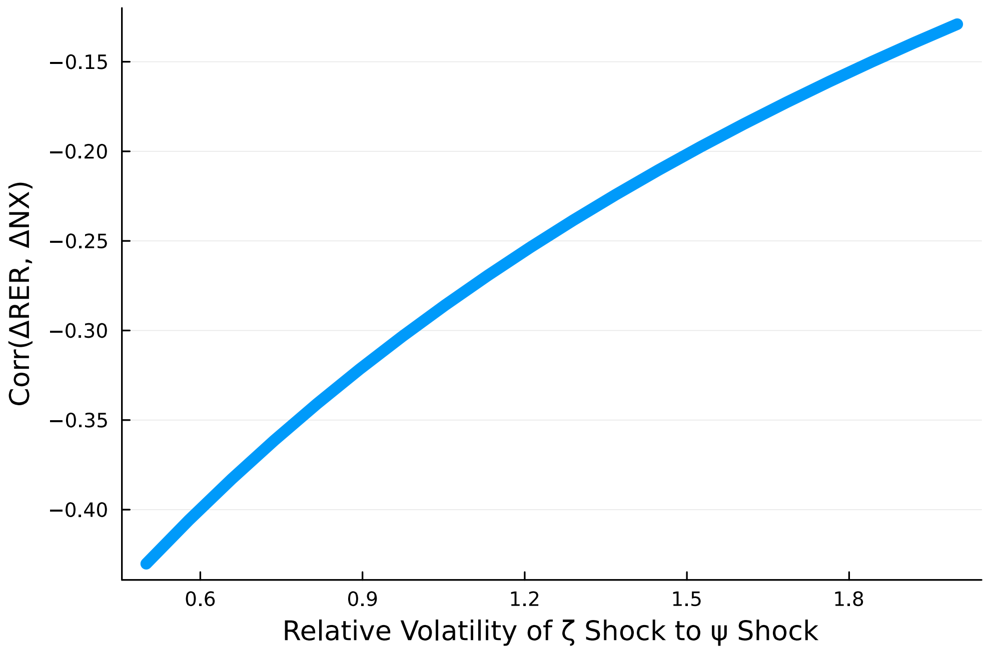


Figure C.2: Corr(ΔRER, ΔNX) versus Relative Volatility of capital flight Shocks

Note: This figure plots Corr(ΔRER, ΔNX) – the correlation of log changes in real exchange rates and changes in the ratio of net exports to GDP – as a function of the relative variance of capital flight shocks to UIP shocks in our FDX model. The relative variance of these two shocks is reported relative to its value in our baseline calibration.

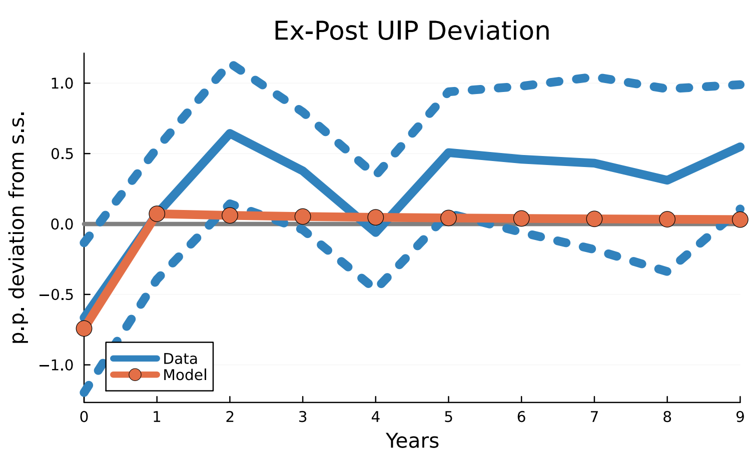


Figure C.3: Ex-Post UIP Deviations

Note: The figure plots the response of ex-post UIP deviations for pegs versus floats in response to a change in the US dollar nominal effective exchange rate. The dependent variable is $\Delta e_{i,t}^{USD} + \ln(1 + i_{i,t}) - \ln(1 + i_{U,t})$, where $\Delta e_{i,t}^{USD}$ denotes log-changes in the exchange rate of country i to the USD from time $t-1$ to t, $i_{i,t}$ is the nominal interest rate of country i from time $t-1$ to t, and $i_{U,t}$ is the US nominal interest rate. The results in blue plot estimates of β_h from equation (2) for different horizons h when UIP deviations are the outcome variable. These results are for the case with our baseline set of controls. The broken lines indicate 95% confidence intervals. The results in orange plot the response of this variable in our model in response to a US UIP shock.

Table C.1: Variance Decomposition

	ψ	ζ
ΔNER	59.05%	40.95%
ΔRER	58.85%	41.15%
ΔC	24.54%	75.46%
ΔGDP	38.50%	61.50%
ΔNX	77.62%	22.38%
$\Delta(1+i)$	60.22%	39.78%

Note: The table reports a variance decomposition of our baseline model in Column (1) of Table 5. Each row decomposes the variance of the variable listed in that row into the part caused by UIP shocks ψ and the part caused by capital flight shocks ζ. All variables except for NX are in logs. NX is expressed as a fraction of steady state GDP.