

# Monetary and Exchange Rate Policies in a Global Economy\*

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## Abstract

A consensus in the small open economy literature is that optimal monetary policy and foreign exchange intervention (FXI) separately stabilize inflation and the exchange rate. I develop an analytically tractable two-country framework where FXI balances internal and external objectives. Under international policy cooperation, optimal FXI mitigates the trade-off between domestic inflation and demand faced by monetary authorities, allowing them to stabilize inflation with moderate changes in the interest rate. At the same time, optimal FXI targets world inflation and demand since it affects international prices. The model thus suggests an interaction between conventional monetary policy and unconventional exchange rate policy tools and provides a rationale for their combined use. I further show that FXI contributes more to domestic inflation stabilization when all goods traded in international markets are priced in dollars. Finally, a quantitative exercise shows that, in a non-cooperative equilibrium, FXI exacerbates distortions to world prices and demand.

*Keywords:* Capital flows, International risk-sharing, Foreign exchange intervention, Optimal targeting rules, International policy cooperation.

*JEL Classification Codes:* E58, F31, F32, F41, F42.

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# 1 Introduction

The classical “trilemma” ([Mundell 1957](#), [Fleming 1962](#)) suggests that, under free capital mobility, monetary authorities cannot simultaneously pursue inflation/output and exchange rate stabilization. In a modern financially globalized world, countries increasingly rely on unconventional policy tools to manage the capital account and insulate themselves from international spillovers of shocks and crises, to preserve their monetary autonomy ([Rey 2015](#), [Kalemli-Özcan 2019](#), [Miranda-Agrippino and Rey 2020](#)). In particular, many countries resort to foreign exchange intervention (FXI), i.e. purchases or sales of foreign currency reserves by central banks, with over 100 countries regularly using FXI ([Adler et al. 2023](#)).<sup>1</sup>

There have been recent discussions on the optimal mix of monetary and exchange rate policies. The consensus in the literature is that monetary policy and FXI are two distinct policies and operate separately on their objectives: FXI exclusively stabilizes the exchange rate while monetary policy independently stabilizes inflation ([Cavallino 2019](#), [Basu et al. 2020](#), [Itskhoki and Mukhin 2023](#)). This rationale is based on a small-open economy case that takes the international prices of goods as given.

This paper studies two features of FXI that became salient during the COVID-19 pandemic and the Russian-Ukraine war. These features depart from the consensus in the literature. First, central banks use FXI to stabilize inflation. For example, the pandemic and the war caused worldwide inflationary pressure due to supply chain disruption. However, China and India set a record low of around 4% interest rate during the pandemic. Brazil also lowered its rate to 2% and Japan even adopted a negative interest rate policy. Instead, they responded to the crisis by selling the dollar reserves: China and Brazil sold 38 billion and 25 billion dollars in 2020, and India and Japan sold 32 billion and 63 billion dollars in 2022, respectively. This approach contrasts with the conventional method of combating inflation by raising the policy rate. This example suggests that the objectives of monetary policy and FXI are not necessarily independent from each other.<sup>2</sup>

Second, large open economies intervene in the FX market on massive scales. Most notably,

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<sup>1</sup>In countries such as Japan, the finance ministry is in charge of FXI instead of the central bank. This paper considers a joint government consisting of the central bank and the finance ministry.

<sup>2</sup>The empirical analysis on the macroeconomic effects of FXI requires a rigorous identification of FXI. As discussed in [Fratzscher et al. \(2019\)](#) and [Maggiori \(2022\)](#), this is a challenging task in the literature and beyond the scope of this paper. As a step toward identification, [Gonzalez et al. \(2021\)](#) and [Rodnyansky et al. \(2024\)](#) combine FXI data with granular bank- or firm-level balance sheet information and study within-country variation of responses to FXI.

China has 3.5 trillion dollars and Japan has 1.4 trillion dollars of FX reserves, accounting for nearly 40% of the world's FX reserves (IMF International Financial Statistics). These countries are on the US monitoring list for accumulating excess FX reserves and gaining an unfair competitive advantage in international trade ([US Department of the Treasury 2024](#)). Moreover, large countries, such as China, India, and Japan, sold FX reserves to protect their currency during the pandemic and the war, as noted above. In such a large open-economy context, exchange rate manipulation may lead to global economic fluctuation by changing the international price and the world demand for domestic and foreign goods. This paper studies whether policies should respond to domestic inflation and output gap or global business cycle conditions and imbalances beyond domestic objectives.

This paper constructs a New Keynesian model that studies the optimality, interactions, and trade-offs of monetary and exchange rate policies. The model features two large countries: the US and the local; two policies: monetary policy and FXI; and two frictions: nominal and financial frictions. The frictions I introduce imply a non-neutral role for monetary policy and FXI: sticky prices allow monetary policy to influence the real interest rate ([Rotemberg 1982](#)) and limits to arbitrage in international capital markets allow FXI to influence the exchange rate by changing the demand and supply of bonds in different currencies ([Gabaix and Maggiori 2015](#), [Itskhoki and Mukhin 2021](#)).<sup>3</sup>

My first contribution is to provide a full analytical characterization of optimal monetary policy and FXI rules in a large two-country framework. I begin with an international cooperation case, in which central banks maximize global welfare.<sup>4</sup> The key finding is that FXI trades off an internal objective (domestic inflation and demand) and an external objective (foreign inflation and demand).

On the one hand, FXI stabilizes inflation. When a central bank purchases local currency bonds using FXI, the demand for the local currency increases so the local currency appreciates. As a result, local goods become more expensive for US households, making them consume less local goods. This reduced US demand, in turn, leads to lower prices and lower inflation of local goods. Hence, FXI allows the local central banks to stabilize inflation even without tightening

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<sup>3</sup>Models of limits to arbitrage are motivated by empirical literature on forward premium puzzle ([Fama 1984](#)). Data shows that cross-currency interest differentials are not offset by expected exchange rate depreciation, resulting in positive excess returns on currency carry trades. Without limits to arbitrage, households would obtain an infinite carry-trade profit by investing in currencies with higher returns.

<sup>4</sup>In the later section, I contrast the optimal policies under cooperative and non-cooperative equilibria and study gains from cooperation.

the monetary policy and depressing local consumption demand. This rationalizes why central banks used FXI rather than monetary policy to stabilize inflation during the pandemic and war.

On the other hand, FXI distorts world inflation and demand. To understand the concept, consider an increase in local output, which increases local consumption. At the same time, a higher supply depreciates the local exchange rate and enables US households to import local goods at lower prices. Hence, US consumption also increases. Exchange rates adjust automatically and smooth consumption across countries, even if households cannot trade state-contingent assets internationally.

However, FXI distorts this consumption smoothing by manipulating the exchange rate. When the central bank purchases the local currency, the local currency appreciates. This appreciation has asymmetric effects on local and US households: local households import US goods at lower prices and increase consumption, while US households import local goods at higher prices and decrease consumption. As a result, FXI disproportionately benefits the local households over the US households.

My result shows that FXI has two main objectives. First, FXI stabilizes non-fundamental volatility in capital flows and exchange rates, as pointed out in the literature of small-open economy ([Cavallino 2019](#), [Basu et al. 2020](#), [Itskhoki and Mukhin 2023](#)). Second, when local inflation is higher than US inflation, the optimal policy is to buy the local currency, which stabilizes domestic inflation. However, this comes at the cost of destabilizing world demand since FXI by large-open economies affects international prices. Hence, optimal FXI under cooperation balances internal objectives (domestic inflation and consumption demand) and external objectives (relative demand across countries). The key policy implication is that monetary policy and FXI are not completely independent and cannot be optimized in isolation but a policy that encompasses both instruments achieves the optimal outcome.

I conduct a quantitative exercise to validate these analytical findings. In response to a 1% increase in the US markup, the optimal FXI is to purchase local currency bonds equivalent to 2.3% of GDP. This local currency purchase mitigates the local currency depreciation by 0.23% and stabilizes the paths of inflation and output gap in the two countries, even though the local monetary policy rate does not increase. However, the trade-off is that FXI distorts consumption allocation across countries: the consumption demand for local households increases by 0.6% relative to that of US households.

Having highlighted the price stabilization channel of FXI, my second contribution is to

establish a novel relationship between capital flow management in international finance and the US dollar's dominance in international trade. These two strands of literature in international macroeconomics are often discussed in separate contexts. My paper aims to bridge the gap between them. Recent evidence suggests that the majority of world trade is invoiced in a small number of dominant currencies, particularly the US dollar ([Gopinath et al. 2020](#)). Motivated by this fact, I consider a case where all goods traded in international markets are priced in dollars (dollar pricing). Under dollar pricing, the following are true. First, an identical local good has different prices in two currencies. When the dollar appreciates, identical local goods are more expensive when denominated in the US dollars than in the local currency. This generates an inefficient cross-currency price dispersion despite the identical marginal costs of production. Second, since both exports and imports are in dollars, changes in the exchange rate affect import prices and consumption for local households but have a muted effect on consumption for US households.

I find that the optimal FXI responds to this price-dispersion wedge under dollar pricing. By manipulating the exchange rate, FXI affects the relative prices of local goods sold locally and in the US, closing the price dispersion. This makes the optimal FXI particularly responsive to shocks under dollar pricing. Moreover, the transmission channel of FXI is asymmetric across countries. Optimal FXI has a large stabilization effect on local inflation without creating a large US inflationary spillover. These results suggest that dollarization in international trade is a key driver of capital flow stabilization policy in international finance.

Finally, as a robustness check, I deviate from the assumption of international policy coordination. The need to fully specify dynamic games poses many challenges to the modern literature on strategic monetary policy coordination. These include the definitions of equilibria (commitment or discretion), the choice of policy instruments (inflation or output gap), and the feasibility of deriving analytical and numerical solutions. In particular, the model is difficult to solve when there are multiple policy instruments: monetary policy and FXI. As a first step toward characterizing FXI in a non-cooperative equilibrium using a quantitative framework, my paper considers a strategic interaction between FXI by the local central bank and the monetary policy of the US central bank (the Fed). I focus on a special case where each central bank initially commits to a state-contingent strategy to maximize its objective and solve the model using a numerical method.

I show that a lack of cooperation results in excess intervention, exacerbating the distortions

of world demand. Intuitively, when the local central bank purchases the local currency and sells the dollar, the local currency appreciates, lowering the import price and stabilizing inflation. The local households increase consumption by importing more US goods.

However, unlike the cooperative equilibrium, the local central bank does not take into account the transmission effect of FXI on international price and demand. By appreciating the local currency, FXI increases the US import price and inflation and reduces consumption. An over-accumulation of local currency reserves without international coordination results in consumption misallocation in favor of the local households over the US households (beggar-thy-neighbor). Conversely, an excess accumulation of the dollar reserves (competitive devaluation) leads to a consumption misallocation in favor of the US households over the local households (beggar-thy-self). This result provides a rationale for international coordination in the monetary and exchange rate policy designs to achieve a globally optimal outcome.

**Literature.** First, this paper builds on models of exchange rate determination in an imperfect financial market ([Gabaix and Maggiori 2015](#), [Itskhoki and Mukhin 2021](#), [Maggiori 2022](#), [Fukui et al. 2023](#)). Their models have been used to study the effect of FXI ([Fanelli and Straub 2021](#), [Davis et al. 2023](#), [Ottonello et al. 2024](#)).<sup>5</sup> Moreover, [Cavallino \(2019\)](#), [Amador et al. \(2020\)](#), [Basu et al. \(2020\)](#), and [Itskhoki and Mukhin \(2023\)](#) study on monetary policy and FXI in a small open economy case, where households take the international price and demand as given.<sup>6</sup> My contribution is to study a global implication of FXI in an analytically tractable two-country framework, in which FXI affects international price and demand, and to provide a full analytical

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<sup>5</sup>The source of non-fundamental exchange rate volatility is modeled in the literature as an exogenous shock to the unhedged carry trade return ([Devereux and Engel 2002](#), [Jeanne and Rose 2002](#), [Kollmann 2005](#)) or convenience yield on the dollar bond ([Jiang et al. 2021; 2023](#), [Engel and Wu 2023](#), [Kekre and Lenel 2023](#)).

<sup>6</sup>[Cavallino \(2019\)](#) shows that FXI is costly for a central bank since FX purchase lowers the FX return while it is profitable for intermediaries as they take an opposite carry trade position against the central bank. When the domestic households do not own the entire share of the intermediaries, FXI trades off the carry cost with exchange rate stabilization. [Amador et al. \(2020\)](#) show that the zero lower bound of the nominal interest rate generates capital inflow since the expected appreciation of local currency is not offset by the lower interest rate. FXI absorbs the capital flows by accumulating foreign reserves but generates a resource cost. [Basu et al. \(2020\)](#) builds an “integrated policy framework” that jointly studies monetary policy, FXI, capital control, and macroprudential regulation. When banks face a sudden outflow of capital, a lower policy rate relaxes the domestic borrowing constraint but tightens the external borrowing constraint due to currency depreciation. FXI limits this depreciation and improves the monetary trade-off. [Itskhoki and Mukhin \(2023\)](#) show that unrestricted use of monetary policy and FXI stabilize both inflation and exchange rate separately. However, when FXI is constrained, monetary policy faces a trade-off between inflation and exchange rate stabilization.

characterization of optimal monetary policy and FXI targeting rules. My model suggests a novel trade-off of FXI between internal objectives (inflation and output) and external objectives (exchange rate and world demand).<sup>7</sup> Moreover, I take the first step to incorporate FXI in a non-cooperative equilibrium and study the strategic interaction between monetary policy and FXI in a large two-country model.

My paper is also based on the large literature on optimal monetary policy. An early strand of literature studies optimal monetary policy in a small open economy ([Clarida et al. 2001](#), [Schmitt-Grohé and Uribe 2001](#), [Kollmann 2002](#), [Galí and Monacelli 2005](#), [Faia and Monacelli 2008](#)). Another strand of papers study international monetary policy transmission and cooperation in a large two-country economy ([Obstfeld and Rogoff 2000](#), [Corsetti and Pesenti 2001](#), [Clarida et al. 2002](#), [Benigno and Benigno 2003](#), [Corsetti and Pesenti 2005](#), [Benigno and Benigno 2006](#), [Devereux and Engel 2003](#), [Corsetti et al. 2010; 2020; 2023](#), [Engel 2011](#)). These papers study monetary policy independently of FXI. I contribute to the literature by providing a joint configuration of monetary policy and FXI.

A growing empirical evidence documents that FXI is effective in stabilizing the exchange rate ([Dominguez and Frankel 1993](#), [Dominguez 2003](#), [Fatum and Hutchison 2010](#), [Blanchard et al. 2015](#), [Kuersteiner et al. 2018](#), [Adler et al. 2019](#), [Fratzscher et al. 2019](#), [Hofmann et al. 2019](#), [Fratzscher et al. 2023](#), [Rodnyansky et al. 2024](#)). My contribution is to provide a normative analysis based on a full analytical characterization of an optimal FXI targeting rule.

This paper is related to recent literature on the dominance of the US dollar in trade invoicing ([Gopinath 2016](#), [Gopinath et al. 2020](#), [Gopinath and Stein 2021](#), [Mukhin 2022](#), [Egorov and Mukhin 2023](#)). My paper bridges the gap between the literature on international trade and finance and suggests a novel mechanism where capital flow management policies are motivated by dollar pricing.

Finally, there are discussions on gains from international monetary policy coordination in a large two-country model ([Obstfeld and Rogoff 2002](#), [Benigno and Benigno 2006](#), [Benigno and Woodford 2012](#), [Corsetti et al. 2010](#), [Bodenstein et al. 2023](#)). [Fanelli and Straub \(2021\)](#) and [Itskhoki and Mukhin \(2023\)](#) study international coordination on FXI between small open economies. I take the first step to incorporate monetary policy and FXI in a large two-country

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<sup>7</sup>Other complementary transmission channels of FXI can create additional trade-offs. [Basu et al. \(2020\)](#), [Davis et al. \(2023\)](#), [Rodnyansky et al. \(2024\)](#) show that FXI mitigates balance-sheet risk when firms or banks have foreign currency debt. [Ottonello et al. \(2024\)](#) show that FXI is used as an industrial policy and helps the convergence to the technological frontier.



framework.

The rest of this paper is organized as follows. [Section 2](#) describes the model environment and setup. [Section 3](#) characterizes optimal monetary policy and FXI under cooperation. [Section 4](#) studies the optimal policies under dollar pricing. [Section 5](#) incorporates FXI in a non-cooperative equilibrium. [Section 6](#) concludes.

## 2 Model Environment: Segmented Currency Markets

The model builds on a standard international real business cycle model ([Clarida et al. 2002](#)). The key departure from the literature is that households are restricted from trading bonds denominated in foreign currency. The households' net foreign asset position must be intermediated by global financial intermediaries with limited capacity to bear exchange rate risks. This creates limits to arbitrage opportunities for households, allowing FXI to affect the relative demand and supply of bonds in different currencies ([Gabaix and Maggiori 2015](#), [Itskhoki and Mukhin 2021](#)).

There are two symmetric economies, the US and local (the rest of the world). I refer to the US unit of account as the dollar. Each country is populated with a continuum of agents of unit mass. Firms in each country are monopolistic suppliers of one type of tradable good and use labor as the only input in production. Households are allowed to trade state-contingent assets domestically but not internationally. In what follows, I describe the setup focusing on the local economy, since similar expressions apply to the US economy. Variables related to the US households and firms are denoted with an asterisk.

**Households.** In each country, there is a continuum of households that maximize the expected discount value of their lifetime utility. I assume the households have a constant relative risk aversion (CRRA) utility in consumption. The maximization of local households is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-\sigma}}{1-\sigma} - \zeta_l \frac{L_t^{1+\eta}}{1+\eta} \right],$$

where  $C_t$  and  $L_t$  are the consumption and labor supply,  $\sigma$  is the inverse intertemporal elasticity of substitution,  $\beta$  is the discount factor, and  $\eta$  is the inverse Frisch elasticity of labor. The households' consumption basket  $C_t$  is a constant elasticity of substitution (CES) aggregator of



local and US goods:

$$C_t = \left[ a C_{Lt}^{\frac{\phi-1}{\phi}} + (1-a) C_{Ut}^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{1-\phi}},$$

where  $C_{Lt}$  and  $C_{Ut}$  are the consumption of local and US goods,  $a$  is the weight of the local good, and  $\phi$  is the elasticity of substitution between the local and US goods. In the limiting case where  $\sigma = \phi = 1$  (Cole and Obstfeld 1991), households have log and Cobb-Douglas utility. I assume  $a \in (1/2, 1]$  so that households exhibit home bias of consumption.  $C_{Lt}$  and  $C_{Ut}$  are the bundles of differentiated goods:

$$C_{Lt} = \left[ \int_0^1 C_t(l)^{\frac{\zeta-1}{\zeta}} dj \right]^{\frac{\zeta}{1-\zeta}}, \quad C_{Ut} = \left[ \int_0^1 C_t(u)^{\frac{\zeta-1}{\zeta}} du \right]^{\frac{\zeta}{1-\zeta}},$$

where  $C_t(l)$  and  $C_t(u)$  are the local households' consumption of the local good  $l$  and imported good  $u$ , respectively, and  $\zeta$  is the elasticity of substitution between differentiated goods.

The local households' budget constraint is:

$$P_{Lt} C_{Lt} + P_{Ut} C_{Ut} + \frac{B_t}{R_t} = B_{t-1} + W_t L_t + \Pi_t + T_t, \quad (1)$$

where  $P_{Lt}$  and  $P_{Ut}$  are the prices of local and US goods faced by local households,  $B_t$  is the local households' investment in one-period state non-contingent bonds denominated in local currency,  $R_t$  is the interest rate on the local currency bond ( $1/R_t$  is the bond price),  $W_t$  is the wage,  $\Pi_t$  is the lump-sum transfer of firms' profit, and  $T_t$  is the government transfer.

The price index of the local good is given by:

$$P_{Lt} = \left[ \int_0^1 P_t(l)^{1-\zeta} dl \right]^{\frac{1}{1-\zeta}},$$

and the consumer price index (CPI) associated with the consumption basket  $C_t$  is given by:

$$P_t = \left[ a P_{Lt}^{1-\phi} + (1-a) P_{Ut}^{1-\phi} \right]^{\frac{1}{1-\phi}}. \quad (2)$$

Let  $\mathcal{E}_t$  denote the nominal exchange rate in terms of the local unit of account per dollar (an increase in  $\mathcal{E}_t$  implies a depreciation of the local currency against the dollar). The real exchange rate is defined as the ratio of CPIs expressed in the same currency, i.e.,  $e_t \equiv \mathcal{E}_t P_t^* / P_t$ .

The households' intratemporal consumption allocation problem gives the following demand for local and US goods:

$$C_{Lt} = a \left( \frac{P_{Lt}}{P_t} \right)^{-\phi} C_t, \quad C_{Ut} = (1 - a) \left( \frac{P_{Ut}}{P_t} \right)^{-\phi} C_t,$$

and the demand for differentiated goods produced within each country:

$$C_t(l) = \left( \frac{P_t(l)}{P_{Lt}} \right)^{-\zeta} C_{Lt}, \quad C_t(u) = \left( \frac{P_t(u)}{P_{Ut}} \right)^{-\zeta} C_{Ut}.$$

The households' Euler equation and labor supply equation are:

$$\beta R_t E_t \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} = 1, \\ C_t^\sigma L_t^\eta = \frac{W_t}{P_t}.$$

**Firms.** Firms use domestic labor to produce a differentiated good  $l$  following a production function:

$$Y_t(l) = A_t L_t(l),$$

where  $Y_t(l)$  is the output and  $L_t(l)$  is the labor input for the producer of good  $l$ .  $A_t$  is a technology shock common to all firms and follows an AR(1) process:  $\log(A_t) = \rho_a \log(A_{t-1}) + \sigma_a \epsilon_{at}$ , where  $\rho_a$  and  $\sigma_a$  are the persistence and the standard deviation, respectively. Let  $Y_{Lt} = \left[ \int_0^1 Y_t(l)^{\frac{\zeta-1}{\zeta}} dl \right]^{\frac{\zeta}{\zeta-1}}$  be the final output of the local good. The demand for the differentiated good  $l$  is given by:

$$Y_t(l) = \left( \frac{P_t(l)}{P_{Lt}} \right)^{-\zeta} Y_{Lt}.$$

Firms are subject to nominal rigidity (Rotemberg 1982) so that firms set the price  $P_t(l)$  but must pay a quadratic adjustment cost  $\frac{\nu}{2} \left( \frac{P_t(l)}{P_{t-1}(l)} - 1 \right)^2 P_t Y_t$ . To capture the key intuition, I assume producer currency pricing (PCP) so that the export price is sticky in the exporters' currency (Section 4 derives the optimal policy under dollar pricing). The firms' maximization problem

is as follows:

$$\max_{\{P_t(l)\}_{t=0}^{\infty}} E_0 Q_{0,t} \left[ (1 + \tau) P_t(l) Y_t(l) - W_t L_t(l) - \frac{\nu}{2} \left( \frac{P_t(l)}{P_{t-1}(l)} - 1 \right)^2 P_{L_t} Y_{L_t} \right], \quad (3)$$

where  $Q_{0,t} = \beta^t \left( \frac{C_t}{C_0} \right)^{-\sigma} \frac{P_0}{P_t}$  is the households' stochastic discount factor and  $\tau_t$  is the sales subsidy. I define  $\pi_{L_t} = P_{L_t}/P_{L_{t-1}} - 1$  as the net inflation rate of local good prices. Solving the maximization problem, we can derive the New Keynesian Phillips Curve (NKPC) that tracks the behavior of inflation:

$$\pi_{L_t}(1 + \pi_{L_t}) = \beta E_t \left[ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{Y_{L_{t+1}}}{Y_{L_t}} \pi_{L_{t+1}}(1 + \pi_{L_{t+1}}) \right] + \frac{\zeta - 1}{\nu} \left[ \frac{\zeta}{\zeta - 1} \frac{W_t}{A_t P_{L_t}} - (1 + \tau_t) \right].$$

**International Financial Markets.** To provide a joint analysis of monetary policy and FXI, I introduce limits to arbitrage in international financial markets in the spirit of [Jeanne and Rose \(2002\)](#), [Gabaix and Maggiori \(2015\)](#), and [Itskhoki and Mukhin \(2021\)](#). This allows FXI to influence the exchange rate by changing the relative demand and supply of bonds in two currencies. The assumption of limits to arbitrage is motivated by an empirical fact that unhedged rates of returns across currencies are not equalized. In other words, the uncovered interest rate parity (UIP) condition does not hold ([Fama 1984](#)).

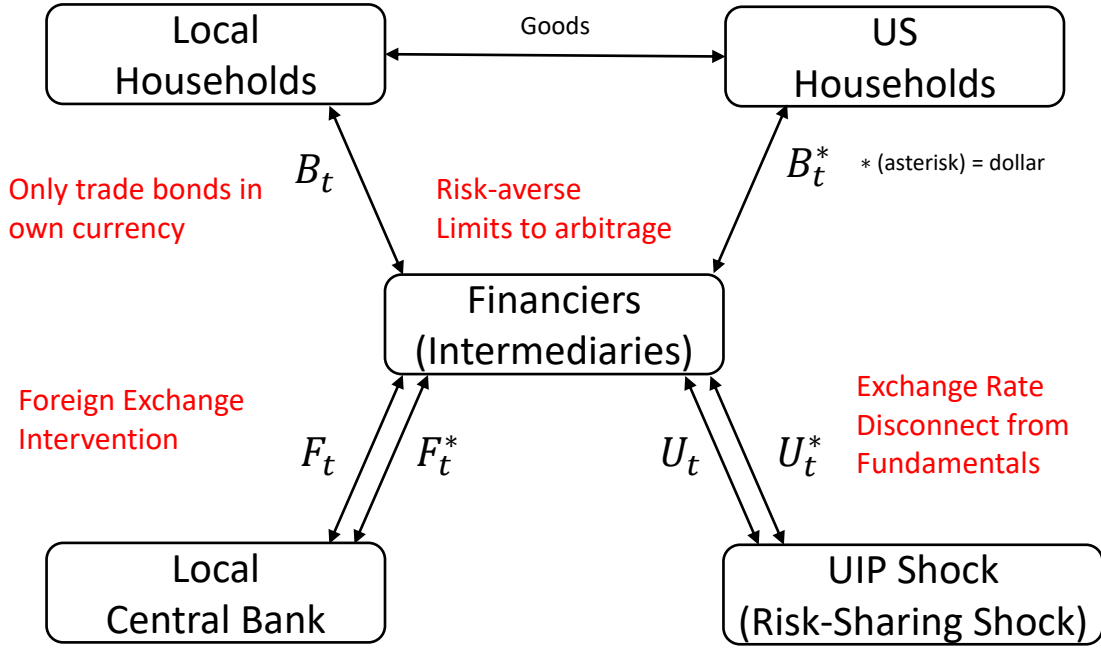
[Figure 1](#) shows the basic structure of the international financial market. Households can only trade bonds in their own currency and their net foreign asset position must be intermediated by financiers (global financial intermediaries) who are averse to exchange rate risk.<sup>8</sup> The local central bank has conventional and unconventional policy instruments: it uses monetary policy to set the nominal interest rates and FXI to trade bonds in two currencies.<sup>9</sup> Finally, I introduce UIP shocks, which affect the relative rates of return on bonds across two currencies. The UIP shock can be understood as an exogenous demand for dollar bonds due to their liquidity and safety of dollar bonds. This is a common way in the literature to generate high exchange rate

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<sup>8</sup>For tractability, I assume that households cannot access foreign currency bonds, following [Gabaix and Maggiori \(2015\)](#) and [Itskhoki and Mukhin \(2021\)](#). [Fukui et al. \(2023\)](#) generalize this setup so that households and firms can borrow and invest in foreign currency but it is costly to access foreign currency bonds.

<sup>9</sup>I assume that the US central bank (the Fed) does not use FXI since data shows that interventions by the US are infrequent.

Figure 1: Basic Structure of the International Financial Market



Note: The figure shows the basic structure of the international financial market. Local and US households can only trade bonds in their own currency ( $B_t, B_t^*$ ). The local central bank uses foreign exchange intervention to trade bonds in two currencies ( $F_t, F_t^*$ ). Liquidity (noise) traders generate an exogenous UIP shock ( $U_t, U_t^*$ ). Financiers (global financial intermediaries) intermediate the net foreign asset positions of the households, the local central bank, and the liquidity traders.

volatility and lack of correlation between exchange rates and macroeconomic fundamentals. <sup>10</sup>

To provide a simple example, consider an increase in demand for dollar bonds. Financiers provide these bonds to investors by taking a short position in dollar bonds and a long position in local currency bonds. However, since intermediaries have limited capacity to bear exchange rate risks, the local bond return must be higher than the dollar bond (UIP deviation) to compensate for exchange risks. Despite higher returns on the local currency bonds, households are restricted from taking carry trade positions so they cannot sell dollar bonds to buy local currency bonds. However, if the local central bank buys local bonds and perfectly offsets the investors' demand for dollar bonds, the rates of return on bonds are equalized across currencies (UIP condition holds).

<sup>10</sup>Since the focus of this paper is the economic consequence of UIP shocks and the role of monetary and exchange rate policies, the model is agnostic about the source of UIP shocks to keep tractability. There is an extensive discussion on the drivers of UIP shocks, including investors' heterogeneous beliefs (Bacchetta and Van Wincoop 2006) and cognitive bias (Burnside et al. 2011), rare disaster risk (Farhi and Gabaix 2016), interbank friction (Bianchi et al. 2023a), and special role of US Treasury bonds, such as liquidity or collateral values. (Bianchi et al. 2023a;b). How different sources of UIP shocks affect the optimal policy design is beyond the scope of this paper and is left for future research.

I will formalize this intuition in the model. There is a measure  $m_u$  of liquidity traders who generate an exogenous UIP shock. The investors hold a zero-net portfolio  $(U_t, U_t^*)$  so the investment  $U_t^*$  in dollar bonds is matched by the investment  $U_t/R_t = -\mathcal{E}_t U_t^*/R_t^*$  in the local currency bonds. The positive  $U_t^*$  implies that the liquidity traders take a long position in the dollar and a short position in the local currency, and vice versa. I assume that the liquidity traders' position follows an AR(1) process:  $U_t = \rho_u U_{t-1} + \sigma_u \epsilon_{ut}$ .

The local central bank uses sterilized intervention and trades bonds in the two currencies. The local central bank holds a zero-net portfolio  $(F_t, F_t^*)$  given by  $F_t/R_t = -\mathcal{E}_t F_t^*/R_t^*$  and its profits and losses are transferred to the local households in a lump-sum way.<sup>11</sup>

There is a measure  $m_d$  of financiers who intermediate the portfolio positions of the households, the liquidity traders, and the local central bank. The financiers hold a zero-net portfolio  $(D_t, D_t^*)$  given by  $D_t/R_t = -\mathcal{E}_t D_t^*/R_t^*$ . Following [Itskhoki and Mukhin \(2021\)](#) and [Fukui et al. \(2023\)](#), I assume that the financiers maximize the following constant absolute risk aversion (CARA) utility:

$$\max_{D_t} E_t \left\{ -\frac{1}{\omega} \exp \left( -\omega \bar{R}_t^* \frac{D_t}{P_t} \right) \right\}, \quad (4)$$

where  $\omega \geq 0$  is a risk-aversion parameter and

$$\bar{R}_t = R_t - R_t^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}$$

is the unhedged return on the carry trade.<sup>12</sup> In a limiting case where  $\omega = 0$ , arbitrageurs are risk-neutral and take a carry trade position without charging a risk premium. Hence, the UIP holds and the expected excess return is zero:  $E_t \bar{R}_t = 0$ . However, when  $\omega > 0$ , arbitrageurs are risk-averse and require a risk premium for taking the risky carry trade position, which drives the UIP deviation:  $E_t \bar{R}_t \neq 0$ .

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<sup>11</sup>I assume that only the local central bank conducts FXI since data shows that interventions by the Federal Reserve Board are infrequent. Moreover, I assume that FXI is unconstrained for simplicity. In reality, central banks face a zero lower bound on FX reserves, which creates an additional policy trade-off. [Davis et al. \(2023\)](#) show that, when reserves cannot be borrowed, the optimal policy is to accumulate the FX reserves during normal times and sell them during crisis times.

<sup>12</sup>The assumption of a CARA utility improves the traceability since their portfolio decision does not depend on the wealth, allowing us to avoid an additional state variable. The potential ways to microfound the banks' risk-aversion are to introduce occasionally binding borrowing constraints, costs of currency hedging, or liquidity holdings by banks ([Bianchi et al. 2023a](#)). Moreover, I assume that the financiers' profit is transferred to the local households as a lump-sum payment. As discussed in [Appendix A.2](#), the profits and losses generated by carry trade positions do not affect the first-order dynamics of the model.

The market clearing conditions for the bond market imply the net demand for local currency and dollar bonds is zero:

$$B_t + U_t + D_t + F_t = 0, \quad \text{and} \quad B_t^* + U_t^* + D_t^* + F_t^* = 0. \quad (5)$$

The competitive equilibrium is defined as the set of prices, quantities, and policy variables that solve the maximization problems of households, firms, and arbitrageurs under the constraints and market clearing conditions.

**Role of FXI in a Segmented Financial Market.** Having described the key ingredients of the model, I will discuss why FXI can improve allocations in a segmented financial market. To this end, I will introduce the concept of “international risk sharing.” Risk sharing implies that the exchange rate adjusts automatically and smooths consumption across countries. Consider an increase in local output so that local consumption increases. At the same time, the local exchange rate depreciates and US households can import local goods at lower prices. Hence, US consumption also increases.

Shocks to capital flows distort this risk sharing. When liquidity traders increase their demand for dollar bonds, the dollar appreciates and US households can import local goods at lower prices. Furthermore, since the rate of return on dollar bonds decreases relative to the return on local bonds, US households have more incentive to consume and less incentive to save. As a result, US consumption increases relative to local consumption. The local central bank can mitigate this risk-sharing distortion using FXI. If the local central bank purchases local currency bonds using FXI and perfectly offsets the traders’ demand for dollars, the local currency appreciates and the rates of return on bonds in two currencies are equalized. Hence, FXI smooths consumption across countries and improves risk-sharing.

I define the risk-sharing wedge  $\mathcal{W}_t$  as the ratio of the marginal utility of consumption across the two countries:

$$\mathcal{W}_t \equiv \frac{(C_t^*)^{-\sigma} / \varepsilon_t P_t^*}{C_t^{-\sigma} / P_t} = \left( \frac{C_t}{C_t^*} \right)^\sigma \frac{1}{e_t}. \quad (6)$$

When  $\mathcal{W}_t = 1$ , consumption risk is efficiently shared (consumption is smoothed) across the two countries. When  $\mathcal{W}_t > 1$ , the marginal utility of the local households is lower than that of the US households (the local households have an excess demand or stronger purchasing power) and

vice versa when  $\mathcal{W}_t < 1$ .

Solving the households' and financiers' maximization problems gives the equilibrium relationship between the risk-sharing wedge, UIP deviation, and the demand for bonds in two currencies.

**Lemma 1.** *The equilibrium condition in the financial market, which is log-linearized under a symmetric steady state, can be written as:*

$$E_t \tilde{\mathcal{W}}_{t+1} - \tilde{\mathcal{W}}_t = \tilde{r}_t - \tilde{r}_t^* - E_t \Delta \tilde{e}_{t+1} = \chi_1 (u_t^* - f_t) - \chi_2 b_t, \quad (7)$$

where  $r_t \equiv R_t - E_t \pi_{t+1}$ ,  $r_t^* \equiv R_t^* - E_t \pi_{t+1}^*$ ,  $f_t \equiv F_t / \bar{Y}$ ,  $u_t \equiv U_t / \bar{Y}$ ,  $b_t \equiv B_t / \bar{Y}$ ,  $\chi_1 \equiv m_u (\omega \sigma_{et}^2 / m_d)$  and  $\chi_2 \equiv \bar{Y} (\omega \sigma_{et}^2 / m_d)$  for finite  $\omega \sigma_{et}^2 / m_d$ , where  $\bar{Y} \equiv \bar{Y}_L = \bar{Y}_U$  is GDP under the symmetric steady state and  $\sigma_{et}^2 \equiv \text{var}(\Delta \log \mathcal{E}_{t+1})$  is the standard deviation of the change in log exchange rate ( $\Delta \log \mathcal{E}_{t+1} \equiv \log \mathcal{E}_{t+1} - \log \mathcal{E}_t$ ).

**Proof.** See [Appendix A.2](#).

Intuitively, suppose that the liquidity traders increase their demand for the dollar bond (positive  $u_t^*$ ). To provide the dollar bonds to liquidity traders, financiers take a short position in the dollar and a long position in the local currency. In a limiting case where  $\omega \sigma_{et}^2 / m_d \rightarrow 0$ , financiers' risk-bearing capacity is sufficiently high so that UIP holds in equilibrium. However, when  $\omega \sigma_{et}^2 / m_d > 0$ , financiers have limited risk-bearing capacity and require a risk premium as compensation for exchange rate risk in carry trade.<sup>13</sup> This results in the positive UIP deviation ( $\widetilde{UIP}_t \equiv \tilde{r}_t - \tilde{r}_t^* - E_t \Delta \tilde{e}_{t+1} > 0$ ) so that the rate of return on the local currency bond is higher than that of the dollar bond. Since households are restricted from trading assets internationally, they cannot take an opposite carry trade position against the liquidity traders. This implies that the local households face a higher rate of return on savings, so they have more incentive to invest in bonds and postpone their consumption than the US households. As a result, the home households' demand is expected to increase in the future ( $E_t \tilde{\mathcal{W}}_{t+1} - \tilde{\mathcal{W}}_t > 0$ ). Similarly, the households' net foreign debt position ( $b_t < 0$ ) is associated with the positive UIP deviation. To focus on the role of financial sectors in driving the UIP deviation, I consider the limiting case

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<sup>13</sup>The risk aversion parameter  $\omega$  is scaled so that the risk premium  $\omega \sigma_{et}^2 / m_d$  is finite and nonzero and the variance of the exchange rate  $\sigma_{et}^2$  affects the first-order dynamics of the model. See discussion by [Hansen and Sargent \(2011\)](#) and [Itskhoki and Mukhin \(2021\)](#).



where  $\chi_2 = 0$ , so that:<sup>14</sup>

$$E_t \tilde{\mathcal{W}}_{t+1} - \tilde{\mathcal{W}}_t = \tilde{r}_t - \tilde{r}_t^* - E_t \Delta \tilde{e}_{t+1} = \chi_1 (u_t^* - f_t). \quad (8)$$

The local central bank can use FXI to eliminate the distortion due to the segmented currency market. If the central bank takes an offsetting position against the liquidity traders and demands the local currency bond ( $f_t = u_t^*$ ), the right-hand side of Equation (7) becomes zero so that the UIP deviation is closed. In other words, FXI effectively shifts the exchange rate risk away from risk-averse financiers to central banks' balance sheets. Since households in the two countries face equal rates of return on savings, the risk-sharing condition holds in expectation ( $E_t \tilde{\mathcal{W}}_{t+1} - \tilde{\mathcal{W}}_t = 0$ ). When  $f_t = u_t^*$ , the resulting allocation is identical to that when the asset market is incomplete but the currency market is not segmented (Corsetti et al. 2010; 2023).

Even if FXI perfectly offsets the risk-sharing shock, this does not necessarily imply the risk-sharing condition holds for every possible state of the economy but only in expectation. Whether the risk-sharing condition holds in every state or not depends on the elasticity of substitution between the local and US goods. To capture the intuition, it is convenient to focus on (a) the log utility ( $\sigma = 1$ ) and (b) the financial autarky case where no international asset trade is allowed (an extreme form of incomplete asset market). However, we obtain similar results when  $\sigma \neq 1$  and households can trade non-contingent bonds internationally.

As discussed in Corsetti et al. (2008), it is possible to write down the relationship between the real exchange rate and the relative consumption as follows:

$$\hat{e}_t = \frac{2a-1}{2a\phi-1} (\hat{C}_t - \hat{C}_t^*), \quad (9)$$

and the allocations under the complete market and financial autarky are equalized when  $\phi = 1$ . The risk-sharing wedge (in log-linearized form with  $\sigma = 1$ ) can be written as  $\tilde{\mathcal{W}}_t = \tilde{C}_t - \tilde{C}_t^* - \tilde{e}_t$ . Intuitively, when the relative local productivity  $\hat{A}_t - \hat{A}_t^*$  increases, the relative consumption  $\hat{C}_t - \hat{C}_t^*$  increases. At the same time, a higher supply depreciates the local exchange rate ( $\hat{e}_t$  increases) and allows US households to import local goods at lower prices. Hence, the exchange rate adjusts automatically to ensure consumption smoothing across countries. When the local and US goods are substitutes ( $\phi > 1$ ), the real exchange rate moves less than one-to-one with

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<sup>14</sup>This assumption can be interpreted so that the size of the financial sector, including liquidity traders ( $m_u$ ) and financiers ( $m_d$ ), are sufficiently large relative to the real sector. See Itskhoki and Mukhin (2021).

consumption, so local households have excess demand or higher purchasing power ( $\tilde{\mathcal{W}}_t > 0$ ). When the goods are complements ( $\phi < 1$ ), the real exchange rate moves more than one-to-one, so US households have excess demand ( $\tilde{\mathcal{W}}_t < 0$ ). Only in a special case where households have a Cobb-Douglas preference ( $\phi = 1$ ), consumption is smoothed across countries ( $\tilde{\mathcal{W}}_t = 0$ ).

Finally, a lack of risk-sharing is an important driver of inflation. As discussed in the next section, this has an important implication when studying the inflation-output trade-off of monetary policy. Using log-linearization, the NKPCs for the local firms (and similarly for the US firms) can be written in terms of the terms-of-trade gap and the risk-sharing wedge in addition to the output gap:

$$\pi_{Lt} = \beta\pi_{Lt+1} + \kappa\{(\sigma + \eta)\tilde{Y}_{Lt} - (1 - a)[2a(\sigma\phi - 1)\tilde{\mathcal{T}}_t - \tilde{\mathcal{W}}_t] + \mu_t\}, \quad (10)$$

$$\pi_{Ut}^* = \beta\pi_{Ut+1}^* + \kappa\{(\sigma + \eta)\tilde{Y}_{Ut} + (1 - a)[2a(\sigma\phi - 1)\tilde{\mathcal{T}}_t - \tilde{\mathcal{W}}_t] + \mu_t^*\}, \quad (11)$$

where  $\pi_{Lt}$  and  $\pi_{Ut}^*$  are the inflation of local (US) goods faced by the local (US) households, respectively,  $\kappa = (1 + \tau_t)(\zeta - 1)/\nu$  is the slope of the NKPCs, and  $\mu_t = \zeta/((\zeta - 1)(1 + \tau_t))$  is the markup shock. The terms-of-trade is defined as the relative price of local imports over exports:  $\mathcal{T}_t = P_{Lt}/\mathcal{E}_t P_{Ut}^*$ .

As in the standard New Keynesian model, inflation depends on the expected inflation  $E_t\pi_{Lt+1}$  and the output gap  $\tilde{Y}_{Lt}$ , defined as the deviation of output from its efficient level. In an open economy ( $a < 1$ ), inflation also depends on two additional factors: the terms-of-trade gap  $\tilde{\mathcal{T}}_t$ , defined as the deviation of the terms-of-trade from its efficient level, and the risk-sharing wedge  $\tilde{\mathcal{W}}_t$ . As discussed in [Clarida et al. \(2002\)](#), the effect of the terms-of-trade gap on inflation depends on whether the local and US goods are substitutes ( $\sigma\phi > 1$ ) or complements ( $\sigma\phi < 1$ ). Consider an increase in the US output, which depreciates the US dollar and decreases the import price of US goods faced by local households. On the one hand, lower import price increases consumption demand for the local households. This increases the marginal cost of production and inflation. On the other hand, higher export price for local firms increases the marginal benefit of production for local firms and reduces inflation. When local and US goods are substitutes ( $\sigma\phi > 1$ ), the former effect dominates the latter, so  $\pi_{Lt}$  is increasing in  $\tilde{\mathcal{W}}_t$  (a local excess demand increases local inflation). When goods are complements, ( $\sigma\phi < 1$ ) the latter effect dominates the former, so  $\pi_{Lt}$  is decreasing in  $\tilde{\mathcal{W}}_t$ . In a special case where households have a log and Cobb-Douglas preference ( $\sigma = \phi = 1$ , [Cole and Obstfeld 1991](#)), the two effects

offset so that risk-sharing wedge has no effects on inflation.

### 3 Optimal Trade-offs of Monetary Policy and FXI

This section provides a full analytical characterization of optimal policy rules under cooperation and commitment. To capture the intuition, I start with the case where only monetary policy is available but FXI is not, based on [Corsetti et al. \(2023\)](#). Next, I provide a joint configuration of optimal monetary policy and FXI rules. Finally, I consider two sources of shocks: productivity and markup, and study how FXI affects their transmission channels.

#### 3.1 Baseline: Optimal Monetary Policy without FXI

I begin with the case where central banks in the two countries can only use monetary policy to set the nominal interest rate, but they cannot use FXI. I focus on the cooperation and commitment case, in which central banks maximize the sum of expected discounted utility in the two countries. This is equivalent to minimizing the quadratic loss function which is approximated around the efficient flexible-price equilibrium:<sup>15</sup>

$$\mathcal{L} = -E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2} \left[ (\sigma + \eta) (\tilde{Y}_{Lt}^2 + \tilde{Y}_{Ut}^2) + \frac{\zeta}{\kappa} (\pi_{Lt}^2 + \pi_{Ut}^{*2}) - \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1} (\tilde{Y}_{Lt} - \tilde{Y}_{Ut})^2 + \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} \tilde{\mathcal{W}}_t^2 \right]. \quad (12)$$

Importantly, under cooperation, the loss function not only depends on the internal objective (inflation and output gap in each country) but also the external objective (relative output gap and risk-sharing wedge across countries).

The following lemma characterizes optimal monetary policy rules under an incomplete asset market.

**Lemma 2** (Optimal Monetary Policy Rules without FXI). *Under PCP, cooperation, and commitment, and when FXI is not available, optimal monetary policy rules for the local and US central banks are characterized by:*

$$0 = \theta\pi_{Lt} + (\tilde{Y}_{Lt} - \tilde{Y}_{Lt-1}) + \psi_D(\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1}), \quad (13)$$

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<sup>15</sup>See [Corsetti et al. \(2023\)](#) for the detailed derivation.

$$0 = \theta \pi_{U_t}^* + (\tilde{Y}_{U_t} - \tilde{Y}_{U_{t-1}}) - \psi_D(\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1}), \quad (14)$$

where:

$$\psi_D = \frac{4a(1-a)\phi}{\sigma + \eta\{4a(1-a)(\sigma\phi - 1) + 1\}} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1}, \quad (15)$$

which hold without imposing restrictions on  $\sigma$  and  $\phi$ .

**Proof.** See [Appendix A.3](#).

Intuitively, as suggested by [Equation \(10\)](#), an increase in the risk-sharing wedge generates endogenous cost-push inflation under incomplete asset markets, even without assuming an exogenous markup shock. Hence, monetary policy faces a trade-off between inflation and growth rates in the output gap and risk-sharing wedge.

Next, I characterize the international transmission of shocks. First, the following lemma characterizes the transmission of productivity shocks.

**Lemma 3** (Transmission of Productivity Shock). *Assume PCP and suppose that FXI is not available and monetary policy follows the optimal rule in [Lemma 2](#).*

- When  $\sigma\phi > 1$ ,  $\frac{\partial \pi_{L_t}}{\partial A_t} > 0 > \frac{\partial \pi_{U_t}^*}{\partial A_t}$ ,  $\frac{\partial \tilde{Y}_{L_t}}{\partial A_t} < 0 < \frac{\partial \tilde{Y}_{U_t}}{\partial A_t}$ , and  $\frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} > 0$ .
- When  $\sigma\phi < 1$ ,  $\frac{\partial \pi_{L_t}}{\partial A_t} < 0 < \frac{\partial \pi_{U_t}^*}{\partial A_t}$ ,  $\frac{\partial \tilde{Y}_{L_t}}{\partial A_t} > 0 > \frac{\partial \tilde{Y}_{U_t}}{\partial A_t}$ , and  $\frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} < 0$ .
- When  $\sigma\phi = 1$ ,  $\frac{\partial \pi_{L_t}}{\partial A_t} = \frac{\partial \pi_{U_t}^*}{\partial A_t} = \frac{\partial \tilde{Y}_{L_t}}{\partial A_t} = \frac{\partial \tilde{Y}_{U_t}}{\partial A_t} = \frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} = 0$ .

Consider an increase in local productivity (or a decrease in US productivity), which depreciates the local exchange rate. When local and US goods are substitutes, the local consumption increases more than the exchange rate depreciates, so the local households have lower marginal utility. This increases the local inflation but decreases the US inflation. The optimal policy is to tighten the policy rate, which leads to a negative output gap. The opposite pattern holds when the two goods are complements. When the two goods are independent, there is no policy trade-off and monetary policy perfectly stabilizes inflation and output gap.

The next lemma characterizes the transmission of an inefficient cost-push shock under the optimal monetary policy without FXI based on [Corsetti et al. \(2010\)](#). I focus on a case where

local and US goods are substitutes since it matches the empirically relevant calibration (Itskhoki and Mukhin 2021) and will provide the most interesting implication of FXI.

**Lemma 4** (Transmission of Cost-Push Shock). *Suppose that  $\sigma\phi > 1$ , FXI is not available, and monetary policy follows the optimal rule in Lemma 2. Up to the first order, the elasticities of inflation, output gap, and real exchange rate to a period-0 US cost-push shock satisfy:*

$$\frac{\partial \pi_{U0}^*}{\partial \mu_0^*} > 0, \quad \frac{\partial \pi_{U1}^*}{\partial \mu_0^*} < \frac{\partial \pi_{U2}^*}{\partial \mu_0^*} < \dots < 0, \quad \frac{\partial \tilde{Y}_{U0}}{\partial \mu_0^*} < \frac{\partial \tilde{Y}_{U1}}{\partial \mu_0^*} < \dots < 0, \quad (16)$$

$$\frac{\partial \pi_{L0}}{\partial \mu_0^*} < 0, \quad \frac{\partial \pi_{L1}}{\partial \mu_0^*} > \frac{\partial \pi_{L2}}{\partial \mu_0^*} > \dots > 0, \quad \frac{\partial \tilde{Y}_{L0}}{\partial \mu_0^*} > \frac{\partial \tilde{Y}_{L1}}{\partial \mu_0^*} > \dots > 0, \quad (17)$$

$$\frac{\partial \tilde{e}_0}{\partial \mu_0^*} > \frac{\partial \tilde{e}_1}{\partial \mu_0^*} > \dots > 0. \quad (18)$$

**Proof.** See Appendix A.5.

In response to a US cost-push shock, the optimal US monetary policy is to commit to tightening, which lowers the inflation expectation and output gap over time. Hence, the United States faces temporary inflation due to the initial impact of the cost-push shock, followed by mild and persistent deflation due to the monetary tightening. At the same time, the decrease in the US output depreciates the local currency and worsens the local terms of trade. As shown in the NKPC (10) for the local firms, as long as the local and US goods are substitutes ( $\sigma\phi > 1$ ), the local terms-of-trade worsening (an increase in  $\mathcal{T}_0$ ) has a similar transmission mechanism to a negative local cost-push shock (a decrease in  $\mu_t$ ) and generates a negative comovement of inflation and output gap across countries. The local currency depreciation causes an increase in demand for local goods, so the local output gap is positive. The optimal local monetary policy is to commit to tightening, so the local economy faces temporary deflation due to tightening, followed by mild and persistent inflation due to higher demand.

### 3.2 Optimal Monetary Policy and FXI

Next, I consider the case where both monetary policy and FXI are available. The following proposition provides a full characterization of optimal monetary policy and FXI rules.

**Proposition 1** (Optimal Monetary Policy and FXI). *Under PCP, cooperation, and commitment, and both monetary policy and FXI are available, optimal monetary policy rules for the local*

and US central banks are characterized by:

$$0 = \theta\pi_{L_t} + (\tilde{Y}_{L_t} - \tilde{Y}_{L_{t-1}}) + \psi_\pi\theta(\pi_{L_t} - \pi_{U_t}^*) + \psi_D(\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1}), \quad (19)$$

$$0 = \theta\pi_{U_t} + (\tilde{Y}_{U_t} - \tilde{Y}_{U_{t-1}}) - \psi_\pi\theta(\pi_{L_t} - \pi_{U_t}^*) - \psi_D(\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1}), \quad (20)$$

where:

$$\psi_\pi = (1 - a) \frac{2a(\sigma\phi - 1) + 1}{\sigma + \eta\{4a(1 - a)(\sigma\phi - 1) + 1\}} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1},$$

and  $\psi_D$  is given in [Equation \(15\)](#). The optimal FXI for the local central bank is characterized by:

$$f_t = u_t^* + \frac{2a(\sigma\phi - 1) + 1}{2a\phi\chi_1} \theta(E_t\pi_{L_{t+1}} - E_t\pi_{U_{t+1}}^*). \quad (21)$$

These optimal rules hold without imposing the restrictions on  $\sigma$  and  $\phi$ .

**Proof.** See [Appendix A.4](#).

The key difference from [Lemma 2](#) is that, in general, optimal FXI does not perfectly offset the UIP shock, i.e.,  $f_t = u_t^*$  is no longer optimal. Instead, when the local inflation expectation is higher than the US ( $E_t\pi_{L_{t+1}} > E_t\pi_{U_{t+1}}^*$ ), the optimal FXI is to buy the local currency and sell the US dollar.

The next two propositions show how optimal FXI trade-offs depend on the source of shocks. In particular, I focus on productivity and cost-push shocks.

**Proposition 2** (Transmission of Productivity Shock when FXI is available). *Assume PCP, cooperation, and commitment, and suppose that the monetary policy follows the optimal rule. When  $\sigma\phi > 1$ , comparing the cases where FXI follows the optimal rule and FXI is not available,*

$$\begin{aligned} \frac{\partial f_t}{\partial A_t} > 0, \quad \frac{\partial \tilde{\mathcal{W}}_t^{FXI}}{\partial A_t} > \frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} > 0, \quad \frac{\partial \pi_{L_t}}{\partial A_t} > \frac{\partial \pi_{L_t}^{FXI}}{\partial A_t} > 0 > \frac{\partial \pi_{U_t}^{FXI*}}{\partial A_t} > \frac{\partial \pi_{U_t}^*}{\partial A_t}, \\ \text{and} \quad \frac{\partial \tilde{Y}_{L_t}^{FXI}}{\partial A_t} < \frac{\partial \tilde{Y}_{L_t}}{\partial A_t} < 0 < \frac{\partial \tilde{Y}_{U_t}}{\partial A_t} < \frac{\partial \tilde{Y}_{U_t}^{FXI}}{\partial A_t}. \end{aligned}$$

When  $\sigma\phi < 1$ ,

$$\begin{aligned} \frac{\partial f_t}{\partial A_t} < 0, \quad \frac{\partial \tilde{\mathcal{W}}_t^{FXI}}{\partial A_t} < \frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} < 0, \quad \frac{\partial \pi_{Lt}}{\partial A_t} < \frac{\partial \pi_{Lt}^{FXI}}{\partial A_t} < 0 < \frac{\partial \pi_{Ut}^{FXI*}}{\partial A_t} < \frac{\partial \pi_{Ut}^*}{\partial A_t}, \\ \text{and} \quad \frac{\partial \tilde{Y}_{Lt}^{FXI}}{\partial A_t} > \frac{\partial \tilde{Y}_{Lt}}{\partial A_t} > 0 > \frac{\partial \tilde{Y}_{Ut}}{\partial A_t} > \frac{\partial \tilde{Y}_{Ut}^{FXI}}{\partial A_t}. \end{aligned}$$

When  $\sigma\phi = 1$ ,

$$\frac{\partial f_t}{\partial A_t} = \frac{\partial \pi_{Lt}}{\partial A_t} = \frac{\partial \pi_{Ut}^*}{\partial A_t} = \frac{\partial \tilde{Y}_{Lt}}{\partial A_t} = \frac{\partial \tilde{Y}_{Ut}}{\partial A_t} = \frac{\partial \tilde{\mathcal{W}}_t}{\partial A_t} = 0.$$

Intuitively, when the local and US goods are substitutes ( $\sigma\phi > 1$ ), an increase in local productivity (or a decrease in US productivity) increases local inflation and risk-sharing wedge and reduces the output, as discussed in [Lemma 3](#). The optimal FXI is to buy the local currency, which creates a non-trivial policy trade-off. On the one hand, the appreciation of the local currency reduces the US demand for local goods and the local inflation rate. On the other hand, not only does this lower demand reduce the output further but local appreciation also widens the risk-sharing wedge. Vice versa, when the local and US goods are complements ( $\sigma\phi < 1$ ), the optimal FXI is to buy the US dollar. Hence, in general, monetary policy and FXI are not two independent policy tools, but they should be used jointly to stabilize inflation.

In the special case where the local and US goods are independent ( $\sigma\phi = 1$ ), productivity shock has no effect on the risk-sharing wedge and the inflation rate. Hence, the optimal FXI is to perfectly offset the UIP shock ( $f_t = u_t^*$ ), and the optimal monetary policy is to set the interest rate at the natural level and close the inflation and output gap in the two countries. This result is a well-known dichotomy in the open economy since the monetary policy and FXI have two separate targets.

The next proposition shows the optimal trade-off of FXI when there is a cost-push shock. Similarly to [Lemma 4](#), I focus on the case where the local and US goods are substitutes.

**Proposition 3** (Transmission of Cost-Push Shock when FXI is available). *Suppose  $\sigma\phi > 1$ . Comparing the cases where FXI follows the optimal rule and FXI is not available,*

$$\frac{\partial \pi_{U0}^{*FXI}}{\partial \mu_0^*} < \frac{\partial \pi_{U0}^*}{\partial \mu_0^*} (> 0), \quad \frac{\partial \pi_{Ut}^{*FXI}}{\partial \mu_0^*} > \frac{\partial \pi_{Ut}^*}{\partial \mu_0^*} (< 0), \quad \frac{\partial \tilde{Y}_{Ut}^{FXI}}{\partial \mu_0^*} > \frac{\partial \tilde{Y}_{Ut}}{\partial \mu_0^*} (< 0), \quad (22)$$

$$\frac{\partial \pi_{L0}^{FXI}}{\partial \mu_0^*} > \frac{\partial \pi_{L0}}{\partial \mu_0^*} (< 0), \quad \frac{\partial \pi_{Lt}^{FXI}}{\partial \mu_0^*} < \frac{\partial \pi_{Lt}}{\partial \mu_0^*} (> 0), \quad \frac{\partial \tilde{Y}_{Lt}^{FXI}}{\partial \mu_0^*} < \frac{\partial \tilde{Y}_{Lt}}{\partial \mu_0^*} (> 0), \quad (23)$$



$$\frac{\partial \tilde{e}_t^{FXI}}{\partial \mu_0^*} < \frac{\partial \tilde{e}_t}{\partial \mu_0^*} (> 0), \quad \frac{\partial \widetilde{UIP}_t^{FXI}}{\partial \mu_0^*} < \frac{\partial \widetilde{UIP}_t}{\partial \mu_0^*} (\cong 0). \quad (24)$$

**Proof.** See [Appendix A.6](#).

The proposition shows that, by combining monetary policy and FXI, both inflation and output gap are smoothed out in both countries. If the central bank buys the local currency using FXI, the local currency appreciates. Hence, the US households decrease the relative demand for local goods via expenditure switching channels. This change in demand composition narrows down the positive local output gap and the negative US output gap. Since FXI partially absorbs the output gap, the monetary policy can focus more on inflation stabilization. In other words, FXI improves the monetary policy trade-off between inflation and output gap stabilization.

However, at the same time, by buying the local currency using FXI, the local bond price increases, and its return decreases relative to the dollar bond. Due to limits to arbitrage, local households cannot invest in the dollar bond despite its higher return. Since the local households face a lower rate of return on savings than the US households, the local households enjoy lower marginal utility than the US households (the risk-sharing wedge becomes positive). Hence, FXI faces a trade-off in stabilizing the internal objective (inflation and output gap in each country) and the external objective (risk-sharing wedge across countries).

### 3.3 Numerical Illustration

To validate these analytical predictions, this section provides a numerical illustration of the transmission mechanisms of FXI. I conduct an impulse response analysis using empirically plausible parameter settings under the optimal monetary policy and FXI rules obtained in the previous section.

[Table 1](#) shows the calibration of key parameters. I set  $\beta = 0.995$  to target the annual interest rate of 2%. The risk aversion parameter  $\sigma$  is between 1 and 5 in most literature. There is a wide range of estimates of trade elasticity parameter  $\phi$  ranging from 0.65 to 4, as discussed in ([Bodenstein et al. 2023](#)). I choose  $\sigma = 5$  and  $\phi = 1.5$ . The inverse Frisch elasticity is set at  $\eta = 1.5$  following [Itskhoki and Mukhin \(2021\)](#). I choose  $a = 0.88$  for the home bias of consumption to match the US trade-to-GDP ratio. I set  $\theta = 10$  for the elasticity of substitution between differentiated goods and  $\nu = 90$  for the price adjustment cost following [Ottonello and](#)

Table 1: Benchmark Parameters

	Description	Value	Notes
$\beta$	Discount factor (local)	0.995	Annual interest rate = 2%
$\sigma$	Relative risk aversion	5	Cole and Obstfeld (1991)
$\eta$	Inverse Frisch elasticity	1.0	Itskhoki and Mukhin (2021)
$a$	Home bias of consumption	0.88	Bodenstein et al. (2023)
$\phi$	CES Local & US goods	1.5	Cole and Obstfeld (1991)
$\theta$	CES differentiated goods	10	Ottonello and Winberry (2020)
$\nu$	Price adjustment cost	90	Ottonello and Winberry (2020)
$\chi_1$	Elasticity of UIP to FXI	0.20	Itskhoki and Mukhin (2021)

Note: The table shows the parameter settings for impulse response analyses in [Table 3.3](#).

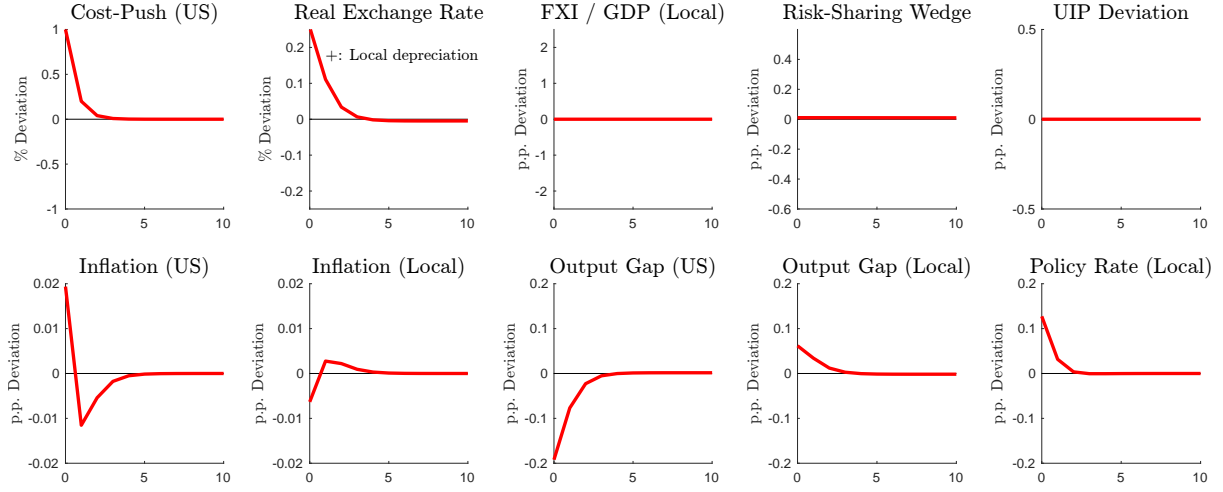
[Winberry \(2020\)](#). Finally, I set  $\chi_1 = 0.2$  to match the relative volatility of productivity and financial shocks ([Itskhoki and Mukhin 2021](#)).

[Figure 2](#), panel (a) provides a graphical representation of [Lemma 4](#). The red line shows the impulse response to a one-percentage increase in the US markup when FXI is not available and monetary policy follows the optimal rule as in [Lemma 2](#). The US experiences temporary inflation followed by negative inflation due to a commitment to monetary tightening. A lower supply of US goods appreciates the dollar by 0.26%, so households face higher import prices of US goods. Hence, households shift demand from the US to local goods, increasing the local output. The local monetary policy rate increases by 0.13pp, creating a deflationary pressure.

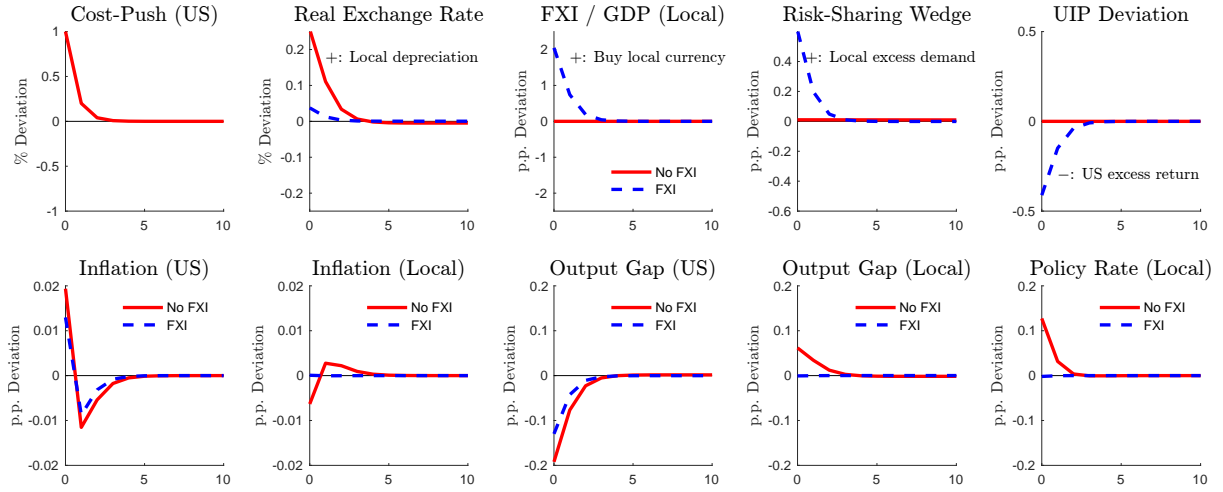
Next, [Figure 2](#), panel (b) provides a graphical representation of [Proposition 3](#). The figure compares the impulse response to a US cost-push shock with and without FXI. The red line shows the case where only monetary policy is available (same as panel a) and the blue line shows the case where both monetary policy and FXI are available as in [Proposition 1](#). The optimal FXI is to buy local currency equivalent to 2.3% of GDP. The local currency depreciation reduces to 0.03%, as opposed to 0.26%, and the local monetary policy rate reduces to 0pp. Since local currency depreciates less, households increase the demand for US goods. This increases the output of US goods and decreases the output of local goods, mitigating the output gap in both countries. Since FXI absorbs the output gap in both countries, the entire path of inflation is stabilized even without local monetary tightening. However, the trade-off is that the local currency purchase increases the local bond price and decreases the return, leading to a UIP deviation of  $-0.4$ pp. The lower import price and lower bond return for local households increase their demand and purchasing power and the risk-sharing wedge increases by 0.6%.

Figure 2: Impulse Response to a US Cost-Push Shock

(a) No Intervention



(b) No Intervention vs. Intervention



Note: The figure plots the impulse responses to a one-percentage increase in the US markup. Panel (a) plots the case without FXI and panel (b) compares the case with and without FXI. Red: the local central bank uses only monetary policy. Blue: the local central bank combines monetary policy and FXI (local bond purchase).

## 4 Dollar Pricing

While PCP assumption provides the simplest analytical solution, data suggests that exports and imports are mainly invoiced in US dollars ([Gopinath et al. 2020](#)). Motivated by this fact, this section explores the novel interplay between dollar dominance in international trade and capital flow management in international finance. To this end, I introduce dominant currency pricing (DCP) and study optimal FXI and transmission channels. Differently from the previous section, I assume that both exports and imports are denominated in US dollars. This has two major implications. First, identical local goods are priced differently in two currencies, i.e., the law of one price (LOOP) does not hold for local goods. This generates an inefficient cross-currency price dispersion despite the same marginal cost of production ([Engel 2011](#)). Second, changes in the exchange rates directly affect import prices for local households, so they change the relative consumption of local and US goods. However, this expenditure-switching effect is muted for US households since US imports are denominated in dollars.

For the local firms, the price-setting problem in local currency is given by [Equation \(3\)](#). The price-setting problem in the US dollar is:

$$\max_{\{P_t^*(l)\}_{t=0}^{\infty}} E_0 Q_{0,t} \left[ (1 + \tau) \mathcal{E}_t P_t^*(l) Y_t^*(l) - W_t L_t(l) - \frac{\nu}{2} \left( \frac{P_t^*(l)}{P_{t-1}^*(l)} - 1 \right)^2 \mathcal{E}_t P_{Lt}^* Y_{Lt}^* \right], \quad (25)$$

where  $P_t^*(l)$  and  $Y_t^*(l)$  are the dollar price and quantity of local good  $l$  sold in the US. Let  $\Delta_{Lt} \equiv \mathcal{E}_t P_{Lt}^* / P_{Lt}$  be the relative price of a local good denominated in the US dollar over the local currency. Under DCP, the price of local goods is sticky in local currency ( $P_{Lt}$ ) in the local economy and sticky in the dollars ( $P_{Lt}^*$ ) in the US. Hence, a local depreciation (higher  $\mathcal{E}_t$ ) increases the dollar price relative to the local currency price (higher  $\Delta_{Lt}$ ). Solving the firms' maximization problem,

$$\pi_{Lt} = \beta \pi_{Lt+1} + \kappa \{ (\sigma + \eta) \tilde{Y}_{Lt} - (1 - a) [2a(\sigma\phi - 1)(\tilde{\mathcal{T}}_t + \tilde{\Delta}_{Lt}) + (\tilde{\mathcal{W}}_t + \tilde{\Delta}_{Lt})] + \mu_t \}, \quad (26)$$

$$\pi_{Lt}^* = \beta \pi_{Lt+1}^* + \kappa \{ (\sigma + \eta) \tilde{Y}_{Lt} - (1 - a) [2a(\sigma\phi - 1)(\tilde{\mathcal{T}}_t + \tilde{\Delta}_{Lt}) + (\tilde{\mathcal{W}}_t + \tilde{\Delta}_{Lt})] - \tilde{\Delta}_{Lt} + \mu_t^* \}, \quad (27)$$

and the NKPC for the US firms is given by [Equation \(11\)](#).

The quadratic loss function in the DCP case can be characterized as:<sup>16</sup>

$$\mathcal{L} = -E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2} \left[ \begin{aligned} & (\sigma + \eta) \left( \tilde{Y}_{Lt}^2 + \tilde{Y}_{Ut}^2 \right) + \frac{\zeta}{\kappa} \left( a\pi_{Lt}^2 + (1-a)\pi_{Lt}^{*2} + \pi_{Ut}^{*2} \right) \\ & - \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1} (\tilde{Y}_{Lt} - \tilde{Y}_{Ut})^2 \\ & + \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} (\tilde{\mathcal{W}}_t + \tilde{\Delta}_{Lt})^2 \end{aligned} \right]. \quad (28)$$

There are two key differences compared to the PCP case (Equation (12)). First, the central banks take into account the weighted sum of local good inflation in the two countries  $(\pi_{Lt}, \pi_{Lt}^*)$ . Second, the loss depends on the deviation from the LOOP  $(\tilde{\Delta}_{Lt})$ .

Under DCP, analytically tractable expressions for the optimal policy rule can be derived under the assumption of linear labor disutility (Engel 2011). The following lemma characterizes the optimal monetary policy under dollar pricing when FXI is not available.

**Lemma 5** (Optimal Monetary Policy Trade-offs under DCP). *Under DCP, cooperation, and commitment,  $\eta = 0$ , and when FXI is not available ( $f_t = 0$ ), optimal monetary policy rules for the local and US central banks are characterized by:*

$$0 = \theta a\pi_{Lt} + (\tilde{C}_t - \tilde{C}_{t-1}) + \frac{2a(1-a)\phi}{2a(\phi - 1) + 1} \frac{\sigma - 1}{\sigma} (\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1} + \tilde{\Delta}_t - \tilde{\Delta}_{t-1}), \quad (29)$$

$$0 = \theta[(1-a)\pi_{Lt}^* + \pi_{Ut}^*] - (\tilde{C}_t^* - \tilde{C}_{t-1}^*) - \frac{2a(1-a)\phi}{2a(\phi - 1) + 1} \frac{\sigma - 1}{\sigma} (\tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}_{t-1} + \tilde{\Delta}_t - \tilde{\Delta}_{t-1}). \quad (30)$$

**Proof.** See Appendix A.7.

The result is isomorphic to the one without currency market segmentation (Corsetti et al. 2020). Importantly, the optimal monetary policy rule is asymmetric across countries. The local central bank trades off the stabilization of domestic inflation  $(\pi_{Lt})$  with growth rates of the risk-sharing wedge and LOOP deviation. In contrast, the US central bank targets the international dollar price, which is the weighted sum of the inflation of local goods prices in the dollars  $(\pi_{Lt}^*)$  and the US-produced goods  $(\pi_{Ut}^*)$ .

Next, I study the case where both monetary policy and FXI are available. DCP has two key implications for the design and transmission mechanism of optimal FXI. First, Proposition 4 shows that the optimal FXI closes the inefficient cross-currency dispersion due to incomplete

<sup>16</sup>See Corsetti et al. (2020) for the details.

exchange-rate pass-through. The full derivation of the policy rules under DCP is available in [Appendix A.8](#).

**Proposition 4** (Targeting the LOOP Deviation). *Under DCP, cooperation, commitment,  $\sigma = \phi = 1$ ,  $\eta = 0$ , and when both monetary policy and FXI follow the optimal rules,*

1. *Optimal local currency purchase  $f_t$  is an increasing function of the price dispersion  $\Delta_{Lt}$ .*
2. *FXI reduces the elasticity of  $\Delta_{Lt}$  to the US cost-push shock.*
3. *The elasticity of optimal local currency purchase to the US cost-push shock is larger under DCP than PCP:*

$$\frac{\partial f_t}{\partial \Delta_{Lt}} > 0, \quad \frac{\partial \Delta_{Lt}^{FXI}}{\partial \mu_t^*} < \frac{\partial \Delta_{Lt}}{\partial \mu_t^*} (> 0), \quad \left( \frac{\partial f_t}{\partial \mu_t^*} \right)^{DCP} > \left( \frac{\partial f_t}{\partial \mu_t^*} \right)^{PCP} (> 0). \quad (31)$$

**Proof.** See [Appendix A.9](#).

Statements 1 and 2 show that optimal FXI addresses the inefficient cross-currency price dispersion due to incomplete exchange-rate pass-through. Under DCP, since the local exporters set the price in US dollars, a depreciation of the local currency increases the dollar price relative to the local currency price of an identical locally produced good, causing a deviation from the LOOP. The proposition implies that the optimal FXI is to buy the local currency and respond to its undervaluation. Hence, the optimal FXI rule targets the LOOP deviation in addition to the UIP deviation and the inflation in the two countries. As implied by Statement 3, the optimal FXI volume is larger under DCP than under PCP.

Second, [Proposition 5](#) characterizes the key difference in the transmission mechanism of FXI under different currency paradigms.

**Proposition 5** (Asymmetric Transmission). *Assume DCP, cooperation, commitment,  $\sigma = \phi = 1$ ,  $\eta = 0$ , and suppose that both monetary policy and FXI follow the optimal rules. In response to the US cost-push shock, under PCP, optimal FXI decreases the local CPI inflation and increases the US CPI inflation by the same degree:*

$$\left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{PCP} = - \left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{PCP} (< 0).$$

Under DCP, optimal FXI decreases the local CPI inflation more and increases the US CPI inflation less than the PCP case:

$$\begin{aligned} \left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{DCP} &< \left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{PCP} (< 0), \\ \left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{DCP} &< \left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{PCP} (> 0). \end{aligned}$$

**Proof.** See [Appendix A.10](#).

Under PCP, FXI decreases local inflation and increases US inflation symmetrically. However, under DCP, the transmission of FXI is asymmetric across countries. On the one hand, FXI decreases local inflation more under DCP than PCP. Since the optimal FXI is larger under DCP ([Proposition 4](#)), FXI reduces the local import price of US goods and thus the local CPI inflation. On the other hand, since the US import price is sticky in dollars, local currency appreciation has a limited effect on the US import price. Hence, by purchasing the local currency, central banks can stabilize local inflation without causing a large upward spillover to US inflation. These results explain why FXI is particularly effective at stabilizing local inflation under DCP.<sup>17</sup>

## 5 Non-Cooperative Equilibrium: A First Step

Finally, I deviate from international cooperation and study FXI in a strategic non-cooperative equilibrium. As discussed in [Corsetti et al. \(2010\)](#), modern literature on international monetary policy coordination requires a full specification of dynamic games between policymakers. Hence, the literature faces a number of challenges, including the definition of equilibrium (commitment or discretion) and the feasibility of deriving analytical and numerical solutions when the steady state is inefficient. This paper takes the first step in this research and focuses on a case where it is feasible to derive a numerical solution.

In particular, I consider an open-loop Nash equilibrium under commitment and with one strategic policy instrument for each policymaker. Under open-loop Nash equilibrium, in the initial period, each player specifies her state-contingent plans for every future state, and each player's action is the best response to the other player's best response. The model can be solved

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<sup>17</sup>Under local currency pricing (LCP) where both exports and imports are invoiced in the destination currency, optimal FXI is larger than the PCP case as it targets the LOOP deviation. However, the transmission is symmetric and FXI has muted effects on the import prices in both countries.



numerically using a second-order perturbation of the equilibrium conditions. To derive the equilibrium conditions analytically, I use the symbolic differentiation toolbox developed by (Bodenstein et al. 2019; 2023).<sup>18</sup> I assume that the local central bank uses FXI and the US central bank uses domestic price inflation as the policy instrument (Benigno and Benigno 2006).

## 5.1 Definition of Equilibrium

Let  $x_t = (\tilde{x}'_t, i_{L,t}, i_{U,t})'$  be the  $N \times 1$  vector of endogenous variables, where  $i_{L,t}$  and  $i_{U,t}$  are the strategic policy instrument chosen by the local and US central banks, respectively. Let  $\epsilon_t$  be the vector of the exogenous shocks. The private optimality and market clearing conditions are summarized by:

$$E_t g(\tilde{x}_{t-1}, \tilde{x}_t, \tilde{x}_{t+1}, i_{L,t}, i_{U,t}, \epsilon_t) = 0.$$

### 5.1.1 Cooperative Equilibrium

Under the cooperative game, the policymakers maximize the weighted average of the local and US households' utility under commitment:

$$\begin{aligned} \max_{\{\tilde{x}'_t, i_{L,t}, i_{U,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t [\alpha U_{L,t}(\tilde{x}_{t-1}, \tilde{x}_t, \epsilon_t) + (1 - \alpha) U_{U,t}(\tilde{x}_{t-1}, \tilde{x}_t, \epsilon_t)], \\ s.t. \quad E_t g(\tilde{x}_{t-1}, \tilde{x}_t, \tilde{x}_{t+1}, i_{L,t}, i_{U,t}, \epsilon_t) = 0. \end{aligned}$$

where  $\alpha$  and  $1 - \alpha$  are the weights on the local and US households' utilities, respectively. I refer to the

### 5.1.2 Non-Cooperative Equilibrium

I consider a non-cooperative interaction between the two central banks under an open-loop Nash game. Let  $j = [L, U]$  be the set of players (the local or US central bank). Let  $\{i_{j,t,-t^*}^*\}_{t=0}^{\infty}$  be the sequence of policies chosen by player  $j$  before and after but not including period  $t^*$  and  $\{i_{-j,t}^*\}_{t=0}^{\infty}$  be the other player's policies. An open-loop Nash equilibrium is a sequence  $\{i_{j,t}^*\}_{t=0}^{\infty}$  such that, for all period  $t^*$ ,  $i_{j,t^*}^*$  maximizes player  $j$ 's objective function subject to the constraints for given sequences of  $\{i_{j,t,-t^*}^*\}_{t=0}^{\infty}$  and  $\{i_{-j,t}^*\}_{t=0}^{\infty}$ . In each period, each player maximizes her

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<sup>18</sup>The toolbox does not currently support the games with multiple strategic instruments per policy-maker.

own following objective function given the other player's policies:<sup>19</sup>

$$\begin{aligned} \max_{\{\tilde{x}'_t, i_{j,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t [U_{j,t}(\tilde{x}_{t-1}, \tilde{x}_t, \epsilon_t)], \\ s.t. \quad E_t g(\tilde{x}_{t-1}, \tilde{x}_t, \tilde{x}_{t+1}, i_{L,t}, i_{U,t}, \epsilon_t) = 0, \quad \text{for given } \{i_{-j,t}\}_{t=0}^{\infty}. \end{aligned}$$

## 5.2 Policy Trade-offs under a Non-Cooperative Equilibrium

I compute the cooperative and non-cooperative equilibria numerically and compare the impulse responses to technology and markup shocks. I consider a strategic interaction between the local FXI and the US monetary policy, assuming that the local monetary policy follows a Taylor rule:

$$\frac{R_t}{R} = \left( \frac{R_{t-1}}{\bar{R}} \right)^{\gamma_R} \left( \frac{\bar{\pi}_{L,t}}{\pi} \right)^{\phi_{\pi}(1-\gamma_R)}.$$

I follow the main parameter settings in [Bodenstein et al. \(2023\)](#). I set  $\phi_{\pi} = 4$  since the policy response to the inflation rate is high enough to ensure the uniqueness of equilibrium. I set  $\alpha = 0.5$  so the local and US households' utilities are equally weighted under cooperation. I compare the impulse responses to US productivity and cost-push shocks under cooperative and Nash equilibria.

First, [Figure 3](#), panel (a) plots the impulse response to a one-percentage increase in US productivity. The red and blue lines show the cooperative and Nash equilibria, respectively. Panel (b) shows the difference between the two equilibria. The figure shows that, under Nash equilibria, the optimal FXI is to buy the dollar more (sell the dollar less) and accumulate excess reserves relative to the cooperation case. Intuitively, the dollar purchase has risk-sharing and expenditure-switching effects. First, since the local return increases relative to the US, the local households have a higher marginal propensity to consume, which lowers the local demand and output. This distorts the international risk-sharing and makes the risk-sharing wedge negative. Second, since the local currency depreciates, the US demand for local goods increases via the expenditure switching channel. This increases the inflation rate of the locally produced goods relative to the US. However, the local central bank does not take into account the US incentive to lower its policy rate, which stabilizes its inflation rate and further increases the US demand

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<sup>19</sup>I adopt the timeless perspective, which requires an initial pre-commitment so that the optimal policy is time-invariant ([Benigno and Woodford 2012](#)).

and output relative to the local. This implies that competitive devaluation via excess reserve accumulation is not only self-defeating as it is matched by the US policy response but also exacerbates the international risk-sharing distortion.

Next, [Figure 4](#) plots the impulse response to a one-percentage increase in US markup. Since the US objective is to stabilize domestic inflation, the optimal US policy is to raise the interest rate higher than the cooperative case. This appreciates the US dollar and increases the demand for local goods, leading to a higher output gap and inflation. The local central bank counteracts against the US dollar by over-accumulating local currency reserves. The local appreciation in turn increases the US import prices. This creates further upward pressure on the US interest rate, stabilizing US inflation and but reducing its output. Hence, a lack of cooperation results in both countries' attempts to stabilize their currency, leading to over-production in the local economy and under-production in the US. Furthermore, since the local currency appreciates due to the accumulation of local currency reserves, the local households can import more at lower prices and increase consumption, resulting in a positive risk-sharing wedge. Hence, over-accumulation of local currency reserves is a beggar-thy-neighbor policy.

Conversely, when there is a decrease in US markup, the local central bank accumulates dollar reserves and the US central bank lowers the monetary policy rate to depreciate their currency relative to the cooperation case. An over-accumulation of dollar reserves is a beggar-thy-self policy since local currency depreciation implies that US households can import local goods at lower prices and increase demand relative to the local households. Monetary policy and FXI

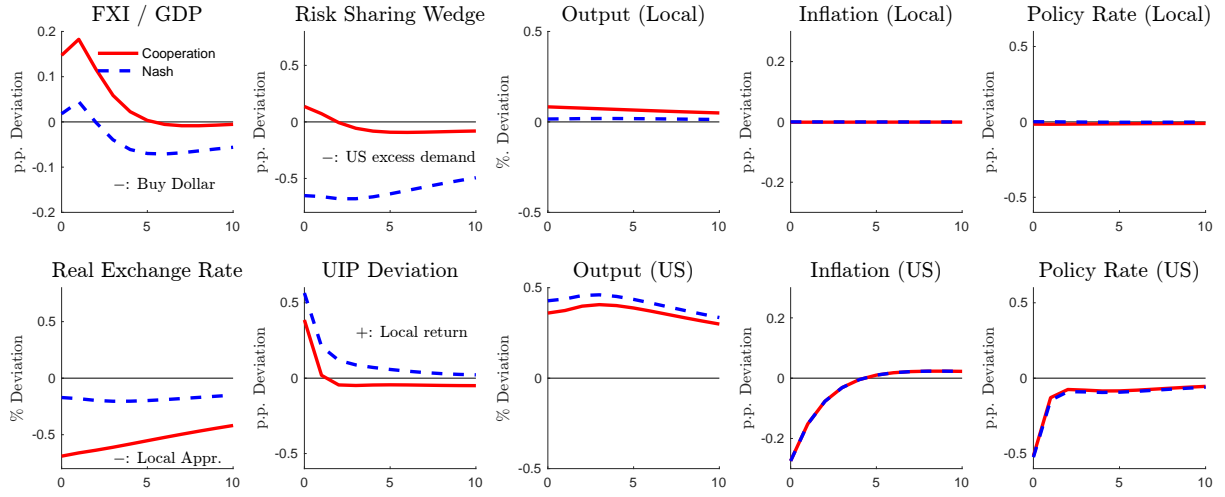
## 6 Conclusion

Conventional wisdom in the literature is that monetary policy and FXI are two distinct policy tools with separate objectives: optimal monetary policy exclusively targets inflation while optimal FXI independently stabilizes the exchange rate. This consensus is based on a small open economy model where agents take the international price as given. However, this consensus changes drastically in large open economies where FXI can affect international prices and demand. Should policies respond to domestic inflation or global business cycle conditions and imbalances?

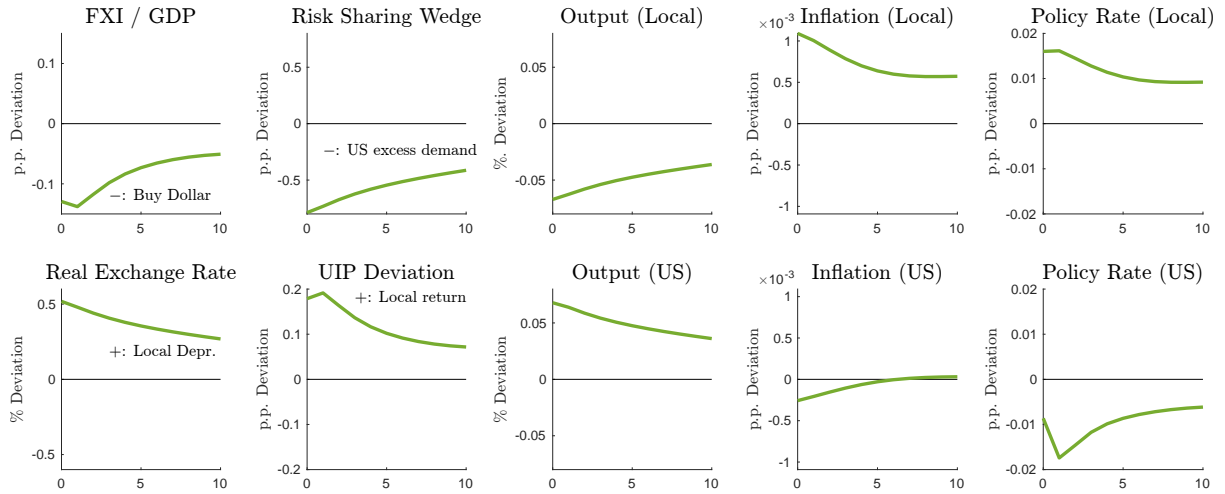
In this paper, I have shown that FXI in large open economies faces a non-trivial trade-off between internal and external objectives. On the one hand, FXI mitigates the inflation-output

Figure 3: Impulse Response to a US Productivity Shock, Cooperation and Nash

(a) Cooperation and Nash



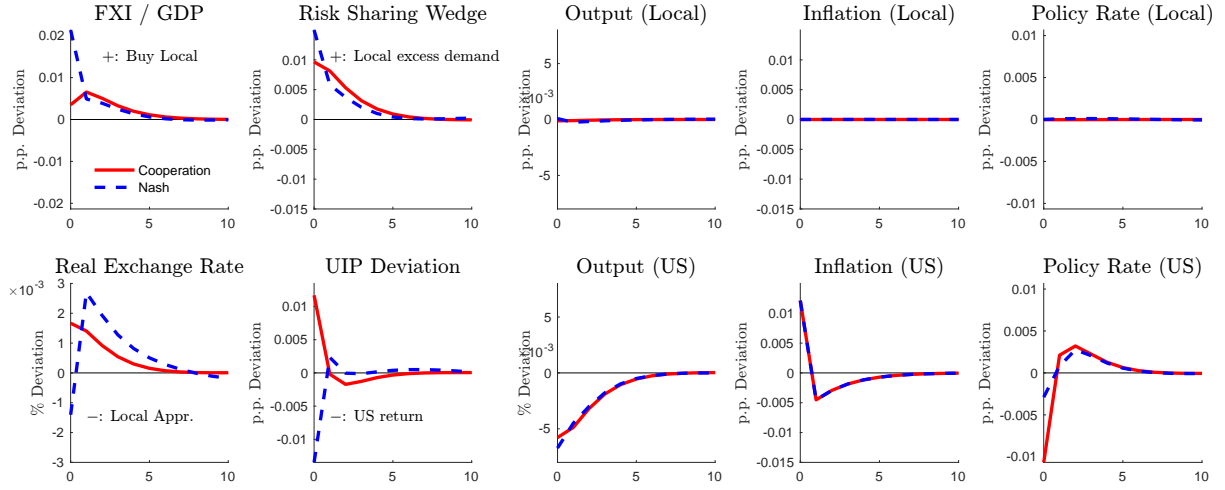
(b) Difference between Cooperation and Nash



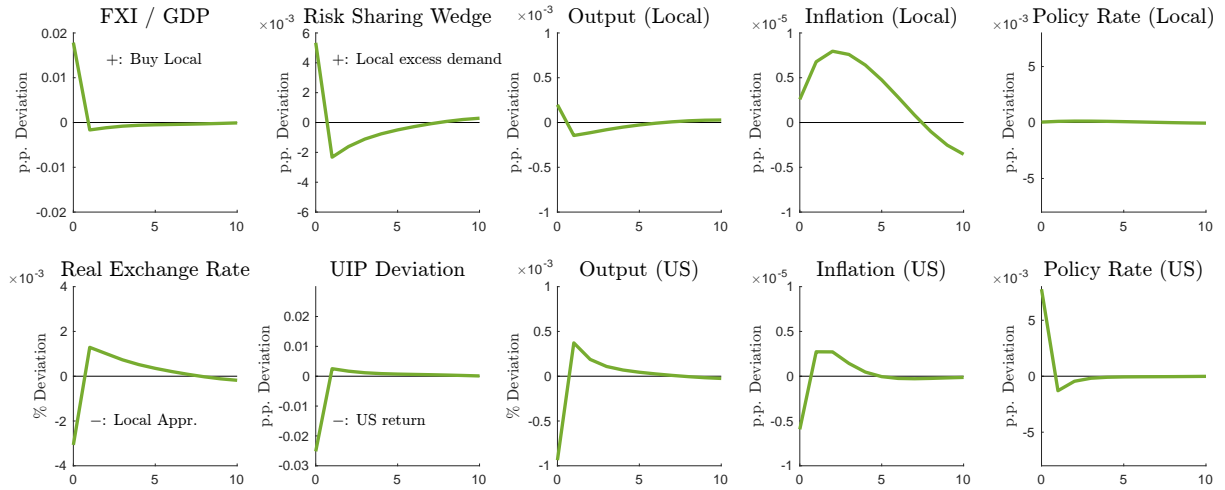
Note: The figure plots the impulse responses to a one-percentage increase in the US productivity under the cooperative equilibrium and the open-loop Nash equilibrium. Panel (a) plots the results under the cooperative equilibrium (red) and the Nash equilibrium (blue). Panel (b) plots the difference between the Nash and the cooperative equilibrium.

Figure 4: Impulse Response to a US Cost-Push Shock, Cooperation and Nash

(a) Cooperation and Nash



(b) Difference between Cooperation and Nash



Note: The figure plots the impulse responses to a one-percentage increase in the US markup under the cooperative equilibrium and the open-loop Nash equilibrium. Panel (a) plots the results under the cooperative equilibrium (red) and the Nash equilibrium (blue). Panel (b) plots the difference between the Nash and the cooperative equilibrium.

trade-off of monetary policy by stabilizing domestic inflation and demand without large changes in policy interest rates. On the other hand, FXI distorts world inflation and demand since FXI affects international prices. This trade-off between internal and external objectives implies that monetary policy and FXI are not completely independent policy instruments, but a policy encompassing both instruments achieves the optimal outcome.

Furthermore, I find that the dominance of the dollar in international trade can be an important driver of capital flow management in international finance. Under dollar pricing, FXI is particularly effective at stabilizing local inflation with limited transmission effects on US inflation. Finally, I take the first step in incorporating FXI in a non-cooperative equilibrium. I find that FXI that targets nationally oriented objectives is a beggar-thy-neighbor policy since it further exacerbates international resource misallocation.

An important and challenging direction for future research is to develop an identification method of FXI and empirically estimate its effects. [Fratzscher et al. \(2019\)](#) compares different identification methods, including reaction function, propensity score matching, instrumental variables, and high-frequency approaches. Recent works exploit granular firm- or bank-level data and combine their balance sheet information with credit supply and employment ([Gonzalez et al. 2021](#)) or with stock prices ([Rodnyansky et al. 2024](#)).

Another important research agenda is understanding how to combine FXI with other capital account management policies, including capital control and macroprudential policy, in the context of IMF's integrated policy framework ([Basu et al. 2020](#)).

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# Appendix

## A Derivations and Proofs

### A.1 Useful Equilibrium Relationships

This section provides equilibrium first-order relationships which are useful for proofs of propositions in Section 2. The derivation follows [Corsetti et al. \(2010; 2023\)](#).

I focus on the LCP case (the PCP case can be derived analogously by setting  $\Delta_t = 0$ ). Let the variables with hat denote the deviation from the steady state. For simplicity, assume symmetry so that  $\mathcal{E}_t P_{Lt}^*/P_{Lt} = \mathcal{E}_t P_{Ut}^*/P_{Ut} = \Delta_t$ . By the definition of real exchange rate, it is expressed in terms of terms of trade and price dispersion:

$$\begin{aligned} e_t = \frac{\mathcal{E}_t P_t^*}{P_t} &= \frac{\mathcal{E}_t \left[ a(P_{Lt}^*)^{1-\phi} + (1-a)(P_{Ut}^*)^{1-\phi} \right]^{\frac{1}{1-\phi}}}{\left[ a(P_{Lt})^{1-\phi} + (1-a)(P_{Ut})^{1-\phi} \right]^{\frac{1}{1-\phi}}} \\ &= \frac{\left[ a \left( \frac{\mathcal{E}_t P_{Lt}^*}{P_{Lt}} \right)^{1-\phi} + (1-a) \left( \frac{\mathcal{E}_t P_{Ut}^*}{P_{Lt}} \right)^{1-\phi} \right]^{\frac{1}{1-\phi}}}{\left[ a + (1-a) \left( \frac{P_{Ut}}{P_{Lt}} \right)^{1-\phi} \right]^{\frac{1}{1-\phi}}}, \end{aligned} \quad (\text{A1})$$

where:

$$\frac{\mathcal{E}_t P_{Ut}^*}{P_{Lt}} = \frac{\mathcal{E}_t P_{Lt}^*}{P_{Lt}} \frac{P_{Ut}}{\mathcal{E}_t P_{Lt}^*} \frac{\mathcal{E}_t P_{Ut}^*}{P_{Ut}} = \Delta_t^2 \mathcal{T}_t, \quad (\text{A2})$$

$$\frac{P_{Ut}}{P_{Lt}} = \frac{\mathcal{E}_t P_{Lt}^*}{P_{Lt}} \frac{P_{Ut}}{\mathcal{E}_t P_{Lt}^*} = \Delta_t \mathcal{T}_t. \quad (\text{A3})$$

Log-linearizing Equation (A1), we obtain:

$$\hat{Q}_t = (2a_H - 1)\hat{\mathcal{T}}_t + 2a_H\tilde{\Delta}_t. \quad (\text{A4})$$

Next, I approximate the aggregate demand. Under the assumption of symmetry, we have:

$$\hat{Y}_{Lt} + \hat{Y}_{Ut} = \hat{C}_t + \hat{C}_t^* = 0. \quad (\text{A5})$$

Combining Equations (6) and (A5) gives:

$$\hat{Y}_{Lt} - \hat{C}_t = \hat{C}_t^* - \hat{Y}_{Ut} = \frac{1}{2}[\hat{Y}_{Lt} - \hat{Y}_{Ut} - \sigma^{-1}(\hat{Q}_t + \tilde{\mathcal{D}}_t)]. \quad (\text{A6})$$

Substituting Equation (2) into the aggregate demand  $Y_{Lt} = C_{Lt} + C_{Lt}^*$  for local good gives:

$$Y_{Lt} = \left(\frac{P_{Lt}}{P_t}\right)^{-\phi} [a_H C_t + (1-a)(e_t \Delta_t^{-1})^\phi C_t^*]. \quad (\text{A7})$$

Log-linearizing the CPI (2) gives:

$$\hat{P}_t - \hat{P}_{Lt} = (1-a)(\hat{\mathcal{T}}_t + \tilde{\Delta}_t). \quad (\text{A8})$$

Using Equation (A8), (A7) can be log-linearized as:

$$\hat{Y}_{Lt} - \hat{C}_t = (1-a)\sigma^{-1}[\sigma\phi(\hat{e}_t + \hat{\mathcal{T}}_t) - \hat{e}_t - \tilde{\mathcal{D}}_t]. \quad (\text{A9})$$

Using Equations (A4), (A9) can be rewritten as:

$$\hat{Y}_{Lt} - \hat{C}_t = (1-a)\sigma^{-1}[2a_H\sigma\phi(\hat{\mathcal{T}}_t + \tilde{\Delta}_t) - \hat{e}_t - \tilde{\mathcal{D}}_t]. \quad (\text{A10})$$

Combining the two expressions (A6) and (A10) for the aggregate demand, the terms of trade can be expressed as:

$$\hat{\mathcal{T}}_t + \tilde{\Delta}_t = \frac{\hat{Y}_{Lt} - \hat{Y}_{Ut} - (2a_H - 1)(\tilde{\mathcal{D}}_t + \tilde{\Delta}_t)}{4a_H(1-a)(\sigma\phi - 1) + 1}. \quad (\text{A11})$$

## A.2 Proof of Lemma 1

The proof follows the appendix of [Itskhoki and Mukhin \(2021\)](#). Differently from their paper, the central bank can use FXI in addition to monetary policy.

To begin with, I show the first equality of Equation (7), which describes the relationship between demand gap and UIP deviation. The Euler equations of local and US households are characterized in log-linearized form:

$$\tilde{r}_t = \sigma E_t [\tilde{C}_{t+1} - \tilde{C}_t], \quad (\text{A12})$$

$$\tilde{r}_t^* = \sigma E_t [\tilde{C}_{t+1}^* - \tilde{C}_t^*] \quad (\text{A13})$$

Taking the difference of Equations (A12) and (A13) and subtracting  $\Delta\tilde{e}_{t+1} = \tilde{e}_{t+1} - \tilde{e}_t$  from both sides,

$$E_t [\sigma \{(\tilde{C}_{t+1} - \tilde{C}_t) - (\tilde{C}_{t+1}^* - \tilde{C}_t^*)\} - \Delta\tilde{e}_{t+1}] = \tilde{r}_t - \tilde{r}_t^* - E_t \Delta\tilde{e}_{t+1}.$$

Using the definition of demand gap (6), we obtain the first equality:

$$E_t \tilde{\mathcal{D}}_{t+1} - \tilde{\mathcal{D}}_t = \tilde{r}_t - \tilde{r}_t^* - E_t \Delta\tilde{e}_{t+1}. \quad (\text{A14})$$

Next, I show the second equality of Equation (7), which describes the relationship between financial flows and UIP deviation. The maximization problem (4) of arbitrageurs can be rewritten as:

$$\max_{d_t^*} E_t \left\{ -\frac{1}{\omega} \exp \left( -\omega \bar{R}_t^* (1 - e^{x_t^*}) \frac{D_t^*}{P_t^*} \right) \right\}, \quad (\text{A15})$$

where  $x_t^* = \tilde{r}_t^* - \tilde{r}_t - \Delta\tilde{e}_{t+1}$  is the nominal carry trade return. When the time period is short,  $x_t^*$  can be expressed as the normal diffusion process:

$$dX_t^* = x_t^* dt + \sigma_{et} dB_t,$$

where  $x_t^* = \tilde{r}_t^* - \tilde{r}_t - \Delta\tilde{e}_{t+1}$  is the nominal carry trade return and  $B_t$  is a standard Brownian motion. Note that the excess return is equal in nominal and real terms when log-linearized:

$$\begin{aligned} x_t^* &= \tilde{r}_t^* - \tilde{r}_t - \Delta\tilde{e}_{t+1} \\ &= (\tilde{R}_t - E_t \pi_{t+1}) - (\tilde{R}_t^* - E_t \pi_{t+1}^*) - E_t (\Delta\tilde{e}_{t+1} + \pi_{t+1}^* - \pi_{t+1}) \\ &= \tilde{R}_t^* - \tilde{R}_t - \Delta\tilde{e}_{t+1}. \end{aligned}$$

The maximization problem (A15) can be rewritten as:

$$\max_{D_t^*} E_t \left\{ -\frac{1}{\omega} \exp \left( -\omega \bar{R}_t^* (1 - e^{dX_t^*}) \frac{D_t^*}{P_t^*} \right) \right\}. \quad (\text{A16})$$

Using Ito's lemma, the objective function can be rewritten as:

$$\begin{aligned} & E_t \left\{ -\frac{1}{\omega} \exp \left( -\omega \bar{R}_t^* \left( -dX_t^* - \frac{1}{2} (dX_t^*)^2 \right) \frac{D_t^*}{P_t^*} \right) \right\} \\ &= -\frac{1}{\omega} \exp \left( \left[ \omega \left( x_t^* + \frac{1}{2} \sigma_{et}^2 \right) \frac{D_t^*}{P_t^*} - \frac{1}{2} \omega^2 \sigma_{et}^2 \left( \frac{D_t^*}{P_t^*} \right)^2 \right] dt \right). \end{aligned}$$

Solving the maximization problem, the optimal portfolio decision is:

$$\frac{D_t^*}{P_t^*} = -m_d \frac{\tilde{R}_t^* - \bar{R}_t - \Delta \tilde{e}_{t+1} + \sigma_{et}^2}{\omega \sigma_{et}^2}. \quad (\text{A17})$$

Substituting Equation (A17) and  $U_t^* = m_u u_t^*$ ,  $F_t^* = m_u f_t^*$  into the market clearing condition (5) for the dollar bond, we obtain:

$$\frac{B_t^*}{P_t^*} + \frac{1}{P_t^*} m_u u_t^* - m_d \frac{\tilde{R}_t^* - \bar{R}_t - \Delta \tilde{e}_{t+1} + \sigma_{et}^2}{\omega \sigma_{et}^2} + \frac{1}{P_t^*} m_u f_t^* = 0. \quad (\text{A18})$$

Since the arbitrageurs, noise traders, and central bank (FXI) takes zero net positions,

$$\frac{D_t + U_t + F_t}{R_t} = -\mathcal{E}_t \frac{D_t^* + U_t^* + F_t^*}{R_t^*}.$$

Using (5), we obtain  $B_t/R_t + \mathcal{E}_t B_t^*/R_t^* = 0$ . Substituting the zero net positions for households and central bank into Equation (A18) yields:

$$\frac{\tilde{R}_t^* - \bar{R}_t - \Delta \tilde{e}_{t+1} + \sigma_{et}^2}{\omega \sigma_{et}^2 / m_d} = \frac{1}{P_t^*} m_u u_t^* - \frac{R_t^*}{R_t} \frac{1}{e_t} \frac{1}{P_t^*} m_u f_t^* - \frac{R_t^*}{R_t} \frac{Y_t}{e_t} \frac{B_t}{P_t Y_t}. \quad (\text{A19})$$

Log-linearizing this gives the second equality:

$$\tilde{r}_t - \tilde{r}_t^* - E_t \Delta \tilde{e}_{t+1} = \chi_1 (u_t^* - f_t) - \chi_2 b_t. \quad (\text{A20})$$

Combining Equations (A14) and (A20), we obtain the UIP equation (7).  $\square$

**Incomes and Losses of Carry Trade Positions.** For simplicity, I assume that the profits and losses of carry-trade positions by the financiers and noise traders and interventions by the local central bank are transferred to the local households in a lump-sum way. However, the assumption on the ownership structure does not affect the first-order dynamics of the model, as



discussed in [Itskhoki and Mukhin \(2021\)](#). To see this, combining the positions of the financiers, the noise traders, and the local central bank, the total carry trade profit can be written as:

$$\bar{R}_t^*(D_t + U_t + F_t) = -\bar{R}_t^*B_t = \bar{R}_t^*\bar{Y}b_t.$$

The combined carry trade profit equals the product of the UIP deviation ( $\bar{R}_t^*$ ) and the households' net foreign asset position ( $\bar{Y}b_t$ ). Each of them is first-order but their product is second-order and small enough relative to the size of the countries' budget constraint.

### A.3 Proof of Lemma 2

The proof follows the appendix of [Corsetti et al. \(2023\)](#). Under cooperation and commitment, the central banks in the two countries minimize the loss (12) subject to the NKPCs (10) and (11) and the UIP condition (8). Let  $\gamma_{Lt}$ ,  $\gamma_{Ut}^*$ , and  $\lambda_t$  be the Lagrange multipliers for the local and US NKPCs and the UIP condition, respectively.

The first-order conditions can be written as:

$$\begin{aligned} \tilde{Y}_{Lt} : \quad 0 = & -(\sigma + \eta)\tilde{Y}_{Lt} + \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1}(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\ & - \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} \tilde{\mathcal{D}}_t \\ & + \left[ \sigma + \eta - \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \right] \kappa\gamma_{Lt} + \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \kappa\gamma_{Ut}^* \\ & - \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} (\lambda_t - \beta^{-1}\lambda_{t-1}), \end{aligned} \quad (\text{A21})$$

$$\begin{aligned} \tilde{Y}_{Ut} : \quad 0 = & -(\sigma + \eta)\tilde{Y}_{Ut} - \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1}(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\ & + \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} \tilde{\mathcal{D}}_t \\ & + \left[ \sigma + \eta - \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \right] \kappa\gamma_{Ut}^* + \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \kappa\gamma_{Lt} \\ & + \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} (\lambda_t - \beta^{-1}\lambda_{t-1}), \end{aligned} \quad (\text{A22})$$

$$\pi_{Lt} : \quad 0 = -\frac{\theta}{\kappa}\pi_{Lt} - \gamma_{Lt} + \gamma_{Lt-1}, \quad (\text{A23})$$

$$\pi_{Ut}^* : \quad 0 = -\frac{\theta}{\kappa}\pi_{Ut}^* - \gamma_{Ut}^* + \gamma_{Ut-1}^*, \quad (\text{A24})$$

$$\begin{aligned}
\mathcal{B}_t : \quad 0 = & \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi-1)+1} (E_t \tilde{\mathcal{D}}_{t+1} - \tilde{\mathcal{D}}_t) \\
& + (1-a) \frac{2a(\sigma\phi-1)+1}{4a(1-a)(\sigma\phi-1)+1} \kappa [(E_t \gamma_{Lt+1} - \gamma_{Lt}) - (E_t \gamma_{Ut+1}^* - \gamma_{Ut}^*)] \\
& - [(E_t \lambda_{t+1} - \beta^{-1} \lambda_t) - (\lambda_t - \beta^{-1} \lambda_{t-1})].
\end{aligned} \tag{A25}$$

Under the assumption of  $f_t = u_t^* = 0$ , we have  $E_t \tilde{\mathcal{D}}_{t+1} - \tilde{\mathcal{D}}_t = 0$ . By taking the sum of the FOCs for the output gap in the two countries and combining it with the FOCs for inflation, we obtain:

$$\begin{aligned}
0 = & \tilde{Y}_{Lt} + \tilde{Y}_{Ut} + \theta(p_{Lt} + p_{Ut}^*) \\
= & (\tilde{Y}_{Lt} - \tilde{Y}_{Lt-1}) + (\tilde{Y}_{Ut} - \tilde{Y}_{Ut-1}) + \theta(\pi_{Lt} + \pi_{Ut}^*).
\end{aligned} \tag{A26}$$

Next, taking the difference of FOCs for the output gap,

$$\begin{aligned}
0 = & \left[ \sigma + \eta - \frac{4a(1-a)(\sigma\phi-1)\sigma}{4a(1-a)(\sigma\phi-1)+1} \right] (\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\
& + \frac{4a(1-a)\phi}{4a(1-a)(\sigma\phi-1)+1} \frac{2a(\sigma\phi-1)+1-\sigma}{2a(\phi-1)+1} \tilde{\mathcal{D}}_t \\
& + \left[ \sigma + \eta - \frac{(1-a)(\sigma-1)}{2a(\phi-1)+1} \right] \theta(\tilde{p}_{Lt} - \tilde{p}_{Ut}^*) \\
& + 2 \frac{2a(\sigma\phi-1)+1-\sigma}{2a(\phi-1)+1} (\lambda_t - \beta^{-1} \lambda_{t-1}).
\end{aligned}$$

The FOC for the net foreign asset implies:

$$-(\lambda_t - \beta^{-1} \lambda_{t-1}) = (1-a) \frac{2a(\sigma\phi-1)+1}{4a(1-a)(\sigma\phi-1)+1} \theta(p_{Lt} - p_{Ut}^*).$$

Combining the FOCs, we obtain the difference rule:

$$\begin{aligned}
0 = & \left[ \sigma + \eta - \frac{4a(1-a)(\sigma\phi-1)\sigma}{4a(1-a)(\sigma\phi-1)+1} \right] [(\tilde{Y}_{Lt} - \tilde{Y}_{Lt-1}) - (\tilde{Y}_{Ut} - \tilde{Y}_{Ut-1}) + \theta(\pi_{Lt} - \pi_{Ut}^*)] \\
& + \frac{4a(1-a)\phi}{4a(1-a)(\sigma\phi-1)+1} \frac{2a(\sigma\phi-1)+1-\sigma}{2a(\phi-1)+1} (\tilde{\mathcal{D}}_t - \tilde{\mathcal{D}}_{t-1}).
\end{aligned}$$

Combining the sum and difference rules, we obtain the country-specific monetary policy rules (13) and (14) (Lemma 2).

When  $\sigma = \phi = 1$ , it is possible to show that when  $\sigma = \phi = 1$ , the constrained optimal allocation under PCP satisfied  $\tilde{\mathcal{D}}_t = 0$  (see Appendix 2.2.2 of Corsetti et al. (2023) for detailed

derivation). The monetary policy rules reduce to:

$$0 = \theta\pi_{Lt} + (\tilde{Y}_{Lt} - \tilde{Y}_{Lt-1}), \quad (\text{A27})$$

$$0 = \theta\pi_{Ut}^* + (\tilde{Y}_{Ut} - \tilde{Y}_{Ut-1}), \quad (\text{A28})$$

and the NKPCs with  $\tilde{\mathcal{D}}_t = \tilde{\Delta}_t = 0$  reduce to:

$$\pi_{Lt} = \beta\pi_{Lt+1} + \kappa(\sigma + \eta)\tilde{Y}_{Lt}, \quad (\text{A29})$$

$$\pi_{Ut}^* = \beta\pi_{Ut+1}^* + \kappa(\sigma + \eta)\tilde{Y}_{Ut}. \quad (\text{A30})$$

Hence, the equilibrium is the first-best:  $\pi_{Lt} = \pi_{Ut}^* = \tilde{Y}_{Lt} = \tilde{Y}_{Ut} = \tilde{\mathcal{D}}_t = 0$ .  $\square$

#### A.4 Proof of Proposition 1

The central banks in the two countries face a similar minimization problem to the case without FXI (Appendix A.3), except that the local central bank chooses  $f_t$  optimally. The first-order condition for  $f_t$  implies:

$$\lambda_t = 0. \quad (\text{A31})$$

First, combining Equation (A31) with Equations (8), (A21), (A22), (A23), and (A24), we obtain the difference rule:

$$\begin{aligned} 0 = & (\tilde{Y}_{Lt} - \tilde{Y}_{Lt-1}) - (\tilde{Y}_{Ut} - \tilde{Y}_{Ut-1}) + \theta(\pi_{Lt} - \pi_{Ut}^*) \\ & + 2(1-a) \frac{2a(\sigma\phi - 1) + 1}{\sigma + \eta\{4a(1-a)(\sigma\phi - 1) + 1\}} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} \theta(\pi_{Lt} - \pi_{Ut}^*) \\ & + \frac{4a(1-a)\phi}{\sigma + \eta\{4a(1-a)(\sigma\phi - 1) + 1\}} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1} (\tilde{\mathcal{D}}_t - \tilde{\mathcal{D}}_{t-1}). \end{aligned}$$

Combining this with the sum rule (A26), we obtain the country-specific monetary policy rules (19) and (20). Next, combining Equation (A31) with Equations (A23), (A24), and (A25), we obtain the optimal FXI rule (21). This proves Proposition 1.

In the special case where  $\sigma = \phi = 1$ , since  $\psi_\pi = \psi_D = 0$ , the optimal output gap and inflation are pinned down by Equations (A27) through (A30), which are the same as in the no FXI case. Hence, the optimal FXI is to set  $f_t = u_t^*$  and the first-best equilibrium

$\pi_{Lt} = \pi_{Ut}^* = \tilde{Y}_{Lt} = \tilde{Y}_{Ut} = \tilde{\mathcal{D}}_t = 0$  is achieved.

## A.5 Proof of Lemma 4

When  $f_t = u_t^* = 0$ , the demand gap  $\tilde{\mathcal{D}}_t$  is zero on average and at most second order. I first consider the US inflation and output gap. Combining the NKPC (11) for the US firms and the optimal monetary policy rule (14) and assuming the economy is initially at the steady state ( $\tilde{Y}_{L,-1} = 0$ ):

$$\frac{\partial \pi_{U0}^*}{\partial \mu_0^*} = \frac{1}{1 + \theta\kappa} > 0, \quad \frac{\partial \tilde{Y}_{U0}}{\partial \mu_0^*} = -\frac{\theta}{1 + \theta\kappa} < 0.$$

in period 0 and:

$$\frac{\partial \pi_{U0}^*}{\partial \mu_0^*} = -\frac{\theta\kappa}{(1 + \theta\kappa)^{t+1}} < 0, \quad \frac{\partial \tilde{Y}_{U0}}{\partial \mu_0^*} = -\frac{\theta}{(1 + \theta\kappa)^{t+1}} < 0.$$

in period  $t \geq 1$ . This confirms Equation (16).

Next, I consider the transmission of the US cost-push shock to the real exchange rate and the local inflation and output gap. Using Equations A4 (with  $\tilde{\Delta}_{Lt} = 0$ ), the elasticity of the terms-of-trade satisfies:

$$\frac{\partial \tilde{\mathcal{T}}_0}{\partial \mu_0^*} > \frac{\partial \tilde{\mathcal{T}}_1}{\partial \mu_0^*} > \dots > 0.$$

Using the relationship (A11) between the real exchange rate and the terms of trade, we obtain Equation (18). To simplify the proof, I consider the case where  $1 + \theta\kappa$  is large enough so that  $\mathcal{T}_0$  has a first-order effect on the local inflation while  $\mathcal{T}_t$  ( $t \geq 1$ ) does not. As shown in Equation (10)  $\sigma\phi > 1$ , an increase in  $\mathcal{T}_t$  is analogous to a decrease in  $\mu_t$ . Hence, Equation (17) can be proven similarly to Equation (16).  $\square$

## A.6 Proof of Proposition 3

From Equations (16), (17), and (21), optimal FXI satisfies  $\partial \tilde{f}_t / \partial \mu_0^* > 0$  for all  $t$  when  $\mu_0^* > 0$  and  $\mu_t^* = 0$  for all  $t \geq 1$ . From Equation (7),

$$\frac{\partial \widehat{UIP}_t^{FXI}}{\partial \tilde{\mathcal{D}}_t} < 0, \quad \text{and} \quad \frac{\partial \tilde{\mathcal{D}}_t}{\partial f_t} > 0,$$

for a given value of  $\tilde{\mathcal{D}}_{t+1}$ . Since  $\partial \tilde{Y}_{Lt} / \partial \tilde{\mathcal{T}}_t = 2a(\phi - 1) + 1$  and:

$$\frac{\partial \tilde{\mathcal{T}}_t}{\partial \tilde{\mathcal{D}}_t} = -\frac{2a - 1}{4a(1 - a)(\sigma\phi - 1) + 1} < 0, \quad (\text{A32})$$

from Equation (A11), we have:

$$\frac{\partial \tilde{Y}_{Lt}}{\partial \tilde{\mathcal{D}}_t} = \frac{\partial \tilde{Y}_{Lt}}{\partial \tilde{\mathcal{T}}_t} \frac{\partial \tilde{\mathcal{T}}_t}{\partial \tilde{\mathcal{D}}_t} = -\frac{(2a - 1)[2a(\phi - 1) + 1]}{4a(1 - a)(\sigma\phi - 1) + 1}$$

Hence, we have:

$$\frac{\partial \tilde{Y}_{Lt}}{\partial \mu_0^*} > \frac{\partial \tilde{Y}_{Lt}^{FXI}}{\partial \mu_0^*}.$$

Combining this result with the optimal policy rule (13), we obtain:

$$\frac{\partial \pi_{L0}}{\partial \mu_0^*} < \frac{\partial \pi_{L0}^{FXI}}{\partial \mu_0^*}, \quad \frac{\partial \pi_{Lt}}{\partial \mu_0^*} > \frac{\partial \pi_{Lt}^{FXI}}{\partial \mu_0^*}.$$

This proves Equation (17). Equation (16) can be proved analogously. Combining Equations (A4) (with  $\tilde{\Delta}_{Lt} = 0$ ) and (A32), we obtain:

$$\frac{\partial \tilde{e}_t}{\partial \mu_0^*} > \frac{\partial \tilde{e}_t^{FXI}}{\partial \mu_0^*}.$$

This proves Equation (24). □

## A.7 Proof of Lemma 5

The proof follows (Corsetti et al. 2020; 2023). Under cooperation and commitment, the central banks in the two countries minimize the loss (28) subject to the NKPCs (26), (27), and (11), the UIP condition (8), and the condition that relates the relative price to the terms-of-trade and the LOOP deviation:

$$\pi_{Ut} - \pi_{Lt} = \tilde{\mathcal{T}}_t - \tilde{\mathcal{T}}_{t-1} + \Delta_{Lt} - \Delta_{Lt-1}.$$

Let  $\gamma_{Lt}$ ,  $\gamma_{Lt}^*$ , and  $\gamma_{Ut}^*$  be the Lagrange multipliers for the local and US NKPCs,  $\lambda_t$  for the UIP condition, and  $\gamma_t$  for the terms-of-trade equation.

The first-order conditions can be written as:

$$\begin{aligned}
\tilde{Y}_{Lt} : \quad 0 = & -(\sigma + \eta)\tilde{Y}_{Lt} + \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1}(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\
& - \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) \\
& + \left[ \sigma + \eta - \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \right] \kappa(\gamma_{Lt} + \gamma_{Lt}^*) + \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \kappa\gamma_{Ut}^* \\
& + \frac{1}{2a(\phi - 1) + 1}(\beta E_t \gamma_{t+1} - \gamma_t) - \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1}(\lambda_t - \beta^{-1}\lambda_{t-1}), \quad (A33)
\end{aligned}$$

$$\begin{aligned}
\tilde{Y}_{Ut} : \quad 0 = & -(\sigma + \eta)\tilde{Y}_{Ut} - \frac{2a(1-a)(\sigma\phi - 1)\sigma}{4a(1-a)(\sigma\phi - 1) + 1}(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\
& + \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1} \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) \\
& + \left[ \sigma + \eta - \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \right] \kappa\gamma_{Ut}^* + \frac{(1-a)(\sigma - 1)}{2a(\phi - 1) + 1} \kappa(\gamma_{Lt} + \gamma_{Lt}^*) \\
& - \frac{1}{2a(\phi - 1) + 1}(\beta E_t \gamma_{t+1} - \gamma_t) + \frac{2a(\sigma\phi - 1) + 1 - \sigma}{2a(\phi - 1) + 1}(\lambda_t - \beta^{-1}\lambda_{t-1}), \quad (A34)
\end{aligned}$$

$$\pi_{Lt} : \quad 0 = -\frac{\theta}{\kappa}\pi_{Lt} - \gamma_{Lt} + \gamma_{Lt-1} - \gamma_t, \quad (A35)$$

$$\pi_{Lt}^* : \quad 0 = -\frac{\theta}{\kappa}\pi_{Lt}^* - \gamma_{Lt}^* + \gamma_{Lt-1}^*, \quad (A36)$$

$$\pi_{Ut}^* : \quad 0 = -\frac{\theta}{\kappa}\pi_{Ut}^* - \gamma_{Ut}^* + \gamma_{Ut-1}^*, \quad (A37)$$

$$\begin{aligned}
\mathcal{B}_t : \quad 0 = & \frac{2a(1-a)\phi}{4a(1-a)(\sigma\phi - 1) + 1}(E_t \tilde{\mathcal{D}}_{t+1} - \tilde{\mathcal{D}}_t) - \\
& + (1-a) \frac{2a(\sigma\phi - 1) + 1}{4a(1-a)(\sigma\phi - 1) + 1} \kappa \left[ \begin{aligned} & (E_t \gamma_{Lt+1} - \gamma_{Lt}) + (E_t \gamma_{Lt+1} - \gamma_{Lt}) \\ & - (E_t \gamma_{Ut+1}^* - \gamma_{Ut}^*) \end{aligned} \right] \\
& - [(E_t \lambda_{t+1} - \beta^{-1}\lambda_t) - (\lambda_t - \beta^{-1}\lambda_{t-1})] \\
& - \frac{2a-1}{4a(1-a)(\sigma\phi - 1) + 1}[(\beta E_t \gamma_{t+2} - E_t \gamma_{t+1}) - (\beta E_t \gamma_{t+1} - \gamma_t)], \quad (A38)
\end{aligned}$$

$$\begin{aligned}
\tilde{\Delta}_{Lt} : \quad 0 = & -\frac{2a(1-a)\phi}{2a(\phi - 1) + 1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) + \kappa \frac{1}{4a(1-a)(\sigma\phi - 1) + 1} \\
& \times \frac{1}{2} \left[ \begin{aligned} & (4a(1-a)(\sigma\phi - 1) + 1)(\gamma_{Lt} - (\gamma_{Lt}^* + \gamma_{Ut}^*)) \\ & - \left\{ (2a-1) - 2(1-a)[2a(\phi - 1) + 1] \frac{2a(1-a)(\sigma\phi - 1) + 1 - \phi}{2a(\phi - 1) + 1} \right\} \\ & \times (\gamma_{Lt} + \gamma_{Lt}^* - \gamma_{Ut}^*) \end{aligned} \right]
\end{aligned}$$

$$\begin{aligned}
& - \frac{2a-1}{2a(\phi-1)+1}(\beta E_t \gamma_{t+1} - \gamma_t) \\
& - \frac{2a[2(1-a)(\sigma\phi-1)+1-\phi]}{2a(\phi-1)+1}(\lambda_t - \beta^{-1}\lambda_{t-1}).
\end{aligned} \tag{A39}$$

Under the assumption of  $f_t = u_t^* = 0$ , we have  $E_t \tilde{\mathcal{D}}_{t+1} - \tilde{\mathcal{D}}_t = 0$ . The FOC for the net foreign asset implies:

$$\begin{aligned}
\lambda_t - \beta^{-1}\lambda_{t-1} = & (1-a) \frac{2a(\sigma\phi-1)+1}{4a(1-a)(\sigma\phi-1)+1} \theta(\gamma_{Lt} + \gamma_{Lt}^* - \gamma_{Ut}^*) \\
& - \frac{2a-1}{4a(1-a)(\sigma\phi-1)+1}(\beta E_t \gamma_{t+1} - \gamma_t).
\end{aligned} \tag{A40}$$

The sum rule for the output gaps is given by [Equation \(A26\)](#). Using the symmetry ([Equation \(A5\)](#)), the sum rule can be rewritten as:

$$0 = \theta[a\pi_{Lt} + (1-a)\pi_{Lt}^* + \pi_{Ut}^*] + (\tilde{C}_t - \tilde{C}_{t-1}) + (\tilde{C}_t^* - \tilde{C}_{t-1}^*). \tag{A41}$$

To derive the difference rule, by taking the difference between [Equations \(A33\) and \(A34\)](#) and substituting [Equation \(A40\)](#), we obtain:

$$\begin{aligned}
2\sigma(\beta E_t \gamma_{t+1} - \gamma_t) = & \sigma[(\tilde{Y}_{Lt} - \tilde{Y}_{Ut})] \\
& + 4a(1-a)\phi \frac{2a(\sigma\phi-1)+1-\sigma}{2a(\phi-1)+1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) \\
& - \sigma\kappa(\gamma_{Lt} + \gamma_{Lt}^* - \gamma_{Ut}^*).
\end{aligned} \tag{A42}$$

Moreover, substituting [Equation \(A40\)](#) into [Equation \(A39\)](#) yields:

$$\begin{aligned}
& \frac{2a(\sigma\phi-1)+1}{4a(1-a)(\sigma\phi-1)+1}(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\
= & - \frac{4a(1-a)\phi}{2a(\phi-1)+1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) + \kappa(\gamma_{Lt} - (\gamma_{Lt}^* + \gamma_{Ut}^*)) - (2a-1)\kappa \frac{\gamma_{Lt} + \gamma_{Lt}^* - \gamma_{Ut}^*}{4a(1-a)(\sigma\phi-1)+1}.
\end{aligned} \tag{A43}$$

Combining [Equations \(A42\) and \(A43\)](#) and rearranging the terms, we obtain:

$$\begin{aligned}
& \frac{2a-1}{4a(1-a)(\sigma\phi-1)+1} \sigma(\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\
& + \left[ (2a-1) \frac{2a(\sigma\phi-1)+1-\sigma}{4a(1-a)(\sigma\phi-1)+1} + \sigma \right] \frac{4a(1-a)\phi}{2a(\phi-1)+1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t)
\end{aligned}$$

$$= \sigma \kappa (\gamma_{Lt} - (\gamma_{Lt} + \gamma_{Ut}^*)).$$

Using the relationships (A4) and (A11), the left-hand side can be rewritten as:

$$\begin{aligned} & (2a-1) \left[ \tilde{\mathcal{T}}_t + \tilde{\Delta}_{Lt} + \frac{(2a-1)(\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt})}{4a(1-a)(\sigma\phi-1)+1} \right] \\ & + \left[ (2a-1) \frac{2a(\sigma\phi-1)+1-\sigma}{4a(1-a)(\sigma\phi-1)+1} + \sigma \right] \frac{4a(1-a)\phi}{2a(\phi-1)+1} (\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt}) \\ & = (\tilde{e}_t - \tilde{\Delta}_{Lt}) + (\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt}) - \frac{4a(1-a)\sigma\phi}{4a(1-a)(\sigma\phi-1)+1} (\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt}) \\ & + \left[ (2a-1) \frac{2a(\sigma\phi-1)+1-\sigma}{4a(1-a)(\sigma\phi-1)+1} + \sigma \right] \frac{4a(1-a)\phi}{2a(\phi-1)+1} (\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt}) \\ & = \tilde{e}_t + \tilde{\mathcal{D}}_t + \frac{4a(1-a)\phi(\sigma-1)}{2a(\phi-1)+1} (\tilde{\mathcal{D}}_t + \tilde{\Delta}_{Lt}). \end{aligned}$$

Using the FOCs for the inflation rates and rearranging the terms, we obtain the difference rule:

$$\begin{aligned} 0 = & \theta [a\pi_{Lt} - (1-a)\pi_{Lt}^* - \pi_{Ut}^*] + (\tilde{C}_t - \tilde{C}_{t-1}) - (\tilde{C}_t^* - \tilde{C}_{t-1}^*) \\ & + \frac{4a(1-a)\phi}{2a(\phi-1)+1} \frac{\sigma-1}{\sigma} (\tilde{\mathcal{D}}_t - \tilde{\mathcal{D}}_{t-1} + \tilde{\Delta}_{Lt} - \tilde{\Delta}_{Lt-1}). \end{aligned} \quad (\text{A44})$$

Combining the sum and difference rules (Equations (A41) and (A44)), the country-specific monetary policy rules are given by Equations (29) and (30).  $\square$

## A.8 Optimal Monetary Policy and FXI under DCP

This section provides a full characterization of optimal monetary policy and FXI rules under DCP and provides proofs of Propositions 4 and 5. Let  $\gamma_{\Delta t} \equiv 2(\beta E_t \gamma_{t+1} - \gamma_t)$ . First, combining the FOCs (A33) and (A34) for the output gap and (A31) for the FXI, the difference rule for the output gap can be written as:

$$\begin{aligned} \gamma_{\Delta t} = & \frac{\sigma}{4a(1-a)(\sigma\phi-1)+1} [2a(\phi-1)+1] (\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) \\ & + \frac{4a(1-a)\phi}{4a(1-a)(\sigma\phi-1)+1} [2a(\sigma\phi-1)+1-\sigma] (\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) \\ & + [\sigma(2a(\phi-1)+1) - 2(1-a)(\sigma-1)] \theta [a\pi_{Lt} + (1-a)\pi_{Lt}^* - \pi_{Ut}^*]. \end{aligned} \quad (\text{A45})$$



Next, from the FOC (A39) for the LOOP deviation and (A31) for the FXI:

$$\gamma_{\Delta t} = -\frac{4a(1-a)\phi}{2a-1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) + \theta \frac{1}{4a(1-a)(\sigma\phi-1)+1} \frac{2a(\phi-1)+1}{2a-1} \times \left[ \begin{aligned} & (4a(1-a)(\sigma\phi-1)+1)[a\pi_{Lt} - ((1-a)\pi_{Lt}^* + \pi_{Ut}^*)] \\ & - \left\{ (2a-1) - 2(1-a)[2a(\phi-1)+1] \frac{2a(1-a)(\sigma\phi-1)+1-\phi}{2a(\phi-1)+1} \right\} \\ & \times [a\pi_{Lt} + (1-a)\pi_{Lt}^* + \pi_{Ut}^*] \end{aligned} \right] \quad (\text{A46})$$

The optimal monetary policy rules can be characterized by the sum rule (A26), the difference rule (A45), and the optimal LOOP deviation (A46). The general implication is that the monetary policy cannot close all gaps but instead, it faces a trade-off between stabilizing inflation, output, demand gap, and LOOP deviation.

To derive the optimal FXI rule, using the FOC (A38) and the UIP condition (8):

$$\begin{aligned} f_t = u_t^* &+ \frac{\theta}{2a\phi\chi_1} [2a(\sigma\phi-1)+1] E_t [a\pi_{Lt+1} + (1-a)\pi_{Lt+1}^* + \pi_{Ut+1}^*] \\ &+ \frac{2a-1}{4a(1-a)\phi\chi_1} (E_t \gamma_{\Delta t+t} - \gamma_{\Delta t}), \end{aligned} \quad (\text{A47})$$

where  $\gamma_{\Delta t}$  is given in Equation (A46).

Under Cole and Obstfeld (1991) case, the above conditions reduce to:

$$\begin{aligned} 0 &= (\tilde{Y}_{Lt} + \tilde{Y}_{Ut}) + \theta[a\pi_{Lt} + (1-a)\pi_{Lt}^* + \pi_{Ut}^*], \\ \gamma_{\Delta Lt} - \gamma_{\Delta Lt-1} &= (\tilde{Y}_{Lt} - \tilde{Y}_{Ut}) + \theta[a\pi_{Lt} + (1-a)\pi_{Lt}^* - \pi_{Ut}^*], \\ \gamma_{\Delta Lt} &= -\frac{4a(1-a)}{2a-1}(\tilde{\Delta}_{Lt} + \tilde{\mathcal{D}}_t) + \theta \frac{1}{2a-1} \\ &\times [a\pi_{Lt} - ((1-a)\pi_{Lt}^* + \pi_{Ut}^*)] - (2a-1)[a\pi_{Lt} + (1-a)\pi_{Lt}^* + \pi_{Ut}^*] \\ f_t = u_t^* &+ \frac{\theta}{2a\chi_1} E_t [a\pi_{Lt+1} + (1-a)\pi_{Lt+1}^* + \pi_{Ut+1}^*] \\ &+ \frac{2a-1}{2a(1-a)\chi_1} (E_t \gamma_{\Delta t+t} - \gamma_{\Delta t}). \end{aligned}$$

Combining these equations, optimal monetary policy and FXI rules are characterized by:

$$0 = \tilde{Y}_{Lt} + \theta[a\pi_{Lt} + (1-a)\pi_{Lt}^*], \quad (\text{A48})$$

$$0 = \tilde{Y}_{Ut} + \theta\pi_{Ut}^* + \gamma_{\Delta Lt} - \gamma_{\Delta Lt-1}, \quad (\text{A49})$$

$$\gamma_{\Delta_{L_t}} = -\frac{4a(1-a)}{2a-1}(\tilde{\Delta}_{L_t} + \tilde{\mathcal{D}}_t) + \theta \frac{1}{2a-1} \times [a\pi_{L_t} - ((1-a)\pi_{L_t}^* + \pi_{U_t}^*)] - (2a-1)[a\pi_{L_t} + (1-a)\pi_{L_t}^* + \pi_{U_t}^*] \quad (\text{A50})$$

$$f_t = u_t^* + \frac{\theta}{2(1-a)\chi_1} E_t[a\pi_{L_{t+1}} + (1-a)\pi_{L_{t+1}}^* + \pi_{U_{t+1}}^*] + \frac{2a-1}{2a(1-a)\chi_1} [(E_t\tilde{Y}_{L_{t+1}} - \tilde{Y}_{L_t}) - (E_t\tilde{Y}_{U_{t+1}} - \tilde{Y}_{U_t})]. \quad (\text{A51})$$

There are two key implications. First, the optimal monetary policy rule is asymmetric. The local central bank trades off inflation and output growth of locally produced goods. However, the US central bank trades off the US inflation and output growth, as well as LOOP deviation and demand gap. Second, and more importantly, the optimal FXI targets the LOOP deviation, as discussed in the next proposition.

## A.9 Proof of Proposition 4

From Equation (A50),  $\partial\gamma_{\Delta_t}/\partial\tilde{\Delta}_{L_t} < 0$ . Hence,

$$\frac{\partial f_t}{\partial\tilde{\Delta}_{L_t}} = \frac{\partial f_t}{\partial\gamma_{\Delta_t}} \frac{\partial\gamma_{\Delta_t}}{\partial\tilde{\Delta}_{L_t}} > 0.$$

Thus, the optimal FXI is increasing in  $\Delta_{L_t}$ . Next, similarly to the PCP case,

$$\frac{\partial\tilde{e}_0}{\partial\mu_0^*} > \frac{\partial\tilde{e}_1}{\partial\mu_0^*} > \dots > 0, \quad \frac{\partial\tilde{e}_t}{\partial\mu_0^*} > \frac{\partial\tilde{e}_t^{FXI}}{\partial\mu_0^*}.$$

Since  $\tilde{e}_t$  is close to  $\tilde{e}_t$  when the price stickiness is sufficiently high,

$$\frac{\partial\tilde{\Delta}_{L0}}{\partial\mu_0^*} > \frac{\partial\tilde{\Delta}_{L1}}{\partial\mu_0^*} > \dots > 0, \quad \frac{\partial\tilde{\Delta}_{L_t}}{\partial\mu_0^*} > \frac{\partial\tilde{\Delta}_{L_t}^{FXI}}{\partial\mu_0^*}.$$

Hence, the FXI reduces the LOOP deviation. Finally, to show that the optimal FXI is larger under DCP than PCP, the optimal FXI rule under PCP and  $\sigma = \phi = 1$  is characterized by:

$$f_t = u_t^* + \frac{\theta}{2a\chi_1} E_t(\pi_{L_{t+1}} - \pi_{U_{t+1}}^*). \quad (\text{A52})$$

I compare the optimal FXI rules (A52) under PCP and (A51) under DCP. First, for the output gap term in Equation (A51), when  $\sigma = \phi = 1$ , since  $\partial\tilde{\mathcal{D}}_t/\partial\tilde{\Delta}_{L_t} = 0$ ,  $\partial\tilde{Y}_{L_t}/\partial\tilde{\Delta}_{L_t} = (\partial\tilde{Y}_{L_t}/\partial\tilde{\mathcal{D}}_t)(\partial\tilde{\mathcal{D}}_t/\partial\tilde{\Delta}_{L_t}) = 0$ . Similarly,  $\partial\tilde{Y}_{U_t}/\partial\tilde{\Delta}_{L_t} = 0$ . Next, for the local inflation, from the

NKPCs (26) and (27),  $\partial\pi_{Lt}/\partial\tilde{\Delta}_{Lt} = 0$  under PCP and  $\partial(a\pi_{Lt} + (1-a)\pi_{Ut}^*)/\partial\tilde{\Delta}_{Lt} = -2\kappa(1-a)$ , which is second-order when the home bias is large enough (large  $a$ ). For the US inflation,  $\partial\pi_{Ut}^*/\partial\tilde{\Delta}_{Lt} = 0$  under both PCP and DCP. Hence, up to the first order and without FXI,

$$\left(\frac{\partial E_t(\pi_{Lt+1} - \pi_{Ut+1}^*)}{\partial\mu_0^*}\right)^{PCP} \doteq \left(\frac{\partial E_t(a\pi_{Lt+1} + (1-a)\pi_{Lt+1}^* - \pi_{Ut+1}^*)}{\partial\mu_0^*}\right)^{DCP} > 0.$$

The reaction coefficient to the inflation differential is larger under DCP than PCP: <sup>20</sup>

$$\frac{\theta}{2(1-a)\chi_1} > \frac{\theta}{2a\chi_1}.$$

Hence,

$$\left(\frac{\partial f_t}{\partial\mu_t^*}\right)^{DCP} > \left(\frac{\partial f_t}{\partial\mu_t^*}\right)^{PCP}.$$

□

## A.10 Proof of Proposition 5

First, I consider the PCP case. Since  $\partial f_t/\partial\mu_t^* > 0$  and  $\partial\tilde{\mathcal{D}}_t/\partial f_t > 0$ , I consider the elasticity of inflation to the demand gap. From the NKPCs for the domestic good inflation in the two countries,

$$\frac{\partial\pi_{Lt}}{\partial\tilde{\mathcal{D}}_t} = -\frac{\partial\pi_{Ut}^*}{\partial\tilde{\mathcal{D}}_t} = \kappa(1-a).$$

Hence,  $\partial\pi_{Lt}/\partial\mu_t^* = -\partial\pi_{Ut}^*/\partial\mu_t^*$ .

For the imported inflation, from the law of one price,

$$\pi_{Ut}^* = \tilde{e}_t - \tilde{e}_{t-1} + \pi_{Ut}^*, \quad \pi_{Lt}^* = -(\tilde{e}_t - \tilde{e}_{t-1}) + \pi_{Lt}. \quad (\text{A53})$$

Hence,

$$\frac{\partial\pi_{Ut}}{\partial\tilde{\mathcal{D}}_t} = -\frac{\partial\pi_{Lt}^*}{\partial\tilde{\mathcal{D}}_t}, \quad \frac{\partial\pi_{Ut}}{\partial\mu_t^*} = -\frac{\partial\pi_{Lt}^*}{\partial\mu_t^*}$$

<sup>20</sup>The difference between inflation differential terms under PCP and DCP is quantitatively at most second-order. The difference in the optimal FXI volumes under PCP and DCP is mainly because the reaction coefficient to the inflation is larger under DCP, which is due to the deviation from the LOOP.

Hence, the response of CPI inflation is symmetric.

$$\left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{PCP} = - \left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{PCP} (> 0).$$

Next, I consider the DCP case. Since the optimal FXI is larger under DCP than PCP (Equation (31)),

$$\left( \frac{\partial \tilde{e}_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \tilde{e}_t}{\partial \mu_t^*} \right)^{DCP} < \left( \frac{\partial \tilde{e}_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \tilde{e}_t}{\partial \mu_t^*} \right)^{PCP} (< 0),$$

For the local imports of US goods, since the LOOP holds,

$$\begin{aligned} \left( \frac{\partial \pi_{U_t}^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_{U_t}}{\partial \mu_t^*} \right)^{DCP} &< \left( \frac{\partial \pi_{U_t}^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_{U_t}}{\partial \mu_t^*} \right)^{PCP} (< 0), \\ \left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{DCP} &< \left( \frac{\partial \pi_t^{FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t}{\partial \mu_t^*} \right)^{PCP} (< 0). \end{aligned}$$

Next, consider the US imports of local goods. Combining Equations (A4) and (A11) and using  $\partial \tilde{\Delta}_{Lt} / \partial \tilde{\mathcal{D}}_t = 0$  when  $\sigma = \phi = 1$ ,

$$\frac{\partial \tilde{e}_t}{\partial \tilde{\mathcal{D}}_t} = -(2a - 1)^2 < 0.$$

When the price stickiness is sufficiently high,  $\partial \tilde{e}_t / \partial \tilde{\mathcal{D}}_t \equiv (2a - 1)^2 < 0$ .

Under PCP, since  $\pi_{Lt}^*$  is determined by the LOOP condition (A53),

$$\left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mathcal{D}}_t} \right)^{PCP} = - \frac{\partial \tilde{e}_t}{\partial \tilde{\mathcal{D}}_t} + \frac{\partial \tilde{\pi}_{Lt}^*}{\partial \tilde{\mathcal{D}}_t} \equiv (2a - 1)^2 + \kappa(1 - a).$$

Under DCP, since the LOOP does not hold and  $\pi_{Lt}^*$  is determined by the NKPC (27),

$$\left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mathcal{D}}_t} \right)^{DCP} = \kappa(1 - a).$$

Comparing the PCP and DCP cases,

$$\begin{aligned} \left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mathcal{D}}_t} \right)^{DCP} - \left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mathcal{D}}_t} \right)^{PCP} &= -(2a - 1)^2, \\ \left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mu}_t^*} \right)^{DCP} - \left( \frac{\partial \pi_{Lt}^*}{\partial \tilde{\mu}_t^*} \right)^{PCP} &< 0. \end{aligned}$$

The difference is first order when  $a$  is sufficiently large. Hence,

$$\left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{DCP} < \left( \frac{\partial \pi_t^{*FXI}}{\partial \mu_t^*} - \frac{\partial \pi_t^*}{\partial \mu_t^*} \right)^{PCP} (> 0).$$

□