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## When is Liquidity Bad?

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# When is Liquidity Bad? \*

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## Abstract

Following U.S. monetary policy shocks, exchange rates initially depreciate sluggishly before overshooting excessively. I show that subjective expectations can account for both the delayed and excessive overshooting puzzles. Investors with subjective expectations amplify exchange rate volatility and generate momentum in exchange rate movements. In contrast, excluding these speculators dampens volatility, leading to more stable inflation and interest rates. Furthermore, FX interventions become more effective when speculators hold subjective expectations, as central banks can influence their beliefs and shape exchange rate dynamics.

*Key words:* foreign financiers, capital controls, subjective expectations

*JEL Codes:* E44, F32, F41, G15, D84, E71

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# 1 Introduction

Two key puzzles in exchange rate dynamics challenge conventional wisdom: delayed overshooting and excessive overshooting. The delayed overshooting puzzle (Eichengreen and Evans (1995)) refers to the sluggish response of exchange rates to monetary shocks. In contrast, the excessive overshooting puzzle (Camara et al. (2024)) arises when exchange rates react too sharply to U.S. monetary policy shocks, depreciating so steeply that the subsequent expected appreciation increases local asset returns relative to dollar returns. Engel (2016) highlights a common pattern in both puzzles: exchange rates initially adjust slowly but later exhibit an exaggerated response.

These puzzles expose a paradox for investors: first, they forgo gains by under investing in dollar assets during delayed overshooting, and then they incur losses by overinvesting in dollar assets during excessive overshooting. Investors take positions in the exchange rate market presumably to make profits. Hence, they aim at buying when the exchange rate is cheap and sell when it is expensive; they provide liquidity to the market and their participation should smooth the exchange rate. However, when foreign investors hold subjective beliefs about future exchange rates (in the spirit of Adam et al. (2017)), these dynamics can instead exacerbate volatility. In this paper, I show that subjective beliefs lead to both delayed and excessive overshooting. Furthermore, investor participation amplifies volatility and generates momentum in exchange rates. Policies limiting their participation in exchange rate markets could significantly reduce this volatility.

Subjective expectations have been shown to explain puzzles in stock markets (Adam et al. (2016, 2017)). For the exchange rate markets, deviating from rational expectations have also been shown to explain certain exchange rate puzzles (Gourinchas and Tornell (2004)). Bacchetta et al. (2009) use survey evidence to show that financial professionals make systematic errors; following their methodology, I also show that exchange rate depreciations lead to a positive expectation error, as professional market participants anticipate larger depreciations than those observed in the data. Ilut (2012) show that ambiguity aversion can explain delayed overshooting, investors react slowly to profit opportunities due to fear of losses. Similarly, Müller et al. (2024) show that informational rigidities can account for delayed overshooting puzzle; investors learn about the state of economy so that they react to shocks slowly. Without taking a stance on microfoundations, Bacchetta and van Wincoop (2021) show that sticky portfolios can explain many of the exchange rate puzzles. However, Engel (2016) argues that investors reacting slowly is not consistent with excessive overshooting (Camara et al. (2024)) and excess volatility puzzles (Rogoff

(1996); Devereux and Engel (2002)) because investors reacting slowly would imply low volatility of exchange rate. In this paper I show that subjective expectations can account for both delayed and excessive overshooting puzzles. At the same time, it can explain excess volatility puzzle and momentum puzzle (Burnside et al. (2011)).

I build a small open economy model with financial frictions. In the model, households and foreign investors can borrow/lend in local currency and the dollar. Local investors have unbiased expectations, whereas foreign investors might have subjective expectations a la Adam et al. (2017). Both local and foreigner investors are subject to preferred habitat; they would like to stay close to their target portfolio but can deviate from their targets if the return difference is high enough. Banks collect investments from households and foreigners and invest in non-financial firms which operate capital for goods production. Banks are subject to financial frictions similar to Gertler and Karadi (2011), which limits their borrowing capacity. Banks accept deposits both in local currency and dollars similar to Dalgic and Ozhan (2022), but their revenues (return from capital) is in local currency so that the financial system has a currency mismatch. Currency mismatch in the financial system creates balance sheet effects; exchange rate depreciations lead to losses in the financial system which limit their borrowing capacity in the subsequent periods and lead to investment decline.

Main source of uncertainty in the model is foreign interest rate shock. The idea of Global Financial Cycle shows that global asset prices move together and the US monetary policy is a strong driver of these cycles (Miranda-Agrippino and Rey (2020)). Similarly, two global factors explain more than half of the movements in exchange rates, particularly important for small open economies (Lustig et al. (2011); Dalgic and Ozhan (2022)). An increase in foreign interest rates make dollar assets more attractive for households and demand for dollar assets depreciate the exchange rate. Exchange rate depreciation leads to lower investment through balance sheet effects. Also, for lower elasticity of substitution between domestic and foreign inputs in production, exchange rate depreciations lead to lower production (Auclert et al. (2021)). It is also argued that significant amount of exchange rate fluctuations come from not fundamentals but noise trading (Eichenbaum et al. (2021); Itskhoki and Mukhin (2021)) and intervening against this kind of noise trading increases welfare (Itskhoki and Mukhin (2023)). In these models, excess volatility in exchange rates come from noise shocks. In our model, the behavior of investors create excess volatility; if foreign investors have unbiased expectations, they react only to fundamentals and trade in a way that reduces exchange rate volatility. On the other hand, foreign investors with subjective expectations will trade in a way that increases ex-

change rate volatility, their trading behavior looks like noise trading. I find that if foreign investors have subjective expectations, excluding them from the FX markets decreases macroeconomic volatility.

This paper also contributes to the literature on FX interventions. When the investors have unbiased expectations, they trade against the central bank and reduce the effectiveness of FX interventions. However, when foreign investors have subjective expectations, they see the initial exchange rate appreciation as a signal of further appreciation so they trade with the central bank by selling dollar assets, which further increases the exchange rate appreciation and makes FX intervention more effective.

The results complement the view that Global Financial Cycle limits domestic monetary policy in small open economies (Kalemli-Ozcan (2019); Miranda-Agrippino and Rey (2020)); in my framework, foreign investors with subjective expectations trade in a way to amplify the effects of foreign shocks. These investors see initial exchange rate depreciation as a signal of future depreciations and sell domestic assets even more, which makes the exchange rate depreciate even more and increases inflation through exchange rate pass through. Monetary policy is constrained because high inflation corresponds to a recession, further interest rate hikes would slow the economy further.

## 2 Exchange Rate Expectations

In this Section, I use data on exchange rate expectations to show whether there is systemic difference in expectation errors. Dataset is from FX4Casts from 10/2001 to 10/2018 and covers 26 currencies<sup>1</sup>, exchange rates are defined as LC per USD<sup>2</sup>. Data on exchange rates, exchange rate expectations, and interest rates are collected at the end of each month. Exchange rate expectations are surveyed among major financial market players and are for 3 months ahead. Therefore, I convert our dataset to a quarterly format, taking only the last month of each quarter. For each currency  $i$ , I define realized and expected depreciation as  $Depr_{i,t+1} = S_{i,t+1}/S_{i,t}$  and  $Depr_{i,t+1}^e = \mathbb{E}_t^{SUBJ}(S_{i,t+1})/S_{i,t}$  respectively, where  $\mathbb{E}_t^{SUBJ}$

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<sup>1</sup>Full set of currencies are Argentine Peso, Australian Dollar, Brazilian Real, Canadian Dollar, Chilean Peso, Colombian Peso, Czech Koruna, Danish Krone, Euro, Hungarian Forint, Indian Rupee, Indonesian Rupiah, Japanese Yen, Mexican Peso, New Zealand Dollar, Norwegian Krone, Philippine Peso, Polish Zloty, Russian Ruble, South African Rand, South Korean Won, Swedish Krona, Swiss Franc, Thai Baht, Turkish Lira, British Pound.

<sup>2</sup>Certain exchange rates (Euro, Pound etc) are reported in the raw data as USD per LC, in these cases I reverse the exchange rate (1/S) to get LC per USD value.

are subjective expectations reported by financial market professionals. Currency returns are defined <sup>3</sup> as

$$Ret_{i,t+1} = \log(R_{i,t}) - \log(R_t^*) - \log(Depr_{i,t+1})$$

where expectation error is defined,  $(\log(Depr_{i,t+1}^e) - \log(Depr_{i,t+1}))$ . Following Bacchetta et al. (2009), I regress expectation error on date  $t - 1$  observables  $Depr_{i,t-1} = S_{i,t-1}/S_{i,t-2}$  and  $Ret_{i,t-1}$ <sup>4</sup>.

	<i>Dependent variable:</i>					
	Expectation Error					
	<i>OLS</i>	<i>panel linear</i>		<i>OLS</i>	<i>panel linear</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
$S_{i,t-1}/S_{i,t-2}$	0.056** (0.028)	0.071*** (0.026)	0.028 (0.035)			
$Ret_{i,t-1}$				-0.073** (0.030)	-0.075*** (0.025)	-0.056* (0.031)
Constant	-0.057** (0.028)			-0.001 (0.002)		
Currency FE	No	Yes	No	No	Yes	No
Time FE	No	No	Yes	No	No	Yes
Observations	1,710	1,710	1,710	1,710	1,710	1,710
Residual Std. Error (df = 1708)	0.064			0.064		

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Table 1: Determinants of Exchange Rate Expectation Errors

Notes: Currency and time clustered standard errors in parenthesis. Quarterly data covers 2001Q3-2018Q3. Data source: FX4Casts

The results indicate that exchange rate depreciations lead to a positive expectation error, as investors anticipate larger depreciations than those observed in the data. Similarly, when a currency yields low returns, investors expect it to depreciate more than it actually does. Notably, this effect loses significance when time fixed effects are included, suggesting that expectation errors are clustered around common exchange rate depreciations across currencies. This reinforces the importance of global shocks in shaping these patterns.

<sup>3</sup>An alternative strategy to take a position in exchange rate markets is to use forward markets. Christiano et al. (2021) show that trading in the forward market is equivalent to borrowing and lending at risk free rates.

<sup>4</sup>I skip date  $t$  because both  $t$  and  $t + 1$  values include  $S_t$

### 3 Model

I build a small open economy New Keynesian model based on Dalgic and Ozhan (2022) and Camara et al. (2024), which includes key mechanisms that align with the observation that small open economies contract sharply following US monetary policy shocks (Cesa-Bianchi et al. (2024)). In EMEs, this contraction is primarily driven by investment declines (Camara et al. (2024)). Two key features help the model capture important dynamics. First, dollar invoicing of exports (Goldberg and Tille (2008) and Gopinath et al. (2020)) dampens the response of exports to exchange rate movements. Second, dollar-denominated debt (Dalgic and Ozhan (2022)) creates balance sheet effects following exchange rate depreciations, leading to a decline in investment and further exacerbating economic contractions. Without these features, a model would predict that depreciation stimulates exports and boosts GDP, contradicting observed dynamics. Details of the model are in Appendix Section A. In the model, households maximize discounted sum of life time utility,

$$E_0 \sum_{t=0}^{\infty} \beta^t \left( u(C_t) - \frac{l_t^{1+\phi}}{1+\phi} - \frac{1}{2} \overbrace{\gamma(\Theta_t - \Upsilon_t)^2}^{\text{Disutility of deviating from target portfolio}} \right)$$

where  $\Theta_t$  is the share of dollar assets in the portfolio and  $\Upsilon_t$  is the target portfolio (preferred habitat similar to Camara et al. (2024) and Gourinchas et al. (2022)). Households get disutility if their portfolio deviates from their target. Household budget constraint,

$$D_t + S_t D_t^* + P_t^c C_t = D_{t-1} R_{d,t-1} + S_t R_{d,t-1}^* D_{t-1}^* + W_t l_t + \Pi_t$$

Households can invest in local currency ( $D_t$ ) and dollar ( $D_t^*$ ) assets. They get income from these assets as well as labor income and profits and transfers. First order conditions imply in the linearized model,

$$r_t - [r_t^* + \mathbb{E}_t s_{t+1}] = -\gamma(\Theta_t - \Upsilon_t)$$

In the absence of portfolio frictions ( $\gamma = 0$ ), the linearized model will not feature any interest rate spread because any expected return difference will be eliminated by households trading.

### 3.1 Goods Production

The model features three final goods, household consumption ( $C_t$ ), capital investment ( $I_t$ ) and exports ( $X_t$ ). All goods are produced from domestic homogeneous good and imported inputs. Since consumption basket includes imported inputs, which are prices in dollars, consumption price index is affected by exchange rate movements. A volatile exchange rate makes consumer prices more volatile. Capital investment is subject to adjustment costs and done by firms which are owned by banks. Export good price is sticky in dollars (Gopinath et al. (2020)), which limits expenditure switching and makes exchange rate depreciations more recessionary (Dalgic and Ozhan (2022)). Domestic homogeneous good  $Y_t$  is produced from intermediate domestic goods ( $Y_{i,t}$ ) and is used as a input for consumption, investment and export goods.

$$Y_t = \left[ \int_0^1 Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

Intermediate goods are imperfect substitutes in the production function and are produced by monopolists using capital and labor, production function of intermediate good firms:

$$Y_{i,t} = K_{i,t-1}^\alpha (l_{i,t})^{1-\alpha}$$

Firms face Calvo sticky prices where only a fraction  $(1 - \theta)$  of them are allowed to change their prices. Similarly, fraction  $(1 - \theta^x)$  of exporting firms can change their prices in dollars. Small open economy faces a downward sloping Foreigner demand local export goods,

$$X_t = \left( \frac{P_t^x}{P_t^f} \right)^{-\eta_f} Y_t^f$$

where  $Y_t^f$  is foreign demand,  $P_t^f$  is foreign currency price of foreign good and  $P_t^x$  is foreign currency price of export good. Similar to consumption and Investment, exports are produced from intermediate export goods and imported inputs. Total production of domestic homogeneous good equals to demand for domestic inputs.

$$Y_t = I_t^d + C_t^d + X_t^d$$



where  $(I_t^d, C_t^d, X_t^d)$  are domestic goods to produce final investment, consumption and export goods respectively.

## 3.2 Financial System

The financial system is composed of banks that intermediate between households, foreigners, and firms. Both households and foreigners deposit funds in local currency and dollars. Figure 1 shows the financial system. Banks collect funds from households and foreigners in dollars and in local currency and invest in local firms which provide capital for production. Since firm revenues are in local currency and they can be funded through dollar deposits, financial system is subject to currency mismatch; exchange rate depreciations hurt balance sheets and lead to lower investment.

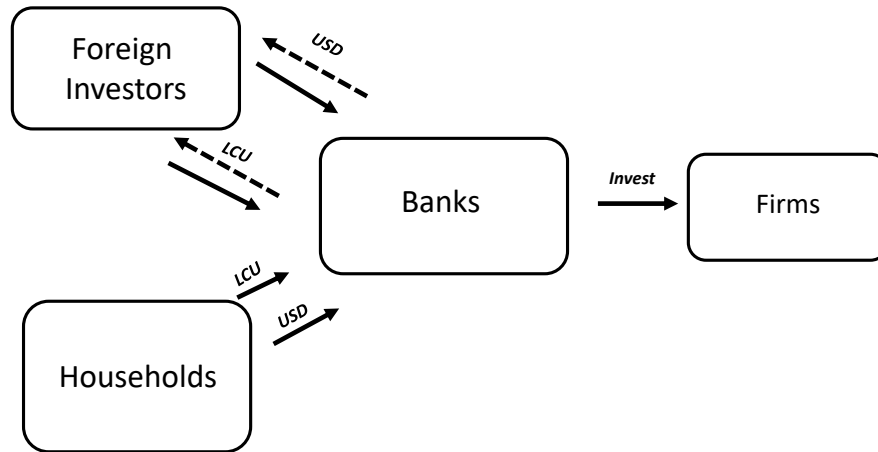


Figure 1: Financial Markets

### 3.2.1 Banks

Banks borrow funds from households and foreigners to finance firm investments, but their borrowing is constrained by financial frictions in the spirit of Gertler and Karadi (2011), which limit the amount they can borrow based on an incentive constraint. Banks with higher equity have greater borrowing capacity. They can choose to borrow in either local currency (LC) or USD, with a preference for the cheaper option. However, they also aim to maintain a balanced portfolio that aligns with their target similar to Dalgic and Ozhan (2022). Details of the banker problem is in Appendix Section A.2.

### 3.3 Foreign Speculators

Foreign investors in the economy take position in the local currency market by lending (or borrowing) in local currency bonds ( $B_t^F$ ). Investors are subject to leverage constraints based on Gabaix and Maggiori (2015). International investors have an initial target portfolio ( $B^F$ ), and they decide how much to deviate from their target their solve,

$$\max V_t = (B_t^F - B^F) \left( \mathbb{E}_t^j \left( \frac{R_t S_t}{S_{t+1}} \right) - R_t^* \right)$$

subject to the incentive constraint,

$$V_t \geq \frac{\lambda(\mathbb{V}_{S_{t+1}})}{2} (B_t^F - B^F)^2$$

Note that their incentive constraint depends on how much they deviate from their ‘preferred habitat’. I could think  $B^F$  as the target exposure of international investors and traders can deviate from this target if the returns are high but there are leverage limits. As in Gabaix and Maggiori (2015), incentive constraint is tighter when the exchange rate is more volatile. The solution of the foreign speculator problem is

$$(B_t^F - B^F) = \frac{\mathbb{E}_t^j \left( \frac{R_t S_t}{S_{t+1}} \right) - R_t^*}{\lambda(\mathbb{V}_{S_{t+1}})}$$

#### 3.3.1 Expectations

Foreign investors can either have rational or subjective expectations. First I consider full information rational expectation (FIRE) case where expectations coincide with objective probabilities

$$\mathbb{E}_t^{FIRE} \left( \frac{S_t}{S_{t+1}} \right) = \mathbb{E}_t \left( \frac{S_t}{S_{t+1}} \right) \quad (1)$$

For subjective beliefs, I follow Adam et al. (2017),

$$\mathbb{E}_t^{SUBJ} \left( \frac{S_t}{S_{t+1}} \right) = \beta_1 \mathbb{E}_t^{SUBJ} \left( \frac{S_{t-1}}{S_t} \right) + \beta_2 \frac{S_{t-2}}{S_{t-1}} \quad (2)$$

I run the regression specified in Equation 2 to pin down the coefficients<sup>5</sup>. The results in Table 2, I find  $\hat{\beta}_2 \approx 0.05$ , similar to 0.0264 in Adam et al. (2017).

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<sup>5</sup>Refer to Section 2 for details of the data.

	<i>Dependent variable:</i>	
	$\mathbb{E}_t^{SUBJ} \left( \frac{S_t}{S_{t+1}} \right)$	
	<i>OLS</i>	<i>panel linear</i>
	(1)	(2)
$\mathbb{E}_t^{SUBJ} \left( \frac{S_{t-1}}{S_t} \right)$	0.209*** (0.042)	0.148*** (0.027)
$\frac{S_{t-2}}{S_{t-1}}$	0.057*** (0.012)	0.050*** (0.004)
Observations	1,736	1,736
Residual Std. Error	0.016 (df = 1733)	
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01	

Table 2: Subjective Expectations

### 3.4 Foreign Sector

Small open economy takes foreign interest rates ( $R_t^*$ ) and foreign demand ( $Y_t^f$ ) as given. Both follow exogenous AR(1) processes. Following Camara et al. (2024) I assume that foreign interest rate shocks adversely affect foreign demand for exports.

$$\begin{aligned}
R_t^* &= (1 - \rho_{R^*})R^* + \rho_{R^*}R_{t-1}^* + \varepsilon_t^R \\
Y_t^f &= (1 - \rho_{Y^f})Y^f + \rho_{Y^f}Y_{t-1}^f + \gamma(R_t^* - R^*) + \varepsilon_t^{Yf}
\end{aligned}$$

### 3.5 Uncertainty

In the model, I focus on foreign interest rates as the source of uncertainty. Extensive literature talks about how foreign interest rate shocks drive small open economy business cycles (Neumeyer and Perri (2005) and Fernandez-Villaverde et al. (2011)). Similarly, global asset prices follow global financial cycle and US interest rates are found to be an important source of its volatility (Kalemli-Ozcan (2019); Miranda-Agrippino and Rey (2020)). An increase in foreign interest rates makes dollar assets more attractive, driving dollar demand higher among both residents and foreign speculators. This surge in demand for

dollar assets causes a depreciation of the local currency, which has several effects on the economy: first, it raises consumer inflation through exchange rate pass-through, leading the central bank to hike interest rates. Second, depreciation weakens bank balance sheets, as many banks have dollar-denominated liabilities but earn revenue in local currency. On the positive side, depreciation can stimulate local production by boosting exports and discouraging imports. However, as discussed in Section 3.4, higher foreign interest rates reduce external demand for exports (see Camara et al. (2024)), sticky export prices limit price adjustment and low short-run import substitution elasticity limits the shift away from imports. Together, these factors weaken the expenditure-switching channel. Overall, unlike the classical Mundell-Fleming framework, an increase in foreign interest rates leads to an economic slowdown in a small open economy.

### 3.6 Parameters

Table 3 presents parameter values. I borrow most parameters from Camara et al. (2024), who estimate them for a set of EME. Elasticities of substitution between domestic and imported inputs for consumption, investment and exports are lower than 1, which indicates they are compliments in the respective production functions; when the exchange rate depreciates, it is not easy to replace imported inputs with domestic production. Consumption elasticity of substitution is especially small, which leads to a large drop following an exchange rate depreciation as imported inputs become more expensive. The economic slowdown caused by consumption demand drop is due to the real income channel discussed by Auclert et al. (2021).

Variable	Description	Value
$\beta$	Discount Factor	0.995
$\alpha$	Capital Share	0.340
$\delta$	Depreciation	0.020
$\varphi$	Inverse Frisch	1.000
$r_\pi$	Taylor Inflation Coefficient	1.500
$r_y$	Taylor Output Coefficient	0.000
$r_S$	Taylor Exchange Rate Coefficient	0.020
$\varepsilon$	Elasticity of Substitution, intermediate goods	6.000
$\theta$	Calvo Parameter, intermediate goods	0.750
$\varepsilon^x$	Elasticity of Substitution, export goods	6.000
$\gamma$	Target Portfolio Cost (UIP Friction)	-2.560
$\theta^x$	Export Calvo Stickiness	0.800
$\kappa$	Investment Adjustment Cost	5.850
$\eta_c$	C, Elasticity of Substitution	0.410
$1 - \omega_c$	Home Bias, C	0.830
$\omega_i$	Home Bias, I	0.290
$\gamma_x$	Home Bias, X	0.500
$\eta^f$	Elasticity of Demand, Exports	1.530
$\eta_i$	I, Elasticity of Substitution	0.910
$\eta_x$	X, Elasticity of Substitution	0.700
$\rho_R$	MP Persistence	0.900
$\phi$	Target Credit Dollarization	0.500
$\Upsilon$	Target Deposit Dollarization	0.200

Table 3: Parameter Values

## 4 Results

In this section, I explore the pivotal role that speculators' expectations play in the transmission of external shocks to a small open economy. First, I examine how a foreign interest rate shock impacts the domestic economy, depending on whether foreign currency speculators hold unbiased or subjective expectations. Following this, I analyze the effects of excluding foreign speculators from the market, again focusing on how the nature of their expectations—whether forward-looking or subjective—influences the overall economic outcome. I find that when foreign investors have unbiased expectations (as in Equation 1), their participation in the financial markets have positive but small impact,

their exclusion makes the exchange rate slightly more volatile. However, when foreign investors have subjective expectations (as in Equation 2), their participation makes the exchange rate much more volatile so that their exclusion smooths the exchange rate.

## 4.1 Response to Foreign Interest Rate Shock

Figure 2 shows the impulse response to a 1% increase in the foreign interest rate across three different economic scenarios, comparing the effects in economies with foreign currency speculators holding unbiased expectations and those with subjective expectations. In all cases, an increase in foreign interest rates causes an immediate depreciation of the domestic exchange rate. In the economy with speculators holding unbiased expectations, the uncovered interest rate parity (UIP) condition holds, meaning that the interest rate spread remains close to zero and does not move significantly. The behavior of the economy without speculators closely mirrors that of the economy with unbiased speculators. This is because households, though they lack speculative activity, are forward-looking and tend to trade in the same direction as unbiased speculators, albeit with a preference for their own "habitat" in financial markets. In contrast, in the economy with speculators holding subjective expectations, the dynamics are notably different. The initial depreciation in the exchange rate creates an expectation of further depreciation. Speculators respond by selling the domestic currency, leading to a decrease in  $b^*$ , which further amplifies the depreciation. This exacerbated depreciation intensifies pass-through inflation, driving up interest rates in response. The large and sustained depreciation also triggers balance sheet effects, particularly for entities holding dollar-denominated debt. The combination of high interest rates and balance sheet stress leads to a sharp decline in investment. However, the significant depreciation also boosts exports, providing a temporary lift to GDP. Despite this, the overall economic impact is negative, as both consumption and investment suffer severe declines, driven by the adverse effects of inflation, higher interest rates, and financial fragility. This highlights how subjective expectations among speculators can create self-reinforcing cycles of currency depreciation and economic instability.

When foreign investors have subjective expectations, the exchange rate displays both delayed (Eichenbaum and Evans (1995)) and excessive (Camara et al. (2024)) overshooting. Following a foreign interest rate shock, the exchange rate depreciates sharply and continues to depreciate further, forming an inverse U shaped response. Following the initial depreciation, the UIP spread turns significantly negative, reducing local asset returns.

This prompts speculators to sell local assets;  $b_t^*$  goes down for several periods (Panel 2,1 in Figure 2). Households also switch their portfolio towards dollars (Panel 2,2). After several quarters, the exchange rate begins appreciating rapidly, making local assets more attractive. Households reallocate to local assets, reducing dollarization. However, foreign investors remain slow to reinvest despite higher local returns, as they do not anticipate the rapid appreciation.

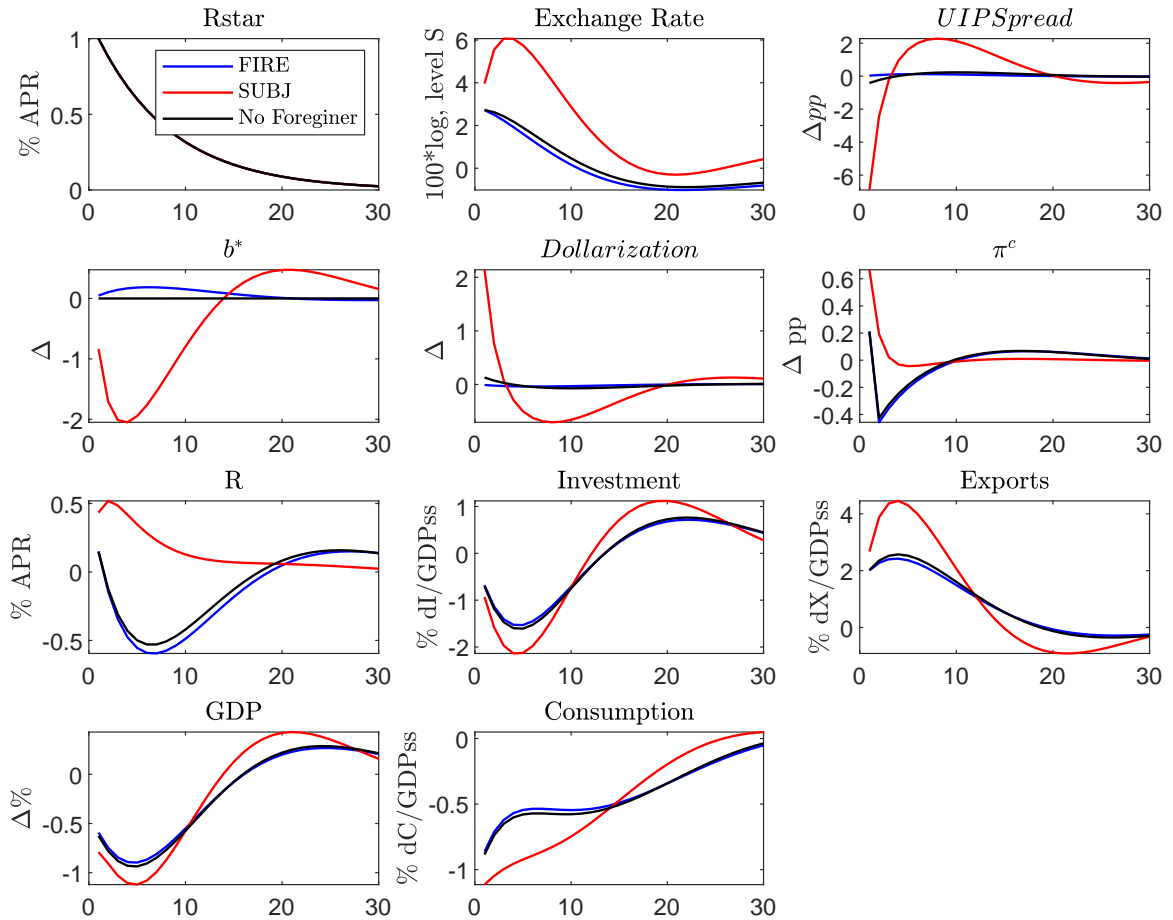


Figure 2: Response to Foreign Interest Rate Shock

## 4.2 Delayed and Excessive Overshooting

Figure 3 compares subjective exchange rate expectations with rational expectations (the realized path) from Figure 2. Initially, subjective expectations are below rational expectations.

tations; investors underestimate the momentum of the exchange rate so that they do not switch to dollar assets as much as they should have. This underestimation in investor expectation creates delayed overshooting. Once the exchange rate reaches its peak, investors underestimate the speed of the appreciation. As a result of this underestimation, they hold on to their dollar assets, which creates excessive overshooting.

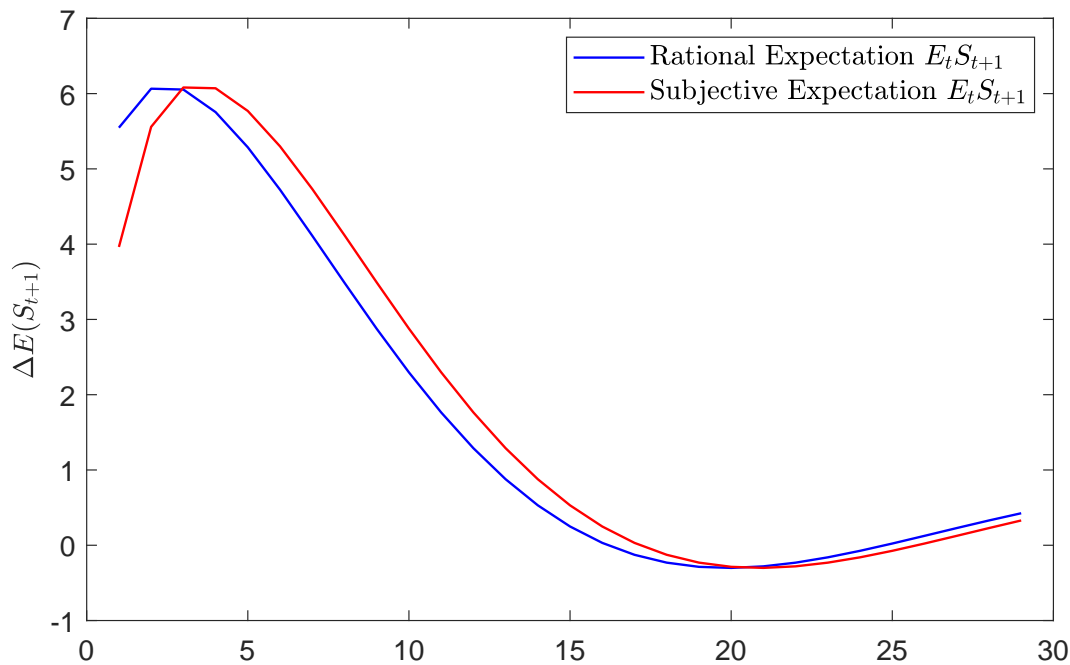


Figure 3: Exchange Rate Depreciation Expectations in response to Foreign Interest Rate Shock

### 4.3 Excluding Foreign speculators

In this section, I examine the economic impacts, particularly on exchange rate volatility, when foreign participants are excluded from the market. To analyze this, I adjust  $\lambda^f$ , the parameter that governs the tightness of the incentive constraint of currency speculators, from 0.01 to 0.1. In the case of financial markets dominated by speculators with unbiased expectations (referred to as FIRE—Full Information Rational Expectations), their exclusion increases exchange rate volatility. Conversely, when speculators hold subjective expectations, their exclusion tends to reduce exchange rate volatility (Figure 4)



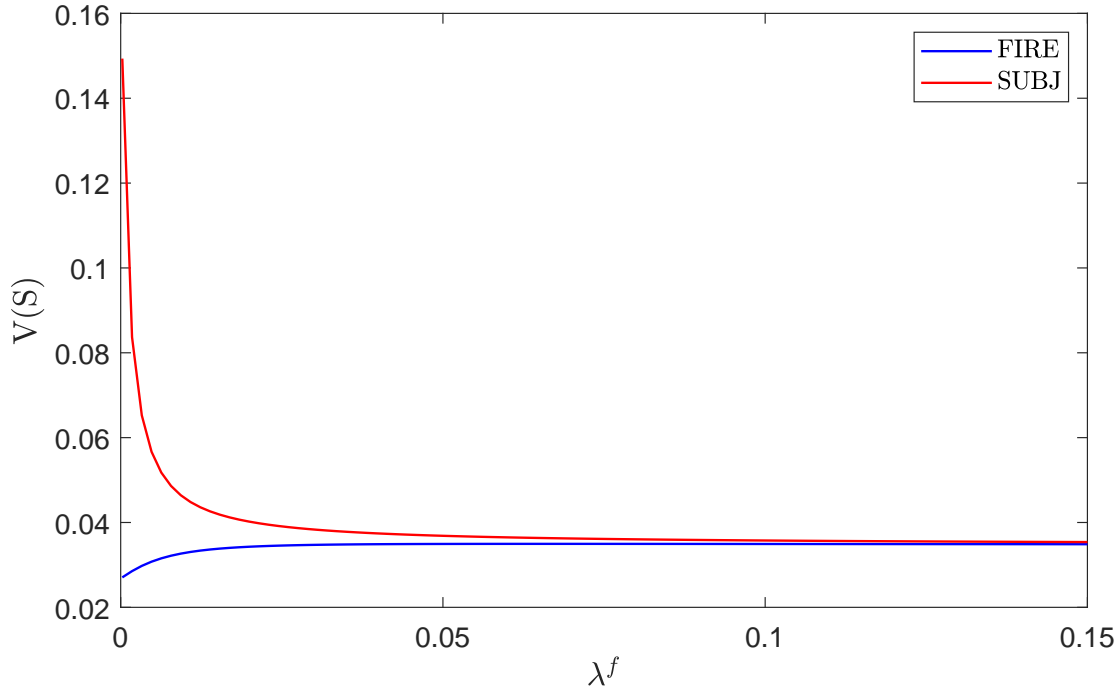


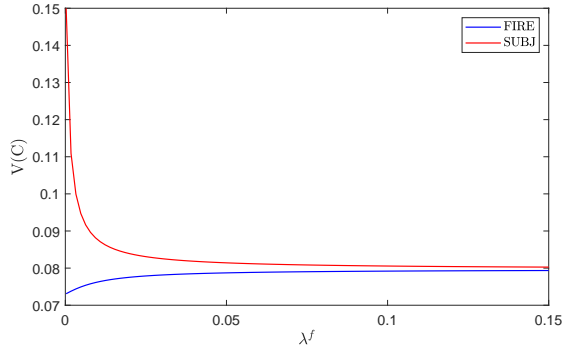
Figure 4: Exchange Rate Volatility vs Foreign Speculator Participation

When speculators with subjective expectations participate in the market, they tend to contribute to higher exchange rate volatility, which has cascading effects on the broader economy. Therefore, excluding them results in lower volatility across several economic variables—exchange rates, output (Figure 5b) and consumption. On the other hand, when speculators are forward-looking and have unbiased, rational expectations, their exclusion tends to increase exchange rate volatility. This, in turn, raises consumption, and output volatility. However, the impact of tightening the constraint on forward-looking speculators is relatively small. In contrast, when speculators have subjective expectations, excluding them yields significant reductions in volatility across the board.

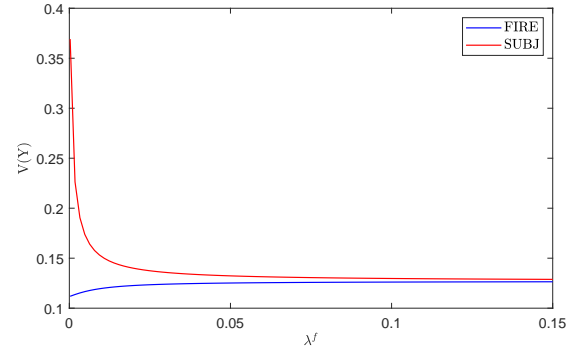
The effect on inflation and interest rates is more subtle; when investors with subjective expectations are very active in the market (very low levels of  $\lambda_f$ ), their presence greatly amplifies inflation and interest rate volatility. This is because high exchange rate volatility translates into inflation volatility because of pass through effect. For moderate levels of  $\lambda_f$  there are two opposing effects on inflation; an exchange rate depreciation increases inflation but GDP slowdown decreases it because of lack of demand. Hence, for very low foreign participation (high values of  $\lambda_f$ ), inflation volatility seems to be higher. This is because comovement between inflation and output changes (Figure 5e), for very low values of  $\lambda_f$ , the comovement is negative; inflation goes up when output goes down. This com-

plicates monetary policy because to bring down inflation, the central bank needs to raise interest rates in a recession (Figure 5f). When foreigner participation is low, comovement between output and inflation turns positive so that the central bank can lower interest rates to combat the recession.

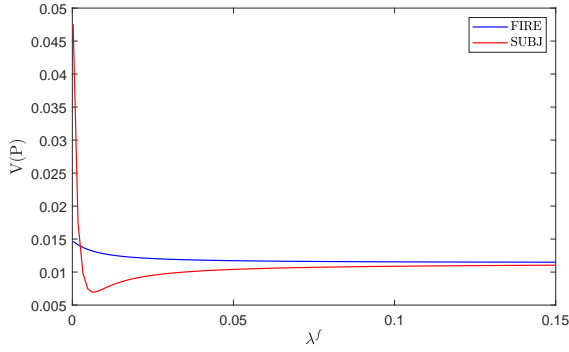
When investors have unbiased expectations, the change in macro quantities are minimal. Thus, the nature of speculators' expectations plays a crucial role in determining the effects of their exclusion on economic volatility.



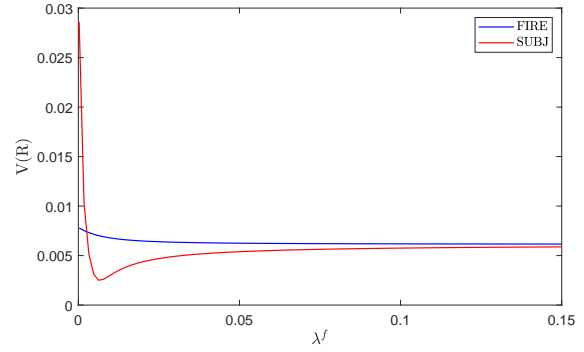
(a) Consumption Volatility vs Foreign Speculator Participation



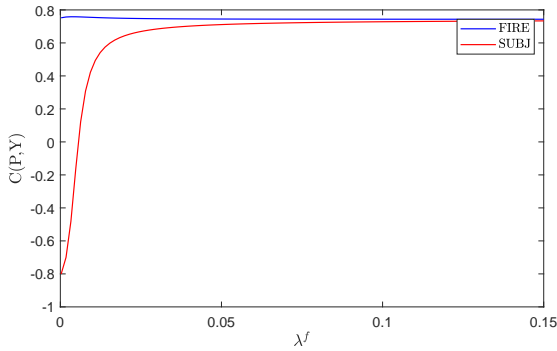
(b) Output Volatility vs Foreign Speculator Participation



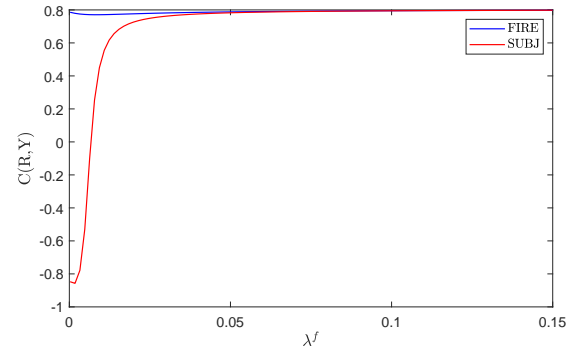
(c) Inflation Volatility vs Foreign Speculator Participation



(d) Interest Rate Volatility vs Foreign Speculator Participation



(e) Inflation and Output Correlation vs Foreign Speculator Participation



(f) Interest Rates and Output Correlation vs Foreign Speculator Participation

Figure 5: Effects of Limiting Foreign Speculator Participation

## 4.4 FX Interventions

In this section, I am going to look at the effects of FX interventions on the economy. I model FX interventions as an AR(1) shock,

$$F_t^* = \rho_{FX} F_{t-1}^* + \sigma_{FX} e_{FXI,t}$$

Consider a negative FX intervention, where the central bank sells dollar assets on the FX market to both foreign and local investors. This action immediately appreciates the exchange rate, as both groups have limited capacity to absorb additional dollars due to preferred habitat assumption. To compensate, they demand higher returns to purchase the central bank's dollar supply. The appreciation leads to an expected depreciation, which raises anticipated returns, motivating investors to buy the available dollars.

An exchange rate appreciation impacts the economy in several ways. First, it improves bank balance sheets by reducing the value of liabilities, which encourages investment. Lower import prices boost consumption, stimulating local production. This increased consumption and investment raises GDP, while the stronger currency reduces demand for exports, causing export volumes to decline.

Figure 6 illustrates the effects of a significant FX intervention (10% of GDP) by the central bank. Investors with unbiased expectations lower intervention effectiveness; they view (correctly) the initial appreciation as a sign of eventual depreciation, making dollar assets attractive and thus buying against the central bank's intervention. In contrast, investors with subjective expectations amplify the intervention's impact. They interpret the initial appreciation as a signal of further appreciation, prompting them to buy local currency assets and sell dollar assets. This increases the market's dollar supply, which households then need to buy in equilibrium. Since households are already saturated with central bank-supplied dollars, they demand higher returns to buy more, leading to an even larger appreciation.

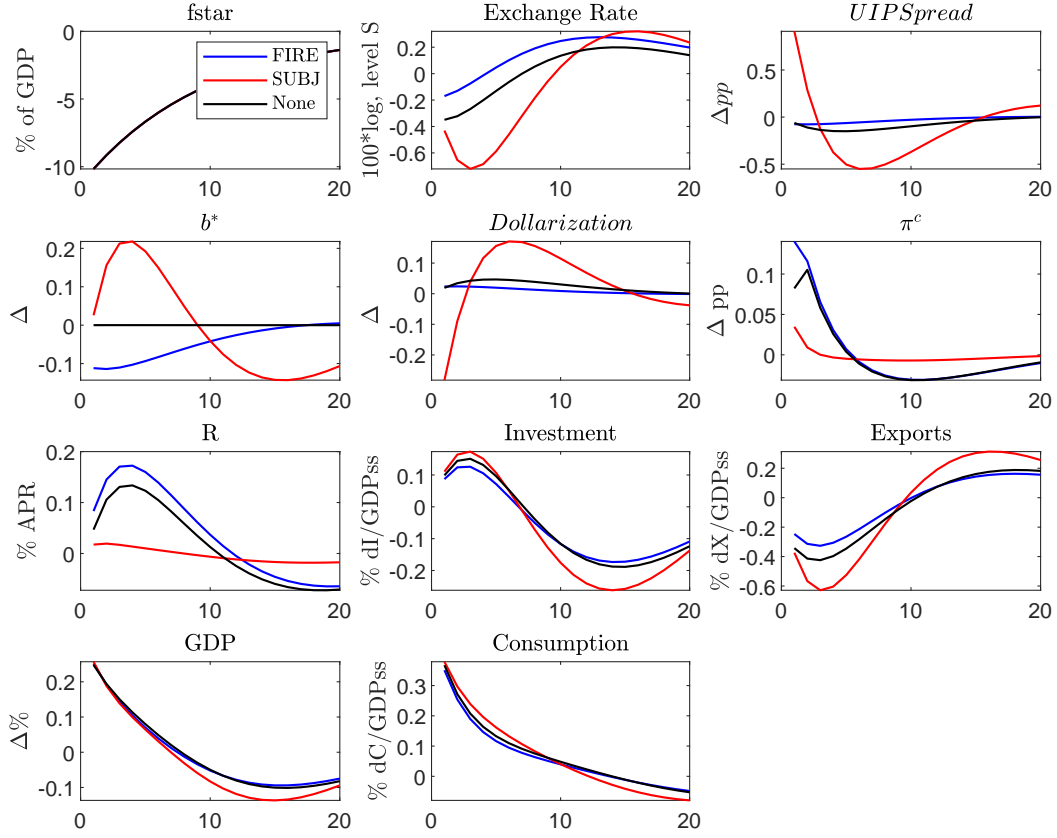


Figure 6: Effects of Foreign Exchange Interventions

## 4.5 Fama Regressions and Momentum in FX Markets

Fama (1984) introduced a key empirical framework for testing the Uncovered Interest Parity (UIP) in foreign exchange (FX) markets. His regression examines the relationship between interest rate differentials and subsequent exchange rate changes:

$$\Delta S_{t+1} = \alpha + \beta^{\text{Fama}}(r_t - r_t^*) + \varepsilon_{t+1} \quad (3)$$

Under UIP, the coefficient  $\beta$  should be equal to 1 if risk premia are absent and rational expectations hold. However, empirical findings consistently show  $\beta < 1$  often negative, implying a violation of UIP and the presence of currency risk premia. Specifically,  $\beta < 1$  implies that exchange rate does not offset the change in interest rates. Related, Burnside

et al. (2011) show that a momentum strategy in FX markets—investing in recently outperforming currencies—yields high returns with a Sharpe ratio comparable to that of the US stock market. Momentum regression,

$$\Delta S_{t+1} = \alpha + \beta^{\text{Mom}} \Delta S_t + \varepsilon_{t+1} \quad (4)$$

In this section, I run Fama and momentum regressions and show that subjective expectations can explain both phenomenon. For the three models—investors with subjective expectations, rational expectations, and no foreign investor I simulate the model and run equations 3 and 4. Table 4 plots the regression results from simulations as well as from the data. In the absence of foreign speculators, or when foreign speculators have rational expectations, exchange rate does not have momentum, past depreciations do not help predicting future depreciations. On the other hand, when foreign investors have subjective expectations, exchange rate displays significant momentum. Similarly, under foreign investors with rational expectations, Fama regressions yield coefficient very close to 1. On the other hand, in the economy with investors with subjective expectations, Fama coefficient is significantly below 1 and close to the data.

	Subjective	FIRE	No Foreign Investor	Data
$\beta^{\text{Mom}}$	0.470	0.036	0.063	0.143 (0.071)
$\beta^{\text{Fama}}$	0.351	1.107	1.086	0.343 (0.441)

Table 4: Fama Regressions Momentum in FX Markets: Model Simulations

## 5 Empirical Evidence

Malaysia introduced a specific capital controls in November 2016 where foreign banks are forbidden to trade in forward exchange rate market. Figure 7a shows that introduction of the rule did not have a visually discernible impact on the level of the exchange rate but exchange rate volatility is significantly reduced. Figure 7b shows daily exchange rate depreciations. There is a clear decline in volatility following capital controls, standard deviation of exchange rate depreciations fall from 0.45% to 0.27%, a decline of almost 40%<sup>6</sup>. In Figure 14 I plot the same graph across major EMEs as well as EME USD Index

<sup>6</sup>Figure 13 in Appendixi, plots estimated time varying volatility from a GARCH(1,1) process on exchange rate depreciations. Similarly, the mean of the time varying volatility before the capital controls is 0.42% and

and Broad USD Index. The only significant volatility reduction is in Malaysian exchange rate.

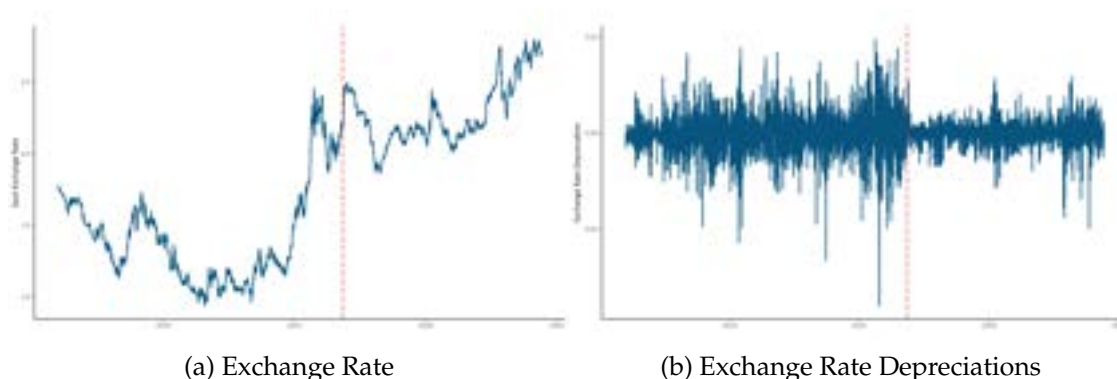


Figure 7: Malaysia Exchange Rate: Level and depreciations

Note: Daily exchange rate is obtained from DataStream. Data covers between 2006-01-02 and 2024-05-29.

The reduction of volatility after foreigners are excluded from the market is not compatible with the theory that foreign speculators provide liquidity to the market. One theory is that by excluding foreigners, the central bank can control the exchange rate much better using instruments like FX interventions. I observe a decline in the volatility of Malaysia's foreign reserves (see Figure 8), which suggests the central bank reduced interventions following the reform. Reduction in interventions can be because the central bank either no longer needs to intervene or can actually smooth the exchange rate with fewer interventions. However, this still begs the question why would the central bank need to exclude foreigners if these foreign speculators themselves smooth the exchange rate. Malaysia is still an open economy with locals being able to buy and sell foreign currency freely. According to IMF 2023 Exchange Arrangements and Exchange Restrictions report (IMF (2023)), exchange rate in Malaysia is classified as freely floating. Foreigners can use forward market to hedge their trade exposure but all ringgit transactions need to happen in Malaysia and locals cannot open ringgit accounts abroad. On the other hand, as I show in Section 4.3, if foreign investors have subjective expectations, their exclusion will both lower exchange rate volatility and make interventions unnecessary.

Figure 8 plots foreign currency reserves of Malaysia (in USD) and the HP-Filtered trend. Following the trend, I see a limited reserve accumulation but more importantly, the volatility of reserves go down significantly. Standard deviation of the cycle of log reserves is 11.5% before the policy and 3.5% afterwards. Volatility of reserves is not a direct measure after the controls is 0.26%.

of FX interventions but it could be interpreted as an indicator that the central bank is not selling/buying FX too much. If the central bank was using interventions to smooth the exchange rate (Castillo et al. (2024)), lower volatility of the exchange rate would imply less FX interventions.

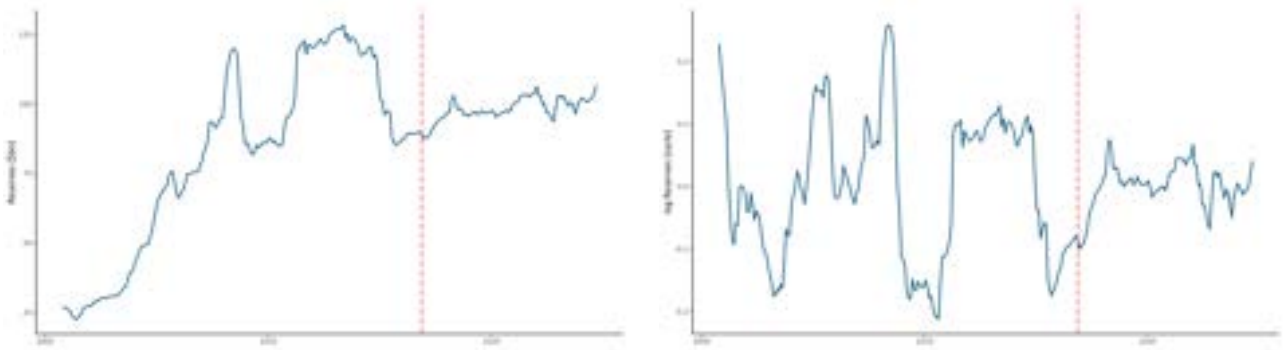


Figure 8: Reserves: Level and the Cycle

Note: Foreign Currency Reserves of Malaysia are obtained from Datastrea. Monthly data covers 10/2000-09/2024. Cycle is obtained using HPFilter with  $\lambda = 129,600$ .

In Appendix Section D.4 I look at how volatilities of macroeconomic quantities like inflation, trade balance and industrial production change following the policy. I do not find a significant change in the standard deviation of these variables, which is reminiscent of the Mussa Puzzle. There is significant and permanent decline in exchange rate volatility, with no discernible effect on other quantities. Still, the period following the policy has been characterized by large shocks like COVID and energy crisis and high global inflation so I leave it to the future research to have a definite answer on the macroeconomic effects of excluding foreign speculators from FX markets.

## 6 Conclusion

Using data on forecasts by professional investors, I show that exchange rate depreciations lead to systematic positive expectation errors, as market participants consistently anticipate larger depreciations than those observed in the data. This finding, in line with the evidence by Bacchetta et al. (2009), highlights the importance of accounting for investor expectation formation. I build a small open economy model with currency traders who hold subjective expectations, following the framework of Adam et al. (2017), and discipline these expectations using exchange rate forecast data. Our results demonstrate that



subjective expectations in exchange rate markets can account for key puzzles such as delayed overshooting and excessive overshooting. Specifically, the presence of traders with subjective expectations exacerbates exchange rate volatility, generates momentum in FX markets, and contributes to excess volatility. Incorporating investors with subjective expectations can also deliver Fama regression coefficients similar to the data.

I show that excluding currency investors with subjective expectations from exchange rate markets results in significant benefits. Exchange rates become less volatile, and the volatility of inflation and interest rates is also reduced. Additionally, central banks can better target inflation in the absence of traders with subjective expectations, improving overall macroeconomic stability.

Malaysia's introduction of capital controls to limit foreign currency speculation in 2016 significantly reduced exchange rate volatility, supporting the notion that limiting the participation of foreign investors with subjective expectations can stabilize FX markets. However, I find no discernible impact of this reform on the volatility of broader macroeconomic variables such as the trade balance, inflation, and industrial output. Future research could further explore the broader macroeconomic effects of such capital controls and investigate how investor expectations are formed and influenced in practice. Understanding the drivers of subjective beliefs in FX markets could provide additional insights into managing exchange rate policy.

## References

- Adam, Klaus, Albert Marcet, and Johannes Beutel**, "Stock Price Booms and Expected Capital Gains," *American Economic Review*, 2017, 107 (8), 2352–2408.
- , —, and **Juan Pablo Nicolini**, "Stock Market Volatility and Learning," *The Journal of Finance*, February 2016, 71 (1), 33–82.
- Auclert, Adrien, Matthew Rognlie, Martin Souchier, and Ludwig Straub**, "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel," *NBER Working Papers*, May 2021, (28872).
- Bacchetta, Philippe and Eric van Wincoop**, "Puzzling Exchange Rate Dynamics and Delayed Portfolio Adjustment," *Journal of International Economics*, July 2021, 131, 103460.

- , **Elmar Mertens**, and **Eric van Wincoop**, “Predictability in Financial Markets: What Do Survey Expectations Tell Us?,” *Journal of International Money and Finance*, April 2009, 28 (3), 406–426.
- Burnside, Craig, Martin Eichenbaum, and Sergio Rebelo**, “Carry Trade and Momentum in Currency Markets,” *Annual Review of Financial Economics*, December 2011, 3 (Volume 3, 2011), 511–535.
- Camara, Santiago, Lawrence Christiano, and Hüsni Dalgic**, “The International Monetary Transmission Mechanism,” in “NBER Macroeconomics Annual 2024, Volume 39,” University of Chicago Press, July 2024.
- Castillo, Paul, Ruy Lama, and Juan Medina**, “Escaping the Financial Dollarization Trap: The Role of Foreign Exchange Intervention,” IMF Working Paper 2024/127, International Monetary Fund June 2024.
- Cesa-Bianchi, Ambrogio, Andrea Ferrero, and Shangshang Li**, “Capital Flows and Exchange Rates: A Quantitative Assessment of the Dilemma Hypothesis,” *CEPR Discussion Papers*, March 2024, (18943).
- Christiano, Lawrence, Hüsni Dalgic, and Armen Nurbekyan**, “Financial Dollarization in Emerging Markets: Efficient Risk Sharing or Prescription for Disaster?,” NBER Working Papers 29034, National Bureau of Economic Research, Inc July 2021.
- Dalgic, Husnu and Galip K. Ozhan**, “Business Cycle Insurance and Currency Returns,” *Working Paper*, 2022.
- Devereux, Michael B. and Charles Engel**, “Exchange Rate Pass-through, Exchange Rate Volatility, and Exchange Rate Disconnect,” *Journal of Monetary Economics*, July 2002, 49 (5), 913–940.
- Eichenbaum, M S, B K Johannsen, and S T Rebelo**, “Monetary Policy and the Predictability of Nominal Exchange Rates,” *The Review of Economic Studies*, January 2021, 88 (1), 192–228.
- Eichenbaum, Martin and Charles L. Evans**, “Some Empirical Evidence on the Effects of Shocks to Monetary Policy on Exchange Rates\*,” *The Quarterly Journal of Economics*, November 1995, 110 (4), 975–1009.
- Engel, Charles**, “Exchange Rates, Interest Rates, and the Risk Premium,” *American Economic Review*, 2016, 106 (2), 436–474.

- Fama, Eugene F.**, "Forward and Spot Exchange Rates," *Journal of Monetary Economics*, November 1984, 14 (3), 319–338.
- Fernandez-Villaverde, Jesus, Pablo Guerron-Quintana, Juan F Rubio-Ramirez, and Martin Uribe**, "Risk Matters: The Real Effects of Volatility Shocks," *American Economic Review*, October 2011, 101 (6), 2530–2561.
- Gabaix, Xavier and Matteo Maggiori**, "International Liquidity and Exchange Rate Dynamics\*," *The Quarterly Journal of Economics*, August 2015, 130 (3), 1369–1420.
- Gertler, Mark and Peter Karadi**, "A Model of Unconventional Monetary Policy," *Journal of Monetary Economics*, 2011, 58 (1), 17–34.
- Goldberg, Linda S. and Cédric Tille**, "Vehicle Currency Use in International Trade," *Journal of International Economics*, December 2008, 76 (2), 177–192.
- Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller**, "Dominant Currency Paradigm," *American Economic Review*, March 2020, 110 (3), 677–719.
- Gourinchas, Pierre-Olivier and Aaron Tornell**, "Exchange Rate Puzzles and Distorted Beliefs," *Journal of International Economics*, December 2004, 64 (2), 303–333.
- , **Walker D. Ray, and Dimitri Vayanos**, "A Preferred-Habitat Model of Term Premia, Exchange Rates, and Monetary Policy Spillovers," NBER Working Papers 29875, National Bureau of Economic Research, Inc March 2022.
- Ilut, Cosmin**, "Ambiguity Aversion: Implications for the Uncovered Interest Rate Parity Puzzle," *American Economic Journal: Macroeconomics*, July 2012, 4 (3), 33–65.
- IMF**, "Annual Report on Exchange Arrangements and Exchange Restrictions 2022," <https://www.imf.org/en/Publications/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions/Issues/2023/07/26/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions-2022-530144> 2023.
- Itskhoki, Oleg and Dmitry Mukhin**, "Mussa Puzzle Redux," June 2021.
- and —, "Optimal Exchange Rate Policy," December 2023.
- Kalemli-Ozcan, Sebnem**, "U.S. Monetary Policy and International Risk Spillovers," NBER Working Papers 26297, National Bureau of Economic Research, Inc September 2019.

- Kayalar, Derya Ezgi and F. Pinar Erdem**, “The Effects of Non-Deliverable Forward Programs of Emerging-Market Central Banks: A Synthetic Control Approach,” *Borsa Istanbul Review*, March 2024.
- Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan**, “Common Risk Factors in Currency Markets,” *Review of Financial Studies*, 2011, 24 (11), 3731–3777.
- Miranda-Agrippino, Silvia and Hélène Rey**, “U.S. Monetary Policy and the Global Financial Cycle,” *The Review of Economic Studies*, 2020, 87 (6), 2754–2776.
- Müller, Gernot J., Martin Wolf, and Thomas Hettig**, “Delayed Overshooting: The Case for Information Rigidities,” *American Economic Journal: Macroeconomics*, July 2024, 16 (3), 310–342.
- Neumeyer, Pablo A. and Fabrizio Perri**, “Business Cycles in Emerging Economies: The Role of Interest Rates,” *Journal of Monetary Economics*, 2005, 52 (2), 345–380.
- Rogoff, Kenneth**, “The Purchasing Power Parity Puzzle,” *Journal of Economic Literature*, 1996, 34 (2), 647–668.

# A Model Equations

## A.1 Good Production

- Consumption bundle and price index

$$C_t = \left[ (1 - \omega_c)^{\frac{1}{\eta_c}} (C_t^d)^{\frac{\eta_c-1}{\eta_c}} + \omega_c^{\frac{1}{\eta_c}} (C_t^m)^{\frac{\eta_c-1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c-1}}$$

$$P_t^c = \left[ (1 - \omega_c) P_t^{1-\eta_c} + \omega_c (P_t^m)^{1-\eta_c} \right]^{\frac{1}{1-\eta_c}}$$

- Investment bundle

$$I_t = \left[ \gamma_I^{\frac{1}{v_I}} I_{d,t}^{\frac{v_I-1}{v_I}} + (1 - \gamma_I)^{\frac{1}{v_I}} I_{m,t}^{\frac{v_I-1}{v_I}} \right]^{\frac{v_I}{v_I-1}}$$

$$P_{I,t} = \left[ \gamma_I P_t^{v_I} + (1 - \gamma_I) (P_t^m)^{1-v_I} \right]^{\frac{1}{1-v_I}}$$

Evolution of capital is subject to capital adjustment costs.

$$K_t = (1 - \delta) K_{t-1} + \left[ 1 - S \left( \frac{I_t}{I_{t-1}} \right) \right] I_t.$$

- Export bundle. Exports are produced from domestic export good and imported input, both priced in dollars.

$$X_t = \left[ \gamma_x^{\frac{1}{\eta_x}} (X_t^d)^{\frac{\eta_x-1}{\eta_x}} + (1 - \gamma_x)^{\frac{1}{\eta_x}} (X_t^m)^{\frac{\eta_x-1}{\eta_x}} \right]^{\frac{\eta_x}{\eta_x-1}}$$

$$P_t^x = \left[ \gamma_x (P_t^{d,x})^{1-\eta_x} + (1 - \gamma_x) (P_t^f)^{1-\eta_x} \right]^{\frac{1}{1-\eta_x}}$$

- Domestic export good production

$$X_t^d = \left[ \int_0^1 X_{i,t}^{\frac{\varepsilon_x-1}{\varepsilon_x}} di \right]^{\frac{\varepsilon_x}{\varepsilon_x-1}}$$

Intermediate export good  $X_{i,t}$  is produced by monopolists using domestic homogenous good. Monopolists price intermediate export good in dollars and face Calvo style sticky prices;  $(1 - \theta_x)$  share of monopolists are allowed to change their prices.

- Domestic Homogenous good production,

$$Y_t = p_t^* K_{t-1}^\alpha (A_t l_t)^{1-\alpha}$$

where

$$p_t^* = \left[ (1 - \theta) \left( \frac{1 - \theta \pi_t^{\varepsilon-1}}{1 - \theta} \right)^{\frac{\varepsilon}{\varepsilon-1}} + \frac{\theta \pi_t^\varepsilon}{p_{t-1}^*} \right]^{-1}$$

$$Y_t = \left[ \int_0^1 Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}, \varepsilon > 1$$

- Market clearing in homogeneous goods

$$Y_t = I_t^d + C_t^d + X_t^d$$

where  $(I_t^d, C_t^d, X_t^d)$  are domestic goods to produce final investment, consumption and export goods respectively.

## A.2 Banker Problem

Banker problem follows Dalgic and Ozhan (2022). Bankers are part of the household, with probability  $\theta$ , they stay bankers and with probability  $(1 - \theta)$  they retire and become workers. Bankers maximize,

$$V_{j,t} = \max \mathbb{E}_t \sum_{i=0}^{\infty} (1 - \theta) \theta^i \beta^{i+1} \Lambda_{t,t+i+1} N_{j,t+i+1}$$

I can write  $V_{j,t}$  recursively

$$V_{j,t} = \mathbb{E}_t [\beta(1 - \theta) N_{j,t+1} + \beta \theta \Lambda_{t,t+1} V_{j,t+1}]$$

Evolution of net worth,

$$N_{j,t+1} = R_{t+1}^k Q_t S_{jt} - R_t B_{j,t}^{LC} - R_t^F \frac{S_{t+1}}{S_t} B_{j,t}^{FC}$$

I want to scale the above expression by  $N_{j,t}$

$$\frac{N_{j,t+1}}{N_{j,t}} = R_{t+1}^k \frac{Q_t S_{jt}}{N_{j,t}} - R_t \frac{B_{j,t}^{LC}}{N_{j,t}} - R_t^F \frac{S_{t+1}}{S_t} \frac{B_{j,t}^{FC}}{N_{j,t}}$$

Define  $\phi_t \in [0, 1]$  as the share of net worth allocated to borrowing in dollars, which leaves  $(1 - \phi)$  share to be allocated to local currency borrowing. Define leverage ratios,  $(L_t^{LC}, L_t^{FC})$  as the ratio of assets that are funded by local currency and dollars respectively

$$\begin{aligned} B_{j,t}^{FC} &= (L_{j,t}^{FC} - 1) \phi_{j,t} N_{j,t} \\ B_{j,t}^{LC} &= (L_{j,t}^{LC} - 1) (1 - \phi_{j,t}) N_{j,t} \end{aligned}$$

Evolution of net worth becomes

$$\frac{N_{j,t+1}}{N_{j,t}} = \left[ \left( R_{t+1}^k - R_t \right) L_{j,t}^{LC} (1 - \phi_{j,t}) + \left( R_{t+1}^k - R_t^F \frac{S_{t+1}}{S_t} \right) L_{j,t}^{USD} \phi_{j,t} + R_t (1 - \phi_t) + R_t^F \frac{S_{t+1}}{S_t} \phi_{j,t} \right]$$

Bankers can divert  $\lambda$  fraction of the assets. In that case, they run away with the money. Understanding this, bankers lend to banks only if the value of being a banker exceeds the diverted assets. I assume that bankers get two separate loans in local currency and in dollars. The implication is that bankers can independently run away with local currency or dollar loans so that the incentive constraint need to bind for both types of borrowing,

$$\begin{aligned} V_{j,t}^{LC} &\geq \lambda L_{j,t}^{LC} N_{j,t}^{LC} \\ V_{j,t}^{FC} &\geq \lambda L_{j,t}^{FC} N_{j,t}^{FC} \end{aligned}$$

where  $N_{j,t}^{LC}$  and  $N_{j,t}^{FC}$  are net worth allocated to local currency and dollar borrowing respectively  $N_{j,t}^{LC} + N_{j,t}^{FC} = N_{j,t}$  and,

$$\begin{aligned} V_{j,t}^{LC} &= \mathbb{E}_t \left[ \beta(1-\theta) \left[ L_{j,t}^{FC} N_{j,t}^{LC} \left( R_{t+1}^k - R_t \right) + R_t(1-\phi_{j,t}) N_{j,t}^{LC} \right] + \beta \theta \Lambda_{t,t+1} V_{j,t+1}^{LC} \right] \\ V_{j,t}^{FC} &= \mathbb{E}_t \left[ \beta(1-\theta) \left[ L_{j,t}^{FC} N_{j,t}^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) + R_t^* \frac{S_{t+1}}{S_t} N_{j,t}^{FC} \right] + \beta \theta \Lambda_{t,t+1} V_{j,t+1}^{FC} \right] \end{aligned}$$

so that  $V_{j,t}^{LC} + V_{j,t}^{FC} = V_{j,t}$

Scale recursive net worth for dollar borrowing,

$$\frac{V_{j,t}^{FC}}{N_{j,t}^{FC}} = \mathbb{E}_t \left[ \beta(1-\theta) \left[ L_{j,t}^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) + R_t^* \frac{S_{t+1}}{S_t} \right] + \beta \theta \Lambda_{t,t+1} \frac{V_{j,t+1}^{FC}}{N_{j,t+1}^{FC}} \frac{N_{j,t+1}^{FC}}{N_{j,t}^{FC}} \right]$$

where  $\frac{N_{j,t+1}^{FC}}{N_{j,t}^{FC}} = \left[ L_{j,t}^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) + R_t^* \frac{S_{t+1}}{S_t} \right]$  is the amount of equity a dollar borrowing bank expect to have at the end of the period. Simplifying,

$$\psi_t^{FC} = \mathbb{E}_t \left[ \left[ \beta(1-\theta) + \beta \theta \Lambda_{t,t+1} \psi_{t+1}^{FC} \right] \left[ L_{j,t}^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) + R_t^* \frac{S_{t+1}}{S_t} \right] \right]$$

similarly for local currency borrowing

$$\psi_t^{LC} = \mathbb{E}_t \left[ \left[ \beta(1-\theta) + \beta \theta \Lambda_{t,t+1} \psi_{t+1}^{LC} \right] \left[ L_{j,t}^{LC} \left( R_{t+1}^k - R_t \right) + R_t \right] \right]$$

Since the last equations are independent of  $j$ , all bankers make the same choice so I can remove  $j$  subscript.

## Banker Optimization

A banker who borrows in dollars solve,

$$\psi_t^{FC} = \max_{L_t^{FC}} \mathbb{E}_t \left[ \beta \left[ (1-\theta) + \Lambda_{t,t+1} \theta \psi_{t+1}^{FC} \right] \left[ L_t^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) + R_t^* \frac{S_{t+1}}{S_t} \right] \right]$$

subject to the incentive constraint



$$\psi_t^{FC} \geq \lambda L_t^{FC}$$

Solution satisfies

$$L_t^{FC} = \frac{v_t^{FC}}{\lambda - \eta_t^{FC}}$$

$$\begin{aligned}\eta_t^{FC} &= \mathbb{E}_t \left[ \beta \Lambda_{t,t+1} \Omega_{t+1}^{FC} \left( R_{t+1}^k - R_t^* \frac{S_{t+1}}{S_t} \right) \right] \\ v_t^{FC} &= \mathbb{E}_t \left[ \beta \Lambda_{t,t+1} \Omega_{t+1}^{FC} R_t^* \frac{S_{t+1}}{S_t} \right] \\ \Omega_{t+1}^{FC} &= (1 - \theta) + \theta \psi_{t+1}^{FC} \\ \psi_t^{FC} &= \lambda L_t^{FC}\end{aligned}$$

similarly local currency borrowing satisfies,

$$L_t^{LC} = \frac{v_t^{LC}}{\lambda - \eta_t^{LC}}$$

$$\begin{aligned}\eta_t^{LC} &= \mathbb{E}_t \left[ \beta \Lambda_{t,t+1} \Omega_{t+1}^{LC} (R_{t+1}^k - R_t) \right] \\ v_t^{LC} &= \mathbb{E}_t \left[ \beta \Lambda_{t,t+1} \Omega_{t+1}^{LC} R_t \right] \\ \Omega_{t+1}^{LC} &= (1 - \theta) + \theta \psi_{t+1}^{LC} \\ \psi_t^{LC} &= \lambda L_t^{LC}\end{aligned}$$

## Currency Choice

Bankers allocate net worth according to

$$\max_{\phi_t} \phi_t \psi_t^{LC} + (1 - \phi_t) \psi_t^{USD} - \frac{\varepsilon}{2} (\phi_t - \bar{\phi})^2$$

where the last term denotes preferred habitat (or regulation) so that banks do not move their portfolios too much away from the target credit dollarization.

$$\begin{aligned}
\psi_t^{LC} - \varepsilon(\phi_t - \bar{\phi}) &= \psi_t^{USD} \\
L_t^{LC} - \frac{\varepsilon}{\lambda}(\phi_t - \bar{\phi}) &= L_t^{USD} \\
\phi_t &= \frac{\lambda}{\varepsilon} (L_t^{LC} - L_t^{USD}) + \bar{\phi}
\end{aligned}$$

### A.3 Market Clearing Conditions

#### Financial Market Clearing

Local currency financial market clearing condition implies local currency deposits by households ( $D_t$ ) and local currency investments by foreigners ( $S_t B_t^F$ ) equal to total bank borrowing in local currency ( $B_t^{LC}$ ). I require  $B_t^{LC} \geq 0$ , but foreigners or local can also have negative position

$$S_t B_t^F + D_t = B_t^{LC}$$

Similarly dollar market clearing condition implies foreign and local dollar deposits ( $S_t B_t^{F,*}$ ,  $D_t^*$ ) equal to bank dollar borrowing ( $B_t^{FC}$ ) in local currency terms. For foreigners, dollar lending/borrowing is riskless and at the exogenous risk free dollar interest rate  $R_t^*$  so that their position ( $B_t^{F,*}$ ) is the difference between household and bank positions.

$$S_t B_t^{F,*} + D_t^* = B_t^{FC}$$

#### Balance of Payments

Net exports ( $X_t - M_t$ ) equal to change in net foreign asset position (which includes interest income earned by foreigners)

$$X_t - M_t = - \left( B_t^{F,*} - B_{t-1}^{F,*} R_{t-1}^* \frac{S_t}{S_{t-1}} \right) - (B_t^F - B_{t-1}^F R_{t-1})$$

## B Response to Foreign Interest Rate Shock

In Figures 9 and 10, I plot impulse response to foreign interest rate shock with different levels of foreign speculator participation in the FX market: High ( $\lambda = 0.0003$ ), moderate ( $\lambda = 0.005$ ) and low ( $\lambda = 20$ ) for unbiased and subjective expectation speculators respectively. . Figure 9 plots the response of the economy with foreign speculators with unbiased expectations. When speculators have unbiased expectations, their participation makes the economy less volatile but the effect is not so strong.

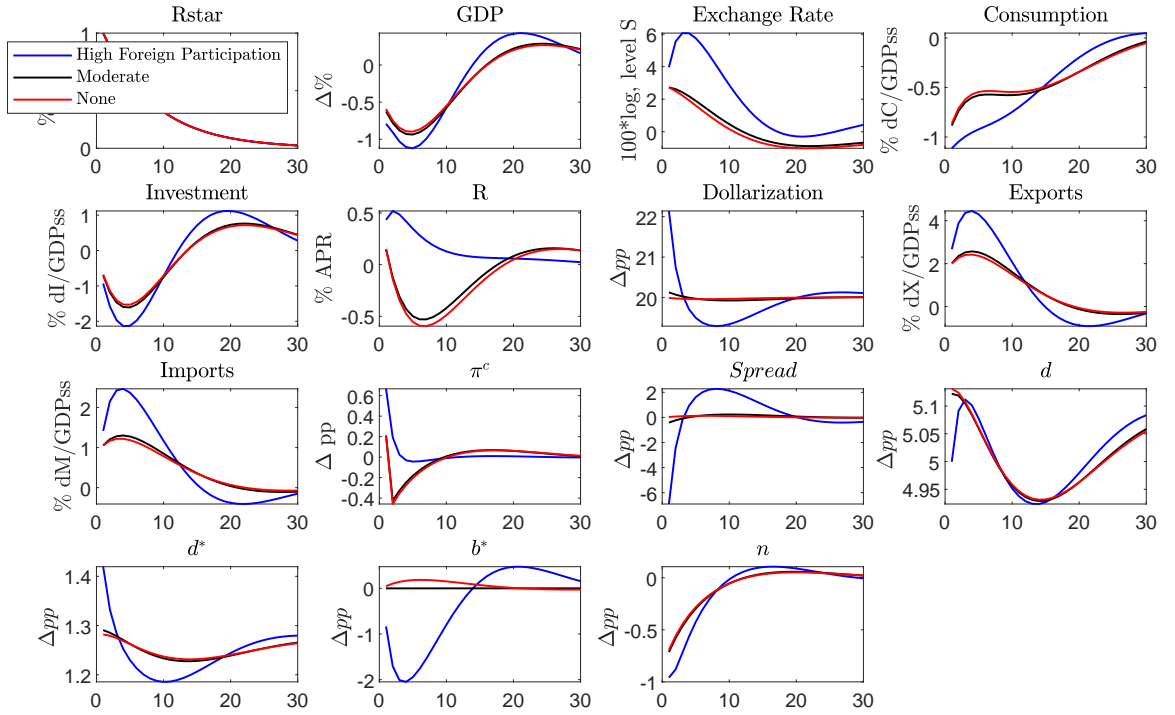


Figure 9: Response to Foreign Interest Rate Shock with FIRE Foreign Speculators

Figure 10 plots the response of the economy with foreign speculators with subjective expectations. When speculators have subjective expectations, their participation makes the economy much more volatile. The effect is non-linear, when  $\lambda$  is very small, their participation is large and their participation makes the exchange rate order of magnitude more volatile.

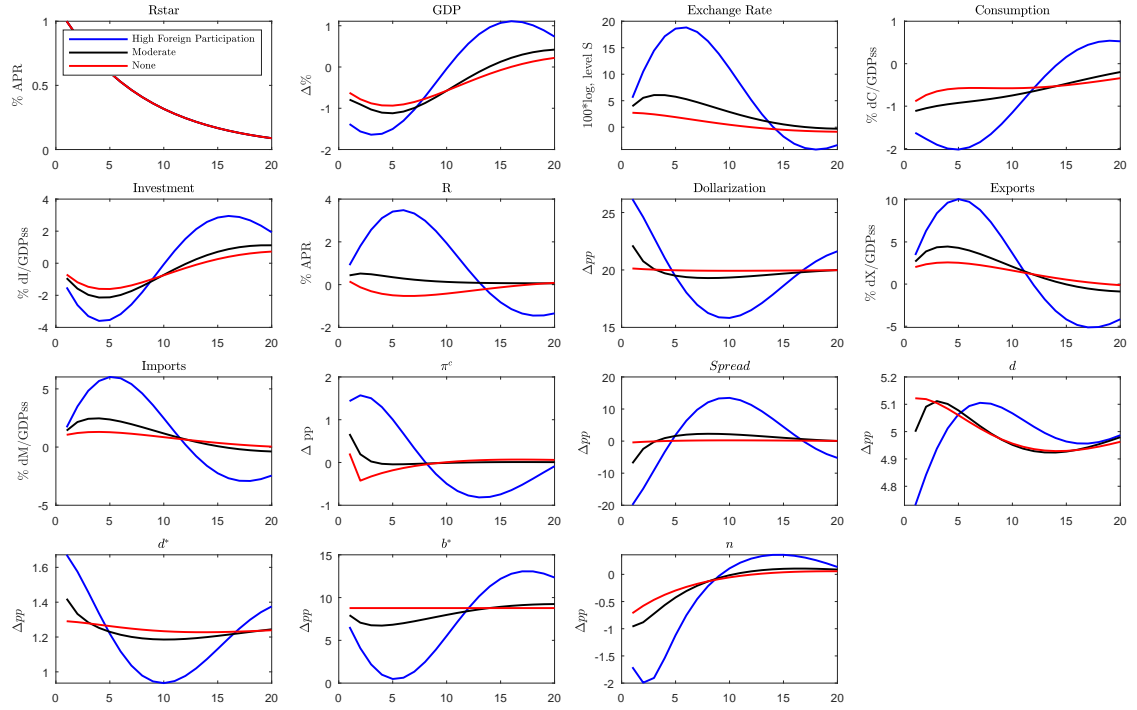


Figure 10: Response to Foreign Interest Rate Shock with SUBJ Foreign Speculators

## C Response to FX Intervention Shock

Similar to the previous section, in Figures 11 and 12, I plot impulse response to FX intervention shock with different levels of foreign speculator participation in the FX market: High ( $\lambda = 0.0003$ ), moderate ( $\lambda = 0.005$ ) and low ( $\lambda = 20$ ) for unbiased and subjective expectation speculators respectively. Figure 11 plots the response of the economy with foreign speculators with unbiased expectations.

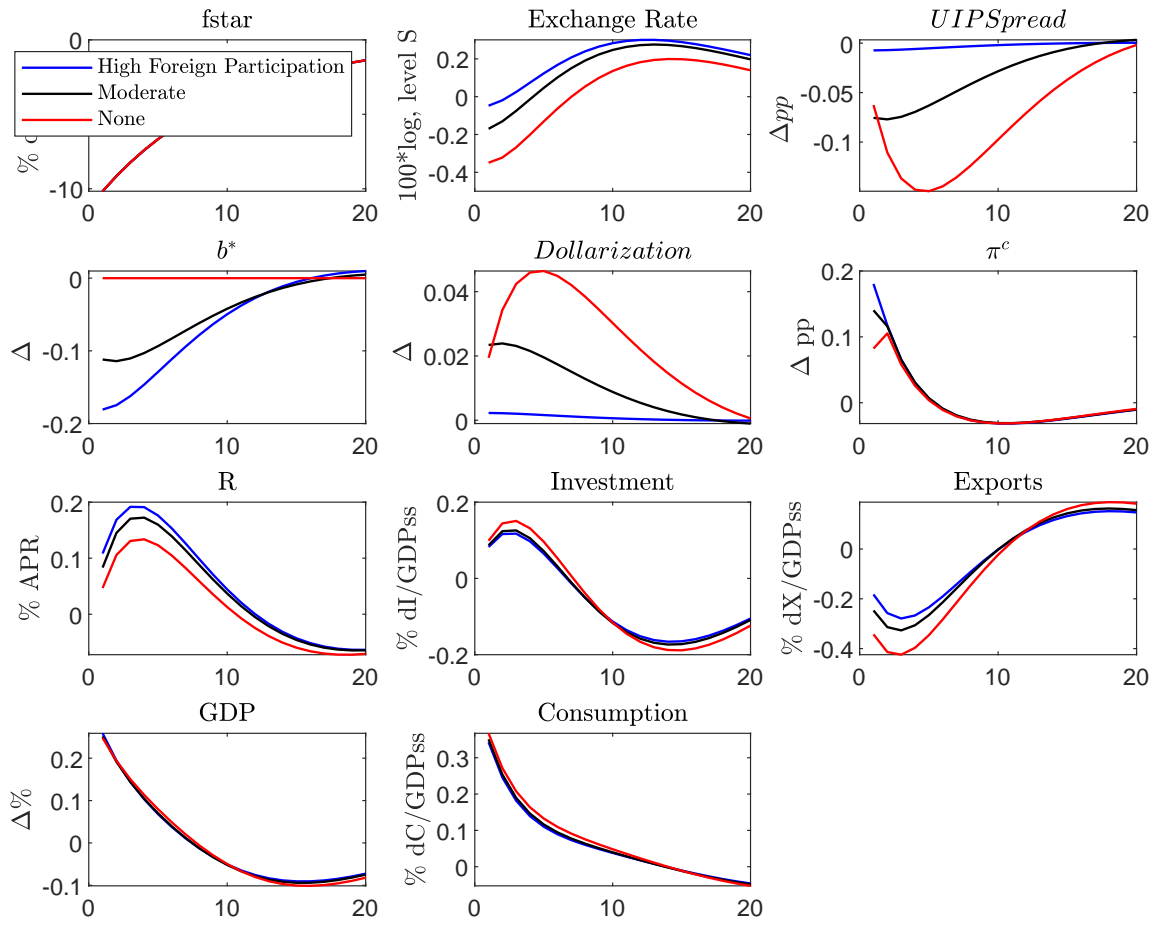


Figure 11: Response to FX Intervention Shock with FIRE Foreign Speculators

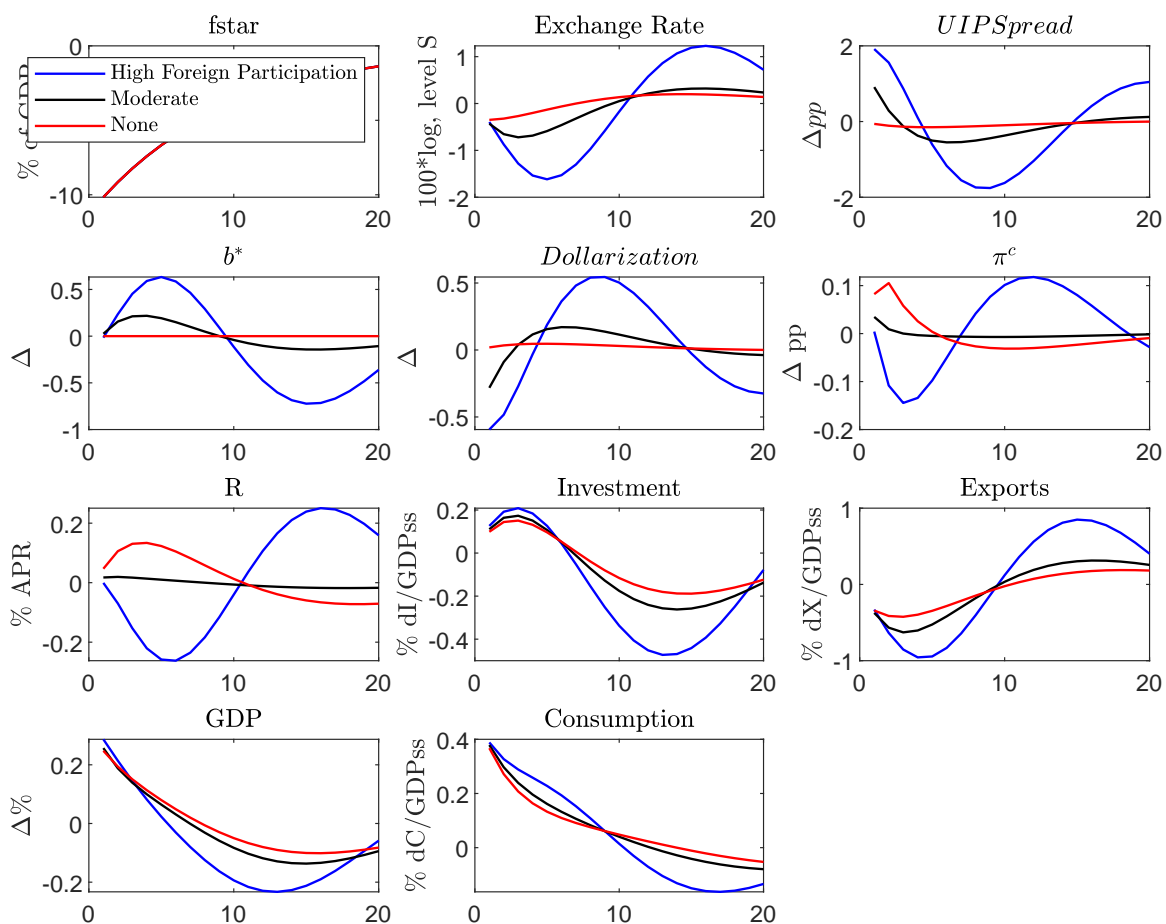


Figure 12: Response to FX Intervention Shock with SUBJ Foreign Speculators

## D Capital Controls in Malaysia

The specific capital control in Malaysia prohibits foreign banks from taking position in the non-deliverable FX forward market. Non-deliverable forwards (NDFs) are financial derivatives used for hedging currency risk, particularly in markets where capital controls or regulatory restrictions prevent the free flow of foreign currency. Unlike traditional forwards, NDFs do not involve the physical exchange of currencies; instead, they are settled in a reference currency, typically the US dollar. This makes NDFs attractive in markets where foreign exchange (FX) transactions are tightly regulated or restricted, as they provide a way to hedge against exchange rate fluctuations without the need for actual

currency transfers. NDF markets are especially prevalent in emerging market economies (EMEs), where central banks may impose restrictions on the use of their domestic currency in international markets. By allowing investors to hedge against currency risks without engaging in onshore currency transactions, NDFs contribute to the liquidity and stability of FX markets. However, their effectiveness as a tool for managing exchange rate volatility varies across different markets and policy environments. In some cases, central banks actively participate in or regulate the NDF market, while others, such as Malaysia, have chosen to ban offshore NDFs entirely. In the case of central banks in some emerging markets such as Brazil, Mexico, and Turkey, NDFs have become an integral part of their currency risk management toolkit (Kayalar and Erdem (2024)). These central banks have engaged in the NDF market not only to help hedge domestic currency exposure but also to enhance market liquidity and mitigate excessive exchange rate volatility. The Central Bank of Brazil, for instance, has been one of the leading emerging market central banks to utilize NDFs in managing the real's exchange rate volatility. Similarly, the Central Bank of Mexico and the Central Bank of the Republic of Turkey have embraced NDFs as a means to stabilize their currencies in response to external shocks and speculative pressures (Kayalar and Erdem (2024)).

## **D.1 Exchange Rate Volatility**

In Figure 13, I fit a GARCH(1,1) process on exchange rate depreciations and calculated time varying volatility. Similarly, the mean of the time varying volatility before the capital controls is 0.42% and after the controls is 0.26%.

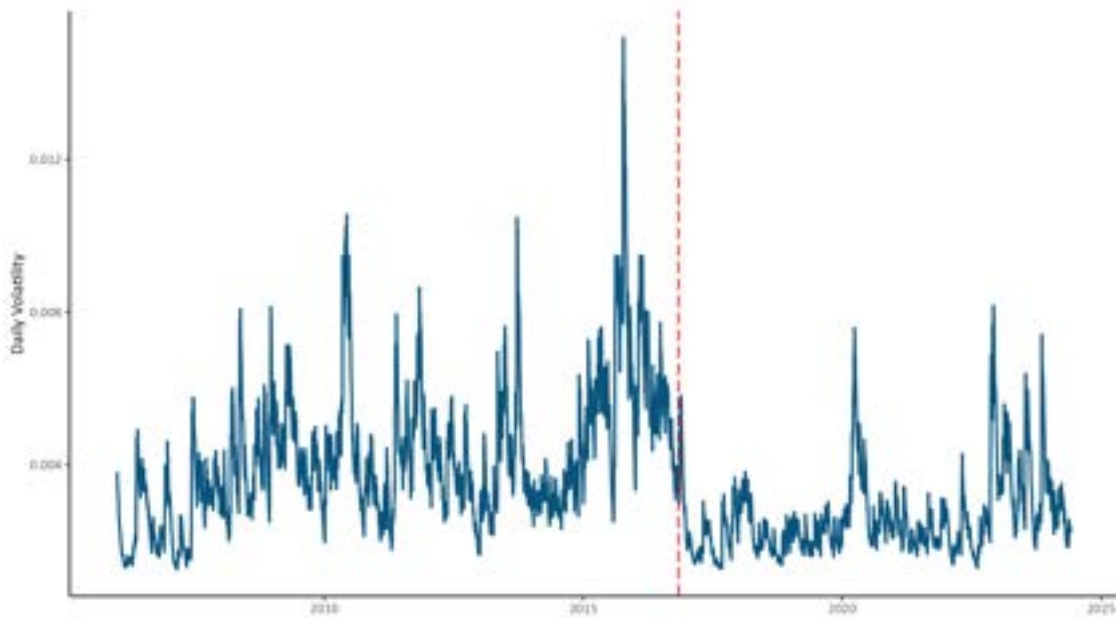


Figure 13: Exchange Rate Volatility

Note: Volatility is measured by fitting a GARCH(1,1) model on exchange rate depreciations. Fitted time varying volatility is plotted. Daily exchange rate is obtained from DataStream. Data covers between 2006-01-02 and 2024-05-29.

## D.2 Other Major EMEs

Figure 14 plots the exchange rate volatilities across major EMEs as well as EME USD Index and Broad USD Index. The only significant volatility reduction is in Malaysian exchange rate<sup>7</sup>.

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<sup>7</sup>I thank Ozer Karagedikli for this graph



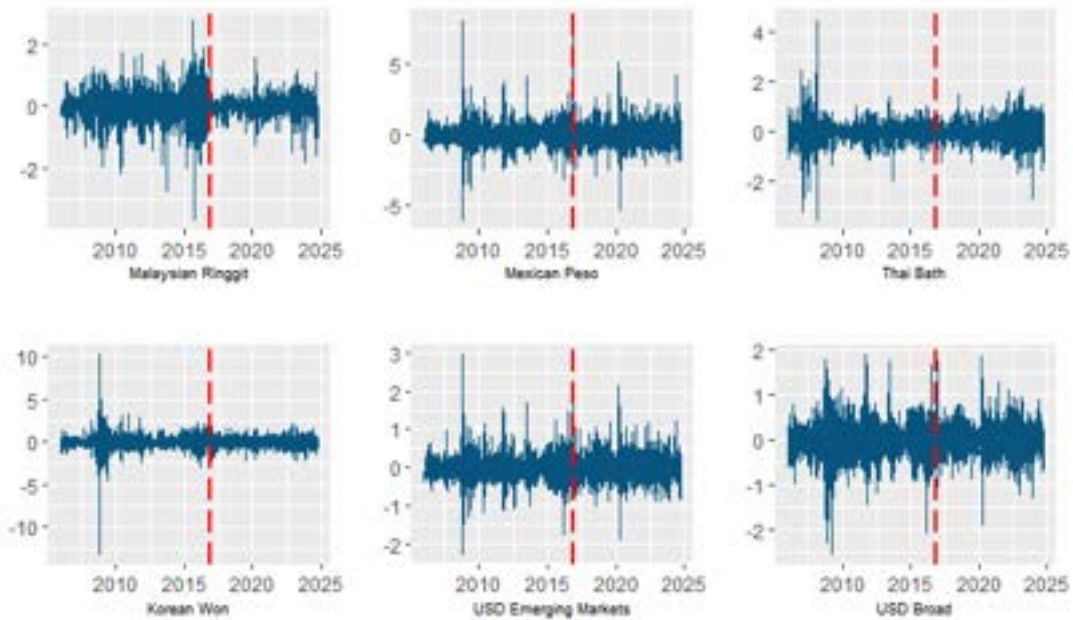


Figure 14: Exchange Rate Depreciations in EMEs

Note: Daily Exchange rate depreciation is plotted. Daily exchanges are obtained from FRED. Data covers between 2006-01-02 and 2024-05-29.

### D.3 Interest Rate Volatility

Figure 15 plots 5 year government bond yields obtained from Datastream as well as its time varying volatility estimated using GARCH(1,1). There is some increase in interest rate level and volatility around the policy date but overall there does not seem to be a significant difference between before and after policy.

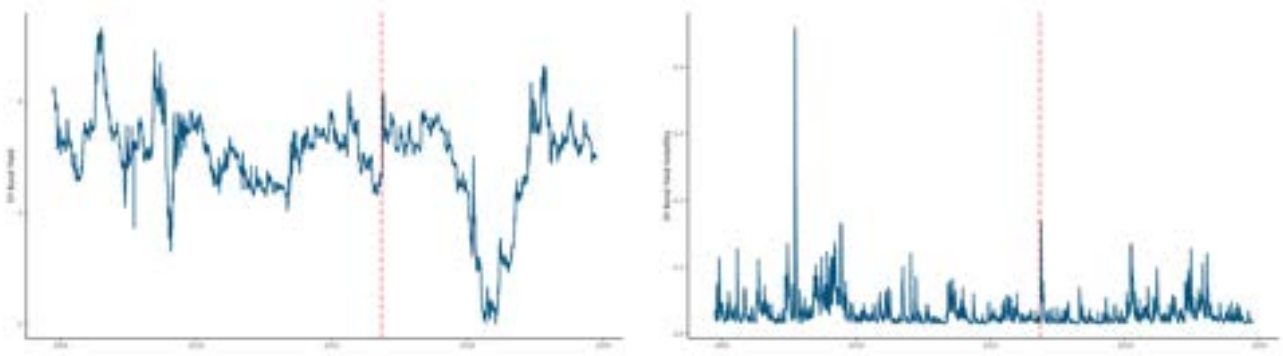
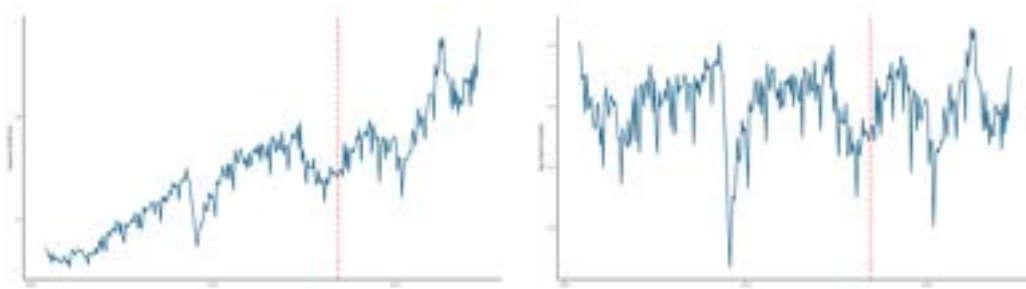


Figure 15: Interests Rates and Volatility

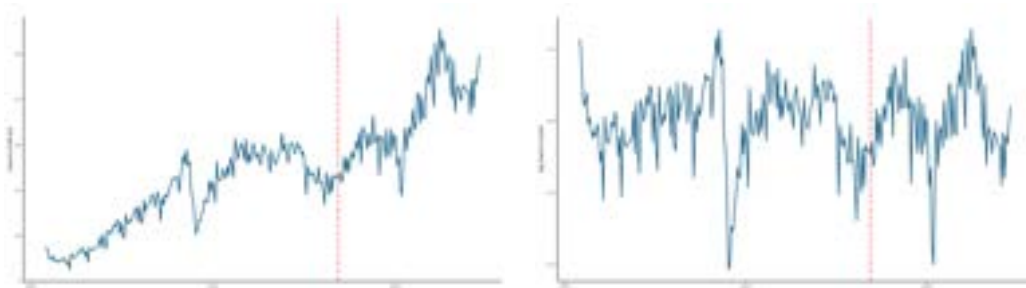
Note: Volatility is measured by fitting a GARCH(1,1) model on 5Y government bond Yield. Fitted time varying volatility is plotted. Government bond yields are obtained from DataStream. Data covers between 2004-09-27 and 2024-09-27.

## D.4 Macroeconomic Quantities

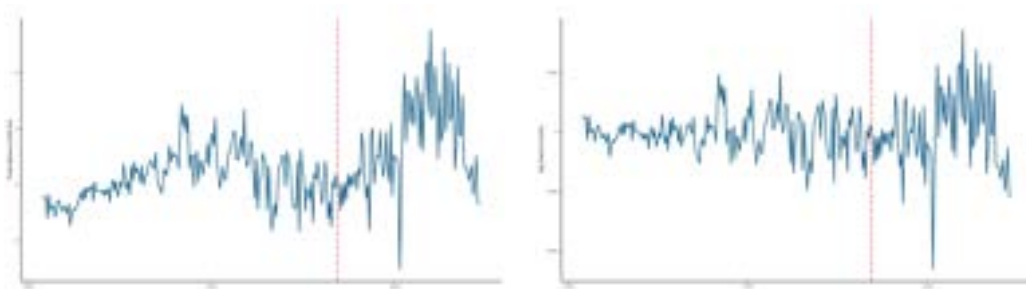
In this Section, I plot various macroeconomic quantities and their HP-Filtered cycles to see whether there is any discernible effect of the policy. Figure 16 plots exports, imports and the trade balance (in USD), there is not a statistically significant difference in the volatility of their cycles before vs after the policy. Similarly, Figure 17 plots consumer price index and industrial production index. Both fall considerably during the COVID period but otherwise there is not statistically meaningful difference. Results are in line with Mussa Puzzle. There is a significant decline in exchange rate volatility but it does not seem to affect the real economy (see Itskhoki and Mukhin (2021)).



(a) Imports



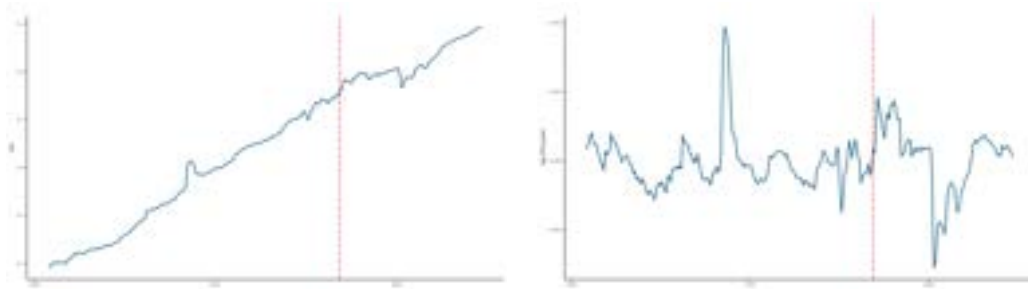
(b) Exports



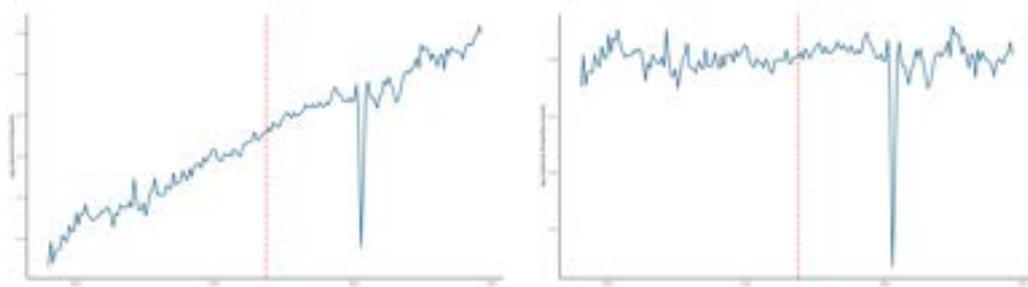
(c) Trade Balance

Figure 16: Foreign Trade and Cycles

Note: Exports and imports of Malaysia are obtained from Datastream. Trade balance is calculated as the difference. Obtained data is in local currency, which is converted to dollars using current exchange rate. Monthly data covers 10/2000-09/2024. Cycle is obtained using HPFilter with  $\lambda = 129,600$ .



(a) Consumer Price Index



(b) Industrial Production

Figure 17: Inflation, Industrial Production and Their Cycles

Note: CPI and industrial production of Malaysia are obtained from Datastream. Both data are indexes. Monthly data covers 10/2000-09/2024. Cycle is obtained using HPFilter with  $\lambda = 129,600$ .