Dominant Currency Paradigm: Pricing and Financing

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Abstract

This paper examines how two empirically proven facts, (1) invoicing of trade in the dominant currency (Dominant Currency Pricing) and (2) borrowings in the dominant currency (Dominant Currency Financing), impact the trade volumes for developing economies around the world. Using panel data of Emerging Market Economies, I find that exports and imports in these EMEs decrease in short run due to a monetary contraction in US. To explain this fact, I build a DSGE model with dominant currency pricing, dominant currency financing, imported inputs in production and financial frictions. These key features of the model, especially a Bernanke-Gertler-Gilchrist style financial accelerator as the financial friction, lead to inefficient current account imbalances. In this paper, I assess the impact on the external balancing mechanism as propounded by Mundell Fleming model through a three-country general-equilibrium model with nominal rigidities, imperfect competition in production, dominant currency pricing and financing, incomplete and imperfect asset markets.
1 Introduction

Empirical research on international spillovers of monetary policy has established the negative externalities effect on emerging market economies (EMEs). The expansive usage of the dominant currencies in international trade as well as international finance has been at the center of research in international economics in recent times. It has been empirically proven that firms in developing countries invoice their trades with each other in the dominant currency (Dominant Currency Pricing) (Gopinath (2016), Goldberg and Tille (2008)) as well as borrow internationally in the dominant currency (Dominant Currency Financing) even though neither the creditor nor the debtor country is the dominant currency country (Bruno and Shin (2017), McCauley et al. (2015)). Recent literature on dominant currency pricing (DCP) (Gopinath et al. (2020), Mukhin (2018)) has been able to assess the effect of pricing in dominant currency on external trade of a small open economy. However, little is known about the implications of financing in dominant currency (DCF) as well as role of financial frictions in a DCP framework which may further impact countries’ external position and adjustment mechanisms. This paper aims at filling this gap in the theoretical literature. To shed light on the impact of US monetary policy on trade volumes of emerging market economies, I incorporate the channels of DCP and DCF in a standard DSGE New Keynesian model and show that the traditional Mundell-Fleming argument of external adjustment fails to hold.

This paper explores the spillover effect of US monetary policy to EMEs when pricing and financing is done in US dollars. First, through an empirical investigation, I establish that monetary tightening in the United States leads to a decline in export and import volumes in the EMEs and the decline in trade volumes is larger for countries having a higher share of dollar invoicing in trade or with a higher share of dollar debt. Motivated by this empirical finding, I develop a DSGE model that combines the two channels of pricing as well as financing in dominant currency with financial frictions. After calibrating the model to Colombian data, I quantify the spillovers of US monetary policy. I confirm that a monetary contraction in US leads to a fall in exports in the small open economy. The model, with frictions, predicts a stronger spillover effects of US monetary policy on investment, imports and output as compared to the frictionless case. Further, in this dominant currency paradigm of pricing and financing, flexible exchange rate regime performs better than the fixed exchange rate regime.
I first empirically explore the spillovers of US monetary policy on trade volumes of EMEs. I investigate the relationship between the change in exports of EMEs and change in US interest rates conditional on the share of the trade invoiced in US dollars as well as share of dollar debt liabilities. For this analysis, I use trade data of 62 EMEs as well as US shadow rate over the period of 1990-2019. I document that a monetary contraction by US leads to fall in exports: 1% increase in US monetary policy is associated with a decline of 1.1% in exports in EMEs. The impact is higher with 1) a higher share of dollar invoicing of exports and also, with 2) a higher share of dollar debt liabilities. Following the taper tantrum of 2013, several empirical research studies have found the monetary spillovers in the emerging market economies in every conceivable asset. I contribute to this literature by establishing an inverse relationship between a monetary contraction by the US and movement in exports in the short run. This empirical finding points to the importance of dominant currency pricing and financing channels that act as barriers in the transmission of external adjustment mechanism in the EMEs.

Motivated by the empirical analysis, I develop a small open economy (arguments extend to three-country) DSGE model to examine the channels of dominant currency pricing and financing in a tractable general framework. I build on the New Keynesian open economy model by Gopinath et al. (2020) and augment it with the following additional features. First, in addition to borrowings in home currency, firms are allowed to borrow in dominant currency as well. Second, rather than perfect financial markets, I introduce imperfect risk sharing through financial frictions. Specifically, I extend to the open economy DCP model the financial accelerator framework developed in Bernanke, Gertler, and Gilchrist (1999) and Gertler et al. (2007), that are in turn based on earlier work by Bernanke and Gertler (1989), Carlstrom and Fuerst (1997) and Kiyotaki and Moore (1997). Introduction of dollar loans coupled with financial frictions reduce the demand of capital whereas import of investment goods reduce the supply of capital due to a depreciation of home currency vis-a-vis dollars which in turn is a result of a monetary contraction by US. The decline in investments reduces the output as well as exports for the small open economy. To illustrate the mechanism of the two channels, I solve the

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1The most comprehensive papers include Rey (2015) and Miranda-Agrippino and Rey (2015), which look at the Fed’s effects on a wide range of markets. However, there are many papers that examine more specific markets. To mention a handful: Brusa et al. (2017) study equity markets; Fratzscher et al. (2017), Burger et al. (2017), and Chari et al. (2017) study capital flows; Cetorelli and Goldberg (2012) and Morais et al. (2015) study bank liquidity and lending; and Gilchrist et al. (2016) study bond markets.
numerical results for a small open economy.

By solving the model analytically, I show that the traditional relationship between nominal exchange rates and terms of trade can breakdown. Financing in dominant currency indicates that exchange rate fluctuations can also have effects through their impact on domestic firms’ balance sheets, a phenomenon widely studied in the literature. A depreciation of country’s currency with respect to US dollar increases the value of a firm’s liabilities relative to its revenues, thereby weakens its balance sheet and hinders access to new financing, because now firms’ capacity to repay has deteriorated. However, this effect depends on the currency in which revenues are earned, that is, whether revenues are in dominant currency or in local currency. A rise in interest rate by the dominant country attacks the flexibility of the nominal exchange rate in two ways. First, the DCP mechanism decreases the impact on increase in exports due to a home currency depreciation and secondly, the presence of currency mismatches in borrowers’ balance sheets curbs the impact of flexible exchange rate on trading volumes of the small open economy. This double jeopardy hampers the external adjustment role of flexible exchange rates.

After showing the theoretical predictions, I evaluate the model quantitatively by taking it to the Colombian data. As Colombia has more than 98% of its exports invoiced in dollars as well as more than 80% of its debt in dollars, it serves as a model economy for this dominant currency paradigm. I conduct a quantitative exercise involving parametrization using Colombian data to investigate the impact of a 1% rise in US interest rates. I find that the exports quantities decline by 0.22% with the two channels of DCP and DCF in contrast to an increase of 0.43% as per the traditional view (without the channels). Import quantities decline too and the decline is accentuated by the frictions present in the model.

I then investigate the role of financial frictions in the channel. Here, I compare three scenarios: 1) frictionless asset markets, 2) borrowings in only domestic currency and 3) borrowings in both domestic as well as dominant currency. I find that investment, imports as well as output decline as we move from frictionless world to a scenario with home currency debt only and the decline is exacerbated (by more than twice) with the introduction of dominant currency borrowings.

In the next step, I compare the flexible exchange rate regime (with DCP, DCF and
financial frictions) and fixed exchange rate regime. One could argue that since in this paradigm of dominant currency financing and pricing, the flexibility of the nominal exchange rate is attacked and therefore, whether the fixed exchange system is in fact better than the flexible one. However, the results suggest that the decline in home country’s output and investment to an increase in dominant country’s interest rate is greater in the fixed exchange regime (with financial accelerator) than the model results for the flexible exchange rate regime.

**Related Literature:** The classic argument for the optimality of floating nominal exchange rates, dating back to Milton Friedman (Friedman (1953)), goes along the following lines: When prices are sticky, shocks to the economy generate deviations of output from its potential and consequently inefficient recessions and booms. For example, a positive productivity shock at home should, with flexible prices, lower the price of home goods relative to foreign goods. When prices are sticky in the producers currency this relative price adjustment however does not happen automatically. In this case a depreciation of the exchange rate can bring about the right relative price adjustment. A depreciation raises the price of imports relative to exports generating a depreciation of the terms of trade and therefore a shift in demand towards domestically produced goods and away from foreign goods. This exchange rate flexibility closes the output gap and leaves the economy at its first best level. On the other hand, if the exchange rate is fixed, then the economy suffers from a negative output gap (output below its potential). A core piece of this argument that favors flexible exchange rates is the strong comovement of the nominal exchange rate and the terms of trade: A depreciation of the nominal exchange rate should be associated with an almost one-to-one depreciation of the terms of trade (of goods with sticky prices). That is a 1% depreciation of the bilateral exchange rate should be associated with a close to 1% depreciation of the terms of trade. However, there is pervasive empirical evidence that this external rebalancing mechanism (with sticky prices in producer’s currency and frictionless asset markets), as propounded by the seminal contributions of Fleming (1962) and Mundell (1961), fails to hold.

This paper belongs to two main strands of literature. First, the literature on currency of pricing. Dominance of the dollar in the international price and asymmetric use of currencies in world trade has been empirically established. (Gopinath (2016) and Boz, Casas, et al. (2020), see C.2). The first generation of open economy models (Fleming (1962), Mundell (1961), Dornbusch (1976), Svensson and Van Wijnbergen (1989), Ob-
stfeld and Rogoff (1995)) assumed that prices are rigid in producer’s currency or PCP. And in those models, a depreciation in a country’s exchange rate (triggered by either monetary policy or commodity prices) would imply a reduction or depreciation of the terms of trade. Because a depreciation in the exchange rate would give rise to expenditure switching, the country’s exports increase as they become relatively cheaper in the international markets as compared to imports which decrease because they become relatively expensive. Second generation models (Betts and Devereux (2000) and Devereux and Engel (2001)) take cognizance of the fact that law of price doesn’t hold and in these models, the assumption is that export prices are rigid in the destination currency. This paradigm is referred to as Local Currency Pricing or LCP. So, in LCP, a depreciation of country’s exchange rate leads to an increase or appreciation of terms of trade. And if the currency of trade invoicing is in a dominant currency rather than producer’s currency for emerging market economies, a nominal depreciation with respect to US dollar leads to an increase in import prices in the short term, inducing the same import compression as in PCP. However, prices faced by non-US trading partners do not move because their exchange rates vis-à-vis the dominant currency have not changed. So, the export quantities don’t move much.\(^2\) Boz, Gopinath, et al. (2019) estimates that a 1% depreciation of the bilateral exchange rate is associated with only a 0.1% depreciation of the bilateral terms of trade. Based on these empirical observations, Gopinath et al. (2020) establish through a DSGE model that if firms set export prices in a dominant currency, face strategic complementarities in pricing, and there is roundabout production using domestic and foreign inputs; a small open economy’s currency depreciation leads to a decrease in imports from all countries and the response of export volumes is muted under dominant currency pricing. And this in fact implies a weaker exchange rate mechanism of external rebalancing through trade volumes. This paper belongs to the third and the most recent paradigm where price stickiness in dominant currency makes currency choice relevant for monetary policy in most existing open-economy models and so it is natural to use the same friction as a starting point to think about firms’ invoicing decisions.

Similarly, it has been established in the literature that firms in emerging market economies often rely on US dollar finding. Through Dominant Currency Financing (DCF), exchange rate fluctuations can also have effects through their impact on firms’ balance sheets, a phenomenon widely studied in the literature. (Bruno and Shin (2017), Bruno and Shin (2020)). However, standard models do not take into account that a

\(^{2}\)Please see Appendix C.3
depreciation of the domestic currency can tighten financial constraints of firms that have debt denominated in foreign currency, thus affecting trade balance through a different channel. If firms borrow in foreign currency, a depreciation of the domestic currency increases the debt burden of those firms and tightens their financial constraints, with potentially contractionary effects on both exports and imports (Casas, Meleshchuk, et al. (2020)). So, the second strand of literature corresponds to the currency of financing and the inclusion of financial frictions in the model. The financial accelerator channel - introduced by Bernanke, Gertler, and Gilchrist (1999) was extended to the open economy New Keynesian literature by Gertler et al. (2007) where their goal was to explore the interaction between the exchange rate regime and financial crises. Akinci and Queralto (2018) explores the role of dominant currency in financing with financial frictions in a PCP model and establishes the case for monetary spillovers.

The contribution of this paper in the literature is to investigate the interaction of dominant currency in pricing as well as financing and to understand its impact on the traditional expenditure switching role of the exchange rates. The model in this paper is richer with a number of features and frictions interacting to bring about the results that we observe in the data. Additionally, it paves a way forward for answering a newer set of policy questions.

The remainder of the paper proceeds as follows: Section 2 presents a small open economy DSGE framework that includes the two channels of DCP and DCF with financial frictions. Section 3 details the mechanism for the theoretical model. Section 4 spells out the Model parameterization. Section 5 presents the results of the model and Section 6 concludes with discussion on further research.

## 2 Empirical Motivation

This section describes how I empirically establish the spillovers from US monetary policy to the trade volumes of 62 emerging market economies across the world. The findings point to the inverse relationship between US monetary policy and exports in EMEs. The method employed in this empirical section is similar to that in Adler et al. (2020) where I examine how the variation in dollar invoicing of trade impacts the trade volumes of EMEs. In this paper, I focus on the spillovers from US monetary policy and I also
study the impact of variation of dollar debt liabilities on trade volumes.

First, I estimate the role of dollar invoicing on spillovers in EMEs. In particular, the approach consists in estimating the response of the total export quantities of country $i$:

$$
\Delta X_{i,t} = \alpha_i + \beta_u \Delta i_{u,t-1} + \beta^\lambda \lambda_{i,t-1}^x \Delta i_{u,t-1} + \beta^\sigma \Delta i_t^{*t-1} + \beta^\theta \theta_{i,t-1} + \beta^\lambda x_{i,t-1}^{x,m} + \beta^\theta x_{i,t-1}^{x,m} + \beta^\theta \theta_{i,t-1} + \Gamma controls_{i,t} + \epsilon_{i,t}
$$

(1)

where $\Delta X_{i,t}(M_{i,t})$ denotes the change in export (import) quantities of country $i$ at time $t$, $\Delta i_{u,t-1}$ denotes the lagged change in US shadow interest rate, $\lambda_{i,t-1}^{x(m)}$ represents the share of dollar invoicing in exports (imports) of country $i$. Following the Global VAR approach, I consider $\Delta i_t^{*t-1}$ as control variable to take into account the influence of countries other than the dominant country. $i^*$ is an indicator of the rest of the world (except US) monetary policy. This measure is approximated by the cross sectional average of rest of the world (ROW) countries’ central bank policy rate (except US). $\beta_u$ is the response of exports at time $t$ to the change in US monetary policy at time $t-1$. The coefficient of the interaction term, $\beta^\lambda$, measures how the spillovers effect of US monetary policy change with the share of exports (imports) invoiced in US dollars. The control variables include domestic GDP growth rate and domestic inflation (PPI inflation for exports and CPI inflation for imports). I also control for dollar debt liabilities denoted as $\theta_{i,t-1}$.

The data used in the empirical evaluation of equation 2 are obtained from the following sources. The International Monetary Fund (IMF) reports country level quarterly data on exports, imports, domestic GDP, PPI inflation, CPI inflation, central bank policy rates. The sample spans from 1991-2019. Since US interest rates hit zero lower bound for a significant period under study, I use US shadow interest rates estimated by Wu and Xia (2016) as a proxy for US interest rates. I use the data on share of invoicing of US dollars estimated by Boz, Casas, et al. (2020). Benetrix et al. (2019) provides a dataset on the currency composition of the international investment position for a group of 50 countries for the period 1990-2017. I use their estimates of dollar debt liabilities as a proxy for share of dollar debt on firms’ balance sheets.

Table 1 provides results for the regression of exports as the dependent variable (Equation 2). I find that the estimated coefficient ($\beta_u$) in Column (1) is negative and significant, which validates the hypothesis that exports in EMEs decline due to a monetary contrac-
tion in US. The coefficient remains significant when I add control variables in Column (2). Columns (3) confirms that the decline in exports is larger with higher share of exports invoiced in dollars as the coefficient on the interaction term ($\beta \lambda$) is negative and significant. The coefficient remains negative and significant when I add time fixed effects (Column (4)) and control for share of dollar debt liabilities, $\theta$ (Column (5)).

Table 1: US Monetary Policy and EMEs’ Exports - Impact of Dollar Invoicing of Exports

<table>
<thead>
<tr>
<th>Dependent Variable: $\Delta X$</th>
<th>$\Delta X$</th>
<th>$\Delta X$</th>
<th>$\Delta X$</th>
<th>$\Delta X$</th>
<th>$\Delta X$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>$\Delta$ US shadow rate</td>
<td>-0.011***</td>
<td>-0.012***</td>
<td>0.013</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$\lambda_x \times \Delta$ US shadow rate</td>
<td>-0.022**</td>
<td>-0.021***</td>
<td>-0.017*</td>
<td>(0.004)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>$\lambda_x$</td>
<td>-0.006</td>
<td>0.078</td>
<td>0.068</td>
<td>(0.010)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>$\theta$</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
<td>(0.019)</td>
</tr>
<tr>
<td>$\Delta$ ROW policy rate</td>
<td>-0.377***</td>
<td>-0.310***</td>
<td>0.066</td>
<td>0.463***</td>
<td>(0.060)</td>
</tr>
<tr>
<td>PPI Inflation</td>
<td>0.172</td>
<td>0.438***</td>
<td>0.203*</td>
<td>0.328</td>
<td>(0.122)</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>0.073***</td>
<td>0.037***</td>
<td>0.023***</td>
<td>-0.041</td>
<td>-0.028</td>
</tr>
<tr>
<td>Constant</td>
<td>5.479</td>
<td>5.479</td>
<td>4.907</td>
<td>4.907</td>
<td>1,057</td>
</tr>
<tr>
<td>Observations</td>
<td>0.002</td>
<td>0.009</td>
<td>0.059</td>
<td>0.533</td>
<td>0.618</td>
</tr>
<tr>
<td>R-squared</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to estimate the spillover impact on imports of EMEs, I run the regression given in equation 2 with change in imports as the dependent variable. The results of the regression are shown in table B.1. I find that the impact of US monetary policy on EME imports is similar to that of exports where a monetary contraction by US central bank leads to a fall in imports and the decline is higher with a higher share of imports invoiced in dollars. These results indicate that higher dollar invoicing in trade leads to a fall in
exports as well as imports in EMEs as a result of an increase in US interest rates.

In the next step, I run regressions to estimate the role of dollar financing on spillovers in EMEs. I use a similar regression equation as in 2. However, in order to estimate the impact of dollar financing, the interaction term is modified to include the share of dollar debt liabilities in country \( i (\theta_i) \). In particular, I estimate the response of the total export quantities of country \( i \) due to a lagged change in US shadow rates. In this specification, I control for the share of dollar invoicing in exports (imports). The specification is as follows:

\[
\Delta X_{i,t} = \alpha_i + \beta^u \Delta i_{u,t-1} + \beta^\theta \theta_{i,t-1} \Delta i_{u,t-1} + \beta^* \Delta i_\tau_{t-1} + \beta^\lambda \lambda_{i,t-1} + \Gamma \text{controls}_{i,t} + \epsilon_{i,t} \quad (2)
\]

Table 2 shows the result of movement in exports as the dependent variable. In Column (2), I add ‘share of dollar invoiced exports’ as the control variable to take out the effect of dollar pricing from the equation. I find that the coefficient of interest, \( \beta^\theta \), is negative and significant implying that the decline in exports in EMEs due to a monetary contraction in US is larger with higher share of dollar financing. Similarly, the regression of ‘change in imports’ as the dependent variable shows us that the decline in imports in EMEs due to a monetary contraction in US is larger with higher share of dollar financing too (B.2). These results indicate that higher dollar financing leads to a fall in exports as well as imports in EMEs as a result of an increase in US interest rates.

To conclude the empirical section, I establish that a monetary contraction in US leads to a decline in exports as well as imports in EMEs. I also document that the decline in trade (exports as well as imports) is larger with a higher share of dollar invoicing and with a higher share of dollar debt financing. The finding points to the importance of the two channels of pricing and financing in a dominant currency on the external adjustment mechanism. Unlike, the traditional view, an increase in interest rates by US central bank leads to a decline in exports as well as imports in EMEs and the fall is larger if these EMEs have higher share of pricing and financing in dominant currency. To explain this empirical finding, I develop a theoretical model in the next section to explore the qualitative and quantitative impact of these channels.
<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Δ X</th>
<th>Δ X</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>θ * Δ US shadow rate</td>
<td>-0.025** (0.010)</td>
<td>-0.029** (0.013)</td>
</tr>
<tr>
<td>θ</td>
<td>-0.002 (0.016)</td>
<td>0.002 (0.019)</td>
</tr>
<tr>
<td>λ</td>
<td>0.071 (0.048)</td>
<td></td>
</tr>
<tr>
<td>Δ ROW policy rate</td>
<td>0.428*** (0.078)</td>
<td>0.463*** (0.094)</td>
</tr>
<tr>
<td>CPI Inflation</td>
<td>-0.057 (0.163)</td>
<td>-0.104 (0.163)</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>0.390 (0.259)</td>
<td>0.334 (0.258)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.031* (0.017)</td>
<td>-0.029 (0.039)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,375</td>
<td>1,057</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.420</td>
<td>0.421</td>
</tr>
<tr>
<td>Country FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
3 Theoretical Framework

In this section, I develop a theoretical model to examine the two channels of DCP and DCF with financial frictions. A small open Economy H (Home) trades goods and assets with the rest of the world. I divide rest of the world into two regions: U for dominant currency country and R for the non-dominant rest of the world. Households work, save and consume tradable goods produced in home and abroad. Firms in H economy produce goods and sell to domestic households in domestic currency and export to economy U and economy R in the dominant currency. I assume the dominant currency to be US dollars. As the trade of final goods is invoiced in dollars, the nominal dollar exchange rate between Home and rest of the world (both U and R included) is denoted as $e_{H,t}^d$, expressed as Home currency per unit of dollar, so that an increase in $e_{H,t}^d$ represents a depreciation of the Home currency against that of dollars. Firms in Home borrow domestically in Home currency and from outside (either U or R) in dollars.

Households

Home is populated with a continuum of symmetric households of measure one. In each period household $h$ consumes a bundle of traded goods $C_t(h)$. Each household also sets a wage rate $W_t(h)$ and supplies an individual variety of labor $N_t(h)$ in order to satisfy demand at this wage rate. Households own all domestic firms. The per-period utility function is separable in consumption and labor and given by

$$U(C_{H,t}, N_{H,t}) = \left( \frac{1}{1-\sigma}C_{H,t}^{1-\sigma} - \frac{\kappa}{1+\varphi}N_{H,t}^{1+\varphi} \right)$$

where $\sigma > 0$ is the household’s coefficient of relative risk aversion, $\varphi > 0$ is the inverse of the Frisch elasticity of labor supply and $\kappa$ scales the disutility of labor. A representative household in country H has the following preferences

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_{H,t}, N_{H,t})$$

where $C_{H,t}$ denotes consumption at home and $N_{H,t}$ denotes household labor supplied in country H, at time t. So, Household’s Consumption bundle $C_{H,t}$ comprises of domestically produced goods ($C_{HH,t}$) and imported goods from U ($C_{UH,t}$) and R ($C_{RH,t}$). $\alpha$ and $\zeta$ are the weights of country U and country R’s good in H’s consumption good and $1-\alpha - \zeta$ is the home bias. $\eta$ represents elasticity of substitution between goods produced
in different countries (same).

\[ CH,t = \left[ (1 - \alpha - \zeta)^{1 \over \eta} C_{HH,t}^{n_1 \over \eta} + \alpha^{1 \over \eta} C_{UH,t}^{n_1 \over \eta} + \zeta^{1 \over \eta} C_{RH,t}^{n_1 \over \eta} \right] \] (5)

Henceforth, \( C_{ij}(\omega) \) means goods produced in country \( i \) and consumed in country \( j \), \( i \in \{H, U, R\} \). Any bundle \( C_{ij}(\omega) \) is a combination of different varieties of the differentiated good by the firm \( \omega \) which is then aggregated using a CES – Dixit Stiglitz aggregator with elasticity of substitution among these different varieties as \( \epsilon \).

\[ C_{ij,t} = \left( \int_0^1 C_{ij,t}(\omega)^{1 \over \epsilon - 1} d\omega \right)^{\epsilon - 1 \over \epsilon - 1} \]

The demand for good produced in country \( j \) good consumed in country \( i \) (where \( i, j \in \{H, U, R\} \) can be written as

\[ C_{ji,t}(\omega) = \left( \frac{P_{ji,t}(\omega)}{P_{jH,t}} \right)^{-\epsilon} C_{ji,t} \] (6)

where \( P_{jH,t} \) represents the producer price index.

\[ P_{ji,t} = \left( \int_0^1 P_{ji,t}(\omega)^{1-\epsilon} d\omega \right)^{1 \over 1-\epsilon} \] (7)

For example, the demand for domestically produced good consumed in country \( H \) can be written as

\[ C_{HH,t}(\omega) = \left( \frac{P_{HH,t}(\omega)}{P_{HH,t}} \right)^{-\epsilon} C_{HH,t} \] (8)

where \( P_{HH,t} \) is the Producer Price index for home good.

\[ P_{HH,t} = \left( \int_0^1 P_{HH,t}(\omega)^{1-\epsilon} d\omega \right)^{1 \over 1-\epsilon} \] (9)

Similarly, the price index for product imported from country \( j \in \{U, R\} \) to country \( H \) is as follows:

\[ P_{jH,t} = \left( \int_0^1 P_{jH,t}(\omega)^{1-\epsilon} d\omega \right)^{1 \over 1-\epsilon} \] (10)

Optimal allocation of expenditures between domestic and imported goods is given by
\[ C_{HH,t} = (1 - \alpha - \zeta) \left( \frac{P_{HH,t}}{P_{H,t}} \right)^{-\eta} C_{H,t} \]  

(11)

\[ C_{UH,t} = \alpha \left( \frac{P_{UH,t}}{P_{H,t}} \right)^{-\eta} C_{H,t} \]  

(12)

\[ C_{RH,t} = \zeta \left( \frac{P_{RH,t}}{P_{H,t}} \right)^{-\eta} C_{H,t} \]  

(13)

Consumer Price Index (for home country)

\[ P_{H,t} = \left[ (1 - \alpha - \zeta) P_{HH,t}^{1-\eta} + \alpha P_{UH,t}^{1-\eta} + \zeta P_{RH,t}^{1-\eta} \right] \left( \frac{1}{1-\eta} \right) \]  

(14)

Given the aggregate price index, the budget constraint for each differentiated labor type \( h \) the households (in H’s currency) is given as

\[ C_{H,t} = \frac{W_{H,t}(h)}{P_{H,t}} N_{H,t}(h) + \Pi_{H,t} - \frac{B_{H,t+1} - (1+i_{t-1})B_{H,t}}{P_{H,t}} - \left( \xi_{H,t+1} B_{H,t+1}^{\Psi_{U,t-1}} \right) \]  

(15)

where the representative household spends resources in buying consumption \( C_{H,t} \) goods as well as domestic bonds (H bonds) \( B_{H,t} \) and the dollar bonds \( B_{U,t} \) and they earn nominal wage \( W_{H,t} \). \( \Pi_{H,t} \) represents profits from ownership of retail firms. In addition, they also earn interest payment on home-bonds (\( B_{H,t} \)) and dollar bonds (\( B_{U,t+1} \)) with interest rates denoted as \((1+i_{t-1})\) and \((1+i_{U,t-1})\) respectively. Since the budget constraint is in domestic currency, the dollar exchange rate enters into the equation. \( \xi_{H,t} \) represent the dollar exchange rate (dollars per unit of home currency). An increase in \( \xi_{H,t} \) would mean appreciation of home currency vis-a-vis dollars.

Since a small open economy is non-stationary around a local point which complicates the dynamics. So, in order to close the small open economy model, I introduce a small friction in the world capital market by introducing a country borrowing premium ‘\( \psi \)’ which depends on total net factor indebtedness (Schmitt-Grohé and Uribe (2003)). \( \Psi_t \) represents a gross borrowing premium that domestic residents must pay to obtain funds from abroad.

Through the first order conditions, we get the following Uncovered Interest Parity (UIP) condition which gives us the relation between the two interest rates, i.e.,
\((1 + i_{t-1}) \) and \((1 + i_{U,t-1})\) and the exchange rates.

\[
(1 + i_t) = \Psi_{U,t}(1 + i_{U,t})\mathbb{E}\left(\frac{\xi^S_{H,t+1}}{\xi^S_{H,t}}\right)
\]  

(16)

The UIP condition implies that an increase in home interest rate would result in an expected appreciation of the home currency vis-à-vis the dollar. Similarly, if US interest rates increase, it would mean that home currency would depreciate against the dollar.

Households are subject to a Calvo friction when setting wages: in any given period, they may adjust their wage with probability \(1 - \Gamma_w\), and maintain the previous-period nominal wage otherwise. The households face a downward sloping demand for the specific variety of labor they supply given by

\[
N_{H,t}(h) = \left(\frac{W_{H,t}(h)}{W_{H,t}}\right)^{-\nu} N_{H,t}
\]

(17), where \(\nu > 1\) is the elasticity of labor demand and \(W_{H,t}\) is the aggregate nominal wage in country H. Each household provides differentiated labor which is then combined using CES aggregator with elasticity of substitution as \(\nu\). The standard optimality condition for wage setting is given by

\[
\mathbb{E}_t \sum_{s=0}^{\infty} \Gamma_w^s \beta^s \left(\frac{C_{H,t+s}}{C_{H,t}}\right)^{-\sigma} \frac{P_{H,t}}{P_{H,t+s}} N_{H,t+s} W_{H,t+s}^{\nu(1+\varphi)}
\]

\[
\left[\frac{\nu}{\nu - 1}\nu \frac{P_{H,t+s}C_{H,t+s}^{\sigma} N_{H,t+s}}{W_{H,t+s}^{\nu(1+\varphi)}} - \frac{W_{H,t}(h)^{1+\nu\varphi}}{W_{H,t+s}^{\nu(1+\varphi)}}\right] = 0
\]

(18)

where \(W_{H,t}(h)\) is the optimal nominal reset wage in country H and period t. This implies that \(W_{H,t}(h)\) is preset as a constant markup over the expected weighted-average of future marginal rates of substitution between labor and consumption and aggregate wage rates, during the duration of the wage. The stickiness in wages is representative of the role of trade unions, employment contracts etc. in the developing economies. Sticky wages are useful to match the empirical fact that wage-based real exchange rates move closely with the nominal exchange rates and is common in the dominant currency literature. (see Gopinath et al. (2020) and Mukhin (2018))

**Firms**
In the home country, there are three types of producers: Entrepreneurs, capital producers and retailers. Entrepreneurs manage production to produce output and also obtain financing for the capital employed in the production process. The job of capital producers is to repair the depreciated capital and construct new capital goods. Retailers are monopolistically competitive. Their job is to introduce nominal price stickiness. They receive the product from the entrepreneur and differentiate it slightly and the final good is a CES composite of individual retail goods.

**Entrepreneurs**

As mentioned above, entrepreneurs manage production and they do it through a Cobb-Douglas production function with capital $K$, labor $L$ and intermediate good $X$ as inputs.

$$Y_{H,t} = A_{H,t}K_{H,t}^{\alpha_K}X_{H,t}^{\alpha_X}L_{H,t}^{1-\alpha_K-\alpha_X}$$

(19)

$A_{H,t}$ denotes productivity and $\alpha_K$, $\alpha_X$ and $1 - \alpha_K - \alpha_X$ signify the share of capital, labor and intermediate goods respectively in the total output.

The intermediate good used in the production process, $X_{H,t}$, follows the same aggregation structure (aggregation of domestic as well as imported goods) as the consumption goods.

$$X_{H,t} = \left[(1 - \alpha - \zeta)^{\frac{1}{\eta}}X_{H,t}^{\frac{n-1}{\eta}} + \alpha^{\frac{1}{\eta}}X_{U,t}^{\frac{n-1}{\eta}} + \zeta^{\frac{1}{\eta}}X_{R,t}^{\frac{n-1}{\eta}}\right]$$

(20)

Another important job for entrepreneurs is capital financing. There are two sources of financing: Internal sources, that is firm’s Net worth ($NW$) and external sources or the loans which the firm borrows ($\ell$). $Q_H$ represents the price of capital.

$$Q_{H,t}K_{H,t+1} = NW_{H,t+1} + \ell_{H,t+1}$$

(21)

For the external financing, I assume here that a fixed proportion of loans, $\theta$, are sourced in domestic currency and $1 - \theta$ in foreign currency. The tacit assumption of $\theta \in [0, 1]$ being exogenous to the model and fixed is done to keep the model simple.

$$\theta \cdot \ell_{H,t} = \frac{B_{H,t+1}}{P_{H,t}}$$

(22)

$$(1 - \theta) \cdot \ell_{H,t} = \frac{\xi_{H,t}^SB_{H,t+1}}{P_{H,t}}$$

(23)
The entrepreneur’s demand for capital depends on the expected marginal return and the expected marginal financing cost. The marginal return to capital (equal to the expected average return due to constant returns) is next period’s ex post output net of labor costs, normalized by the period t market value of capital:

$$1 + r_{H,t+1}^k = \frac{Y_{H,t+1} - \frac{W_{H,t+1}}{P_{H,t+1}} L_{H,t+1}}{Q_{H,t}K_{H,t+1}}$$

$$= \omega_{H,t+1} \left[ \left( \alpha K + \alpha X \right) \frac{Y_{H,t+1}}{K_{H,t+1}} - \frac{P_{H,t+1} \delta}{P_{H,t+1}} + Q_{H,t+1} \right]$$

(24)

where $Y_{H,t+1}$ is the average level of output per entrepreneur ($Y_{H,t+1} = \omega_{H,t+1} Y_{H,t+1}$), $\omega_{H,t+1}$ represents idiosyncratic shock. Equation 24 shows that the marginal return varies proportionately with $\omega_{H,t+1}$ and since $E_t\{\omega_{H,t+1}\} = 1$, we can express equation 24 as follows:

$$E_t\{1 + r_{H,t+1}^k\} = \frac{E_t\left\{ \left( \alpha K + \alpha X \right) \frac{Y_{H,t+1}}{K_{H,t+1}} - \frac{P_{H,t+1} \delta}{P_{H,t+1}} + Q_{H,t+1} \right\}}{Q_{H,t}}$$

(25)

The marginal cost of funds to the entrepreneur depends on financial conditions. Following Bernanke, Gertler, and Gilchrist (1999) and Gertler et al. (2007), I postulate an agency problem that makes uncollateralized external finance more expensive than internal finance. As in Carlstrom and Fuerst (1997), I assume a costly state verification problem. The idiosyncratic shock $\epsilon_t$ is private information for the entrepreneur, implying that the lender cannot freely observe the project’s gross output. To observe this return, the lender pays an auditing cost-interpretable as a bankruptcy cost-that is a fixed proportion $\mu_b$ of the project’s ex post gross payoff, $\left\{1 + r_{H,t+1}^k Q_{H,t}K_{H,t+1} \right\}$. The entrepreneur and the lender negotiate a financial contract that: (i) induces the entrepreneur not to misrepresent his earnings; and (ii) minimizes the expected dead-weight agency costs (in this case the expected auditing costs) associated with this financial transaction.

As per the standard contract between the lender and the borrower, if entrepreneur defaults, lender audits and seizes whatever it finds. If entrepreneur doesn’t default, lender receives a fixed payment independent of $\omega_{H,t}$. The agency problem arising from Costly State Verification implies that opportunity costs of external finance is more expensive than internal finance. Lender charges the borrower a premium to cover the expected bankruptcy costs. The external finance premium affects the entrepreneur’s demand for
capital because it affects the overall cost of finance. Further, the external finance premium varies inversely with the entrepreneur’s net worth: the greater the share of capital that the entrepreneur can either self-finance or finance with collateralized debt, the smaller the expected bankruptcy costs and, hence, the smaller the external finance premium. Following Bernanke, Gertler, and Gilchrist (1999) and Gertler et al. (2007), External finance premium varies, $\chi_t(\cdot)$ inversely with net worth and is an increasing function of leverage ratio, $\ell_{H,t+1}/NW_{t+1}$.

$$\chi_{H,t}(\cdot) = \chi \left( \frac{B_{H,t+1}}{P_{H,t}} + \frac{\xi_{U,t} B_{U,t+1}}{P_{H,t}} \right)$$

$$\chi'(\cdot) > 0, \chi(0) = 0, \chi(\infty) = \infty. \quad (26)$$

With capital market frictions, entrepreneur’s overall marginal cost of funds can be written as:

$$\mathbb{E}_t\{1 + r^k_{H,t+1}\} = (1 + \chi_{H,t}(\cdot))\mathbb{E}_t \{(1 + i_t)\theta \ell_{H,t} + (1 + i_{U,t})(1 - \theta)\ell_{H,t}\} \quad (27)$$

Let $V_{H,t}$ is the value of the entrepreneurial firm net of borrowing costs which is equal to the return on the capital minus any repayment of loans (RoL) taken in the previous period.

$$V_{H,t} = (1 + r^k_{H,t})Q_{H,t-1}K_{H,t} - RoL \quad (28)$$

$$RoL = (1 + \chi_{H,t-1}(\cdot))\mathbb{E}_t \left\{(1 + i_{t-1})\frac{B_{H,t}}{P_{H,t-1}} + (1 + i_{U,t-1})\frac{\xi_{H,t} B_{H,t}}{P_{H,t-1}}\right\} \quad (29)$$

The repayment of loan comprises of interest repayment of home currency borrowings as well as dollar borrowings. If we suppose that there are no dollar borrowings and only home currency borrowings, any additional home currency debt, raises the leverage ratio thereby increasing the external finance premium and the overall marginal cost of finance. However, if we have dollar borrowings, then there is an additional factor, i.e., dollar exchange rate, entering into the repayment of loan equation and further impacting the leverage. If there is a depreciation of the home currency vis-a-vis the dollar, interest payments in dollars would increase. It would lower the net worth of the firm. Through this financial accelerator channel, external finance premium would rise thereby the demand for capital would be lower as compared to the perfect capital markets case.
To ensure that the entrepreneurs never accumulate enough funds to fully self-finance their capital acquisitions, I assume they have a finite expected horizon. Each entrepreneur survives until the next period with probability $\phi$. The entrepreneurs’ population is stationary, with new entrepreneurs entering to replace those who exit. This implies that if $V_{H,t}$ represents the value of the entrepreneurial firm in period $t$, $\phi$ times $V_{H,t}$ would be the net worth next period. And $1 - \phi$ entrepreneurs consume the rest of the value, $C_{H,t}^e$, and die at the end of period $t$.

\[
NW_{H,t+1} = \phi V_{H,t} \tag{30}
\]

\[
C_{H,t+1}^e = (1 - \phi)V_{H,t} \tag{31}
\]

**Capital Producers**

Capital producers have the task of constructing new capital goods. For this purpose, they use the investment good ($I_{H,t}$). Investment good is bundled in a similar fashion as the consumption good ($C_{H,t}$) and intermediate good ($X_{H,t}$). The bundling involves domestically produced goods and imported goods from U and R.

\[
I_{H,t} = (1 - \alpha - \zeta \eta I_{H,H,t}^{\eta - 1} + \alpha \eta I_{H,U,t}^{\eta - 1} + \zeta \eta I_{H,R,t}^{\eta - 1}) \tag{32}
\]

Parameters $\alpha$ and $\zeta$ measure the relative weights of inputs produced in Country U and Country R’s respectively. Therefore $1 - \alpha - \zeta$ represent home bias in investment input. $\eta$ represents elasticity of substitution between investment goods produced in different countries.

Optimal allocation of expenditures between domestic and imported investment goods is given by

\[
I_{H,H,t} = (1 - \alpha - \zeta) \left( \frac{P_{H,H,t}}{P_{H,t}} \right)^{-\eta I} I_{H,t} \tag{33}
\]

\[
I_{U,H,t} = \alpha \left( \frac{P_{U,H,t}}{P_{H,t}} \right)^{-\eta I} I_{H,t} \tag{34}
\]

\[
I_{R,H,t} = \zeta \left( \frac{P_{R,H,t}}{P_{H,t}} \right)^{-\eta I} I_{H,t} \tag{35}
\]
Investment Price Index (for home country) $P_{H,t}^I$ is given by

$$P_{H,t}^I = \left[ (1 - \alpha - \zeta)P_{H,t}^{I1-\eta} + \alpha P_{UH,t}^{I1-\eta} + \zeta P_{RH,t}^{I1-\eta} \right]^{\frac{1}{1-\eta}}$$  \hspace{1cm} (36)

The next period capital is equal to the non-depreciated capital and new investment which is subject to adjustment costs represented by $\Phi$, following Lucas Jr (1967) and Eisner and Strotz (1963). Consistent with the notion of adjustment costs for investment, $\Phi(.)$ is increasing and concave.

$$K_{H,t+1} = (1 - \delta)K_{H,t} + \Phi \left( \frac{I_{H,t}}{K_{H,t}} \right) K_{H,t}$$  \hspace{1cm} (37)

The objective of the capital producers is to maximize profits from the construction of investment goods which gives us the following optimality condition for investment or the supply side of investment.

$$E_{t-1} Q_{H,t} \Phi' \left( \frac{I_{H,t}}{K_{H,t}} \right) - P_{H,t}^I = 0$$  \hspace{1cm} (38)

Since imports of the investment goods are priced in dollars, any depreciation of home currency with respect to dollars makes the imports of these investment goods expensive, increases the price of investment good, thereby reducing the investments.

**Retailers**

There are a continuum of monopolistically competitive retailers whose job is to introduce nominal stickiness into the prices. These retailers buy wholesale goods from entrepreneurs and differentiate it slightly at no cost. Because the product is differentiated, each retailer $z$ has a bit of market power.

$$Y_{Hi,t} = \left[ \int_0^1 Y_{Hi,t}(\omega)^{\frac{1}{\epsilon}} d\omega \right]^{\frac{1}{\epsilon}}$$  \hspace{1cm} (39)

The CES aggregator, with elasticity as epsilon of these differentiated goods, makes the final good, which is either consumed, invested or is used as an intermediate input and sold either domestically or is exported to rest of the world.
Since the retail sector provides nominal stickiness in the economy where prices are sticky in domestic currency as well as dollars, I assume a calvo pricing environment with the probability of resetting the prices as 1−Γ.

The retailer’s pricing decision problem involves choosing optimal prices for domestic goods (in home currency) as well as exports (in dollars) to maximize

\[
E_t \sum_{s=0}^{\infty} \Gamma^s \beta^s \left( \frac{C_{H,t+s}}{C_{H,t}} \right)^{-\varsigma} \frac{P_{H,t}^{o}}{P_{H,t+s}^{o}} \left[ P_{HH,t}^{o}(z) Y_{HH,t+s}(z) \right] \\
+ \xi_{Ht} P_{Hj,t}(z) Y_{Hj,t+s}(z) - MC_{H,t+s} Y_{H,t+s}(z)
\]  

Equation 40 gives the optimal price setting condition (in domestic currency) which involves the retailers probability who could not reset the prices as Γ and the stochastic discount factor \((\beta^s \left( \frac{C_{H,t+s}}{C_{H,t}} \right)^{-\varsigma} \frac{P_{H,t}^{o}}{P_{H,t+s}^{o}})\). The retailers get their revenue by selling in domestic market (using optimal domestic price \(P_{HH,t}^{o}(z)\) and by exporting (using optimal dollar price of \(P_{Hj,t}^{o}, j \in \{U, R\}\)). \(MC_{H,t}\) represents marginal costs.

The first order condition gives us optimal prices for domestically sold goods as well as exported goods.

\text{Optimal Home prices}

\[
P_{HH,t}^{o}(z) = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{s=0}^{\infty} \Gamma^s Q_{H,t+s} MC_{H,t+s} Y_{HH,t+s}(P_{HH,t+s})^\varsigma}{E_t \sum_{s=0}^{\infty} \Gamma^s Q_{H,t+s} Y_{HH,t+s}(P_{HH,t+s})^\varsigma}
\]

\text{Optimal Export prices}

\[
P_{Hj,t}^{o}(z) = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{s=0}^{\infty} \Gamma^s Q_{H,t+s} MC_{H,t+s} Y_{Hj,t+s}(P_{Hj,t+s})^\varsigma}{E_t \sum_{s=0}^{\infty} \Gamma^s Q_{H,t+s} Y_{Hj,t+s}(P_{Hj,t+s})^\varsigma}
\]

\text{Interest rates}

The domestic risk-free interest rate is set by H’s monetary authority and follows an inflation targeting Taylor rule with inertia where \(\phi_M\) captures the sensitivity of policy rates to domestic price inflation and \(\rhoo\) captures the inertia in setting rates. \(\bar{\iota}\) denotes the target nominal interest rate. Shock to the home interest rates, \(\epsilon_{i,t}\) follows AR(1)
process:

\[ i_t - \bar{i} = \rho_m (i_{t-1} - \bar{i}) + (1 - \rho_m) \phi_M \pi_t + \epsilon_{i,t} \]  

(41)

Dollar interest rate is exogenously given which is assumed to be international interest rate \( i^* \) and another shock \( \epsilon_{U,t} \) which may enter through country U’s monetary policy.

\[ i_{U,t} = i^* + \epsilon_{U,t} \]  

(42)

Market Clearing

Resource Constraint (Goods market clearing) for home tradable goods sector is

\[ Y_{H,t} = C_{HH,t} + C_{HU,t} + C_{HR,t} + I_{HH,t} + I_{HU,t} + I_{HR,t} + X_{HH,t} + X_{HR,t} + X_{HU,t} + C_{H,t}^e. \]  

(43)

Final good produced in country H is consumed, invested and used as domestic inputs (domestically and exported to U and R). \( C_{H,t}^e \) represents entrepreneurial consumption of domestic good.

4 Mechanism

Let us understand the model mechanism through a thought experiment of a nominal depreciation of home currency with respect to the dominant currency and its impact on investment.

An increase in the home interest rates leads to a nominal depreciation of the home exchange rate vis-a-vis the dominant currency (Equation ??). As evident from equation 29, a nominal depreciation of home currency increases the interest payments on loans taken by the entrepreneurs in dominant currency. An increase in repayment lowers the value of the entrepreneur (Equation 28), that further reduces the net worth of the firm (Equation 30). Since the external finance premium varies inversely with net worth (Equation 26), a lowering of net worth increases the external finance premium. This implies that entrepreneur’s marginal cost of funds increases and we would expect the investment demand curve to shift to the left. The reduction on the equilibrium level of investment
as shown in the figure 1 (shown in green color) is due to a combination of financing in dominant currency as well as frictions in the asset market (financial accelerator).

On the supply side of capital, since investment good is a composite of domestically produced investment good and investment goods imported from country U and R, a nominal depreciation of home currency leads to a reduction in the import of investment goods as the price of imports goes up. This implies that the supply of investment goods decreases and we expect the investment supply curve of the capital producers to shift to the left as well. The reduction in the equilibrium level of investment as shown in the figure 1 (shown in red color) is due to the dominant currency pricing.

As clear from the figure 1, the combined effect of DCP and DCF on the equilibrium level of investment on impact is greater than each of the individual effects (from $I^*$ to $I^{**}$). Further, let us extend the argument and see the impact on exports due to a depreciation of home currency vis-a-vis the dominant currency.
Through DCP, a depreciation of home currency implies an increase in price of imported inputs which increases the marginal costs of the firms and dampens the incentive for the firms to reduce the prices of their exports. And therefore, we would expect the effect of a currency depreciation on exports would be muted. Additionally, through DCF, a depreciation of home currency would imply the interest payments on the loans borrowed by the entrepreneur goes up thereby lowering net worth and increasing external finance premium which further increases the price of imported investment good and we expect the investments, output as well as exports to go down. So, the export volumes are in double jeopardy and depending on the relative elasticity of exports, we may observe that the effect on exports due to a depreciation of home currency may be further muted, no effect or even dampening of exports thereby indicating that the Mundell-Fleming external rebalancing mechanism does not hold in this Dominant Currency Paradigm of pricing and financing.

5 Model Parameterization

The quantitative analysis in the next section is meant to capture the broad features of an emerging market economy such as Colombia with its heavy reliance on dollar invoicing and financing. Table 3 lists parameter values employed in the simulation for quarter as the time period. A number of parameters are set to values standard in the literature.

\[ \beta = 0.99 \]
\[ \kappa = 1 \]
\[ \eta = 0.5 \]
\[ \sigma = 0.2 \]
\[ \Gamma_w = 0.85 \]

On the production side, depreciation is assigned the conventional value of 0.025. Through the following methodology adopted by Daudey and García-Péñalosa (2007) and

\[ \text{see Gali and Monacelli (2008), Galí (2010), Gopinath et al. (2020)} \]
\[ \text{For instance, Reichling and Whalen (2012) suggest that the estimates of the Frisch elasticity most} \]
\[ \text{relevant for fiscal policy analysis range from 0.27 to 0.53, with a central estimate of 0.40.} \]
Jayadev (2007), Guerriero (2019) estimates the share of labor compensation in GDP of Colombia from the period 1970-2015 to be 0.39.

\[
\text{Labor Share} = \frac{\text{compensation of employees}}{\text{value added - indirect taxes - fixed capital}}
\]

As per the world bank estimates, the average of gross fixed capital formation to GDP ratio for Colombia for the period 1960-2020 is 0.19. Accordingly, the remainder 0.55 share is attributed to the share of intermediate inputs in the production function. Following Gertler et al. (2007) and Gopinath et al. (2020), I set the price stickiness parameter \( \Gamma = 0.75 \).

For the monetary rule, as is standard in the literature, I set inertia parameter, \( \rho_m \), equal to 0.5, inflation sensitivity, \( \phi_M \) as 1.5 and steady state interest rate, \( \bar{i} = 1/\beta - 1 \).

As per Colombian’s recent thin capitalisation rule, the debt to equity ratio is now 2:1, which is almost twice that of US. I set the steady state leverage ratio equal to 2. Following Gertler et al. (2007), I set the steady-state external finance premium at 3.5%, roughly 200 basis points higher than U.S. historical data. To obtain these steady-state values, I need to set the non-standard parameters of the model that affect the relation between real and financial variables such as the entrepreneurs’ death rate, \( (1 - \phi) \), equal to 0.0272. Further, I assume that the idiosyncratic productivity variable \( \omega_t \) is log-normally distributed with variance equal to 0.29. Finally, I fix the fraction of realized payoffs lost in bankruptcy, \( \mu_b \), to 0.15.

6 Qualitative Analysis

6.1 Monetary Tightening by Dominant Country

As the previous discussion reveals, the implications for DCP and DCF are more grave than each of the channels considered separately. In this section, I present numerical impulse responses to a monetary policy shock in the dominant country to tease out the

\footnote{\textit{Gopinath et al. (2020)} uses labor share as 1/3 and intermediate inputs share as 2/3 (There is no capital in their production function). In the literature, with only capital and labor in the production function, normally labor share is between 0.55-0.65 and rest is attributed to capital.}
<table>
<thead>
<tr>
<th>Description</th>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td><strong>Household Sector</strong></td>
<td></td>
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<tr>
<td>Discount Factor</td>
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<td>Risk Aversion</td>
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<td>Elasticity of substitution</td>
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<td>Wage rigidity</td>
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<td>R-bias</td>
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<td>Share of dollar loans</td>
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<td>(log) Productivity</td>
<td>$A$</td>
<td>1</td>
</tr>
<tr>
<td>Fraction of payoff lost in bankruptcy</td>
<td>$\mu_b$</td>
<td>0.15</td>
</tr>
<tr>
<td>Variance of log normal productivity</td>
<td>$\sigma_\omega$</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Monetary Policy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inertia Parameter</td>
<td>$\rho_m$</td>
<td>0.5</td>
</tr>
<tr>
<td>Inflation Sensitivity</td>
<td>$\phi_M$</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 3: **Parameter values for calibrated model**
effect of each of the channels separately and combined together.

Figure 2 plots the impulse response to a 1 percent increase in country U’s interest rates or monetary tightening by the dominant country. In each subfigure, I show the response in the baseline case (that is, with producer currency pricing and financing with no frictions) and add each of the channels subsequently to show the effect of each of the channels separately as well as together. The solid black line represents the baseline case. The dashed red line represents the case where instead of PCP, I introduce DCP and there are no dominant currency loans as well as the financial accelerator channel is shut off. Similarly, represented by green dashed line, we see the impact of DCF with financial accelerator but with PCP. Finally, the solid blue line indicates the combination of both the channels together - DCP and DCF with financial frictions.

Due to a monetary tightening in the dominant country (country U), Equation 16 tells us that the home currency depreciates against the dominant currency as shown in Figure 2b. If we look at Figure 2c, we notice that due to a depreciation of home currency, exports are muted in case of DCP with no DCF and no financial frictions as compared to the baseline case despite the expansionary effect of monetary policy. Similarly, if we shut the DCP channel and allow for DCF with financial frictions, we see a similar impact on the export quantity where the exports so not increase as much as they do in baseline case due to a home currency depreciation. The most interesting and novel result is the case represented in the solid blue line where both the channels DCP and DCF with financial frictions act together and we observe that exports go down as a result of a depreciation of home currency. And this is in congruence with the empirical results in Figure C.3 where in short run exports decrease due to a depreciation of the currency. Further, this signifies a major blow to the external rebalancing mechanism as mentioned in the traditional literature.

Similarly, if we compare the baseline case where a depreciation of home currency leads to a reduction in imports (Figure 2d) with the cases where the new channels are added, we observe that the decline of imports in the case of DCP is bigger than that of DCP because of export contraction under DCP and use of imported inputs. Similarly, DCF (with financial frictions) implies that imported investment goods become expensive and

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6My results concur with Gopinath et al. (2020) where they too find that export quantities are muted in DCP as compared to PCP
Figure 2: Impact of monetary tightening by dominant country on Home country

we see a larger decline as compared to the baseline case. And if we combine the two channels together, we see a bigger decline than the decline from the individual channels respectively.

6.2 Role of Financial Frictions

In order to understand the role of financial frictions in this model, I compare three cases - 1) DCP without financial frictions, 2) DCP with frictions and home currency
borrowing only and 3) DCP and DCF with financial frictions. In the third scenario, we consider a mix of home currency and dominant currency loans with the ratio of home currency loans to domestic currency loans as 1:1. As discussed previously, due to the introduction of financial frictions, a depreciation of the home currency is expected to lead to a decline in the investment quantity. Figure 3a clearly shows the decline in the investment if we move from frictionless case to the home currency debt case and they fall further if the debt is financed in dominant currency too. Further, we observe the impact of financial frictions on imports (Figure 3b) as well where dominant currency financing coupled with financial frictions leads to a larger decline in imports as compared to the frictionless case. With foreign currency debt, the depreciation of the exchange rate reduces entrepreneurial net worth, thus enhancing the financial accelerator mechanism.

![Graphs showing the role of financial frictions on investment and imports](image)

Figure 3: Role of financial frictions due to monetary tightening by dominant country on Home country

### 6.3 Fixed v/s Flexible Exchange rates

In this section, we consider shocks to the home economy under three different scenarios (i) a fixed exchange rate regime and (ii) a floating exchange rate regime where the central bank manages the nominal interest rate according to a Taylor rule.

Under the fixed exchange rate regime, the central bank keeps the nominal exchange rate pegged at a predetermined level, i.e.,

\[ S_t = \bar{S}, \forall t \]  \hspace{1cm} (44)
Under the fixed exchange rate regime, the domestic nominal interest rate rises to match the increase in dominant country’s monetary tightening as per equation 16. Due to nominal price rigidities, there is also a significant increase in the real interest rate which, in turn, induces a contraction in output. The financial accelerator magnifies the output drop — the rise in the real interest rate induces a contraction in asset prices, which raises the leverage ratio and the external finance premium. The increase in the latter further dampens investment and output.

Under the flexible exchange rate regime, the policy instrument becomes the nominal interest rate. As per equation 41, the central bank adopts a feedback rule that has the nominal rate adjust to deviations of CPI inflation from the target value. So, the domestic nominal interest rate is no longer tied to country U’s interest rate, rather governed by the feedback rule. The rise in the country risk premium produces an immediate depreciation of the domestic currency, but due to the dominant currency framework, we observe a decrease in exports and a drop in CPI inflation. The central bank reduces the nominal interest rate, according to the feedback rule. With the current parameterization, this implies only a modest increase in the real interest rate however, and a moderate drop in investment. Because the fall in domestic inflation is due to the currency depreciation, it is short-lived. Output falls slightly on net, due to offsetting effects of a reduction in investment demand and increasing exports. Overall, output is significantly more stable under the flexible exchange rate regime.

7 Concluding Remarks and Further Research

This paper presents a unique paradigm for small open economies involving the pricing and financing in dominant currency - the dominant currency paradigm. In this paper, I developed a small open economy general equilibrium framework that incorporated nominal price and wage rigidities, financial frictions, imported inputs into production and pricing and borrowing in dominant currencies. The objective was to explore the interaction between pricing and financing in a dominant currency to explain the failure of external readjustment mechanism of exchange rates which has been explored in the empirical literature extensively. I found that the model’s mechanism is quite successful in explaining the impact on trade volumes due to (say) a monetary tightening in the dominant country. The findings imply that a weakening of emerging market currencies
relative to the dominant (dollar) currency following, say, a monetary policy tightening in the latter, will be associated with a decline in world trade (exports plus imports) relative to the situation when pricing and financing is in the producer’s currency.

7.1 Further Research - Optimal Debt

There are two possible extensions of this paper. First, in this paper the choice of the ratio of home currency to dominant currency loans has been kept exogenous. Endogenizing this choice would lead to an interesting question of optimal portfolio of debt for the small open economy. The current assumption of a fixed ratio of the debt portfolio is useful in simplifying the model which would otherwise be further complicated by this choice since the dynamics of the ratio of the domestic debt to foreign debt would further affect the net worth and external finance premium. And it is a pertinent question for a small open economy to determine the optimal level of dominant currency debt on its balance sheet. In this direction, Eren and Malamud (2021) does a good job in developing an international general equilibrium model in which firms optimally choose the currency composition of their nominal debt but their model does not venture into the intersection where dominance of the currency is applicable in pricing and financing. This paper has the potential of taking that discussion forward.
7.2 Further Research - Optimal Policy

Another extension of this paper is in the realm of optimal monetary policy. In the NOEM literature pioneered by Obstfeld and Rogoff (1995), it has been shown that, although gains from coordination are theoretically possible, they are quantitatively small (Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005)). The remarkably strong conclusion about the lack of gains from coordination has stimulated a lively debate and a growing strand of literature in search of sources of coordination gains by enriching the simple framework built by Obstfeld and Rogoff (2000) and Obstfeld and Rogoff (2002).

Clarida et al. (2002) developed the canonical model for open-economy monetary policy analysis in the New Keynesian framework. Their two-country model assumes PCP, and that Home and Foreign households have identical preferences. These two assumptions lead to the conclusion that purchasing power parity holds at all times—the consumption real exchange rate is constant. They argued that optimal policy is isomorphic to the baseline closed-economy models.

Underlying the classical view, there are two key assumptions. First, frictionless asset markets provide insurance against all possible contingencies across countries. Second, producer prices are sticky in domestic currency, so that the foreign currency price of products move one-to-one with the exchange rate (Producer Currency Pricing).

However, Corsetti, Dedola, et al. (2010) identifies deviations from the said assumptions. For instance, the gains from coordination can be related to the degree of exchange-rate pass-through. Exchange rate plays a dual role of relative price in the goods and the asset markets which is the source of the policy problem raised by misalignments and imbalances in a closed-economic context. In addition, inefficiencies and trade-offs with specific international dimensions result from cross-border monetary spillovers when these are not internalized by domestic monetary authorities.

In this direction, several papers have attempted to relax one or both the assumptions to highlight the gains from coordination. For example, Engel (2011) draws out the im-

\footnote{Similar result by G. Benigno and P. Benigno (2006)}
plications for monetary policy using LCP in a complete market setting and argues that trade-off should involve not only inflation and the output gap but also the exchange rate misalignment. Casas, Diez, et al. (2017) also derive the linear quadratic representation of the optimal monetary policy problem for a small open economy with DCP and complete markets, following Woodford (2003). Corsetti, Dedola, et al. (2018) study the exchange rate misalignments (using LCP) in an incomplete market setting. However, as Engel (2016) points out that “...monetary policy cooperation versus non-cooperation has not yet addressed how various financial market distortions affect policy rules...” and also that “...Research has not caught up with policy concerns about spillovers from monetary policy and the gain from monetary policy coordination...”. As per the results of this paper, standard monetary policy and exchange rate flexibility would not be able to fully insulate a small open economy from shock as it does in the Mundell-Fleming Framework. And therefore, it seems that the introduction of imperfect asset market in this paper along with dominant currency pricing and financing may provide directions for future research.

However, one caveat is that since all these models (including this paper) show the impact on terms of trade and achieving optimal monetary policy through terms of trade adjustment or the situation where the central bank (may) targets current account imbalances has not provided a clear answer on whether there are gains from cooperation or/and how non-cooperative policy would differ. To address this, Basu et al. (2020) provides an integrated framework since interest rate may not function as effective instrument of monetary policy. On separate lines, Gourinchas et al. (2021) use market segmentation and investigate how non-conventional policies such as Quantitative Easing and Forward Guidance transmit. Optimal policies (monetary or macroprudential) remains an open question to be answered.
References


Friedman, M. (1953). The case for flexible exchange rate in essays in positive economics, chicago: University press.


## Appendices

### A The Financial Contract

### B Tables

Table B.1: US Monetary Policy and EMEs’ Imports - Impact of Dollar Invoicing of Imports

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>$\Delta M$ (1)</th>
<th>$\Delta M$ (2)</th>
<th>$\Delta M$ (3)</th>
<th>$\Delta M$ (4)</th>
<th>$\Delta M$ (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta$ US shadow rate</td>
<td>-0.005</td>
<td>-0.011***</td>
<td>-0.009</td>
<td>(0.008)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$\lambda_m \cdot \Delta$ US shadow rate</td>
<td>-0.034*</td>
<td>-0.030*</td>
<td>-0.017**</td>
<td>(0.012)</td>
<td>(0.012)</td>
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<tr>
<td>$\lambda_m$</td>
<td>-0.041*</td>
<td>-0.005</td>
<td>0.200**</td>
<td>(0.022)</td>
<td>(0.084)</td>
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<tr>
<td>$\theta$</td>
<td></td>
<td></td>
<td></td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td>$\Delta$ ROW policy rate</td>
<td>-0.317***</td>
<td>-0.337***</td>
<td>0.169</td>
<td>-0.142</td>
<td>(0.069)</td>
</tr>
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<td>0.180</td>
<td>0.078</td>
<td>0.328</td>
<td>(0.146)</td>
</tr>
<tr>
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<td>0.016</td>
<td>-0.010</td>
<td>-0.105</td>
<td>(0.027)</td>
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<tr>
<td>Constant</td>
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<td>0.029***</td>
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<td>-0.039</td>
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<td>Observations</td>
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<td>4,907</td>
<td>4,907</td>
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<td>0.0031</td>
<td>0.355</td>
<td>0.618</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Time FE</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

### C Figures
Table B.2: US Monetary Policy and EMEs’ Imports - Impact of Dollar Financing

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Δ M</th>
<th>Δ M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>θ * Δ</td>
<td>-0.038***</td>
<td>-0.046***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>θ</td>
<td>-0.017</td>
<td>-0.021</td>
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<tr>
<td></td>
<td>(0.017)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>λₘ</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td></td>
</tr>
<tr>
<td>Δ ROW policy rate</td>
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<td>0.062</td>
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<td></td>
<td>(0.081)</td>
<td>(0.099)</td>
</tr>
<tr>
<td>CPI Inflation</td>
<td>1.111***</td>
<td>0.912**</td>
</tr>
<tr>
<td></td>
<td>(0.322)</td>
<td>(0.375)</td>
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<td>GDP Growth</td>
<td>0.091</td>
<td>0.056</td>
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<tr>
<td></td>
<td>(0.729)</td>
<td>(0.840)</td>
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<tr>
<td>Constant</td>
<td>0.048***</td>
<td>0.060**</td>
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<td></td>
<td>(0.018)</td>
<td>(0.029)</td>
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<td>Observations</td>
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<td>R-squared</td>
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<td>Number of countryid</td>
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<td>19</td>
</tr>
</tbody>
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Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Figure C.1: Source: Ilzetzki et al (2018)

Figure C.2: Source: Boz et al (2020)
Figure C.3: Source: Adler et al (2020)

Figure C.4: Source: Casas et al (2020)