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Currency Returns and Fundamental Sources of Risk

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Abstract

We present evidence that uncertainty regarding to investment-specific technology, the marginal efficiency of investment, and the growth of money stock are the key sources of currency risk. We develop an open-economy DSGE model in which these three processes become risk factors that drive currency excess returns. These new factors prove to be empirically relevant for pricing currency excess returns. The risk prices associated with these factors are positive and significant. We find that currencies from countries with low levels of investment-specific technology processes, low levels of the marginal efficiency of the investment process, and high money growth rates earn higher excess returns. Furthermore, we show that currencies from countries with low exposure to the global component of the three processes earn higher excess returns. Our empirical evidence accounts for both the cross-section of average excess returns (portfolios) and individual currency payoffs with the US Dollar. We also reveal a downward trend in the carry trade return over the period 1980 to 2019.

Key-words: carry trade; business cycles; consumption growth; exchange rates; currency risk.

JEL Classification code: F31, F41, G12.

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1 Introduction

What are the fundamental sources of currency risk? The Consumption Capital Asset Pricing Model (CCAPM) suggests an answer: the covariance between currency excess returns and factors that originate business cycle fluctuations. Favourable evidence for partial equilibrium versions of the model is controversial at best. There is no conclusive finding which supports a factor model for currency risk, so the quest remains open (Cochrane, 2017; Ready et al., 2017; Colacito et al., 2020). This raises a more specific question. Can macroeconomic shocks simultaneously explain business cycle fluctuations and currency excess returns in a general equilibrium model? Providing coherent answers to these questions is the main challenge of our study.

We propose an open-economy general equilibrium model that explains the dynamics between business cycle fluctuations and currency excess returns. Our model puts together three crucial ingredients to the asset pricing literature in open macro-finance: i) Ricardian and non-Ricardian households; ii) a shock structure with three main sources of business cycle fluctuations: investment-specific technology (IST), the marginal efficiency of investment (MEI), and money growth processes (MON), and iii) innovations that depend on both local (domestic - idiosyncratic) and global (systemic) components. In a nutshell, these shocks cause fluctuations in macroeconomic variables and can also change the time preference parameter used to discount the future utility of the Ricardian households[2]. This, in turn, affects the relative demand for each available asset in the economy. The IST, MEI, and money growth shocks thus play a central role in the theory of currency risk pricing. Our model, therefore, offers a unified framework to explain business cycle fluctuations and currency excess returns.

In the empirical part, we investigate whether these macroeconomic sources of risk are relevant risk factors for the traditional carry trade (CT) strategy. This foreign exchange (FX) speculative investment consists in borrowing from low-interest rate currencies to invest in high-interest rate countries. In equilibrium, CT appears to be a profitable investment. High-interest-rate currencies tend to appreciate over low-interest-rate ones. This also corresponds to the well-known *forward premium puzzle*, an anomaly largely investigated by the literature (Fama, 1984a; Evans and Lewis, 1995; Engel, 1996; Frankel and Poonawala, 2010).

In our asset pricing analysis, we employ the methodology of Fama and MacBeth (1973) to investigate whether risk factors derived from our three shock processes can price currency excess returns. By assuming a linear relationship between our risk factors and currency excess returns, we are able to test whether our proposed risk factors are priced in foreign exchange markets, both in the time series of individual currencies and in a broad cross-section of currency portfolios.

Using an annual dataset from 1980 to 2019 from the International Financial Statistics (IFS) of the International Monetary Fund, we document the behaviour of CT returns, our three shock processes, and a set of macroeconomic variables for a large sample of countries: nominal interest rate, exchange rate, inflation, and the marginal product of capital. Our investigation reveals a downward trend in CT returns. We unveil an average decline of approximately 8% in the CT returns during the period. We show that this trend is consistent with the cross-country behaviour of nominal interest rate, exchange rate, inflation, and the marginal product of capital. In addition, we show that this downward trend is also seen in the growth rate of the IST, MEI, and money aggregates.

In our asset pricing exercises, we find that the risk factors derived from the IST, MEI, and money growth help to explain currency excess returns. Our findings suggest that these factors are priced in a cross-section of currency excess returns and that the prices of risk are positive and significant. We find that the *risk premia* associated with the IST, MEIN, and money growth ranges from 2.66% to 8.01% per annum. We also find evidence that our proposed factors are important to explain country-level excess returns. Overall, these results can be interesting to academics, policymakers, and agents in the financial industry alike. Detecting the fundamental sources of risk is crucial to explain the dynamics and differences in real interest rates across countries. Properly understanding currency risk is important to portfolio allocation. Finding the relevant signals for factor investing is paramount to proper risk management.

The rest of the paper is organized as follows. The next section presents a brief review of the related literature. Section 3.7 presents our economic model. Section 4 provides the results of our asset pricing exercises. Finally, we present our concluding remarks.

2 Currency Excess Returns and Risk Factors

The literature investigating asset pricing in the FX market can be classified into two categories. The first approach, also known as Macro-Finance, assesses the link between asset pricing and economic fluctuations (Cochrane, 2017). The second focuses on the empirical analysis of asset pricing models. The approach investigates the link

[2] There are several papers which consider preferences or “taste shocksâĂŹâĂŹ in asset pricing (Campbell, 1986; Stockman and Tesar, 1995; Pavlova and Rigobon, 2007; Maurer, 2012; Gabaix and Maggiori, 2015; Albuquerque et al., 2016; Chen and Yang, 2019; Gomez-Cram and Yaron, 2021). Our model is capable to deliver an asset pricing equation with a risk factor associated with time preference shocks like the "Valuation risk" explored in the asset pricing literature (Albuquerque et al., 2016).

between risk factors and moments of exchange rate distributions. The following is a review of recent papers in these two lines of research.

An early contribution to the literature is given by the work of Lustig and Verdelhan (2007). They apply the theoretical model introduced by Yogo (2006) to evaluate the yields from CT. These authors build portfolios of positions in currency forward contracts sorted by interest rate differentials and show that the UIP condition fails in the cross-sectional dimension. They are primarily concerned with explaining CT returns through the CCAPM, using consumption growth of durable and non-durable goods as risk factors. Conversely, Burnside (2011b) argues that the consumption betas estimated by the CCAPM are statistically insignificant and/or economically too small to rationalize the high returns from CT portfolios. In a similar vein, Burnside (2011a) finds that traditional CAPM risk factors, the three factors of Fama and French (1992), and the standard CAPM augmented with industrial production and the US stock market volatility do not have sufficient explanatory power of CT excess returns. Our work complements this literature by expanding the CCAPM with a risk factor associated with changes in household time preference. This allows them to dynamically swap current consumption for future consumption. From our open economy model, we derive the CCAPM with two factors associated with the growth rate of consumption and time preference. The latter depends on household expectations about the future economic developments of domestic and foreign countries. This in turn depends on the IST, MEI, and MON shocks.

By applying factor analysis to a collection of time series formed by the returns on FX portfolios, Lustig et al. (2011) directly extract two principal components able to capture most of the data variance. The level factor (labeled as RX factor) which essentially represents the average yield on portfolios, and the slope factor (labeled as HML factor). Then, they propose a no-arbitrage model of exchange rates with a specific and a global risk factor capable of replicating the empirical findings of the level and slope factors, respectively. The first type of priced risk arises from country-specific shocks and the second is associated with a common shock. In parallel to that, they complement their empirical work by constructing an alternative proxy for the slope factor derived from the global stock market volatility. The authors find a negative relation between yields on CT and stock market volatility. High interest-rate bearing currencies tend to have low returns in moments of high stock market volatility. Building on the work of Lustig et al. (2011), a novel measure of global volatility risk that comes out of FX markets is proposed by Menkhoff et al. (2012a). Essentially, their empirical results corroborate the evidence found by Lustig et al. (2011). High interest rate currencies are negatively correlated with global currency market volatility, offering lower returns in times of unexpected high volatility. Our study also adds to this literature by revealing three new risk factors priced in the currency markets. These risk factors stem from fundamental macroeconomic sources of risk associated with the IST, MEI, and money growth processes.

A growing number of papers have yielded alternative answers to the *forward premium puzzle* and the high average payoffs from CT (see, e.g., Bansal and Shaliastovich (2013), Burnside et al. (2010), Hassan (2013), Ferreira and Moore (2015), Ready et al. (2017), and Fratzscher et al. (2018)). The works of Berg and Mark (2019) and Backus et al. (2013) connect technology shocks and monetary policy with empirical regularities observed in currency markets. Berg and Mark (2019) develop a two-country DSGE model in to investigate the forward premium bias, the CT return, and the long-run risk reversal. They show that heterogeneity between countries in TFP processes is capable of generating the systematic risk priced in currency returns. In their model, monetary policy rules can act to amplify or reduce the *risk premium.* Focusing on the role of monetary policy, Backus et al. (2013) develop a two-country complete markets endowment economy model. Their purpose is to examine which specification of the Taylor's rule can resolve the *forward premium puzzle.* As in Berg and Mark (2019), they find that heterogeneity between countries is necessary to explain currency excess returns: the currency of the country with the most pro-cyclical Taylor rule earns a positive excess return.

Lustig et al. (2014) propose a novel currency investment strategy, the "dollar carry trade". In this strategy, the investor takes a long position in a portfolio of foreign currencies and a short position in the US dollar whenever the average foreign nominal interest rate is above the US nominal interest rate, while she shorts all foreign currencies and takes a long position in the US dollar otherwise. They extend the no-arbitrage model of exchange rates developed by Lustig et al. (2011) to allow the risk price associated with the common factor to depend on world and country-specific factors. They find that the "dollar carry trade" generates a Sharpe ratio around 0.50. Using their no-arbitrage model, they show that currency excess returns are a compensation to US investors for taking a long position in foreign currencies when the US pricing kernel is more volatile than the foreign counterpart. The connection between a world factor and currency excess returns is also analyzed by Colacito et al. (2018). They develop a multi-country endowment economy to analyze the interaction between currency excess returns and the heterogeneous exposure of countries to global endowment long-run growth news shocks. In their framework, this heterogeneous exposure stands out as a key driver of currency and interest rates movements. They argue that the exposures of country endowments to global growth news capture fundamental differences across countries (e.g., size (Hassan, 2013), commodity intensity (Ready et al., 2017), monetary policy rules (Backus et al., 2013) and financial development (Maggiori, 2017)).

The most recent papers have set out to explore the relationship between gains from CT and the international spillover of monetary policy, orchestrated by the world's leading central banks (Calomiris and Mamaysky, 2019), fluctuations in sovereign credit default swaps (Della Corte et al., 2022), and the strength of the business cycles of countries measured by the output gap (Colacito et al., 2019). Two important insights associated with currency returns have emerged from the international finance literature: i) the differences between macroeconomic fundamentals of countries are essential for understanding currency *risk premiums* Backus et al. (2013); Berg and Mark (2018a, 2019); Colacito et al. (2019), and; ii) currency-specific risk as well as global risks are compensated in currency excess returns Lustig et al. (2011); Atanasov and Nitschka (2014); Lustig et al. (2014); Berg and Mark (2018b); Colacito et al. (2018); Verdelhan (2018). In general, the literature has associated changes in global risks with various economic variables (e.g., macroeconomic fluctuations, shifts in risk aversion, changes in expectations, catastrophic episodes (crash risk), etc.). Our work complements this literature by providing a risk-based explanation for CT returns derived from: i) cross-country differences in the local IST, MEI, and money growth shocks, and; ii) heterogeneous exposure of countries to global IST, MEI, and money growth shocks. Most importantly, we reconcile exchange rate risk factors with these three sources of macroeconomic fluctuations, which is new in the literature.

IST, MEI, and Money Growth Shock Processes. One of the most contentious issues among macroeconomists concerns the origins of business cycle fluctuations. The debate focuses on identifying the most relevant shocks capable of explaining the variability of output and hours worked at business cycles. In open economy models, the international flow of goods and capital is the key driving force behind the transmission of these disturbances. The protracted recession starting from the GFC reignited the debate over the sources of business cycle movements. Justiniano et al. (2011) argue that investment shocks appear to be a more promising way to explain macroeconomic fluctuations than the traditional total factor productivity, especially for reconciling the events triggered by the GFC. They develop a business cycle model where the capital accumulation process can be affected by two different shocks. The IST shock affects the transformation of consumption into investment goods. The MEI shock impacts the process by which investment goods are transformed into physical capital. In their model, the IST shock is equal to the inverse of the price of investment relative to consumption. They also argue that the MEI shock may be associated with disturbances in the financial system's intermediation capacity (e.g., the credit spread between the returns on high-yield and AAA corporate bonds).

An early contribution to the analysis of the importance of investment shocks as driving forces of macroeconomic fluctuations is given by Greenwood et al. (1988). In contrast to the view that cycles are generated by exogenous shocks to the production function, they argue that it is shocks to the marginal efficiency of investment that are important in producing fluctuations in output. In their model, positive shocks to the marginal efficiency of investment are associated with reductions in the cost of capital accumulation and trigger the production of new more efficient physical capital. The relevance of investment shocks was later reinforced by Greenwood et al. (1997b) and Greenwood et al. (2000).

Since the work Greenwood et al. (1988), Greenwood et al. (1997b), and Greenwood et al. (2000) several papers incorporated investment shocks in their DSGE models in order to: i) analyze business cycle fluctuations (**?**Liu et al., 2011; Khan and Tsoukalas, 2011; Hirose and Kurozumi, 2012; Moura, 2018; Furlanetto et al., 2013); ii) explore long-run macroeconomic trends (Chen and Wemy, 2015); iii) derive restrictions from DSGE models to be used in the estimations of Structural Vector Autoregressive (SVAR) (Braun and Shioji, 2007; Fisher, 2006), and; i) explain the historical changes in labour and capital share (Karabarbounis and Neiman, 2014).

Our study is related to the growing literature on international real business cycles that has employed the IST and MEI shocks in explain macroeconomic fluctuations and the dynamics of the balance of payments. Early contributions are given by Finn (1999), Boileau (2002) and Letendre and Luo (2007). More recently, Jacob and Peersman (2013) estimate a two-country DSGE model and find that the MEI shock is the source of nearly %50 of the variance in the US business cycle fluctuations. They also show that IST shocks can have a deteriorating effect on the trade balance. Their results are in line with Raffo (2010). The two models have different features and transmission channels for investment shocks. However, in general, a local positive investment shock has the following results in the domestic economy: i) increase of output, investment, consumption, and imports; ii) appreciation of the terms of trade (increase in domestic prices). Therefore, the investment shock is associated with a trade deficit. Dogan (2019) explores the spillover effect of IST shocks originating in advanced economies (USA) on emerging countries (Mexico). The author sets up a two-country economy and assumes that IST shocks originates in the advanced economy and is transmitted emerging country. Dogan (2019) finds that IST shocks in the advanced economy explain roughly 44% to 60% of the variability in output, investment and consumption in the emerging country.

Many other papers incorporate investment shocks in their open-economy framework. Liu et al. (2011); Khan and Tsoukalas (2012); Miyamoto and Nguyen (2020) use investment shocks to analyze the sources of macroeconomic fluctuations. Coeurdacier et al. (2010) investigate equity home bias, the dynamics of foreign asset positions, and international capital flows. Differently, Mandelman et al. (2011) focus on solving the puzzles of international real business cycle models (the "quantity, international co-movement, Backus-Smith, and price puzzles"). Basu and Thoenissen (2011) question the ability of the inverse of the relative price of investment to work as a proxy to measure the IST in an open-economy setting. Schmitt-Grohé and Uribe (2012) estimate a DSGE model to investigate the role of the reaction of forward-looking agents to anticipated future changes in macroeconomic fundamentals on business cycle fluctuations. We complement this literature by incorporating an additional transmission channel for the IST and the MEI shocks, through their effect on the time preference parameter. In our model, this second channel reflects changes in the expectations of Ricardian households and has important implications for macroeconomic fluctuations and asset prices.

Investment shocks are also key ingredients in the finance literature. The work of Papanikolaou (2011) uses the IST to explain differences in *risk premium* between firms in the consumer and investment goods sectors. The author develops a DSGE model and derives an asset pricing equation where the expected equity excess return depends on the covariance of the stochastic discount factor with shocks in the consumer goods sector and shocks in the investment goods sector shocks. Furthermore, Papanikolaou (2011) shows that, in general, a calibrated version of the model can generate keys moments (volatility and correlation) of real macroeconomic aggregates and asset returns consistent with those observed in the data for the US economy. Kogan and Papanikolaou (2013), Yang (2013), Kogan and Papanikolaou (2014), Li (2018), Dissanayake et al. (2019), Garlappi and Song (2020) explore the connection between IST shocks and the cross-section of US and international stock returns. Unlike these works, our study helps clarify the connection between currency excess returns and country characteristics related to the magnitudes of the IST and MEI shocks.

Our study is also related to the literature investigating money's role in business cycle fluctuations. Typically, models that analyze the effects of monetary policy on macroeconomic variables and asset pricing employ a setup where monetary shocks stem from an interest-rate rule or a money supply equation. On the other hand, models that explore the role of money demand employ a framework where money enters the utility function and is affected by an exogenous shock process (Nelson, 2002; Andrés et al., 2009; Canova and Menz, 2011; Castelnuovo, 2012). The finance literature uses different approaches to explore the idea that real money growth is a priced risk factor in asset markets. An ongoing debate in the literate concerns the sign of the risk premium associated with money in the stock market (Chan et al., 1996; Balvers and Huang, 2009; Gu and Huang, 2013). Unlike these works, we consider the role of money demand in an open-economy scenario. Our analysis explores the domestic effects of money demand shocks and their spillovers abroad. Furthermore, our study complements this literature by analyzing the sign and magnitude of the *risk premium* associated with money growth in the foreign exchange market.

2.1 Fundamental Shocks

In our model the IST, MEI, and MON processes are the fundamental sources of risk that affect households' decision about consumption and savings. Furthermore, changes in MPK, inflation and exchange rate arise due to these shocks. There are two types of households: Rule-of-thumb (ROT) and Optimizing (OPT). The first type does not have access to financial markets and spends all of its income on consumption. The second type has access to capital and financial markets and divides income optimally between consumption and savings.

In what follows, we explore the behaviour of CT returns and its components: i) the differential between nominal interest rates, and; ii) exchange rate fluctuations. Then, we analyze the first and second moments of the following quantities: i) inflation, nominal interest rate, the MPK, and exchange rate; ii) the IST, MEI, and MON processes; iii) the growth rate of investment, capital stock and consumption. The purpose of this analysis is to explore the possible connections between the CT returns and the IST, MEI and MON processes. This is important, as our theoretical model associates expected CT returns with the IST, MEI, and MON processes.

In our analysis, we work with a broad panel of developed and developing countries. The developed group consists of the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The other countries in the sample are: Bangladesh, Bolivia, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Ecuador, Egypt, Hong Kong, Hungary, India, Indonesia, Israel, Lithuania, Malaysia, Mexico, Morocco, Paraguay, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Thailand, Tunisia, Turkey, Ukraine and Uruguay. We also bring to the forefront the set of G-10 countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, and the United Kingdom. We employ monthly, quarter, and annual data from different sources. Appendix A.1 describes our dataset.

Our study consider a sample of 60 countries and cover the period between 1980 and 2019. As outlined by Lustig and Verdelhan (2007) the restrictions imposed by the Euler equation on the joint distribution of exchange rates and interest rates is coherent only if foreign investors are allowed to purchase local assets. As noted by Lane and Ferretti (2003), the process of financial globalization, promoted by capital account liberalizations, electronic trading, increasing flow of information across economies and falling transaction costs, has led to a large expansion in cross-border asset trading. The clear reduction in barriers to international trade in financial markets have been especially notorious since the 1980s, as pointed by Coeurdacier and Rey (2013). These authors present empirical evidence of the growth in cross-border financial diversification over the last decades, which confirms the findings of several other papers (see, among others, Tesar and Werner (1995); Lane and Milesi-Ferretti (2003, 2007b,a)). Therefore, we believe it is reasonable to regard our sample period as appropriate, given that most countries, particularly emerging economies, have been part of this unprecedented wave of international financial integration and trade openness since the beginning of the 1980s.

In Appendix A.1.6, we briefly discuss the connection between CT returns and the relevant macroeconomic variables behind their fluctuations. CT returns are computed according to equation 76 in Appendix A.1.6 from the point of view of a US investor who goes long in countries with a nominal interest rate higher than the US or short, otherwise. We use monthly nominal interest rates and end-of-month nominal exchange rates. Due to the nature of foreign exchange investments, we had to refine the raw data to take into account issues related to countries' financial openness, sovereign defaults, and the entry of European countries into the Eurozone. Appendix A.1 provides a detailed description of these refinements.

Regarding interest rates, treasury bills were the most common rates chosen as a proxy of returns on short-term bonds. When these interest rates were not available, we worked with money market rates. In the absence of the latter, we selected Government Bonds and, finally, if all the aforementioned options were unavailable, we used Deposit Rates. CT returns are traditionally constructed using short-term assets, which explains our choice.[3] Finally, we implemented two additional adjustments in our dataset: i) the exclusion of countries during periods when they undergo states of very low international financial openness or sovereign default, and ii) the exclusion of European countries in their month of entry into the Eurozone, due to the change in the currency denomination.

We follow Greenwood et al. (1992), Greenwood et al. (1997a) and Justiniano et al. (2011) and use the relative price of investment as a proxy for the IST process: $IST_t = \frac{P_t^c}{P_t^i}$, where P_t^c is the consumer price index and P_t^i is the price of investment. The MEI shock might reflect fundamental disturbances in the ability of the financial system to intermediate capital investments. As emphasized by Justiniano et al. (2011) the financial system plays a crucial role in the process of producing physical capital. They use the external finance premium, proxied by the spread between the returns on high-yield and AAA corporate bonds, as a measure of the MEI process. We consider a broader measure as a proxy for the MEI process, the Index of Financial Development (IFD) developed by the IMF (Svirydzenka, 2016). The IFD considers in its composition not only the typical empirical measures of financial development (the ratio of private credit to GDP and the stock market capitalization to GDP), but also a set of nine sub-indicators that summarize how financial institutions and financial markets are in terms of their depth, access, and efficiency. Due to the existence of more than one measure of money aggregate, we chose to use both M1 and M3 as proxies for the MON process. By using a narrow and broad money measure, we can also check whether differences in liquidity play a role in our asset pricing exercises. [4]

2.1.1 Carry Trade Returns

To establish our claims, we start with the analysis of our series of CT returns. Figure (1) presents the evolution of the 10-year moving average of CT returns by country groups (All, Developed, Developing and G10) and CT portfolios. Panels (a) and (b) consider the entire dataset. In panels (c) and (d) we consider only Germany as the country associated with the Euro, therefore we exclude all members of the Eurozone from their entry into the membership onward. The portfolio returns - panels (b) and (d) - are obtained from the high-minus-low strategy of building CT portfolios (Lustig et al., 2011; Menkhoff et al., 2012a; Corte et al., 2016; Colacito et al., 2019). In this case, currency excess returns are constructed by sorting countries by nominal interest rates and dividing them into six portfolios: portfolio one with the countries with the lowest interest rates and portfolio six with the countries with the highest interest rates. The returns of CT portfolios correspond to the difference between the return of portfolios six to two and portfolio one (high-minus-low). We applied the same methodology to analyze CT returns from developed countries. In this case, we form only five excess currency return portfolios and show only the result for the return of the CT portfolio formed by the difference between portfolio five and one (denoted as "P5-P1" in the figure). We also used the forward and spot exchange rates instead of nominal interest rates to derive CT returns by country groups and portfolios. We found very similar results to those shown in figure (1).[5]

The most important feature of Figure (1) is the clear decline in CT returns between 1980 and 2019. For example, panels a) and c) show that the high average returns in the 1980s (close to 7% p.a.) collapsed to roughly zero at the end of the 2010s. The qualitative result of panels b) and d) in the figure is essentially equivalent to those presented a) and c), a drop in CT returns in recent decades. For example, average returns dropped by around $12\% - 15\%$ p.a. in the 1980s to approximately $4\% - 6\%$ p.a. in the late 2010s. As will be discussed below, this reduction is accompanied by a decline in nominal interest rate differentials across countries and a reduction in exchange rate variation.

Table (1) is a representative summary of the 5-year average of CT returns from country groups (All, Developed, Developing, and G10) and the high-minus-low (HML) portfolio strategy (return on portfolio six minus the return on portfolio one). The table reports that, in general, the average of CT returns falls over time. However, it is important to note that CT returns across country groups increased markedly in 2002 and 2003. It is informative to compare the CT returns of these two years with those reported in the table. CT returns reached $11.12\%, 16.31\%, 7.89\%$, and

[3]Most of the data are from the International Monetary Fund (IFS). Moreover, we complemented IFS data on interest rates with the information provided by the OECD. We collected data on the 3-month money market rate from the OECD for the following countries: Canada (2017:M5 to 2019:M12), Japan (2017:M7 to 2019:M12), Sweden (2017:M6 to 2019:M12), Belgium (2017:M12 to 2019:M12), Finland (2018:M2 to 2019:M12), France (2017:M6 to 2019:M12), Ireland (2017:M4 to 2019:M12), Lithuania (2017:M6 to 2019:M12), Luxembourg (2017:M6 to 2019:M12), The Netherlands (2019:M7 to 2019:M12), Portugal (2017:M6 to 2019:M12), and Paraguay (2017:M4 to 2019:M12). We also used data on the 3-month money market from the European Central Bank (ECB) for the following economies: Croatia (2014:M2 to 2019:M12) and India (1991:M1 to 2004:M12).

[4]Our choice of M1 and M3 over M0 and M2 is motivated by two reasons: i) M3 is less liquid than M2, therefore M3 can better capture liquidity differences, and; ii) there is no data available for M0 covering our period of investigation.

[5]These results are not reported but are available from the authors upon request.

10.70% in 2002, and 14.70%, 17.29%, 13.08%, and 14.44% in 2003, for the group of All, Developed, Developing, and G10 countries, respectively. The increase in average returns over the period 2000-2004 can be attributed to these two unconventional fluctuations in returns.

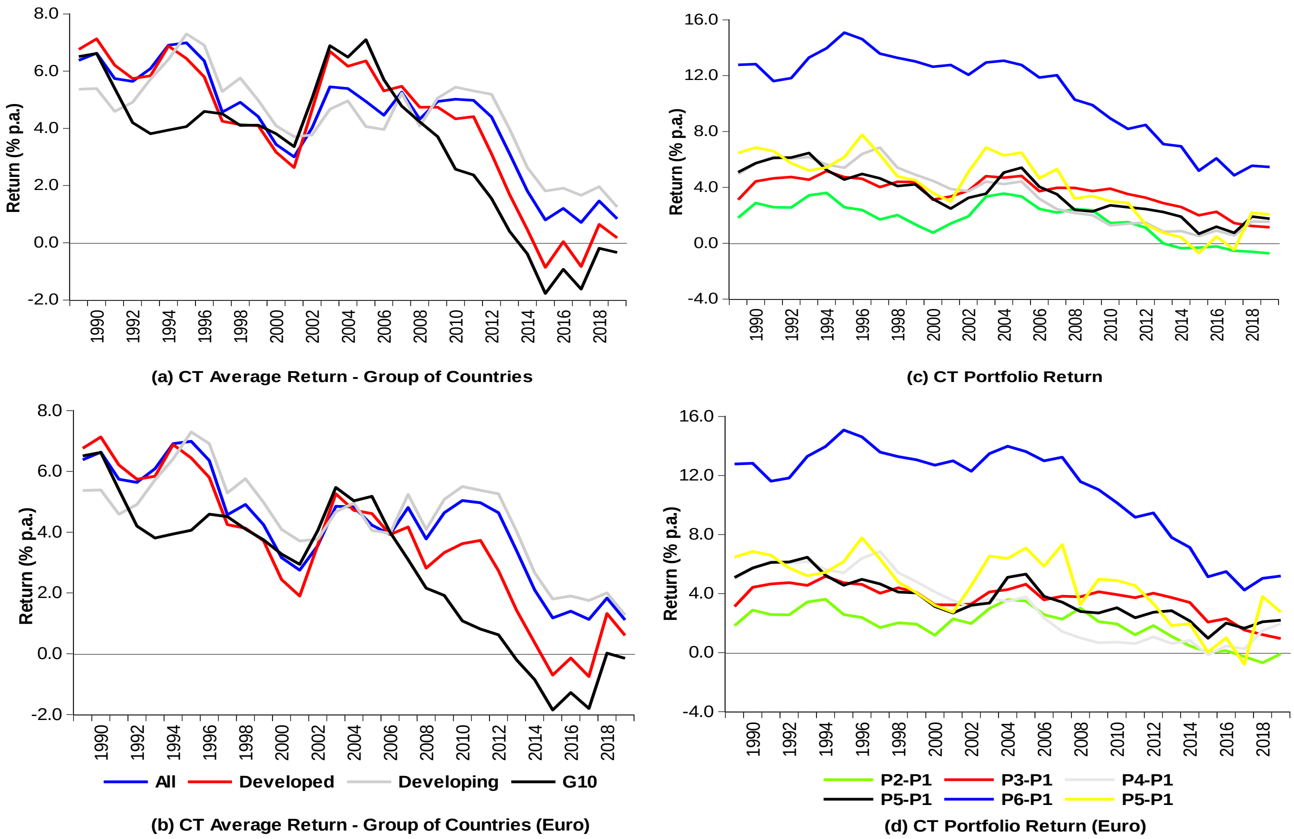

Figure 1: CT Return. The figure shows the evolution over time of the 10-year moving average of CT returns. Panels (a) and (b) consider the entire dataset. In panels (c) and (d) we consider only Germany as the country associated with the Euro, therefore we exclude all members of the Eurozone from their entry into the membership onward. The portfolio returns - panels (b) and (d) - are obtained from the high-minus-low strategy of building CT portfolios (Lustig et al., 2011; Menkhoff et al., 2012a; Corte et al., 2016; Colacito et al., 2019). To obtain the 10-year moving average values, we first computed the cross-sectional mean of the monthly data for each country group (All, Developed, Developing, and G10) and portfolios. We then used these values to calculate the average annual returns. Finally, we employed these annual values to obtain the 10-year moving average. The monthly CT returns are annualized (multiplied by twelve). The sample period is 1980-2019.

To complement our analysis, we also performed a linear time series regression of the CT returns for each group of countries on a constant and a time trend. We aggregate monthly data at annual frequency before generating average CT returns for each group of countries. We found that in all cases the estimated trend parameter is statistically significant at the 1% level. The parameter estimates and the adjusted R^2 from the regressions are as follows: i) -0.16 and 0.66 (All countries); ii) -0.21 and 0.63 (Developed); iii) -0.12 and 0.53 (Developing), and; iv) -0.21 and 0.56 (G10). This implies a reduction in CT returns ranging from 0.12% to 0.21% per year or equivalently a reduction ranging from approximately 4.80% to 8.40% over four decades. Which is in line with the results reported in Table (1).

As discussed at the beginning of this section, CT returns derive from two sources: the nominal interest rate differential and exchange rate changes. Therefore, to better understand the downward trend in CT returns, it is important to analyse the behaviour of both sources over the period investigated. Table (2) details the decomposition of CT returns between the exchange rate return (denoted by 'FX') and the differential in nominal interest rates (denoted by 'IR'). Three main results emerge from this table. First, reading down the columns of the table, we can see that the average IR returns decrease across all country groups. Second, we also find that the average FX increases between the periods 1980-1999 (average of -8.42% p.a.) and 2000-2019 (average of -1.39% p.a.) in the group of developing countries. Overall, the opposite applies to developed and G10 countries. We observe a decrease in the average FX, with the exception of the 2000-2004 period. As discussed above, the figures for this period were severely affected by the unconventional CT returns of 2002 and 2003. Third, reading across the rows of the table, we identify that, in general, the absolute values of the average IR and FX are higher in developing countries than in developed and G10 countries.

Table 1
Descriptive Statistics - CT Returns

The table shows the mean and standard deviation of CT returns considering a five-year data window. The figures in each panel are five-year averages and standard deviations of the means of the cross-sectional values for each country group (All, Developed, Developing, and G10). We also included in the last two columns of the table the average and standard deviation of CT returns from the high-minus-low (HML) investment strategy. The monthly values of CT returns are annualized (multiplied by twelve). All values in the table are presented in % p.a. The sample period is 1980-2019.

	All		**Developed**		**Developing**		**G10**		**HML**	
Period	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**
1980-1984	4.14	12.17	4.01	14.96	4.36	10.60	8.10	19.00	9.27	22.60
1985-1989	8.52	14.59	9.43	18.30	6.29	8.50	4.88	10.61	16.15	17.31
1990-1994	5.29	18.86	4.31	28.46	6.53	8.36	2.99	28.37	11.76	13.06
1995-1999	3.51	9.10	3.85	7.98	3.41	14.56	5.22	14.67	14.27	33.83
2000-2004	7.26	13.84	8.48	22.64	6.51	10.73	7.76	20.38	11.85	18.45
2005-2009	2.61	23.86	0.99	29.69	3.61	21.18	-0.33	28.46	7.91	24.50
2010-2014	0.99	23.49	-0.06	27.29	1.63	21.78	-0.43	23.40	5.95	13.59
2015-2019	0.68	9.65	0.40	14.23	0.85	11.55	-0.24	16.92	4.95	25.27

Figure (2) complements the analysis of the CT return decomposition between IR and FX. In all of the panels in this figure, the left axis measures changes in the groups of all countries and developing countries, while the right axis measures changes in the groups of developed countries and G10 countries. Panels a) and b) present the 10-year moving average of the decomposition of CT returns between the IR and FX. Panel a) reveals that the FX is almost always negative and increases over time in developing countries. On the other hand, FX is generally positive and declines over time in developed and G10 countries. In this latter case, the figure shows a downward trend until 2001, a peak in FX of approximately 7% around 2002 and 2003, and a new downward trend from this interval onward. Panel b) of the figure confirms the decrease in CT returns associated with nominal interest rate differentials for all country groups. In summary, Panels a) and b) reveal a downward trend in the magnitudes of both components of CT returns between 1980 and 2019. These results indicate that both the IR and FX are important to explain the trend decline in CT returns.

Table 2
CT Return Decomposition

The table shows the decomposition of CT returns between the FX return (denoted by 'FX') and the differential in nominal interest rates (denoted by 'IR') considering a five-year data window. The figures in each panel are the five-year average of the cross-sectional means for each country group (All, Developed, Developing, and G10). The monthly values of returns are annualized (multiplied by twelve). All values in the table are presented in % p.a. The sample period is 1980-2019.

	All		**Developed**		**Developing**		**G10**	
Period	**IR**	**FX**	**IR**	**FX**	**IR**	**FX**	**IR**	**FX**
1980-1984	6.07	-1.86	3.65	0.37	10.19	-5.27	3.29	4.76
1985-1989	7.78	0.30	4.82	4.57	13.01	-7.34	2.66	2.20
1990-1994	10.18	-5.14	4.72	-0.39	16.27	-10.49	3.45	-0.45
1995-1999	9.48	-5.78	1.85	2.00	14.59	-10.57	1.91	3.30
2000-2004	5.30	2.05	1.83	6.63	7.56	-0.71	1.57	6.17
2005-2009	3.24	-0.61	2.05	-1.04	3.87	-0.10	1.49	-1.82
2010-2014	3.36	-2.35	1.69	-1.75	4.16	-2.36	0.93	-1.36
2015-2019	2.64	-1.95	1.23	-0.83	3.43	-2.40	1.12	-1.37

Panels c) and d) of the figure display the 10-year moving averages of the standard deviations of the cross-sections of the FX and IR by country groups. To obtain the figures, we first computed the cross-sectional standard deviations of the FX and IR using monthly data from each country group. We then averaged these values considering data from a 10-year window. Panel c) reveals that the standard deviation of the FX declines both for developed and G10 countries (between 1990 and 2019) and for developing countries (from 2000 onward). The results are similar with regard to the trajectory of the standard deviation of the IR.

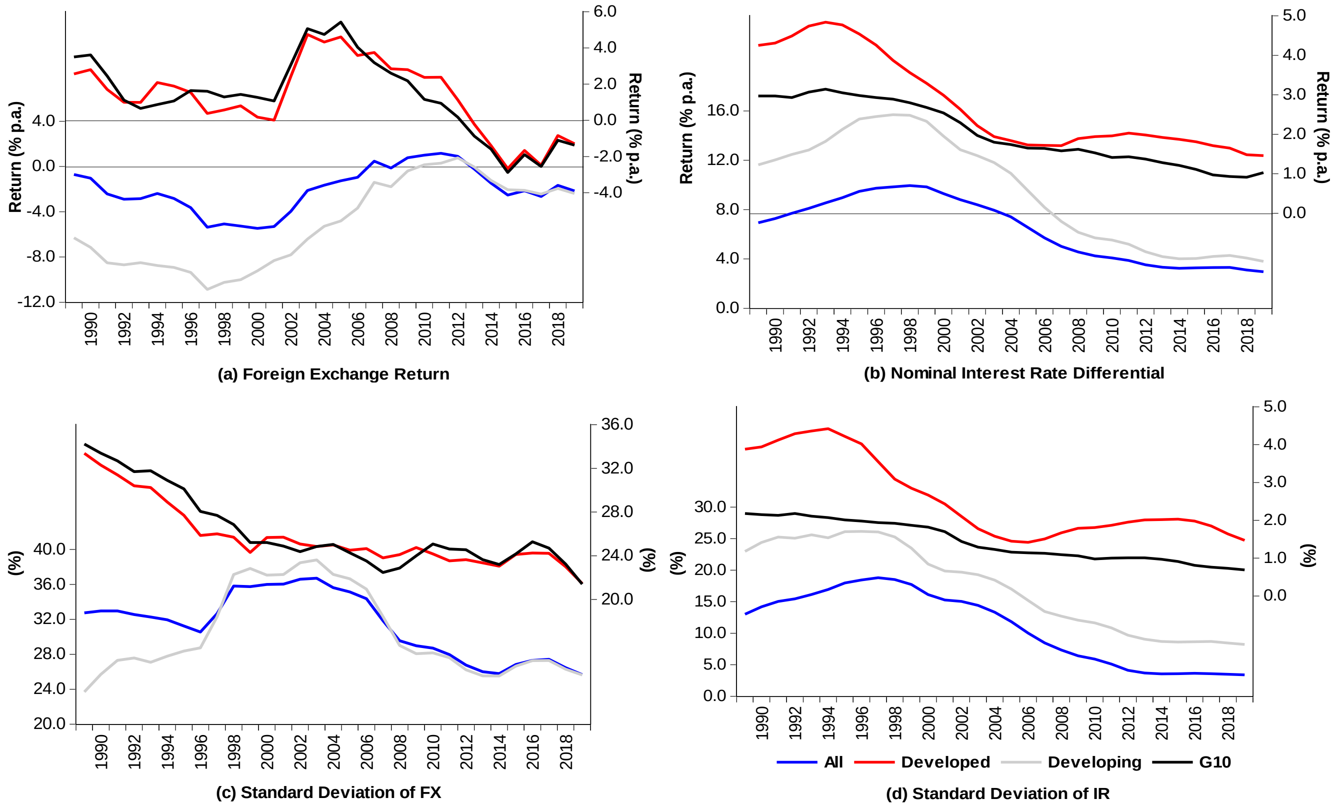

Figure 2: CT Return Decomposition. The figure exhibits the 10-year moving averages of the decomposition of CT returns between the FX and IR (Panels a) and b)) and of the standard deviations of the cross-sections of the FX and IR by country groups. The left axis measures changes in the groups of all countries and developing countries, while the right axis measures changes in the groups of developed countries and G10 countries. To build all the panels in this figure, we used our entire dataset. To obtain the 10-year moving average values of the FX and IR, we first computed the cross-sectional mean of the monthly data for each country group (All, Developed, Developing, and G10). We then used these values to calculate the average annual FX and IR by country groups. Finally, we employed these annual values to obtain the 10-year average shown in Panels a) and b). To obtain the figures of Panels c) and d), we first computed the cross-sectional standard deviations of the FX and IR using monthly data from each country group. We then averaged these values considering data from a 10-year window. The monthly FX and IR are annualized (multiplied by twelve). The sample period is 1980-2019.

We also computed the 10-year moving average of the percentage of countries that had positive annual FX between 1990 and 2019. Developed and G10 countries maintained a stable $50\% - 55\%$ of positive FX throughout the period. On the other hand, the number of developing countries with positive FX increased from around 10% in 1990 to 45% in 2019 (the results are not reported but are available from the authors upon request).

2.1.2 IST, MEI, and MON Shocks

In our theoretical model, the short-run fluctuations of the nominal interest rate and exchange rate are determined in the context of free capital mobility by the IST, MEI, and MON shocks. These shocks, in turn, have real effects on the economy, leading to changes in the capital stock and production flow. Ultimately, this affects the long-term level of the nominal interest rate and the exchange rate. Another implication of our model is that changes in the capital stock and in the production of goods also imply adjustments to short-term fluctuations and long-term trends in the MPK and inflation rates. We have already analyzed the evolution over time of nominal interest and exchange rates. Additionally, we have also explored the series of both the MPK and inflation rates. In what follows, we scrutinize the behaviour of the IST, MEI, and MON during the recent decades.

Table 3
IST, MEI, and MON Processes

The table shows the mean and standard deviation of the IST, MEI, and MON processes considering a five-year data window. To obtain the values in the table, we first computed the cross-sectional mean of the annual data for each country group. We then used these values to calculate the mean and standard deviation for each five-year data window. M1 and M3 growth rates are annualized. The sample period is 1980-2019 (IST and MEI).

	All		**Developed**		**Developing**		**G10**		**USA**	
Period	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**	**Mean**	**Sd.**
Panel A: Investment Specific Technology										
1980-1984	1.97	0.03	1.38	0.04	2.35	0.03	1.41	0.05	1.25	0.06
1985-1989	1.90	0.04	1.25	0.04	2.35	0.06	1.29	0.03	1.12	0.01
1990-1994	1.64	0.09	1.06	0.07	1.95	0.10	1.12	0.07	1.05	0.05
1995-1999	1.42	0.06	1.01	0.05	1.63	0.12	1.06	0.04	1.03	0.04
2000-2004	1.39	0.04	1.14	0.05	1.51	0.04	1.18	0.04	1.03	0.04
2005-2009	1.24	0.04	0.98	0.05	1.36	0.04	1.04	0.04	0.93	0.02
2010-2014	1.15	0.03	0.87	0.03	1.29	0.03	0.92	0.02	0.88	0.03
2015-2019	1.08	0.02	0.81	0.01	1.21	0.02	0.87	0.01	0.94	0.01
Panel B: Marginal Efficiency of Investment										
1980-1984	0.27	0.02	0.31	0.02	0.23	0.01	0.38	0.03	0.36	0.06
1985-1989	0.34	0.02	0.44	0.03	0.25	0.01	0.51	0.03	0.52	0.05
1990-1994	0.36	0.02	0.48	0.03	0.26	0.01	0.55	0.04	0.61	0.06
1995-1999	0.42	0.03	0.60	0.06	0.30	0.02	0.69	0.06	0.84	0.05
2000-2004	0.48	0.01	0.68	0.01	0.34	0.01	0.77	0.01	0.89	0.01
2005-2009	0.53	0.02	0.73	0.02	0.39	0.02	0.81	0.02	0.88	0.02
2010-2014	0.53	0.00	0.71	0.01	0.40	0.00	0.81	0.01	0.89	0.01
2015-2019	0.54	0.00	0.70	0.01	0.41	0.00	0.81	0.01	0.90	0.00
Panel C: Money Growth Rate (M1)										
1980-1984	15.50	2.90	11.31	2.88	25.69	5.16	6.16	4.20	7.52	4.45
1985-1989	20.14	3.93	13.43	3.82	30.28	7.72	9.89	6.40	7.00	6.06
1990-1994	14.93	3.02	6.71	3.12	23.58	5.79	4.88	2.94	7.54	4.44
1995-1999	14.03	3.68	9.00	2.96	18.08	5.16	8.52	3.29	-0.68	3.33
2000-2004	13.18	2.37	8.77	3.20	16.65	3.04	7.79	3.56	4.18	4.55
2005-2009	11.73	2.68	9.43	3.13	13.78	3.88	7.28	4.58	4.12	7.02
2010-2014	9.25	2.80	4.91	2.13	12.18	4.73	6.06	2.11	10.87	5.80
2015-2019	9.00	2.02	7.27	2.22	10.09	2.25	6.71	1.68	6.26	3.24
Panel D: Money Growth Rate (M3)										
1980-1984	18.52	2.10	13.70	2.26	29.21	4.17	7.58	1.45	18.52	3.50
1985-1989	19.02	3.26	11.25	1.91	31.83	6.64	8.08	1.70	18.98	2.80
1990-1994	15.73	2.71	5.84	2.21	26.38	4.08	4.44	2.74	17.45	1.85
1995-1999	14.34	2.03	6.06	1.73	21.62	3.31	5.41	2.25	14.77	1.93
2000-2004	10.47	2.18	6.65	1.75	13.68	3.45	5.12	1.75	12.16	2.62
2005-2009	11.80	3.43	8.62	3.93	14.38	3.30	6.30	2.74	11.55	2.89
2010-2014	7.37	1.29	3.92	2.02	10.18	1.44	3.64	1.11	8.83	3.00
2015-2019	6.12	1.08	4.65	1.19	7.41	1.32	4.56	1.34	6.94	1.69

An increase in the consumption price-to-investment price ratio is a positive IST shock. It immediately increases the marginal return on capital investment. The MEI process is a measure of the marginal efficiency of investment in the intermediate-goods producer sector. An increase in the country's financial development is a positive MEI shock. It also promptly lowers investment adjustment costs. The IST and MEI shocks directly affect capital investment growth. Finally, the MON is a measure of money growth. An increase in the country's money growth is a positive MON shock. In our open economy model, these three shocks generate fluctuations in the nominal interest rate and in the exchange rate.

We follow the literature and provide results in terms of the inverse of the IST process (P_t^i/P_t^c). Throughout this subsection, we use the term 'IST' to mean the inverse of the IST. Table (3) reports mean and standard deviation of the IST (Panel A), MEI (Panel B), and MON (Panels C and D) considering 5 years of data for each set of countries. Money growth rates were computed as the log difference of the M1 and M3 money stock between periods $t+1$ and t and are presented in % p.a..[6]

[6]Our dataset of M1 and M3 comprises quarter data from OCDE for the following countries: Australia (1980:Q1-2019:Q4), Brazil

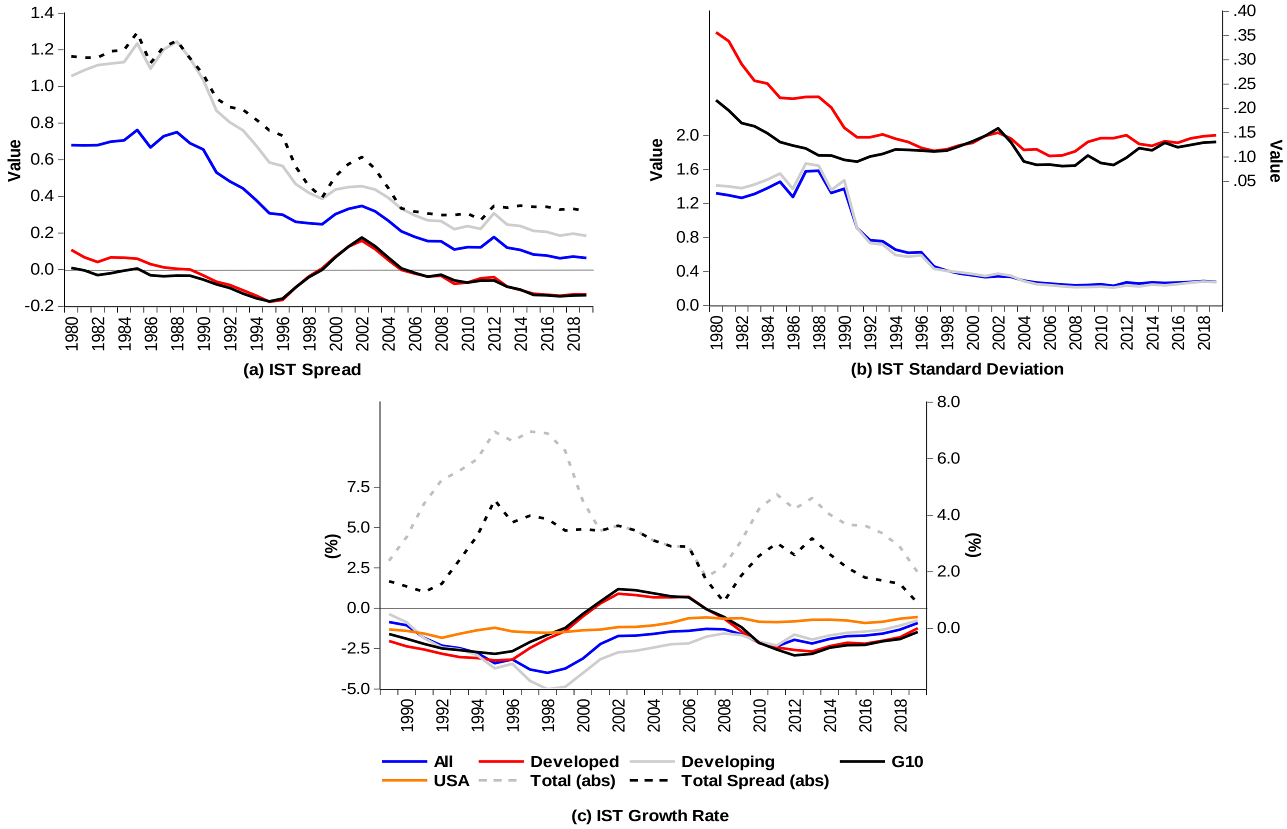

Figure 3: IST shocks. The figure presents the behaviour of the IST spread (Panel a), the IST cross-sectional standard deviation (Panel b), and the IST growth rate (Panel c) by groups of countries. IST spread is the difference between the relative price of investment the USA and each group of countries. The values in Panel a) are cross-sectional simple averages by groups of countries. The values in Panel c) are 10-year moving averages of the cross-sectional averages of the IST growth rate by groups of countries. IST growth rates were computed as the log difference of the value of IST between periods $t+1$ and t. In Panels b) and c), the left axis measures values for the group of All and Developing countries, while the right axis measures the values corresponding to the Developed and the G10 countries. The sample period is 1980-2019.

Overall, reading down the columns of Panel A (Panel B), the IST (MEI) values decrease (increase) over time for all country sets. Panel C and D reveal a great deal of uncertainty about the direction of changes in money growth over the period 1980 to 2019. On the one hand, the mean (standard deviation) of developing countries sharply decline from 25.69% and 29.21% (5.16% and 4.17%) in 1980-1984 to 10.09% and 7.41% (2.25% and 1.32%) in 2015-2019, for the M1 and M3 growth rates, respectively. On the other hand, the US M1 growth rate increases from -0.68% (standard deviation of 3.33%) in 1995-1999 to the peak of 10.87% (standard deviation of 5.80%) in 2010-2014. The M1 growth rate of developed countries and the G10 fluctuate over the period without a clear trend. However, overall, all groups of countries show a decline in the growth rate of M3.

The behaviour of the three shock processes can be better explored through graphical analysis capable of showing their evolution over time gradually. We start by analyzing the difference in the value of the IST process between each country group and the US (IST spread) as shown in Panel a) of Figure (3). Note that while IST spread of developing countries declines from a peak close to 1.20 for to a low of approximately 0.20, the IST spreads of developed and G10 countries oscillate around the zero line. Overall, the 'Total Spread (abs)' - the sum of the absolute values of the spreads of developed and developing countries - also falls between the 1980s and 2010s.

To generate Panel b) of Figure (3) we applied the same methodology used in the construction of Panels c) of Figure (2). In this panel, the left axis measures the standard deviation of the IST process of all developing countries groups, while the right axis measures the values corresponding to the developed and the G10 countries.

(1995:Q1-2019:Q4), Canada (1980:Q1-2019:Q4), Chile (1986:Q3-2019:Q4), Colombia (1982:Q1-2019:Q4), Costa Rica (2001:Q3-2019:Q4), Czech Republic (1992:Q2-2018:Q4), Denmark (1980:Q1-2019:Q4), Hungary (1992:Q3-2019:Q4), Iceland (1980:Q1-2019:Q4), India (1980:Q1-2019:Q4), Indonesia (1990:Q3-2018:Q4), Israel (1987:Q3-2019:Q4), Japan (1980:Q1-2019:Q4), Mexico (1980:Q1-2018:Q4), New Zealand (1980:Q1-2018:Q4), Norway (1980:Q1-2019:Q4), Poland (1989:Q3-2019:Q4), Russia (1996:Q1-2018:Q4), South Africa (1980:Q1-2019:Q4), South Korea (1984:Q4-2019:Q4), Sweden (1998:Q3-2018:Q4), Switzerland (1980:Q1-2018:Q4), Turkey (1980:Q1-2019:Q4), the United Kingdom (1984:Q4-2019:Q4), and the USA (1980:Q1-2019:Q4). We complemented our dataset with information from the Federal Reserve Bank (Fred St. Louis) for the following countries: France (1984:Q4-1998:Q4), Germany (1980:Q1-1998:Q4), Saudi Arabia (1993:Q2-2017:Q4), and Spain (1980:Q1-1998:Q4). We included the euro from 1999:Q2 to 2019:Q4 (Data from the Fred St. Louis).

In general, the standard deviation of all countries' groups declines over time. Overall, the standard deviation for all countries declines from 1980 through the early 2000s and then remains fairly constant. It is important to note that the standard deviation of the components of CT returns also declined during the period investigated (see Panels c) and d) of Figure (2)).

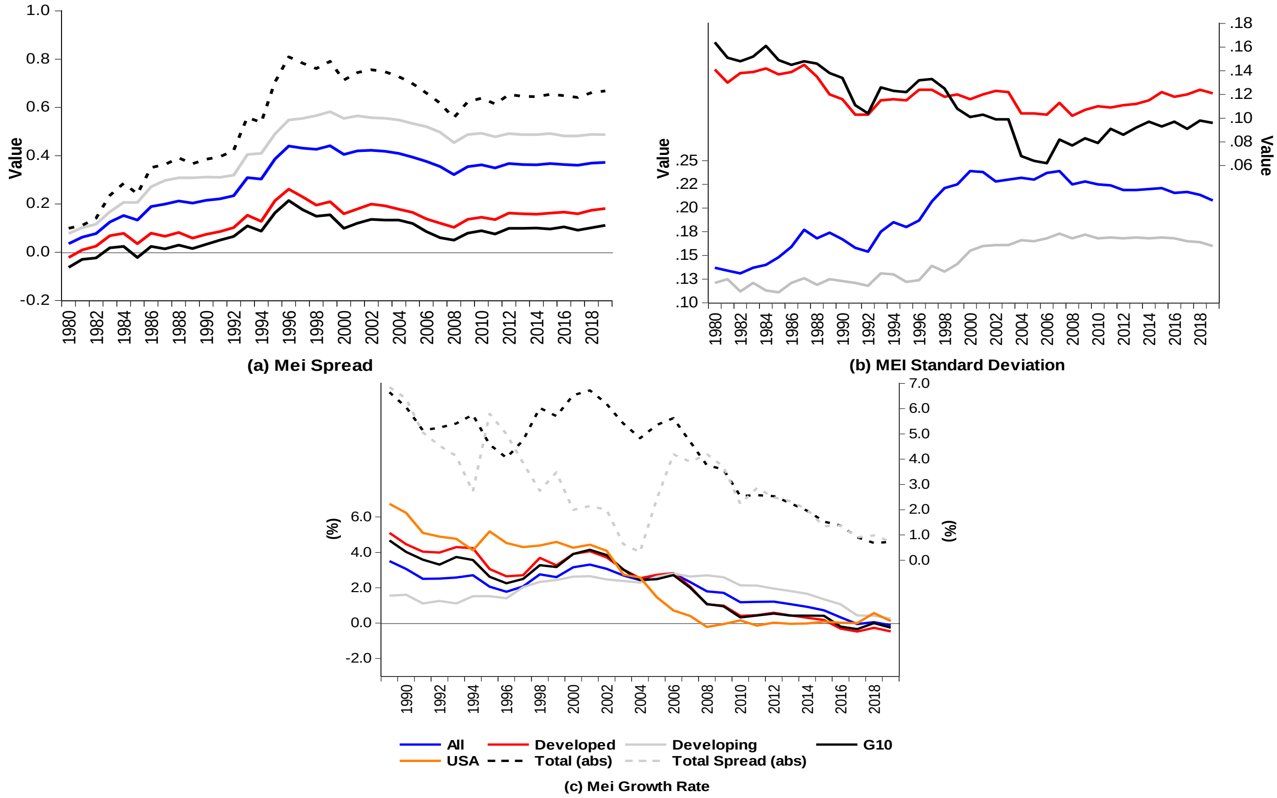

Figure 4: MEI shocks. The figure shows the behaviour of the MEI spread (Panel a), the MEI cross-sectional standard deviation (Panel (b)) and the MEI growth rate (Panel (c)). MEI spread is the difference between the value of the Financial Development Index of the USA and each group of countries. MEI growth rates were computed as the log difference of the value of MEI between periods $t+1$ and t. The values in Panel c) are 10-year moving averages of the cross-section averages of the MEI growth rate for the groups of countries. In Panels b) and c), the left axis measures values for the group of All and Developing countries, while the right axis measures the values corresponding to the Developed and the G10 countries. The sample period is 1980-2019.

The values in Panel c) are 10-year moving averages of the cross-sectional means of the IST growth rate by groups of countries. The left axis measures IST growth rate and the right axis measures 'Total (abs)' and 'Total Spread (abs)'. In this panel, 'Total (abs)' is the sum of the absolute values of the IST growth rate of developed and developing countries. 'Total Spread (abs)' is the sum of the absolute values of the differential in the IST growth rate between developed and developing countries and the US. This panel shows that the growth rate of IST in developing countries decreases between 1990 and 1999 and increases from 2000 onward. The growth rates of developed and G10 countries fluctuate in the period. It is informative to compare Panel c) of Figure (3) with Panel a) of Figure (1). Overall, the two panels point to similar downward trends in CT returns and in 'Total Spread (abs)'. This comparison is important because in our model CT returns is associated with IST growth rates.

Panels a) to c) of Figure (4) were produced following the same procedure applied in the creation of the respective Panels a) to c) of Figure (3). As can be seen from Panel a), regardless of the group of countries, the MEI spread increases from 1980 to the end of the 1990s, decreases from then until the end of the 2000s, and stabilizes from this period onward. Most importantly, however, is the downward trend revealed by Panel c) for the 'Total Spread (abs)'. A comparison between this panel and Panel a) of Figure (1) shows that from the early 1990s to 2002 both the 'Total Spread (abs)' and CT returns are large and decreasing. Between 2003 and the late 2000s, we observe a hump-shaped increase in both the 'Total Spread (abs)' and CT returns. Starting in the late 2000s, both variables decline sharply. Also, note that the MEI growth rate of developed countries and the US decreased over the period. This pattern has also been followed by developing countries since mid-2000. If we assume that the Financial Development Index is an adequate proxy for the marginal efficiency of the capital process, this result would mean a reduction in the magnitude of the shocks associated with it. Again, this comparison is important because in our model CT returns is also associated with the MEI growth rates.

Overall, Panel b) of Figure (4) documents a decrease (increase) in the cross-sectional standard deviation of the MEI process of developed and G10 (developing) countries from 1980 to the early 2000s, followed by a period of small oscillations until 2019.

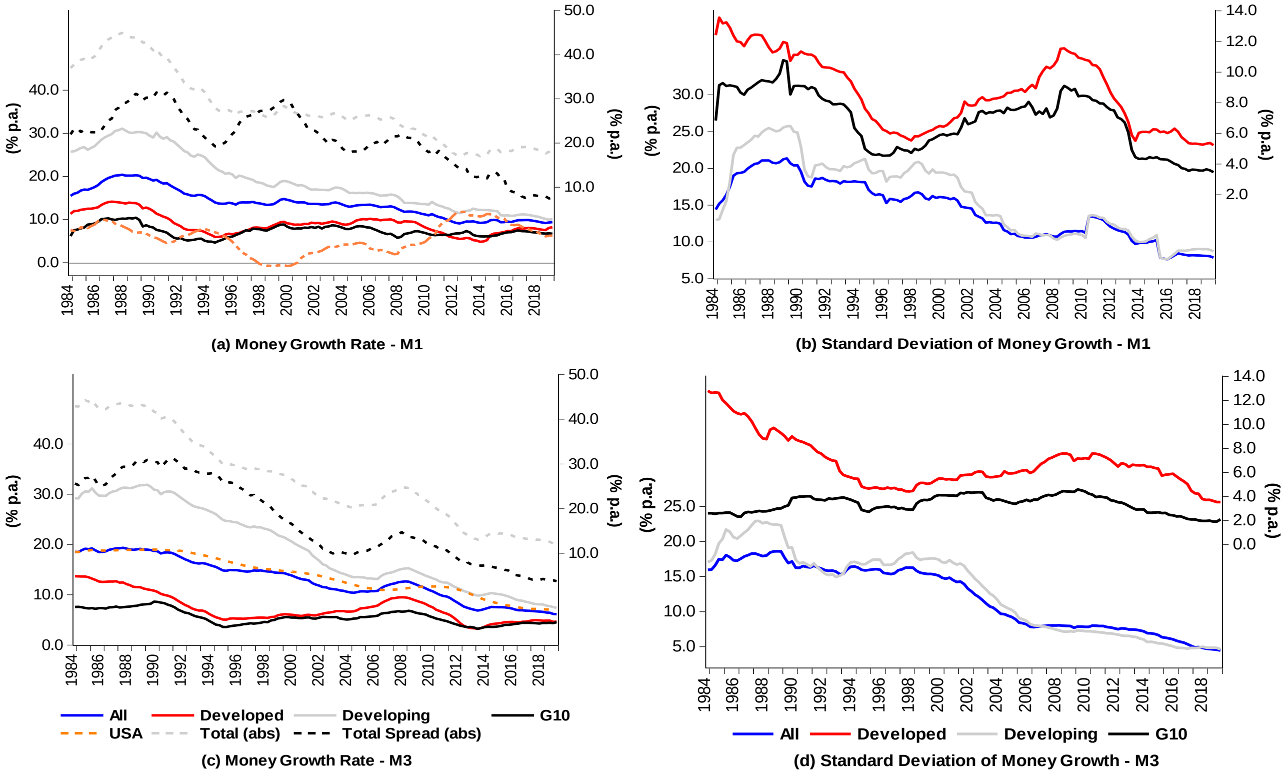

Figure 5: MON shocks. The figure presents the behaviour of the money growth rate (Panels (a) and (c)) and its standard deviation. In Panel (a) and (c), the left axis measures the money growth rate of the four groups of countries and the right axis measures the 'Total (abs)' and 'Total Spread (abs)'. Money growth rates were computed as the log difference of the aggregate money stock between periods $t+1$ and t. The values in Panels (a) and (c) are 20-quarter moving averages of the cross-section averages of the growth rate of money by groups of countries. The values in Panel (b) and (d) are 20-quarter moving averages of the cross-sectional standard deviation of money growth by groups of countries. In Panels b) and d), the left axis measures the standard deviation of money growth of the group of All and Developing countries, while the right axis measures the values corresponding to the Developed and the G10 countries. The sample period is 1990-2019.

As a robustness exercise we constructed an alternative to the Financial Development Index of Svirydzenka (2016). We applied the methodology used by Svirydzenka (2016) to the World Bank Financial Development and Structure dataset. It consists of thirty-one indicators that measure the size, activity, and efficiency of financial intermediaries and markets (Beck et al., 2010). Covering 213 countries at an annual frequency between 1960 and 2017, the dataset is useful for comparing the evolution of countries' financial development. Beck et al. (2000) and Beck et al. (2010) describe the sources and the methodology to build the indicators. We constructed our index for the 60 countries included in our sample (the results are not reported but are available from the authors upon request). Overall, we find very similar results to those reported above for the Financial Development Index of Svirydzenka (2016).

Panels a) to d) of Figure (5) were produced using the same methodology applied to obtain the respective Panels a) to c) of Figure (3). Panel a) indicates that the declining rate of money growth in developing countries from 1990 onward and the rising rate of money growth of the US since the late 1990s are the main sources behind the downward trend in the 'Total Spread (abs)' over the period. The Panel also shows that between 1984 and the end of the 1990s the growth rate of money of developed countries slows down smoothly and remains stable from the end of this period.

As can be seen from Panel (c) of the figure, the behaviour of the M3 growth rate among the groups of countries is similar to that of M1. We observe a drop in the growth rate for all groups of countries along with a decline in the spread against the US. However, unlike Panel (a), the US shows a steady decline in its M3 growth rate. Most importantly, both panels show that the 'Total Spread (abs)' fluctuations are in line with those of CT returns shown in Panel a) of Figure (1). Both 'Total Spread (abs)' and CT returns show similar downward trends. Moving on to the other two panels, we find that overall, the standard deviations of M1 (Panel (b)) and M3 (Panel (d)) for all groups of countries decrease from 1984 to 2019.

Based on the results presented so far, it is clear that there is a process of convergence between developed and developing countries in terms of the IST, MEI, and MON processes. Motivated by this finding, we analyzed the variance matrix of our three shock processes. We apply the principal components method to the dataset of each process separately, considering the total sample of countries and the period from 1980 to 2019.

Two findings stand out in this analysis. First, a small number of factors are able to explain much of the variation in the data. The first two factors together explain 76.58% and 78.43% of the total variance of the IST and MEI data, respectively. The first five factors explain 50.85% and 52.56% of the total variance in the growth rates of M1 and M3, respectively. Second, we found a large dispersion between values across countries. The commonality between countries varies between 3.94% and 98.48% for the IST, and between 5.94% and 99.54% for the MEI for an analysis performed with 2 common factors. On the other hand, it varies between 8.61% and 69.97% for M1 and between 21.08% and 72.85% for M3, for in3-factor analysis. These results suggest the existence of a global component in each shock process that is responsible for a relevant part of the country's shock variance. In our model, the IST, MEI, and MON shocks are driven by a local and a global component and this is key to explaining CT return fluctuations.

We can summarize our main findings for the period between 1980 and 2019 as follows:

1. a downward trend in CT returns by group of countries and portfolios. We also identified a reduction in the values and standard deviation of both components of CT returns ('FX' and 'IR');

2. a downward trend in the relative price of investment of countries, together with a narrowing in the spread between developed and developing countries. Overall, we also found a decline in the spread between the average IST growth rate of our full set of countries and the US;

3. an upward trend in countries' MEI process between 1980 and the early 2000s. Followed by different trajectories of the groups of countries: i) the US maintained a stable MEI level between the early 2000s and 2019; ii) developed and developing countries maintained an upward trend until 2009, followed by a stable level of the MEI from 2010 onward. Overall, we also detected a decline in the spread between the average MEI growth rate of our full set of countries and the US;

4. a downward trend in the M1 and M3 growth rates for developing countries between 1990 and 2019. We also detected a nearly stable M1 growth rate for developed economies and a slight decline in the M3 growth rate from 1984 to the early 2000s, followed by a period of stability until 2019. In general, we also found a decline in the spread between the average growth rate of the money stock of our full set of countries and the US;

The results presented in this section reveal several stylized facts associated with CT returns and the IST, MEI, and MON processes. The objective was to identify a connection between CT returns, macroeconomic variables, and the shock processes, through the analysis of their evolution in recent decades. Our main findings indicate that the IST, MEI, and MON processes may be possible candidates to explain the fall in CT returns identified in the data. These shocks act through several channels in the economy causing fluctuations in macroeconomic variables and driving CT returns in the short and long term. Next, we develop an open-economy DSGE model where IST, MEI, and MON processes enter as the main ingredients to explain fluctuations in macroeconomic variables and CT returns.

3 The Model Economy

Motivated by the initial data analysis, we present a model for the world economy, characterized by N open economies. The basic setup is the open economy New Keynesian model developed by Benigno (2009) extended with elements from several papers within the related literature (see, e.g., Mendoza (1991), Greenwood et al. (1992), Greenwood et al. (1997a), Heathcote and Perri (2002), Nelson (2002), Schmitt-Grohé and Uribe (2003), Gali et al. (2007), Gali and Monacelli (2005), Andrés et al. (2009), Coeurdacier et al. (2010), Justiniano et al. (2011), Canova and Menz (2011), Landi (2021), among others). Our framework allows for the introduction of an asset pricing model that incorporates our proposed risk factors into a traditional CCAPM.

There are N symmetric economies characterized by perfect competition in the final-good sector and monopolistic competition in the intermediate-goods sector. In each period, firms in each economy produce country-specific internationally tradable goods. Financial markets are incomplete. Following Gali et al. (2007), we assume that a fraction of households have access to capital and financial markets (the optimizing households or OPT) where they can trade physical capital, and domestic, and foreign bonds. The remaining fraction of households have no assets or liabilities and only consume their current income (the rule-of-thumb households or ROT). Both households can consume domestic and imported goods. Firms set prices in their own currency (producer currency pricing) and the law of one price holds. It turns out that the exchange rate pass-through is complete. However, due to home bias in consumption, purchasing power parity (PPP) does not hold.

Following Justiniano et al. (2011), we assume that households are exposed to random shocks arising from innovations in investment-specific technology (IST) and the marginal efficiency of investment (MEI). Furthermore, agents are subject to money demand (MON) innovations as in Nelson (2002) and Andrés et al. (2009). Households are also subject to total factor productivity, government spending, and monetary shocks. The IST, MEI, and MON processes are disturbed by a local shock and a global shock. Local shocks stem from domestic changes in each of the three processes. Global shocks stem from global changes in each of the three processes. Global shocks are common to all countries, but their impact in each country may differ due to heterogeneity in countries' sensitivity to the shocks.

In our model, the time preference parameter used to discount the future utility of OPT households is time-varying. We assume that the time preference parameter depends on OPT households' expectations about future economic developments in both countries. The agents use the current state of the growth rate of the IST, MEI, and MON processes to form their expectations. This can trigger further increases or decreases in consumption and investment. Therefore, the only source of heterogeneity between countries stems from the exposure of households in each country to IST, MEI, and MON shocks.

We assume that total factor productivity shocks are local disturbances with perfect positive correlation across all countries. Thus, there is no heterogeneity between countries' exposure to total factor productivity. We also assume that the government maintains a balanced budget financed by levying taxes on households. Thus, OPT households assume that government shocks do not convey relevant information for the formation of expectations about the future evolution of the economy. Regarding the monetary side, in our model, monetary policy decisions follow an adjusted Taylor rule. Monetary policy shocks reflect factors that affect the nominal interest rates but are not related to the targets considered in our Taylor rule (inflation, output, and money demand). However, OPT households cannot accurately measure and identify monetary shocks.[7] Therefore, they are unable to infer the importance of such shocks for the formation of expectations. Consequently, central bank changes in rule-based nominal interest rates affect the dynamics of the economy, but OPT households do not take monetary shocks into account when forming their expectation about the future evolution of the economy.

Since all countries are symmetrical, we restrict our analysis to two countries (denoted by Home and Foreign). Time-varying stochastic time preference brings a new source of risk. IST, MEI, and MON shocks are sources of business cycle fluctuations and can affect foreign currency returns, as their occurrence potentially triggers movements in nominal interest rates and exchange rates. Our model also allows us to infer the effects of IST, MEI, and MON shocks on the long-term trend of foreign currency returns.

Environment. Consider that there are N open economies, $N = 0, 1, 2...$. Time is discrete and indexed by $t = 0, 1, 2...$, and all economies are characterized by incomplete financial markets and have symmetric technologies, preferences, and market structures, even though the disturbances affecting each economy are possibly different. In each country, households consume a bundle with two final goods, one produced by perfectly competitive final-good firms in the Home country and one produced by perfectly competitive final-good firms in the Foreign country. In each country, the final good is aggregated by using differentiated intermediate goods produced by intermediate firms that operate in monopolistic competition and are subject to price adjustment costs. Output can be consumed or transformed into capital by means of linear technology. The two final goods are imperfect substitutes.

There is a floating exchange rate system and barriers to international trade in goods (we assume the existence of consumption home bias), which implies that PPP fails.[8] The UIP also does not hold due to the presence of a *risk premium* on foreign exchange assets. The *risk premium* is a compensation for: i) consumption growth risk, and; ii) the time-preference risk arising from changes in the growth rates of the IST, MEI, and MON processes.

Households. A fraction Φ of households are rule-of-thumb consumers. They simply consume their respective disposable incomes in each period. The remaining fraction $(1 - \Phi)$ of households are optimizing, who have access to both financial and capital markets. In each country, OPT households own local firms and the local stock of capital. OPT households choose the level of capital utilization and lease "capital services" to firms. We also assume that the depreciation rate is a function of the level of capital utilization. This structure implicitly assumes that foreign households cannot hold local capital stock. They are risk averse and choose plans for consumption, labour,

[7] As highlighted by Miranda-Agrippino and Ricco (2021), analyzing the effect of monetary policy is challenging. This is because most of the variation in the nominal interest rates is accounted for by how policy itself responds to the state of the economy, rather than by random shocks to the central bank's reaction function. They argue that to correctly trace the causal effects of monetary policy it is necessary to: i) isolate unexpected exogenous changes in monetary policy instruments that are not due to the systematic policy response to current or forecast economic conditions (Sims, 1992, 1998); ii) generate responses of macroeconomic variables using an econometric model that is capable of summarising the dynamic interaction among such variables. There is a vast literature exploring different identification schemes and empirical specifications. In general, they obtain conflicting results (see, among others, (Ramey, 2016; Champagne and Sekkel, 2018; Miranda-Agrippino and Ricco, 2021) for a discussion on measuring and identifying monetary policy shocks).

[8] There is a large body of literature that attempts to explain both consumption and asset home bias (e.g., transaction costs in international trading of assets and goods, lack of information about foreign assets, capital controls, moral hazard, etc.), see, e.g., French and Poterba (1991); Gehrig (1993); Tesar and Werner (1995); Lewis (1999); Pesenti and van Wincoop (2002); Karolyi and Stulz (2003); Engel and Matsumoto (2005); Daude and Fratzcher (2005). For empirical evidence on both consumption and asset home bias see, e.g., Lewis (1999); Sorensen et al. (2007); Fidora et al. (2007); Sercu and Vanpee (2008); Coeurdacier and Rey (2013).

investment, and bond holdings to maximize lifetime utility. Each consumer type is composed of infinitely lived identical households. The OPT agent is born in period $t = 0$ with an initial endowment of capital, cash, Home bond, and Foreign bond. In addition, all individuals receive a unit of productive time in each period t to be used for work or leisure.

In each period, OPT households receive wages, intermediate-good firm profits, government transfers, capital rents, pay government tax, pay union fee, and pay or receive interest from the bond market. Either they spend their income on a consumption basket made up of domestically produced and imported goods, or they invest in a portfolio of assets containing capital stock (rented to domestic intermediate-good firms) and bonds (issued at home or abroad). Similarly, ROT households receive wages, government money transfers and pay government tax. They spend their resources on a consumption basket made up of domestically produced and imported goods. To gain access to consumer goods, OPT and ROT households can exchange goods (barter) or make purchases with cash. Money reduces the transaction cost and search cost that comes with barter trading. In addition, real balances enter the utility function of OPT households to provide for emergencies (e.g., illness, accidents etc.)[9].

Following Gali et al. (2007) we assume a monopolistic competitive labour market. Workers provide differentiated labour types, sold by unions to perfectly competitive labour packers. Monopolistic competitive firms employ labour pooled by packers to produce differentiated intermediate goods. Wages are set centrally by unions. Hours worked are determined by firms (rather than optimally chosen by households), given the wage set by unions. Households are willing to meet the firms' demand, under the assumption that wages always remain above all households' marginal rate of substitution. As in Furlanetto (2011), we do not explicitly model the wage negotiation process but assume that wage adjustments are costly, since unions have to negotiate wages every period and this activity demands economic resources. As emphasized by Furlanetto (2011) the greater the wage increase obtained, the more effort unions would need to put into the negotiation process.

OPT households are subject to exogenous IST, MEI, MON, and TFP shocks that potentially influence their allocations of consumption (domestic and imported goods), labour supply, and savings (domestic capital, Home bonds, and Foreign bonds). They build their asset portfolios to smooth intertemporal consumption and to hedge against negative fluctuations prompted by the shocks (precautionary and purchasing power motives). Since households of each type are all identical, we can, without loss of generality, assume that there is only two representative households in each country.

Firms. The economy's producing sector is divided into two parts: i) an intermediate-goods sector and a final-goods sector. The former consists of a large number of firms, each one producing differentiable goods (monopolistic competition). In each period intermediate-good firms solve a two-stage problem. In the first stage, they hire local labour and rent capital in perfectly competitive factor markets to minimize real production costs. In the second stage, they set the price that maximizes discounted real profits subject to the demand of the final goods sector. In addition, intermediate firms pay adjustment costs, whenever they adjust prices with respect to the inflation target determined by the monetary authority. The adjustment cost accounts for the negative effects of price changes on the customer-firm relationship. In the final goods sector, there is a large number of identical firms that aggregate intermediate goods into one single good using a specific technology. The final good can be sold at Home, exported or invested locally to expand capital stock. The setting with two production sectors, different production technologies and market structures is necessary to explain CT returns from macroeconomic fluctuations triggered by the fundamental shocks of our model.

Government and Monetary Authority. Government enters the economy with three main roles: i) receiving bond transaction costs from the Foreign country for subsequent transfer to OPT households; ii) collect lump-sum taxes from households, which may differ between OPT and ROT, and; iii) consuming exclusively domestic produced goods. Government spending is fully funded by lump-sum taxes levied on both types of households. This implies that the government keeps a balanced budget constraint in each period. Following Nelson (2002) and Andrés et al. (2009), we assume that the monetary authority is characterized by a set of rules, where the current nominal interest rate depends on the past value of the nominal interest rate, on current values of output, inflation, and nominal money growth relative to the equilibrium value of interest rate (natural interest rate), potential output, an inflation target, and a nominal money growth target. Therefore, the monetary authority sets the nominal interest rate according to an adjusted Taylor rule.

Financial markets. Bonds are issued by households in the debtor's home currency and pay nominal interest rate. They are default risk-free one-period zero-coupon discount bonds that pay with certainty one currency unit at maturity. These claims may be purchased by both local and Foreign investors. However, the yield on nominal Foreign bonds in Home currency is known only on the redemption date, at the time $t+1$ when the exchange rate is revealed. Households may invest or borrow in the domestic and international bond markets.

Information. We assume that there is no information asymmetry, households from both countries have access to

[9] See also Brock (1974) and Feenstra (1986) for additional reasons to put money in the utility function.

the same information set and news are revealed simultaneously to both of them. All individuals from both countries have identical probability beliefs for the states of the world. For simplicity, we abstract from population growth. We focus our attention primarily on the Home economy only. Identical expressions apply to the Foreign country.

3.1 Households

There is a continuum of infinitely lived households. A fraction $1-\lambda$ of households have access to capital markets where they can trade bonds and buy and sell physical capital (OPT households). The remaining fraction λ of households consume their disposable income each period and do not own any assets nor have any liabilities (ROT households). A typical household consumes the composite good C_t^i, which is a constant elasticity of substitution (CES) aggregate of Home-produced and Foreign exports goods:

$$C_t^i = \left[(1-\gamma)^{\frac{1}{\eta}} \left(C_{h,t}^i\right)^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} \left(C_{f,t}^i\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{1}$$

$$C_t^{i,*} = \left[\gamma^{*\frac{1}{\eta}} \left(C_{h,t}^{i,*}\right)^{\frac{\eta-1}{\eta}} + (1-\gamma^*)^{\frac{1}{\eta}} \left(C_{f,t}^{i,*}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{2}$$

where $C_{h,t}^i$ is the Home country consumption of Home final good; $C_{f,t}^i$ represents the Home country consumption of Foreign final good; $i \in \{o,r\}$ denotes the type of household - OPT or ROT, respectively; η is the elasticity of substitution between the two goods (trade elasticity); n denotes the share of consumption spending with the Foreign good. Following Coeurdacier and Rey (2013), we assume an exogenous consumption home bias, therefore $0 < \gamma < \frac{1}{2}$. The investment bundles are defined analogously:

$$I_t^o = \left[(1-\gamma)^{\frac{1}{\eta}} \left(I_{h,t}\right)^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} \left(I_{f,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3}$$

$$I_t^{o,*} = \left[\gamma^{*\frac{1}{\eta}} \left(I_{h,t}^*\right)^{\frac{\eta-1}{\eta}} + (1-\gamma^*)^{\frac{1}{\eta}}{}_t^* \left(I_{f,t}^*\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{4}$$

In our environment, both the Home consumption and investment bundles ($C_{h,t}^i$ and I_t^o) are aggregates of Home and Foreign produced intermediate goods. As we assume that both trade elasticity and local bias for consumption and investment are identical, their respective price indices are also identified within each country. The consumer price indices (CPI) that correspond to the preferences for both consumption and investment bundles are given by:

$$P_t = \left[(1-\gamma)\left(P_{h,t}\right)^{1-\eta} + \gamma\left(P_{f,t}\right)^{1-\eta}\right]^{\frac{1}{(1-\eta)}}, \tag{5}$$

$$P_t^* = \left[\gamma^*\left(P_{h,t}^*\right)^{1-\eta} + (1-\gamma^*)\left(P_{f,t}^*\right)^{1-\eta}\right]^{\frac{1}{(1-\eta)}}, \tag{6}$$

where P_t, $P_{h,t}$ and $P_{f,t}$ denote Home consumer price index (CPI), the price of Home-produced goods, and Foreign-produced goods, respectively. All these prices are denominated in Home currency. We assume that the law of one price holds, thus $P_{f,t} = S_t P_{f,t}^*$ and $P_{h,t} = S_t P_{h,t}^*$. Where S_t indicates the nominal exchange rate, defined as the price of one unit of Foreign currency in terms of Home currency, and $P_{f,t}^*$ is the price of Foreign-produced goods in Foreign currency. The solutions to the cost minimization problem of purchasing the least-cost combination of Home-and-Foreign produced goods are as follows:

$$C_{h,t}^i = (1-\gamma)\left(\frac{P_{h,t}}{P_t}\right)^{-\eta} C_t^i, \qquad C_{f,t}^i = \gamma\left(\frac{P_{f,t}}{P_t}\right)^{-\eta} C_t^i. \tag{7}$$

$$C_{h,t}^{i,*} = \gamma^*\left(\frac{P_{h,t}^*}{P_t^*}\right)^{-\eta} C_t^{i,*}, \qquad C_{f,t}^{i,*} = (1-\gamma^*)\left(\frac{P_{f,t}^*}{P_t^*}\right)^{-\eta} C_t^{i,*}. \tag{8}$$

The investment baskets are defined analogously for the optimizing household. Define $p_{h,t} = \frac{P_{h,t}}{P_t}$ and $p_{f,t} = \frac{P_{f,t}}{P_t}$ as the price of Home and Foreign goods in terms of the Home CPI. If we assume the same definitions for $P_{h,t}^*$ and $P_{f,t}^*$ we obtain:

$$C_{h,t}^i = (1-\gamma)p_{h,t}^{-\eta} C_t^i, \qquad C_{f,t}^i = \gamma p_{f,t}^{-\eta} C_t^i.$$

$$C_{h,t}^{i,*} = \gamma^* p_{h,t}^{*}{}^{-\eta} C_t^{i,*}, \qquad C_{f,t}^{i,*} = (1-\gamma^*) P_{f,t}^{*}{}^{-\eta} C_t^{i,*}.$$

$$1=\left[(1-\gamma)p_{h,t}^{1-\eta}+\gamma p_{f,t}^{1-\eta}\right]^{\frac{1}{(1-\eta)}}, \qquad 1=\left[\gamma^{*}{p_{h,t}^{*}}^{1-\eta}+(1-\gamma^{*}){p_{f,t}^{*}}^{1-\eta}\right]^{\frac{1}{(1-\eta)}}, \tag{9}$$

and similar expressions hold for the demand for investment goods of optimizing households. We can define the terms of trade (tot_t) and the real exchange rate (Q_t) as follows:

$$tot_t=\frac{p_{f,t}}{p_{h,t}}, \tag{10}$$

$$Q_t=\frac{S_tP_t^*}{P_t}. \tag{11}$$

As the law of one price holds $p_{f,t}=Q_tp_{f,t}^*$ and $p_{h,t}=Q_tp_{h,t}^*$.

In the second step the OPT household problem is to maximize

$$u_t^o=E_0\sum_{t=0}^{\infty}\theta_t\kappa_tU^o(C_t^o,M_t^o/P_t,L_t^o)-MAC_t, \tag{12}$$

$$\theta_0=1,$$

$$\theta_{t+1}=\beta^c(\Delta\tilde{C}_t)\theta_t \qquad \text{for all t} > 0,$$

$$\beta^c(\tilde{C}_t)=\beta(1+\nu_1\Delta\tilde{C}_t)^{-\nu_2},$$

$$MAC_t=\frac{d1}{2}\left\{\exp\left(d2\left[\frac{m_t^o}{m_{t-1}^o}-1\right]\right)+\exp\left(-d2\left[\frac{m_t^o}{m_{t-1}^o}-1\right]\right)-2\right\}.$$

where E_0 is the conditional expectation operator; $\beta(\Delta\tilde{C}_t)$ is the endogenous discount factor; $\Delta\tilde{C}_t$ represents the change in average consumption between periods t and $t-1$, which the individual household takes as given, $\Delta\tilde{C}_t=\frac{\tilde{C}_t-\tilde{C}_{t-1}}{\tilde{C}_{t-1}}$; β, ν_1, and ν_2 are positive parameters, and $\beta^c_{\Delta c}<0$ is the first derivative with respect to $\Delta\tilde{C}_t$[10]; κ_t stands for the time preference shock; $m_t^o=M_t^o/P_t$ are real balances (M_t^o is cash in nominal terms)[11]; ι_t is the money demand shock; L_t^o hours devoted to work; MAC_t denotes portfolio adjustment costs of real assets with positive parameters, $d1$ and $d2$; U^o is the period utility function which we assume to be continuously differentiable, strictly increasing in the first and second arguments, decreasing in the third, strictly concave, bounded, and satisfies the Inada conditions.

Note that the functional form of portfolio adjustment costs is that of used by Andrés et al. (2009). They argue that these costs are not necessarily transaction costs, but they can be rationalized, for example, by viewing money as a contingency reserve. This functional form implies a forward-looking money demand that is supported by many empirical works. These studies find that the lagged dependent variable enters positively in the money demand function (Andrés et al., 2009). Furthermore, Andrés et al. (2009) show that, under this functional form of adjustment costs, money plays a relevant role even in New-Keynesian models with separability between consumption and money in the utility function. The capital stock evolves according to the following equation of motion:

$$K_t^o=(1-\delta(u_t)K_{t-1}^o+\left[1-\frac{\Xi_I}{2}\left(\frac{I_t^o}{\mu_tI_{t-1}^o}-1\right)^2\right]\psi_tI_t^o, \tag{13}$$

where K_t^o is the stock of capital; $\delta(u_t)$ is the depreciation rate that is a function of capital utilization, u_t; I_t^o represents the investment, and; Ξ_I is a non-negative parameter that measures the investment adjustment cost in terms of units of the consumption index. We assume that capital is built with the same shares of varieties of Home and Foreign consumption goods as the final consumption basket described by equation (7). Therefore, the price index associated with the capital stock is also given by P_t. The accumulation process described by equation (13) can be affected by two types of disturbances: the IST and MEI shocks, denoted by ψ_t and μ_t, respectively. The IST shock influences the transformation of consumption goods into investment goods. Shocks to the marginal efficiency of investment (MEI) affect the process by which investment goods are transformed into productive capital. In our model, the MEI shock affects the value of investment adjustment costs.

External adjustment cost occurs when firms desire a perfectly elastic supply of capital. In the real world, however, the availability of capital goods occurs at different speed and depends on many factors. One factor that plays a crucial role in this process is the financial system. If capital producers depend on loans to carry out their

[10] Note that in equilibrium, individual and average *per capita* variables are identical, that is, $C_t=\tilde{C}_t$ (Schmitt-Grohé and Uribe, 2003).

[11] We assume that it is the household's real money holding at the end of period t, M_t/P_t, after having purchased consumption goods, that yield utility (Walsh, 2017).

activities, capital production will be affected by their ability to access credit, as well as the efficiency with which the financial system allocates that credit (Justiniano et al., 2011). In our model, there is no explicit role for financial intermediation, however, the transformation of foregone consumption (real savings) into productive capital depends on the MEI. Negative shocks to the MEI decrease the amount of effective capital installed per unit of foregone consumption (increase in investment adjustment cost). Therefore, a possible interpretation of the MEI process is as a proxy for the effectiveness with which the financial sector directs household savings to productive capital. As will be discussed later, we employ a measure of financial development as a proxy for the MEI shock in estimating the asset pricing model derived from our model.

Note that in our model the MEI process plays - in reduced form - an economic role similar to that of entrepreneurs' net worth in Carlstrom and Fuerst (1997). In their model, entrepreneurs borrow from households to produce capital, but their idiosyncratic productivity is private information. This setting incurs costs associated with monitoring failing projects. Which, in turn, results in a partial loss of investment goods, representing a leak on the capital formation process. In their model, the capital evolves according to:

$$K_t = (1-\delta)K_{t-1} + (1-\Upsilon_t)I_t,$$

where Υ_t is the aggregate amount of new capital destroyed by the monitoring activity, which in their model, equilibrium depends on entrepreneurs' net worth. As noted by Justiniano et al. (2011), Carlstrom and Fuerst (1997) emphasize that their framework "is isomorphic to a model in which there are costs to adjusting the capital stock" if net worth is held constant. A lower probability of default and external finance premium can boost the supply of new capital goods. In a recent paper, Hirose and Kurozumi (2012) found that investment fluctuations in Japan are mainly driven by investment adjustment cost shocks. The estimated investment adjustment cost shock series obtained from their model are highly correlated with the Financial Position Diffusion Index disclosed by the "Tankan" (which is an economic survey realized with Japanese firms). This reinforces our argument of linking the MEI process with financial constraints for investment spending.

In our economy, there is variable capital utilization. The depreciation rate is a function of it. OPT Households choose the level of utilization and lease "capital services" to firms. The cost of capital utilization is faster depreciation. Define $\widehat{K_t^o} \equiv u_t K_{t-1}^o$ as capital services, the depreciation rate is defined as follows:

$$\delta(u_t) = \delta_0 + \Xi_1(u_t - 1) + \frac{\Xi_2}{2}(u_t - 1)^2, \tag{14}$$

$\delta_0 \in [0,1]$ is the depreciation rate in steady state, when $u_t = 1$.

The representative OPT household faces the following sequential budget constraint:

$$P_t C_t^o + B_{h,t}^o + S_t B_{f,t}^o + P_t I_t^o + M_t^o + \frac{\Xi_b}{2} S_t P_t^* \left(\frac{B_{f,t}^o}{P_t^*} - \bar{b}_f \right)^2 = P_t W_t L_t^o + P_t r_t^k u_t K_{t-1}^o + R_{t-1} B_{h,t-1}^o +$$

$$S_t R_{t-1}^* B_{f,t-1}^o + M_{t-1}^o - P_t T_t^o - P_t Z_t + P_t \Gamma_t^o, \tag{15}$$

where $B_{h,t}^o$ and $B_{f,t}^o$ represent the respective quantities of internationally traded Home and Foreign bonds paying out next period one unit of the currency of the issuing country (we maintain the convention that positive values of $B_{h,t}^o$ and $B_{f,t}^o$ denote bond holdings); R_t and R_t^* are the Home and Foreign gross nominal return on bonds purchased in period t; W_t denotes the real wage and r_t^k is the real rental rate of capital, where both are measured in units of the consumption good basket; T_t represents lump-sum tax paid to the government, Z_t is a membership fee paid to the unions, and; Γ_t^o denotes profits distributed by intermediate firms. We assume that there is a quadratic cost in changing the asset position in the foreign bond market $\left(\frac{\Xi_b}{2} S_t P_t^* \left(\frac{B_{f,t}^o}{P_t^*} - \bar{b}_f \right)^2 \right)$ with respect to a constant value, denoted by $\bar{b}_f$.[12] This cost is paid to the Foreign government that transfers this revenue to the Foreign OPT households. Ξ_b is a non-negative parameter that measures this cost in terms of units of the consumption index.

The representative OPT household takes $\{S_t, W_t, P_t, R_t, R_t^*, r_t^k, T_t^o, Z_t, \Gamma_t^o\}_{t=0}^{\infty}$ as given and for all $t \geq 0$ solves the following problem:

$$\max_{\left\{C_t^o, M_t^o/P_t, L_t^o, I_t^o, K_t^o, u_t, B_{h,t}^o, B_{f,t}^o\right\}_{t=0}^{\infty}} u_t^o = \mathbb{E}_0 \sum_{t=0}^{\infty} \theta_t \kappa_t U^o(C_t^o, M_t^o/P_t, L_t^o) - MAC_t \tag{16}$$

s.t

$$P_t C_t^o + B_{h,t}^o + S_t B_{f,t}^o + P_t I_t^o + M_t^o + \frac{\Xi_b}{2} S_t P_t^* \left(\frac{B_{f,t}^o}{P_t^*} - \bar{b}_f \right)^2 - P_t W_t L_t^o - P_t r_t^k u_t K_{t-1}^o - R_{t-1} B_{h,t-1}^o -$$

[12] This assumption ensures the existence of a determinate steady state and a stationary solution (see, e.g.,Schmitt-Grohé and Uribe (2003) and Boileau and Normandin (2008)).

$$S_tR^*_{t-1}B^o_{f,t-1} - M^o_{t-1} + P_tT^o_t + P_tZ_t - P_t\Gamma^o_t = 0,$$

$$K^o_t = (1-\delta(u_t)K^o_{t-1} + \left[1 - \frac{\Xi_I}{2}\left(\frac{I^o_t}{\mu_t I^o_{t-1}} - 1\right)^2\right]\psi_t I^o_t,$$

$$C^o_t, K^o_t, W_t, P_t, M^o_t, \geq 0, \qquad 0 \leq L^o_t \leq 1,$$

$$\theta_0 = 1,$$

Given K_{-1}, $B^o_{h,0}$, $B^o_{f,0}$, M^o_0.

Households are subject to an individual borrowing constraint that rules out Ponzi schemes. The representative household selects her portfolio, consumption, and labour supply that maximize her-life time utility (12) subject to the budget constraint (15). The budget constraint of the OPT household problem can be rewritten in real terms:

$$C^o_t + b^o_{h,t} + Q_t b^o_{f,t} + I^o_t + m^o_t + \frac{\Xi_b}{2}Q_t\left(b^o_{f,t} - \bar{b}_f\right)^2 = W_tL^o_t + r^k_t u_t K^o_{t-1} + \frac{R_{t-1}b^o_{h,t-1}}{\pi_t} + Q_t\frac{R^*_{t-1}b^o_{f,t-1}}{\pi^*_t} + \frac{m^o_{t-1}}{\pi_t}$$

$$\frac{m^o_{t-1}}{\pi_t} - T^o_t - Z_t + \Gamma^o_t,$$

where $b^o_{h,t} = \frac{B^o_{h,t}}{P_t}$; $b^o_{f,t} = \frac{B^o_{f,t}}{P^*_t}$; $\pi_t = \frac{P_t}{P_{t-1}}$, and; $\pi^*_t = \frac{P^*_t}{P^*_{t-1}}$. We assume that the OPT representative household has the period utility function given by:

$$U^o_t = \frac{(C^o_t)^{1-\gamma_c}}{1-\gamma_c} + \chi_m\frac{\iota_t^{\gamma_m}(M^o_t/P_t)^{1-\gamma_m}}{1-\gamma_m} - \chi_l\frac{(L^o_t)^{1+\gamma_l}}{1+\gamma_l}. \tag{17}$$

where $\gamma_c > 0$ is the risk aversion coefficient; $\gamma_m > 0$ denotes the inverse of the elasticity of money holdings with respect to the interest rate; $\gamma_l > 0$ is the inverse of the Frisch elasticity; χ_m and χ_l represent the utility parameter for real cash balances and labour, respectively. Real cash holdings depend positively on consumption with an elasticity equal to γ_c/γ_m and negatively on the nominal interest rate. The necessary first-order conditions for the OPT household decision problem are given by equation (15) together with the following equations:
First-order condition with respect to consumption:

$$C^o_t = \left(\frac{\lambda_t}{\kappa_t}\right)^{-\frac{1}{\gamma_c}}, \tag{18}$$

First-order condition with respect to real money:

$$m^o_t = \iota_t(\kappa_t\chi_m)^{\frac{1}{\gamma_m}}\left\{\lambda_t - \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\pi_{t+1}}\right) + \frac{d1}{2}\left\{\frac{d2}{m^o_{t-1}}\exp\left(d2\left[\frac{m^o_t}{m^o_{t-1}} - 1\right]\right) - \frac{d2}{m^o_{t-1}}\exp\left(-d2\left[\frac{m^o_t}{m^o_{t-1}} - 1\right]\right)\right\} + \right.$$

$$\left. \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\frac{d1}{2}\left\{d2\frac{m_{t+1}}{(m^o_t)^2}\exp\left(-d2\left[\frac{m^o_{t+1}}{m^o_t} - 1\right]\right) - d2\frac{m_{t+1}}{(m^o_t)^2}\exp\left(d2\left[\frac{m^o_{t+1}}{m^o_t} - 1\right]\right)\right\}\right\}^{-\frac{1}{\gamma_m}}, \tag{19}$$

First-order condition with respect to investment:

$$1 = \psi_t\vartheta_t\left[1 - \frac{\Xi_I}{2}\left(\frac{I^o_t}{\mu_tI^o_{t-1}} - 1\right)^2 - \Xi_I\left(\frac{I^o_t}{\mu_tI^o_{t-1}}\right)\left(\frac{I^o_t}{\mu_tI^o_{t-1}} - 1\right)\right] +$$

$$\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\vartheta_{t+1}\psi_{t+1}\Xi_I\left[\left(\frac{I^o_{t+1}}{\mu_{t+1}I^o_t}\right)^2\left(\frac{I^o_{t+1}}{\mu_{t+1}I^o_t} - 1\right)\right]\right\}, \tag{20}$$

First-order condition with respect to capital:

$$1 = \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\frac{\left[r^k_{t+1}u_{t+1} + (1-\delta(u_{t+1})\vartheta_{t+1}\right]}{\vartheta_t}\right\}, \tag{21}$$

First-order condition with respect to capital utilization:

$$\vartheta_t(\Xi_1 + \Xi_2(u_t - 1) = r^k_t, \tag{22}$$

First-order condition with respect to Home bond:

$$1=\beta^{c}(\Delta\tilde{C}_t)\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\lambda_t}\frac{R_t}{\pi_{t+1}}\right), \tag{23}$$

First-order condition with respect to Foreign bond:

$$1+\Xi_b\left(b^o_{f,t}-\bar{b}_f\right)=\beta^{c}(\Delta\tilde{C}_t)\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\lambda_t}\frac{Q_{t+1}}{Q_t}\frac{R^*_t}{\pi^*_{t+1}}\right). \tag{24}$$

where λ_t is the Lagrangian multiplier associated with the budget constraint and ϑ_t is the marginal Tobin's Q.

ROT households fully consume their current labour income and money transfer. They do not smooth their consumption path in the face of fluctuations in labour income, nor do they intertemporally substitute in response to changes in Home and Foreign interest rates. Their period utility is given by:

$$\max_{\{C^r_t,L^r_t\}_{t=0}^{\infty}} u^r_t=\mathbb{E}_t\sum_{t=0}^{\infty}\theta_t\kappa_t\left(\frac{(C^r_t)^{1-\gamma_c}}{1-\gamma_c}-\chi_l\frac{(L^r_t)^{1+\gamma_l}}{1+\gamma_l}\right), \tag{25}$$

s.t

$C^r_t=W_tL^r_t-T^r_t-Z_t.$

Because a ROT household simply consumes its current income, consumption follows directly from the budget constraint.

3.2 Final-Good Producers

The final-good producers act as retail firms. They combine a large number of intermediate goods into a final output. We assume that the final-good market structure is of perfect competition. Therefore, these are the inputs used by the final-good producers in their production process. The result is an aggregate good sold to households. We assume that each intermediate good is indexed within the unit interval [0,1]. Thus, the final good is produced by perfectly competitive final-good producers that combine the intermediate inputs into a final output $Y_{h,t}$ through a constant return to scale technology:

$$Y_{h,t}=\left(\int_0^1 Y_{h,t}(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}} \tag{26}$$

where $Y_{h,t}(i)$ is an intermediate input produced by the intermediate firm i, whose price is $P_{h,t}(i)$. Final-good firms are perfectly competitive and maximize profits subject to the production function (26), taking as given all prices of intermediate goods $P_{h,t}(i)$ and the price of the final good $P_{h,t}$. Since all final-good firms are identical, we can proceed by considering a representative final-good firm that faces the following maximization problem:

$$\max_{Y_{h,t},\{Y_{h,t}(i)\}_{i\in[0,1]}} P_{h,t}Y_{h,t}-\int_0^1 P_{h,t}(i)Y_{h,t}(i)di \tag{27}$$

s.t

$$Y_{h,t}=\left(\int_0^1 Y_{h,t}(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}.$$

The first-order condition with respect to the generic input i is as follows:

$$Y_{h,t}(i)=\left(\frac{p_{h,t}(i)}{p_{h,t}}\right)^{-\epsilon}Y_{h,t}, \tag{28}$$

where $p_{h,t}(i)=\frac{P_{h,t}(i)}{P_t}$. Next we derive the equilibrium price level $P_{h,t}$ as a function of the price of intermediate goods $P_{h,t}(i)$. Note that the price level is defined as the price of one unit of the final good. Therefore, it can be obtained from solving the following problem:

$$P_{h,t}=\min_{\{Y_{h,t}(i)\}_{i\in[0,1]}}\left(\int_0^1 P_{h,t}(i)Y_{h,t}(i)di\right), \tag{29}$$

s.t

$$Y_{h,t}=1. \tag{30}$$

Solving this minimization problem we obtain an expression for the price level as a function of the price of intermediate goods:

$$P_{h,t} = \left(\int_0^1 P_{h,t}(i)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}. \quad (31)$$

Given the assumptions imposed on final-good firms, the total cost of production equals output, which yields zero profit for all $t \geq 0$.

3.3 Intermediate-Good Producers

There is a continuum of firms indexed by $i \in [0, 1]$. Each firm uses an identical technology to produce a differentiated good. All firms face an identical demand schedule and take the aggregate price level, P_t and aggregate consumption index C_t as given. Each intermediate-good firm i produces a differentiated domestic input using the following technology:

$$Y_t(i) = A_t \left(\widehat{K^o}_{t-1}(i) \right)_t^{\alpha} (L_t(i))^{1-\alpha}, \quad (32)$$

where A_t is the total factor productivity, and; $\alpha \in (0, 1)$. $L_t(i)$ is an aggregator of the different labour varieties indexed by j:

$$L_t(i) = \left(\int_0^1 L_t(i,j)^{\frac{\epsilon_w - 1}{\epsilon_w}} dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$$

$L_t(i,j)$ represents the amount of labour variate j used by firm i, and; ϵ_w is the elasticity of substitution between labour types. We follow Gali et al. (2007) and assume that the fraction of ROT and OPT consumers are uniformly distributed across worker types and therefore across unions. Firms allocate labour demand proportionally.

Firms operate in monopolistic competition, thus they have some degree of market power. They set up their prices subject to the demand of final good firms (see Equation (28)). As firms face negatively sloped demand curves, marginal revenue curves are strictly below their demand curves. This implies that firms' profit maximization choice will result in a price higher than the marginal cost. As emphasized by Rotemberg (1982) changing prices is costly. For example, there are administrative costs of changing the price lists, informing clients, etc. There is also an implicit cost resulting from the negative reaction of clients to large price changes. They may prefer small and frequent price changes to infrequent large ones (Rotemberg, 1982). Therefore, we follow Rotemberg (1982) and assume that and assume that firms face a nominal price adjustment cost with respect to the benchmark $\overline{\pi}$:[13]

$$PAC_t(i) = \frac{\Xi_p}{2} \left(\frac{P_{h,t}(i)}{P_{h,t-1}(i)} - \overline{\pi} \right)^2 P_{h,t} Y_{h,t}.$$

Taken the input prices W_t and r_t^k as given, intermediate good firms hire labour, and rent capital in perfectly competitive factor markets, in addition to choosing the price of the intermediate good that maximizes discounted real profits. The problem, expressed in terms of the domestic CPI, is as follows:

$$\max_{\left\{P_{h,t}(i), L_t(i), \widehat{K^o}_{t-1}(i), Y_{h,t}(i)\right\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \theta_t \frac{\lambda_t}{\lambda_0} \left[\frac{P_{h,t}(i)}{P_t} Y_{h,t}(i) - W_t L_t(i) - r_t^k \widehat{K^o}_{t-1}(i) - \frac{PAC_t(i)}{P_t} \right] \right\}, \quad (33)$$

s.t

$$Y_{h,t}(i) = \left(\frac{P_{h,t}(i)}{P_{h,t}} \right)^{-\epsilon} Y_{h,t},$$

$$Y_t(i) = A_t \left(\widehat{K^o}_{t-1}(i) \right)^{\alpha} (L_t(i))^{1-\alpha}.$$

The first-order conditions for this problem are:

[13] The two most used modelling, approaches to price setting are Rotemberg (1982) and Calvo (1983). Up to a first-order approximation the two frameworks provide identical expressions for the New Keynesian Phillips Curve, leading to observationally equivalent dynamics for inflation and output (Rotemberg, 1987; Roberts, 1995). Our choice for pricing is due to three important characteristics of the Rotemberg model: i) in the presence of trend inflation, the long-run relationship between inflation and output is negative in the Calvo model and positive in the Rotemberg model, which is in line with most of the empirical data; ii) contrary to the Calvo model, where an increase in trend inflation shrinks the determinacy region of the steady state, it enlarges this area in the Rotemberg model. This implies that the range of optimal and implementable monetary and fiscal rules under Rotemberg pricing is greater than Calvo pricing (Schmitt-Grohé and Uribe, 2007; Ascari and Rossi, 2012), and; iii) the Rotermberg model generates more volatility at the Zero Lower Bound than the Calvo model, which helps to explain the fluctuations found in the US data during the GFC (Richter and Throckmorton, 2016).

First-order condition with respect to capital:

$$r_t^k = mc_t(i)\alpha A_t \left(\widehat{K^o}_{t-1}(i)\right)^{\alpha-1} (L_t(i))^{1-\alpha}. \tag{34}$$

First-order condition with respect to labour:

$$W_t = mc_t(i)\,(1-\alpha)\,A_t \left(\widehat{K^o}_{t-1}(i)\right)^{\alpha} (L_t(i))^{-\alpha}. \tag{35}$$

First-order condition with respect to $P_{h,t}(i)$:

$$(1-\epsilon)\,\frac{1}{P_t}\left(\frac{P_{h,t}(i)}{P_{h,t}}\right)^{-\epsilon} Y_{h,t} - \frac{\Xi_p}{P_{h,t-1}(i)}\left(\frac{P_{h,t}(i)}{P_{h,t-1}(i)} - \overline{\pi}\right)\frac{P_{h,t}Y_{h,t}}{P_t} + \epsilon mc_t(i)\frac{Y_{h,t}}{P_{h,t}}\left(\frac{P_{h,t}(i)}{P_{h,t}}\right)^{-\epsilon-1} +$$

$$\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\Xi_p\frac{P_{h,t+1}(i)}{P_{h,t}(i)^2}\left(\frac{P_{h,t+1}(i)}{P_{h,t}(i)} - \overline{\pi}\right)\frac{P_{h,t+1}Y_{h,t+1}}{P_{t+1}}\right] = 0 \tag{36}$$

where mc_t is the Lagrangian multiplier, which can be interpreted as the marginal cost of producing an additional unit of output. In a symmetric equilibrium, firms choose the same inputs, outputs and prices. Thus, by imposing symmetric equilibrium the production function and the first-order conditions become:

$$Y_t = A_t \left(\widehat{K^o}_{t-1}\right)^{\alpha} (L_t)^{1-\alpha}. \tag{37}$$

$$r_t^k = mc_t\alpha\frac{Y_{h,t}}{\widehat{K^o}_{t-1}}. \tag{38}$$

$$W_t = mc_t\,(1-\alpha)\,\frac{Y_{h,t}}{L_t}. \tag{39}$$

$$\frac{(1-\epsilon)\,Y_{h,t}}{P_t} - \frac{\Xi_p}{P_{h,t-1}}\left(\frac{P_{h,t}}{P_{h,t-1}} - \overline{\pi}\right)\frac{P_{h,t}Y_{h,t}}{P_t} + \frac{\epsilon mc_t Y_{h,t}}{P_{h,t}} +$$

$$\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\Xi_p\frac{P_{h,t+1}}{P_{h,t}^2}\left(\frac{P_{h,t+1}}{P_{h,t}} - \overline{\pi}\right)\frac{P_{h,t+1}Y_{h,t+1}}{P_{t+1}}\right] = 0. \tag{40}$$

We can rearrange the pricing condition to obtain:

$$\pi_{h,t}\left(\pi_{h,t} - \overline{\pi}\right) = \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\pi_{h,t+1}\left(\pi_{h,t+1} - \overline{\pi}\right)\frac{p_{h,t+1}Y_{h,t+1}}{p_{h,t}Y_{h,t}}\right] + \frac{\epsilon}{\Xi_p}\left(\frac{mc_t}{p_{h,t}} - \frac{\epsilon-1}{\epsilon}\right). \tag{41}$$

where $\pi_{h,t} = \frac{P_{h,t}}{P_{h,t-1}} = \frac{p_{h,t}}{p_{h,t-1}}\pi_t$. Note that ϵ is the elasticity of substitution between differentiated goods. In the extreme case where $\epsilon \to \infty$, intermediate goods are perfect substitutes, and all firms are price takers, turning off the effect of monopolistic competition in the model. Real profits for intermediate firms in a symmetrical equilibrium are as follows:

$$\Gamma_t = p_{h,t}Y_{h,t} - W_tL_t - r_t^r K_{t-1} - \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 p_{h,t}Y_{h,t}. \tag{42}$$

3.4 Packers and Unions

Workers supply differentiated types of labour, sold by unions to perfectly competitive labour packers who assemble them and sell the homogeneous labour to intermediate-good firms. Packers use the following technology to aggregate labour:

$$L_t = \left(\int_0^1 L_t(j)^{\frac{\epsilon_w-1}{\epsilon_w}}dj\right)^{\frac{\epsilon_w}{\epsilon_w-1}}, \tag{43}$$

where $L_t(j)$ is labour of type j. Packers maximize profits subject to the aggregation function (43), taking as given the wage paid for each type of work performed. Since all packers are identical, we can proceed by considering a representative packer that faces the following maximization problem:

$$\max_{L_t,\{L_t(j)\}_{j\in[0,1]}} P_tW_tL_t - \int_0^1 P_tW_t(j)L_t(j)dj, \tag{44}$$

s.t

$$L_t = \left(\int_0^1 L_t(j)^{\frac{\epsilon_w - 1}{\epsilon_w}} dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}.$$

As the representative packer's maximization problem is similar to that of the representative final-good producer, we follow the same steps presented in section 3.2 to obtain the first-order condition with respect to the generic labour type j:

$$L_t(j) = \left(\frac{W_t(j)}{W_t} \right)^{-\epsilon_w} N_t. \tag{45}$$

Similarly, the wage index is given by:

$$W_t = \left(\int_0^1 W_t(j)^{1-\epsilon_w} dj \right)^{\frac{1}{1-\epsilon_w}}. \tag{46}$$

There is a continuum of unions, each representing a continuum of workers, according to the fraction of worker type (ROT and OPT). Each union defines the wage rate for its members, who satisfy any firm's demand for its labour services at the chosen cost. Workers perform the same type of work (regardless of his consumer type) different from the type of work performed by workers of other unions. Following Gali et al. (2007) we assume that the union takes into account the fact that firms allocate labour demand across different workers of type j, regardless of their consumer type. Thus, in the aggregate, $L_t^r{=}L_t^o{=}L_t$ for all t. Consequently, all workers earn the same wage and work the same number of hours. Each union sets nominal wages for its members by maximizing their utility subject to labour demand and quadratic adjustment costs (Rotemberg (1982)). Following Furlanetto (2011), we assume that unions face adjustment costs relative to the benchmark $\overline{\pi}_t$, and charge each member lump-sum fees to pay the adjustment costs. We also assume that the adjustment cost is proportional to the aggregate wage bill in the economy as follows:

$$UAC_t(j) = \frac{\Xi_w}{2} \left(\frac{P_t}{P_{t-1}} \frac{W_t(j)}{W_{t-1}(j)} - \overline{\pi} \right)^2 P_t W_t N_t,$$

where Ξ_W governs the size of the adjustment costs. Note that $Z_t(j){=}UAC_t(j)$ for all t. Each period, a typical union sets the wage for its workers by solving the following problem:

$$\max_{\{W_t(j)\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \theta_t \left[UM_t \left(\frac{P_t W_t(j) N_t(j)}{P_t} - \frac{UAC_t(j)}{P_t} \right) - \frac{\chi_l N_t(j)^{(1+\gamma_l)}}{1+\gamma_l} \right] \right\}, \tag{47}$$

s.t

$$L_t(j) = \left(\frac{W_t(j)}{W_t} \right)^{-\epsilon_w} N_t,$$

where $UM_t = \frac{\lambda}{(C_t^r)^{\gamma_c}} + \frac{1-\lambda}{(C_t^o)^{\gamma_c}}$. As consumption generally differs between ROT and OPT consumers, the union weighs labour income with their respective marginal utility of consumption (Furlanetto, 2011). The first-order condition is given by:

$$UM_t \left[(1-\epsilon_w) \left(\frac{W_t(j)}{W_t} \right)^{-\epsilon_w} N_t - \Xi_w \left(\frac{P_t}{P_{t-1}} \frac{W_t(j)}{W_{t-1}(j)} - \overline{\pi} \right) \frac{P_t}{P_{t-1}} \frac{W_t}{W_{t-1}(j)} N_t \right] - \chi_l \left[\left(\frac{W_t(j)}{W_t} \right)^{-\epsilon_w} N_t \right]^{\gamma_l}$$

$$\left[-\epsilon_w \left(\frac{W_t(j)}{W_t} \right)^{(-1-\epsilon_w)} \frac{N_t}{W_t} \right] + \beta^c(\Delta \tilde{C}_t) \mathbb{E}_t \left[UM_{t+1} \Xi_w \left(\frac{P_{t+1}}{P_t} \frac{W_{t+1}(j)}{W_t(j)} - \overline{\pi} \right) \frac{P_{t+1}}{P_t} \frac{W_{t+1} W_{t+1}(j)}{W_t(j)^2} N_{t+1} \right] = 0. \tag{48}$$

In a symmetric equilibrium, the first-order condition can be written as the New-Keynesian Phillips Curve for wage inflation:

$$\pi_t \pi_t^w \left(\pi_t \pi_t^w - \overline{\pi} \right) = \beta^c(\Delta \tilde{C}_t) \mathbb{E}_t \left[\frac{UM_{t+1}}{UM_t} \left(\pi_{t+1} \pi_{t+1}^w - \overline{\pi} \right) \pi_{t+1} (\pi_{t+1}^w)^2 \frac{N_{t+1}}{N_t} \right] + \frac{\epsilon_w}{\Xi_w} \left(\frac{N_t^{\gamma_l} \chi_l}{UM_t W_t} - \frac{\epsilon_w - 1}{\epsilon_w} \right). \tag{49}$$

3.5 Government and Monetary Authority

The Home government finances public spending g_t by collecting lump-sum taxes from both types of households and receiving bond transaction costs from the Foreign country:

$$p_{h,t}G_t = T_t + \frac{\Xi_b}{2}\left(b_{h,t}^{o,*} - \overline{b}_h^*\right)^2, \tag{50}$$

Since both types of households pay lump-sum taxes:

$$T_t = (1-\Phi)\,T_t^o + \Phi T_t^r. \tag{51}$$

As the Ricardian equivalence property does not hold due to the presence of ROT households, the following fiscal policy rule determines the path for taxes:

$$T_t^o = \overline{T^o} + \phi_g\left(G_t - \overline{G}\right), \qquad T_t^r = \overline{T^r} + \phi_g\left(G_t - \overline{G}\right),$$

where $\overline{T^o}$ and $\overline{T^r}$ are steady-state values of OPT and ROT lump-sum taxes, respectively; $\phi_g > 0$, and; $\overline{G}$ is the steady-state value of government spending. We follow Andrés et al. (2009) and Castelnuovo (2012) and assume that the monetary authority sets the nominal interest rate according to the following modified Taylor rule:

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\rho_r}\left[\left(\frac{\pi_t}{\overline{\pi}}\right)^{\phi_\pi}\left(\frac{gdp_t}{\overline{gdp}}\right)^{\phi_{gdp}}\left(\frac{mg_t}{\overline{mg}}\right)^{\phi_m}\right]^{1-\rho_r}\exp(gc_t), \tag{52}$$

where $gdp_t = p_{h,t}Y_{h,t}$; $mg_t = \frac{M_t}{M_{t-1}}$; $\overline{R}$, $\overline{gdp}$, and $\overline{mg}$ are the respective equilibrium nominal interest rate (natural interest rate), potential output, and target rate of money growth (steady-state values of the variables); ϕ_π, ρ_{gdp}, and ρ_{mg} are positive parameters chosen by the monetary authority with the objective of driving the variables towards their respective targets; $\rho_r > 0$ controls the monetary policy *inertia*, and; gc_t is an exogenous monetary policy shock whose evolution will be described below. As emphasized by Andrés et al. (2009), the response by the monetary authority to money growth can be rationalized both by money's usefulness in forecasting inflation and by considering that the variability of money growth appears in the central bank's loss function. The specification includes a lagged nominal interest rate term, thus allowing for interest rate smoothing. This implies a gradual adjustment of policy rates to their benchmark level.

3.6 Aggregation and Market Clearing

Aggregate consumption, investment, capital and hours are given by a weighted average of the corresponding variables for each type of consumer:

$$C_t = (1-\Phi)\,C_t^o + \Phi C_t^r, \qquad L_t = (1-\Phi)\,L_t^o + \Phi L_t^r,$$

$$B_{h,t} = (1-\Phi)\,B_{h,t}^o, \qquad B_{f,t} = (1-\Phi)\,B_{f,t}^o, \qquad M_t = (1-\Phi)\,M_t^o, \qquad K_t = (1-\Phi)\,K_t^o,$$

$$\Gamma_t = (1-\Phi)\,\Gamma_t^o, \qquad I_t = (1-\Phi)\,I_t^o. \tag{53}$$

The market clearing condition for the Home good is as follows:

$$Y_{h,t} = C_{h,t} + I_{h,t} + G_t + C_{h,t}^* + I_{h,t}^* + \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 Y_{h,t} + \frac{\Xi_w}{2}\left(\pi_t\pi_t^w - \overline{\pi}\right)^2 W_t N_t. \tag{54}$$

The assumption of zero net supply in the bond market implies that:

$$b_{h,t} + b_{h,t}^* = 0, \qquad b_{f,t} + b_{f,t}^* = 0. \tag{55}$$

The trade balance is defined as the difference between exports and imports:

$$TB_t = EXP_t - IMPt \tag{56}$$

$EXP_t = p_{h,t}\left(C_{h,t}^* + I_{h,t}^*\right)$ and $IMP_t = p_{f,t}\left(C_{f,t} + I_{h,t}\right)$. To derive the equilibrium in the trade balance we combine the real budget constraints of both types of households and the aggregate condition (53) with equations (42), (50), (51) to obtain:

$$C_t + I_t + p_{h,t}G_t + b_{h,t} + Q_t b_{f,t} + m_t = \frac{R_{t-1}b_{h,t-1}}{\pi_t} + Q_t\frac{R_{t-1}^* b_{f,t-1}}{\pi_t^*} + \frac{m_{t-1}}{\pi_t} + \frac{\Xi_b}{2}\left(b_{h,t}^{o,*} - \overline{b}_h^*\right)^2 -$$

$$\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2+p_{h,t}Y_{h,t}-\frac{\Xi_p}{2}\left(\pi_{h,t}-\bar{\pi}\right)^2 p_{h,t}Y_{h,t}-\frac{\Xi_w}{2}\left(\pi_t\pi_t^w-\bar{\pi}\right)^2 W_tN_t. \tag{57}$$

In order to derive an expression for the trade balance, we need to adjust equation (57) to account for changes in Foreign money holdings:

$$C_t+I_t+p_{h,t}G_t+b_{h,t}+Q_tb_{f,t}+m_t-Q_tm_t^*=\frac{R_{t-1}b_{h,t-1}}{\pi_t}+Q_t\frac{R_{t-1}^*b_{f,t-1}}{\pi_t^*}+\frac{m_{t-1}}{\pi_t}-Q_t\frac{m_{t-1}^*}{\pi_t^*}+$$
$$\frac{\Xi_b}{2}\left(b_{h,t}^{o,*}-\bar{b}_h^*\right)^2-\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2+p_{h,t}Y_{h,t}-\frac{\Xi_p}{2}\left(\pi_{h,t}-\bar{\pi}\right)^2 p_{h,t}Y_{h,t}-\frac{\Xi_w}{2}\left(\pi_t\pi_t^w-\bar{\pi}\right)^2 W_tN_t. \tag{58}$$

Using the market clearing conditions, the identities $C_t=p_{h,t}C_{h,t}+p_{f,t}C_{f,t}$ and $I_t=p_{h,t}I_{h,t}+p_{f,t}I_{f,t}$ together with the definitions of exports and imports, we obtain the adjusted budget constraint of the economy:

$$p_{h,t}\left[C_{h,t}+I_{h,t}+G_t+\frac{\Xi_p}{2}\left(\pi_{h,t}-\bar{\pi}\right)^2 p_{h,t}Y_{h,t}+\frac{\Xi_w}{2}\left(\pi_t\pi_t^w-\bar{\pi}\right)^2 W_tN_t-Y_{h,t}\right]+p_{f,t}(C_{f,t}+I_{f,t})=$$
$$\frac{R_{t-1}b_{h,t-1}}{\pi_t}+Q_t\frac{R_{t-1}^*b_{f,t-1}}{\pi_t^*}+\frac{m_{t-1}}{\pi_t}-Q_t\frac{m_{t-1}^*}{\pi^*}-b_{h,t}-Q_tb_{f,t}-m_t+Q_tm_t^*+\frac{\Xi_b}{2}\left(b_{h,t}^*-\bar{b}_h^*\right)^2-$$
$$\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2. \tag{59}$$

Applying the definition of exports and imports we obtain an expression for the trade balance:

$$-EXP_t+IMP_t=\frac{R_{t-1}b_{h,t-1}}{\pi_t}-b_{h,t}+Q_t\frac{R_{t-1}^*b_{f,t-1}}{\pi_t^*}-Q_tb_{f,t}+\frac{m_{t-1}}{\pi_t}-m_t-Q_t\frac{m_{t-1}^*}{\pi_t^*}+Q_tm_t^*+$$
$$\frac{\Xi_b}{2}\left(b_{h,t}^*-\bar{b}_h^*\right)^2-\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2. \tag{60}$$

$$TB_t=b_{h,t}-\frac{R_{t-1}b_{h,t-1}}{\pi_t}+Q_tb_{f,t}-Q_t\frac{R_{*t-1}b_{f,t-1}}{\pi_t^*}+m_t-\frac{m_{t-1}}{\pi_t}-Q_tm_t^*+Q_t\frac{m_{t-1}^*}{\pi_t^*}+\frac{\Xi_b}{2}\left(b_{h,t}^*-\bar{b}_h^*\right)^2-$$
$$\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2. \tag{61}$$

The current account is the sum of the trade balance with interest received from the Foreign country:

$$CA_t=TB_t+b_{h,t-1}\left(\frac{R_{t-1}}{\pi_t}-1\right)+Q_tb_{f,t-1}\left(\frac{R_{t-1}^*}{\pi_t^*}-1\right)+\frac{\Xi_b}{2}\left(b_{h,t}^*-\bar{b}_h^*\right)^2-\frac{\Xi_b}{2}Q_t\left(b_{f,t}-\bar{b}_f\right)^2. \tag{62}$$

Note that, due to the presence of money holdings in the economy budget constraint, the economy is subject to temporary current account imbalances. However, in the steady state, current account equals the financial account, restoring equilibrium to the balance of payments.

3.7 Intertemporal Asset Pricing Model

If we subtract equation (23) from (24) we obtain the following no-arbitrage condition:[14]

$$TC_t=\mathbb{E}_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(\frac{C_{t+1}^o}{C_t^o}\right)^{-\gamma_c}\frac{P_t}{P_{t+1}}\left(\frac{S_{t+1}}{S_t}R_t^*-R_t\right)\right], \tag{63}$$

where $TC_t=\Xi_b\left(b_{f,t}^o-\bar{b}_f\right)/\beta^c(\Delta\tilde{C}_t)$. When the expression in the second parentheses inside the brackets of equation (63) equals zero, the UIP condition holds. Otherwise, it gives rise to currency excess returns. If we multiply this term by $\frac{P_t}{P_{t+1}}$ we arrive at an Euler's equation with real excess returns earned by a Foreign bond in terms of a Home bond, net of currency depreciation:

$$TC_t=\mathbb{E}_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(\frac{C_{t+1}^o}{C_t^o}\right)^{-\gamma_c}RX_{t+1}\right], \tag{64}$$

where $RX_{t+1}=\frac{P_t}{P_{t+1}}\left(\frac{S_{t+1}}{S_t}R_t^*-R_t\right)$. Equation (64) is crucial for asset pricing, since it shows that the expected excess returns discounted by the stochastic discount factor are zero (abstracting from the transaction costs associated with the asset position in the foreign bond market, TC_t). The representative household will exhaust all discounted profit opportunities. The risks associated with foreign bonds result from the covariance between excess returns with consumption growth and time preference changes. This is what we now formally demonstrate.

[14]Note that we have dropped the $\beta(\tilde{C}_t)$, since it is a known constant value at t.

3.8 Beta Representation

Breeden and Litzenberger (1978) show that the consumption of each individual at a given date is an increasing function of aggregate consumption in an economy where unrestricted Pareto-optimal consumption allocation is allowed. Suppose all OPT individuals have the same subjective discount factor. Each marginal utility of the OPT individual's optimal consumption in a given t is equal to a scalar multiplied by a monotonically decreasing aggregate consumption function, $f(C)$. Breeden et al. (1989) demonstrate that in a Pareto-efficient capital market, the rate of growth of marginal utility of consumption would be identical for all individuals and equal to the rate of growth of aggregate marginal utility of consumption at equilibrium:

$$\frac{U_c^o(C_{t+1}^o, M_{t+1}^o/P_{t+1}, L_{t+1}^o)}{U_c^o(C_t^o, M_t^o/P_t, L_t^o)} = \frac{f(C_{t+1})}{f(C_t)}. \tag{65}$$

Using a first order Taylor expansion around C_t^o and assuming the power utility function given by equation (17) yields the following expression:

$$\frac{U_c^o(C_{t+1}^o, M_{t+1}^o/P_{t+1}, L_{t+1}^o)}{U_c^o(C_t^o, M_t^o/P_t, L_t^o)} = 1 - \gamma_c \Delta C_{t+1}^o. \tag{66}$$

Combining equations (64) and (66) yields the subsequent expression:

$$I\!E_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(1-\gamma_c\Delta C_{t+1}^o\right) RX_{t+1}\right] = TC_t. \tag{67}$$

We can derive the beta representation of equation (67) by following Cochrane (2005b) and Bohrnstedt and Goldberger (1969):[15]

$$\begin{aligned} I\!E_t(RX_{t+1}) = & \left(\frac{\gamma_c I\!E_t(\kappa_{t+1}^p){}_t(\Delta C_{t+1}^o)}{I\!E_t\left[\kappa_{t+1}^p(1-\gamma_c\Delta C_{t+1}^o)\right]}\right)\left(\frac{{}_t(\Delta C_{t+1}^o, RX_{t+1})}{{}_t(\Delta C_{t+1}^o)}\right) \\ & + \left(\frac{\left[1-\gamma_c I\!E_t(\Delta C_{t+1}^o)\right]_t(\kappa_{t+1}^p)}{I\!E_t\left[\kappa_{t+1}^p(1-\gamma_c\Delta C_{t+1}^o)\right]}\right)\left(\frac{{}_t(-\kappa_{t+1}^p, RX_{t+1})}{{}_t(\kappa_{t+1}^p)}\right) - TC_t, \end{aligned} \tag{68}$$

where $k_{t+1}^p = \frac{k_{t+1}}{k_t}$. The Beta representation is as follows:

$$I\!E_t\left(RX_{t+1}\right) = \lambda_c\beta_c + \lambda_\kappa\beta_\kappa - TC_t, \tag{69}$$

λ's represent the risk prices and β's are the risk quantities of our two risk factors (the growth rate of consumption and time preference), as expressed below:

$$\begin{aligned} \lambda_c = & \left(\frac{\gamma_c I\!E_t(\kappa_{t+1}^p){}_t(\Delta C_{t+1}^o)}{I\!E_t\left[\kappa_{t+1}^p(1-\gamma_c\Delta C_{t+1}^o)\right]}\right); \qquad \lambda_\kappa = \left(\frac{\left[1-\gamma_c I\!E_t(\Delta C_{t+1}^o)\right]_t(\kappa_{t+1}^*)}{I\!E_t\left[\kappa_{t+1}^p(1-\gamma_c\Delta C_{t+1}^o)\right]}\right) \\ \beta_c = & \left(\frac{{}_t(\Delta C_{t+1}^o, RX_{t+1})}{{}_t(\Delta C_{t+1}^o)}\right); \qquad \beta_\kappa = \left(\frac{{}_t(-\kappa_{t+1}^p, RX_{t+1})}{{}_t(\kappa_{t+1}^p)}\right) \end{aligned} \tag{70}$$

Equation (68) represents the fundamental asset pricing condition to foreign assets in our economy. The model implies that currency excess returns should be a compensation for risks associated with consumption growth and changes in household time preference.

3.9 Structural Shocks and CT Returns

IST, MEI, and MON Shocks Definition. In the model of Justiniano et al. (2011), the IST shock affects the transformation of final goods into investment goods and can be associated with the relative price of investment to consumption goods. The MEI shock affects the production of installed capital from investment goods or, more broadly, the transformation of savings into the future capital input. They show that their multi-sector model with intermediate goods producers, final goods producers, investment goods producers, and capital producers can be condensed into a model where the capital accumulation process is centralized in only one sector. They argue that this modelling strategy is necessary to distinguish the two disturbances that affect capital investment.

In our model, we combine the IST and MEI shocks in just on sector of capital accumulation. The IST shock directly affects investment. On the other hand, unlike Justiniano et al. (2011), the MEI shock enters the model by

[15] To compute the covariance of the products of our three random variables we followed Bohrnstedt and Goldberger (1969) and assumed that these three variables are multivariate normal distributed. As emphasized by Bohrnstedt and Goldberger (1969) the expression for the covariance term of these random variables are asymptotic approximations of the exact covariance.

reducing investment adjustment costs. The distinction between IST and MEI is crucial, as they capture different aspects of capital investment. The MON shock affects the stock of money held by households. This choice is motivated by a variety of recent empirical studies that support the role of money demand in explaining fluctuations in macroeconomic variables and asset prices. Furthermore, the quantitative easing programs implemented by many central banks after the outbreak of the GFC provide additional incentive to investigate the role of money demand in the economy. Finally, we combine the IST, MEI, and MON disturbances to obtain the time preference process.

As emphasized by Greenwood et al. (1997a), technological advances have made equipment less expensive triggering increases in the capital investment both in short and long run. The authors show that large part of output and capital stock growth is due to investment-specific technological change. Greenwood et al. (1992) show that the IST shock is a significant factor in U.S business cycle fluctuations. They emphasize that the IST shock makes new capital less expensive, which in turn stimulates the demand of new capital. They argue that the fall in the relative price of equipment can be used as a direct measure of IST shock. Therefore, we follow Greenwood et al. (1992), Greenwood et al. (1997a), Justiniano et al. (2011), and Dogan (2019) use the relative price of investment as a proxy for the IST process.[16]

As emphasized by Justiniano et al. (2011), the financial system plays a crucial role in the process of physical capital production. They argue that the MEI shock might reflect more fundamental disturbances in the ability of the financial system to intermediate capital investments. For example, if capital producers need to borrow to buy investment goods, the creation of productive capital will be affected by their capacity to access credit, as well as by the efficiency with which the financial system designates that credit. More efficient financial systems can also act to reduce external costs of investment adjustment, by increasing financing for the production of capital goods, improving the speed of capital availability. Furthermore, the findings of Basu and Kimball (2003) suggest that investment adjustment costs may proxy delays in investment planning or inflexibility in changing the planned investment pattern. If investment planning and the investment pattern rely on borrowing, more efficient financial systems can reduce the frictions arising from these two sources.

In our model, there is no explicit role for financial intermediation, however, the transformation of foregone consumption (real savings) into future productive capital is affected by investment adjustment costs, which in equilibrium is affected by μ_t. Negative shocks to μ_t decrease the amount of effective capital installed per unit of foregone consumption. Thus, one possible interpretation of μ_t is as a proxy for the effectiveness with which the financial sector channels the household savings into new productive capital, reducing investment adjusment costs.

Justiniano et al. (2011) employ the external finance premium proxied by the spread between the returns on high-yield and AAA corporate bonds as the measure of the MEI process. In our asset pricing exercises, we consider a broader measure as a proxy for the MEI process, the Index of Financial Development (IFD) developed by the IMF (Svirydzenka, 2016). The IFD considers in its composition not only the typical empirical measures of financial development (the ratio of private credit to GDP and the stock market capitalization to GDP), but also a set of nine sub-indicators that summarize how financial institutions and financial markets are in terms of their depth, access, and efficiency. In addition, it has a wide coverage of 183 countries from 1980 onward. The advantage of the IFD is that it encompasses several features of the financial market, not only the corporate bond market. This is important because in our empirical analysis we work with countries with different financial structures. For example, it may be that some countries in our sample have experienced a major improvement in the functioning of their financial sector without the presence of a well-developed corporate bond market. This could have been achieved through the development of the stock market or the banking system.

In our model, MON shocks affect real money demand and can generate business cycle fluctuations. As highlighted by Andrés et al. (2009), money demand may exert 'direct' and policy effects on the economy. The direct effect arises due to the presence of portfolio adjustment costs, which affects directly agents' utility. Portfolio adjustment costs make the money demand equation dynamic, creating a forward-looking dimension to it. The interest-elastic and forward-looking aspect of real balances allows them to function as leading indicators of future movements in the natural real interest rate (Nelson, 2002; Andrés et al., 2009). In this case, money demand contains important information besides that obtained from its responses to current income and nominal interest rate. It varies in reaction to movements in expected future natural real rates not incorporated in short-term nominal interest rate. Which, in turn, has information about expected output and inflation. The policy effect concerns to the reaction of the monetary authority to the nominal money growth rate. When a money demand shock materializes, the monetary authority may neutralize the effect on the policy rate by adjusting money supply. Consequently, real balances may move as a reflection of a monetary policy that stabilizes output and inflation.

There are several papers that consider money demand as a source of fluctuation in output and inflation in New-Keynesian models (see, e.g., Nelson (2002), Ireland (2004), Andrés et al. (2009), Arestis et al. (2010), Canova and Menz (2011), Castelnuovo (2012), Benchimol and Fourçans (2012), Benchimol and Fourçans (2017), and

[16]The link between the relative price of investment and the inverse of the IST may not hold in: i) non-competitive multi-sector models with nominal rigidities and sectors with different markups (Justiniano et al., 2011), and; ii) open-economy models with different home bias in consumption and investment goods (Basu and Thoenissen, 2011). Both cases create a wedge between the relative price of investment and the inverse of the IST shock. Note that our model economy abstracts from both features. Furthermore, in our asset pricing exercises, we assume that, regardless of magnitude, any wedge between the relative price of investment and the inverse of the IST is equal across countries. Thus, the results of our asset pricing estimation turns out to be invariant to the presence of the wedge.

Benchimol and Qureshi (2020). Chadha et al. (2014) find that money convey significant information to the central bank when there are shocks to credit supply. Andrés et al. (2009) and Castelnuovo (2012)) show that the inclusion of money demand in the utility function and in the central bank's reaction function improves the model's fit when compared with the standard New-Keynesian model. There are also many empirical studies that find significant effects of monetary aggregates on business cycle (see, e.g., Leeper and Roush (2003), Sims and Zha (2006), Hafer and Jones (2008), Favara and Giordani (2009), Šustek (2010), El-Shagi et al. (2015), and Benchimol and Fourçans (2017)).

In general, the literature that explore the role of money demand shocks in the economy assume, in addition to the endogenous determinants of real balances, the existence of exogenous disturbances reflecting macroeconomic uncertainties and financial innovations. In general, increases in uncertainty are positively associated with money demand (precautionary reasons). On the other hand, financial innovations are negatively associated with money demand (reduction of losses arising from the opportunity cost of holding money). We assume that the MON shock summarizes the combined effect of macroeconomic uncertainties and financial innovations.[17]

Macroeconomic uncertainty reflects a broad concept, a set of forces that can contribute to changes in money demand. In addition, it may affect household's expectations about the evolution of the economy. The literature suggests several factors underlying macroeconomic uncertainty, such as: i) volatility in monetary and fiscal policies; ii) occurrence of rare events, such as wars, natural disasters, and pandemic outbreaks; iii) political disputes and banking crisis, and; iv) volatility in financial markets. Financial innovations are associated with all technological and regulatory changes that encourage agents to use electronic payment instead of cash in their transactions.

Short-term and Long-term Effects of IST, MEI and MON Shocks. IST and MEI shocks can affect the economy both in the short term (business cycle fluctuations) and in the long term (trend evolution of economic variables). For example, following a positive innovation in the IST or MEI processes, the return on capital investment increases, immediately encouraging new capital investments. Both shocks help to explain business cycle fluctuations, as increased investment demand triggers short-term output growth. The process of capital accumulation and the expansion of the supply of goods tend to reduce the MPK (real interest rate) and inflation, respectively. The Fisher's (1930) equation predicts this dynamic would lead to a reduction in nominal interest rates. This implies that if countries with high nominal interest rates (with high MPK and inflation rate) witness higher IST and MEI growth rates than countries with low nominal interest rates (with low MPK and inflation rate), we should observe a catching-u process in nominal interest rates.

In section 2, we also uncover a process of convergence in the growth rate of aggregate real balances. Developing countries' the growth rate of the stock of money approached that of developed countries. The connection between the demand for money and nominal interest rate suggests that the convergence in the growth rate of the money stock accelerates the process of convergence of nominal interest rates across countries. Therefore, a natural explanation for the long-term convergence of nominal interest rates between developed and developing countries observed from 1980 to 2019 can be obtained from the behavior of the IST, MEI, and MON processes. Reducing nominal interest rate differentials reduces the portion of CT returns arising from the interest rate differential.

Exchange rate variation also plays a role in explaining CT returns. We also explored the behavior of exchange rates considering the period between 1980 and 2019. We analyzed the volatility, the growth rate, and the absolute value of the growth rate of exchange rates (the results are not reported but are available upon request from the authors). We found that, in general: i) exchange rate volatility and the absolute value of exchange rate growth have declined in recent decades for all groups of countries, and; ii) exchange rate growth has slowed in recent decades in developing countries and hovers around -4% and +4% in developed countries.

The reduction in the growth rate and volatility of exchange rate may also affect CT returns. There are three possible channels through which the IST, MEI, and MON shocks can help explain the lower growth rate and volatility of exchange rates. The first is the magnitude of the shocks. As will be shown next, these shocks affect the nominal exchange rate and returns to CT. The greater the magnitude of the shocks, the greater the change in CT returns triggered by them. In Section 2 we show that, in general, the growth rate of the IST, MEI, and MON processes fell from 1980 to 2019.

The second channel is associated with the decrease in the variance of the growth rate of the IST, MEI and money stock. For example, if the distribution of shocks is very dispersed, flows between countries triggered by the shocks should reflect this characteristic in their own distribution. It is reasonable to expect that more volatile flows increase exchange rate volatility. Thus, the greater the variance of the growth rate of the processes, the greater should be the exchange rate volatility resulting from flows between countries produced by the shocks. Consequently, we can associate the fall in exchange rate volatility with the fall in the variance of the growth rate of the three processes. Overall, this is what we report in Section 2.

[17] Atta-Mensah (2004) analyzes the demand for money in Canada considering the period between 1960 and 2003. In their model, the demand shock process is proxied by an index of economic uncertainty. The author finds that an increase in economic uncertainty leads, in the short-run, to a rise in money balances. Cusbert et al. (2013) and Bahmani-Oskooee and Nayeri (2018) analyze the impact of macroeconomic uncertainty on money demand in Australia. Overall, they find that increased uncertainty induces the public to hold more cash to cover themselves against an uncertain future. In general, the results of these authors are in line with Bjørnland (2005), Miyagawa (2009), Bahmani-Oskooee et al. (2012), Bahmani-Oskooee et al. (2013), and Bahmani-Oskooee and Xi (2014)

The third channel to explain the fall in exchange rate variance is associated with the nature of the MEI and the MON processes. As will be shown next, in the short run, a positive MEI shock generates exchange rate volatility. However, in the long run, the improvement in financial development brought about by positive MEI shocks can reduce the effects of macroeconomic uncertainty and acts to reduce exchange rate volatility. The strengthening of the financial system, increasing liquidity, and credit availability improve the perspective of growth and alleviate the effects of uncertainty on the economy. During periods of uncertainty, with a less-developed financial sector, credit constraints affecting firms and households are more likely to bind, and the cost of external financing increase. In summary, countries with poor financial sectors experience higher levels of volatility in GDP, inflation, interest rates, and exchange rates than economies with developed financial sectors. On the other hand, a reduction in money demand (proxied by the MON shock) is an indication of lower macroeconomic uncertainty. Which often implies lower exchange rate volatility. This suggests a natural connection between the MEI process and exchange rate volatility.[18]

Time Preference and Household Expectations. Models of capital accumulation have been at the center of the theory of economic growth and business cycles. Based on the agents' dynamic consumption and saving decisions, driven by intertemporal utility trade-offs between current and future consumption, a key component of these models is the rate of time preference. Unlike the usual neoclassical approach, we do not assume that time preference is a fixed parameter, but rather that it adjusts according to average consumption growth, the IST, MEI, and MON shocks. We assume that time preference captures two important features of the OPT agent's behavior related to intertemporal decisions about consumption and saving. The first, reflects a consumption externality. The agent's consumption is affected by the consumption of others. The second, reflects changes in expectations. Agents' consumption is affected by changes in expectations about the evolution of the economy caused by macroeconomic shocks. Our choice of time preference modeling is grounded on the existing literature that models discount factors as time-varying variables. There are several theoretical and empirical studies that question the major use of fixed discount factors (see, e.g., Frederick et al. (2002)). Furthermore, the IST, MEI, and MON shocks play a central role in determining asset prices, because these shocks also affect demand for assets through changes in agents' time preference. Our model delivers an asset pricing equation with a risk factor associated with time preference shocks that is similar to the "Valuation risk" explored in the asset pricing literature.[19]

As emphasised by Becker and Mulligan (1997), time preference plays a key role in theories of saving and investment, economic growth, interest rate determination, and asset pricing. The literature proposes several possible determinants of time preference, such as education, changes in life expectancy and death probability, consumption habit, present and future "selfies", uncertainty about future rewards in uncertain environments, and changes in the stock of wealth (Becker and Mulligan, 1997; Frederick et al., 2002). The early contributions on the theory of time preference focus on the endogeneity of agents' discount rate. These works assume that time preference is an increasing function of the utility level and, therefore, consumption flows (Uzawa, 1968; Epstein, 1987; Obstfeld, 1990) or an increasing function of wealth (Lucas Jr and Stokey, 1984). One implication of this assumption is that agents become impatient as they become richer. More recent papers propose that agents become more patient as they become richer and assume that the discount factor depends positively on the flow of consumption or the stock of wealth (Becker and Mulligan, 1997; Das, 2003; Kam, 2005; Kam and Mohsin, 2006) and the stock of capital (Stern, 2006; Erol et al., 2011). On the other hand, Chen and Yang (2019) associates time-varying discount factor with agent's longevity[20], Creal and Wu (2020) assume that the rate of time preference is stochastic but it also depends on macroeconomic variables (aggregate consumption and inflation), and other authors consider a pure stochastic discount factor (Dutta and Michel, 1998; Eggertsson, 2011; Maurer, 2012; Nakata and Tanaka, 2020; Guerrieri et al., 2020; Gomez-Cram and Yaron, 2021; Kliem and Meyer-Gohde, 2022).[21]

[18]The conjecture that the financial sector is critical for mitigating the adverse effects of uncertainty on the economy has been widely investigated in the literature (Aghion et al., 2004; Raddatz, 2006; Carriere-Swallow and Cespedes, 2013; Dabla-Norris et al., 2013; Bloom et al., 2018; Karaman and Karaman-Yildirim, 2019). The model developed by Aghion et al. (2004) focus on the role of financial constraints on firms and financial development to explain macroeconomic stability and business cycle fluctuations. They show that economies at an intermediate level of financial development - rather than the very developed or underdeveloped - are the most unstable ones. Thus, countries experiencing a phase of financial development may become more unstable in the short run. They stress that their model is consistent with the experience of several emerging market countries from Asia, Latin America, and Europe.

[19]There are several papers that consider shocks to preferences or "taste shocks" in the asset pricing literature (Campbell, 1986; Stockman and Tesar, 1995; Pavlova and Rigobon, 2007; Maurer, 2012; Gabaix and Maggiori, 2015; Albuquerque et al., 2016; Chen and Yang, 2019; Gomez-Cram and Yaron, 2021). Albuquerque et al. (2016) call the risk associated with preference shocks as "Valuation risk".

[20]Chen and Yang (2019) explore the implications of time preference shocks, triggered by changes in longevity, on the cross-sectional asset pricing of US equity returns. They find that agents become impatient when a negative longevity shock hits. They build a consumption-based three-factor model, including longevity risk, consumption growth rate, and the market portfolio, where longevity has a negative price of risk.

[21]Maurer (2012) shows that shocks to the agent's subjective time discount rate are a key driving force in asset pricing. The author finds that uncertainty in time discounting generates a large equity *premium*. The time series of time discount rate generated by his model is highly positively correlated with the price-earnings ratio of US stocks. As emphasized by the author, the price-earnings ratio reveals a lot of information on financial and macroeconomic variables. On the other hand, Gomez-Cram and Yaron (2021) find highly negatively correlation between the time series of time discount rate generated by their model and measures of the degree of financial stress in the US markets.

While the aforementioned studies deal with the world where consistency of preferences prevails, another strand of the literature argues that this traditional assumption of discount rates is unrealistic. These authors modify the discount function, allowing, for example, decreasing discount rates (hyperbolic discounting), which contradicts the time consistency assumption (see, e.g., (Mazur, 1987; Loewenstein and Prelec, 1992; Barro, 1999; Luttmer and Mariotti, 2003).[22]

The time discount factor represents the degree to which the individual values future utility when making present decisions. OPT households see savings as necessary to increase future Home production and consumption. In addition to the traditional neoclassical motives for determining the subjective discount factor, we assume that time preference is also driven by a "long-term" and a "short-term" factor. These factors originate from the household expectation formation about future prospects of the Home and Foreign economies. The "long-term" factor can be connected with longer lifetimes and lower death probabilities on households' plan on future consumption (Becker and Mulligan, 1997). In our model, individuals perceive the future utility from consumption as uncertain. Thus, they save in the present in order to reduce consumption fluctuations in the future and provide retirement consumption.

The "short-term" factor can be associated with the "catching up with the Joneses" behavior. As emphasized by Obstfeld (1990), when time preference depends on households' own consumption, it can be viewed as a special case of habit formation. In our model, we follow Schmitt-Grohé and Uribe (2003) and assume that time preference depends on average past consumption growth. In particular, it can be seen as a simple case of "catching up with the Joneses", where household's impatience to consume increases as past average consumption growth rises. This feature is captured by the endogenous part of the discount factor. Thus, this endogenous part of time preference implies that the higher the average past consumption growth, the lower the household discount factor.

Our model connects local (Home and Foreign) and global shocks with good news about investment and consumption. Global shocks have the potential to affect all economies. They aim to capture waves of world economic growth due to, for example, positive global investment shocks (IST and MEI) or economic slowdown due to, for example, increases in money demand (MON) triggered by greater global uncertainty. As global shocks affect all countries simultaneously, they lower consumption of OPT households in both countries. Either because OPT households can take advantage of higher investment opportunities or because they face a higher level of macroeconomic uncertainty. This dynamic reflects observed periods of global economic growth or recession. However, due to the heterogeneity of countries in terms of shocks absorption, global shocks can have different effects across countries.

Local disturbances only affect the domestic economy. Home agents become optimistic about the future prospects of the Home economy when it becomes more competitive than the Foreign economy. Households know that the future developments of the domestic economy depends on physical capital investment. Which, in turn, determine the level of future consumption. They also know that the payoff from their capital investment depends on the Foreign economy. In summary, an increase in capital investment in the Foreign economy raises Foreign production and has the potential to substitute Home products by Foreign imports. Home agents form their expectations about future developments of the economy of both countries from the comparison of local IST, MEI, and MON shocks that hit both economies.[23]

When local shocks materialize they reveal the present state of the economies. Agents use this information to form their expectations about the future evolution of the Home and Foreign economies. A decrease in κ_t means that Home agents become more confident and their expectations about the future is positive (larger investment opportunity set relative to the Foreign economy). It can also mean a higher level of macroeconomic uncertainty, which leads Home agents to reduce current consumption in order to smooth future consumption. This works as an incentive to reduce present consumption and increase savings ("good news for investment" or "bad news for consumption"), thus it is the case where the "long-term factor" dominates the agents' decision. On the other hand, an increase in κ_t means that Home agents become less confident (smaller investment opportunity set relative to the Foreign economy). It can also mean a lower level of macroeconomic uncertainty, which leads expansionist consumption by Home agents. This works as an incentive to increase present consumption and reduce savings ("bad news for investment" or "good news for consumption"), thus it is the case where the "short-term factor" dominates the agents' decision.

Home Households' expectations about the prospects on the future developments of both countries are driven by the effect of local shocks on κ_t. A combination between the difference in Home and Foreign IST, MEI, and MON local shocks. As positive local IST and MEI shocks are associated with improvements within the production sector

[22]In intertemporal optimization models, monetary superneutrality arises due to the separation between the monetary sector and the real sector of the economy. If the rate of time preference is fixed, monetary policy has no effect on steady-state capital stock as it is determined by equality between the rate of time preference and the MPK. An additional effect of endogenous time preference is to break down the disconnection between the monetary sector and the real sector, allowing for the *Tobin effect* to appear in models with money in the utility function. Therefore, endogenous time preference creates a role for monetary policy in determining the steady state of capital and consumption (Kam, 2005; Kam and Mohsin, 2006; Gong, 2006).

[23]For example, suppose there is a positive technological shock in both the Home and Foreign economies and that the magnitude of the shock in the Foreign country is larger than in the Home economy. Then, despite the positive effect caused by the Home IST/MEI shock on the return in local capital investment, time preference decreases and Home households become less patient (boost in Home consumption). Notice that the results depend only on the magnitudes of the shocks, since the Home and Foreign economies are symmetric.

of the economy, they are interpreted as "good news for investment". On the other hand, a positive local MON shock means the dominance of increases in macroeconomic uncertainty when compared to current financial innovations. This results in an increase of money demand. Households perceive this shock as "bad news for consumption", increasing savings. In contrast, negative news to local investment or decreases in macroeconomic uncertainty reinforces the *consumption externality* associated with "catching up with the joneses". Home households become more impatient about consuming right now. On the other hand, a positive global IST and MEI shocks (or a negative global MON shock) are interpreted as "good news for investment" in both economies. Home and Foreign households become more patient about consuming right now. Most importantly, local and global shocks drive CT returns in both countries.

Asset Pricing and Time Preference. CT returns are connected with the IST, MEI, and MON processes through time preference shocks. Three points are worth mentioning about the time preference channel of shock transmission:

1. our model predicts that CT returns depend on: i) the difference between local Home and Foreign IST, MEI, and MON shocks, and; ii) the heterogeneity between countries related to the effect of the global IST, MEI, and MON shocks in each economy;

2. incorporating time preference shocks can be crucial in understanding the behavior of CT returns. To illustrate this point, notice that "bad news for consumption" triggered by local shocks is associated with a low CT return, a low level of consumption, and a low realization of the time preference shock. This last effect implies that a low payoff occurs when the OPT agent values even more the additional dollar of return, when marginal utility of future consumption depends on time preference shocks. Consequently, uncertainty in the agent's subjective time discount rate carries a market price of risk. An increase in patience is associated with a reduction in current consumption, and since CT returns are decreasing in patience, the agent requires a positive compensation to engage in such investment.

3. positive news about CT returns is associated with increases in OPT households consumption and a high realization of time preference shock (when caused by local shocks). Therefore, we expect agents to become less patient when facing a positive increase in Foreign asset returns because they have the opportunity to enlarge the gap between their level of consumption in relation to the average individual. Therefore, the time preference shock affects the consumption-savings decision and acts as an intertemporal asset demand shifter.[24]

Shock Processes Structure. Total factor productivity, government expenditure, and the monetary policy innovation obey the following stationary stochastic process:

$$LogA_t = (1-\rho_A)log\overline{A} + \rho_A LogA_{t-1} + \epsilon_{A,t},$$

$$LogG_t = (1-\rho_G)log\overline{G} + \rho_G LogG_{t-1} + \epsilon_{G,t},$$

$$gc_t = \rho_{gc} gc_{t-1} + \epsilon_{gc,t}, \tag{71}$$

where $\overline{A}$ is the steady state total factor productivity value, $\rho_i \in (-1,1)$, $\epsilon_{i,t} \sim N(0,\sigma_i)$, where $i \in \{A,G,v\}$; $\text{Cov}(\epsilon_{i,t},\epsilon_{j,t}) = 0$ and $\text{Cov}(\epsilon_{i,t},\epsilon^*_{j,t}) = 0$, where (i, j) $\in \{A,G,v\}$ for all t ≥ 0, with the exception of the total factor productivity process, since we assume that the correlation between the Home and Foreign shock is equal to 1. We also assume that there is no correlation between the three processes mentioned above and the IST, MEI and MON processes of both countries.

We follow the literature and assume that CT returns are compensation to Home households for bearing a Home country specific risk and a global risk (Lustig et al., 2011, 2014; Colacito et al., 2018; Verdelhan, 2018). The first is associated with changes in the IST, MEI, and MON processes caused by country-specific shocks. The second is associated with changes in the same processes caused by global shocks. We allow the Home and Foreign countries to have distinct exposures to global shocks. When consumption is low in the Home country, Home households demand a higher return for taking on Home country specific risk and global risk. We assume that the IST, MEI, and MON follow the joint process:

$$\begin{bmatrix} log\psi_t \\ log\mu_t \\ log\iota_t \end{bmatrix} = \begin{bmatrix} 1-\rho_\psi & 0 & 0 \\ 0 & 1-\rho_\mu & 0 \\ 0 & 0 & 1-\rho_\iota \end{bmatrix} \begin{bmatrix} log\overline{\psi} \\ log\overline{\mu} \\ log\overline{\iota} \end{bmatrix} + \begin{bmatrix} \rho_\psi & 0 & 0 \\ 0 & \rho_\mu & 0 \\ 0 & 0 & \rho_\iota \end{bmatrix} + \begin{bmatrix} \psi_{t-1} \\ \mu_{t-1} \\ \iota_{t-1} \end{bmatrix} + \begin{bmatrix} \Gamma^g_\psi & 0 & 0 \\ 0 & \Gamma^g_\mu & 0 \\ 0 & 0 & \Gamma^g_\iota \end{bmatrix} \begin{bmatrix} \epsilon^g_{\psi,t} \\ \epsilon^g_{\mu,t} \\ \epsilon^g_{\iota,t} \end{bmatrix} + \begin{bmatrix} \epsilon_{\psi,t} \\ \epsilon_{\mu,t} \\ \epsilon_{\iota,t} \end{bmatrix}$$

[24] As emphasized by Albuquerque et al. (2016) time preference shocks can also be thought of as a way of capturing the effect of fluctuations in market sentiment on the volatility of asset prices, as discussed in Barberis et al. (1998) and Dumas et al. (2009).

$$\text{with} \begin{bmatrix} \epsilon^g_{\psi,t} \\ \epsilon^g_{\mu,t} \\ \epsilon^g_{\iota,t} \end{bmatrix} \sim \text{i.i.d N} \left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^g_\psi & 0 & 0 \\ 0 & \sigma^g_\mu & 0 \\ 0 & 0 & \sigma^g_\iota \end{bmatrix} \right) \quad \text{and} \quad \begin{bmatrix} \epsilon_{\psi,t} \\ \epsilon_{\mu,t} \\ \epsilon_{\iota,t} \end{bmatrix} \sim \text{i.i.d N} \left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_\psi & 0 & 0 \\ 0 & \sigma_\mu & 0 \\ 0 & 0 & \sigma_\iota \end{bmatrix} \right). \quad (72)$$

where $\overline{\psi}$, $\overline{\mu}$, and $\bar{\iota}$ are the steady state values of the respective stochastic processes, $\epsilon^g_{i,t}$ represent global shocks; $\rho_i \in (-1,1)$ where $i \in \{\psi,\mu,\iota\}$, and; $\text{Cov}(\epsilon^g_{i,t}, \epsilon_{j,t}) = 0$, where (i, j) $\in \{\psi,\mu,\iota\}$ for all t ≥ 0. However, we allow contemporaneous correlation between countries of innovations in the IST, MEI, and MON processes (e.g., the correlation between $\epsilon_{\psi,t}$ and $\epsilon^*_{\psi,t}$ may differ from zero). However, we assume that there is no cross-correlation between the processes (e.g., the correlation between $\epsilon_{\psi,t}$ and $\epsilon^*_{\mu,t}$ or $\epsilon_{\psi,t}$ and $\epsilon_{\mu,t}$ equals zero). $\Gamma^g_\psi, \Gamma^g_\mu$, and Γ^g_ι represent the weights of the global shocks in the disturbances affecting the processes.

As emphasized by Colacito et al. (2018) the heterogeneity loadings (Γ^g_ψ, Γ^g_μ, and Γ^g_ι) can be seem as a reduced form way of capturing a mix of fundamental differences across countries such as size, commodity intensity, financial integration, and trade openness. Since the evolution of the IST, MEI, and MON processes is key for agents expectation formation, the cross-country heterogeneity exposure to global shocks ends up as an important driver of the households' consumption-savings decisions and CT returns. We assume that innovations to time preference are combinations of the Home and Foreign IST, MEI, and MON shocks and assume the following form:

$$Log\kappa_t = (1-\rho_\kappa)log\overline{\kappa} + \rho_\kappa Log\kappa_{t-1} + \epsilon_{\kappa,t},$$

$$\epsilon_{\kappa,t} = \gamma \left[(\epsilon^*_{\psi,t} - \epsilon_{\psi,t}) + (\epsilon^*_{\mu,t} - \epsilon_{\mu,t}) + (\epsilon^*_{\iota,t} - \epsilon_{\iota,t}) - (\Gamma^g_\psi \epsilon^g_{\psi,t} + \Gamma^g_\mu \epsilon^g_{\mu,t} + \Gamma^g_\iota \epsilon^g_{\iota,t}) \right]. \quad (73)$$

OPT households reason that the lower the degree of home bias, the greater should be the impact of the difference between Foreign and Home shocks. This is because the home bias is direct associated with international trade, which is an important transmission channel in our model. As global shocks affect both countries, when they occur, we observe a decrease in OPT household consumption in both countries. Thus, the covariance between currency excess returns and κ_t also depends on the values of the heterogeneous loadings in both countries. As will be shown next, if the Foreign country has larger loadings than the Home country, the investment of OPT Home agents in Foreign bonds will provide hedge against drops in their consumption. Otherwise, such investments will be risky.

Heterogeneous loadings capture each country's exposure to global shocks. A country's exposure depends on to how much the country is affected by global shocks and its absorption capacity. In general, developed countries use their available resources more productively and tend to have a higher level of absorption of the IST and MEI global shocks than developing countries. They have more diversified economies (they produce and export more products) and are more technologically advanced than developing countries. Developed countries tend to have synchronized business cycles and tighter trade and financial linkages. These linkages generate both demand and supply spillovers across countries (Kose et al., 2003b; Ahir et al., 2022). As emphasized by Sala-i Martin and Artadi (2004) developed countries tend to be more efficiency-driven or innovation-driven economies, in contrast with factor-driven developing countries.[25] Therefore, they are more prone to take advantage of global IST and MEI shocks.

We also assume that developed countries carry a higher level of absorption in the global MON shock than developing countries. First, because they are more globally interconnected than developing countries. Second, we do not directly model international flows of real assets, but the literature generally reports that, in moments of uncertainty, capital flows away from emerging countries and towards advanced economies (see, e.g., Obstfeld et al. (2009), Caldara and Iacoviello, and Kang et al. (2020)). This is an additional source of money demand in advanced economies during periods of global uncertainty. Note that, in general, developing countries experience more volatile business cycles than developed ones. Therefore, we should expect them to be more affected by MON shocks. However, we believe that much of the increase in money demand in these countries is driven by local rather global disturbances. For instance, developing countries are more subject to the occurrences of revolutions, wars, political instability, and have less effective stabilizing macroeconomic policies (Koren and Tenreyro, 2007).

In our model, heterogeneous country's exposure to the global shocks creates differences in currency excess returns across countries. IST, MEI, and MON shocks affect the nominal exchange rate and interest rates. The magnitude and direction of these fluctuations are determined by each country's exposure to the global shocks. Equation (70) shows that the price of risk associated with both risk factors (consumption growth and time preference changes) is positive for risky assets. Thus, investors demand compensation for the risk arising from investments whose returns covariate positively with growth in consumption and negatively with changes in time preference.

[25] Factor, efficiency, and innovation-driven are growing degrees of complexity in the operation of an economy. They are used by Sala-i Martin and Artadi (2004) to construct the Global Competitive Index. Note that, developed and developing countries can be at different stages of complexity. For example, a developing country can be in a transition from factor to innovation-driven stage.

3.10 Deterministic Steady State

Variables with no time index denote the steady-state level. Next, we derive the steady state of the Home country. Similar expressions apply to the Foreign country. We assign the following values to the threshold bond real values $\overline{b}_h = \overline{b}_f = 0$ ($b_h^* = \overline{b}_f^* = 0$), for the inflation target $\overline{\pi} = \overline{\pi}_h = 1$ ($\overline{\pi}^* = \overline{\pi}_f^* = 1$) and for the constant parameters of the stochastic processes $\overline{\psi} = \overline{\mu} = \overline{\iota} = \overline{\kappa} = 1$, and $v = 0$. We also assume that $P = P_h = p_h = 1$, $\pi^w = 1$ ($\pi^{w,*} = 1$), and a zero-inflation steady state, $\pi = \pi_h = 1$ ($\pi^* = \pi_f^* = 1$). In the steady-state, the share of government spending of GDP equals $G = 0.2$ ($\overline{G} = 0.2$) and OPT households do not hold any bonds, $b_h^o = b_f^o = 0$. Since $\overline{A}$ only affects the scale of the economy, we normalize $GDP = 1$ and compute *ex-post* $\overline{A}$. We also normalize $u = 1$ and compute Ξ_1. We set $L = 1/3$ and compute χ_l *ex-post*. We set T^r to obtain $C^o = C^r = C$. Note also that, based on the assumptions imposed in the Unions problem, $L^o = L^r = L$. The stochastic processes in the steady state imply:

$$A = \overline{A}, \quad G = \overline{G}, \quad \psi = \overline{\psi}, \quad \mu = \overline{\mu}, \quad \iota = \overline{\iota}, \quad \text{and} \quad \kappa = \overline{\kappa}.$$

Equations (22), (20), (23), and (24) imply the following steady-state values:

$$r^k = \frac{1}{\beta} - 1 + \delta_0, \quad \vartheta = 1, \quad R = \frac{\pi}{\beta}, \quad \text{and} \quad R^* = \frac{\pi^*}{\beta}.$$

From the first-order condition for capacity utilization, Ξ_1 must be set to fix steady-state utilization equal to 1:

$$\Xi_1 = \frac{1}{\beta} - 1 - \delta_0.$$

Given the value for p_h, we obtain p_f from equation (9):

$$p_f = \left\{ \frac{1}{\gamma} \left[1 - (1-\gamma) p_h^{1-\eta} \right]^{\frac{1}{1-\eta}} \right\}.$$

We obtain the real exchange rate by combining the law of one price with equation (9):

$$1 = \left[\gamma^* \left(p_h^*\right)^{1-\eta} + (1-\gamma^*)(p_f^*)^{1-\eta} \right],$$

$$1 = \gamma^* \left(\frac{p_h}{Q} \right)^{1-\eta} + (1-\gamma^*) \left(\frac{p_f}{Q} \right)^{1-\eta},$$

$$Q = \left[\gamma^* p_h^{1-\eta} + (1-\gamma^*) p_f^{1-\eta} \right]^{\frac{1}{1-\eta}}.$$

By equation 41 we obtain:

$$mc = p_h \frac{\epsilon - 1}{\epsilon}.$$

Using the definition of GDP and rearranging equation 38:

$$Y_h = \frac{gdp}{p_h} \quad \text{and} \quad K = \frac{\alpha Y_h}{r^k} mc.$$

The steady-steady investment level can be obtained from the law of motion of capital stock:

$$I = \delta_0 K$$

Using equation (61) we obtain the trade balance:

$$TB = b_h - \frac{R b_h}{\pi} + Q b_f - Q \frac{R_* b_f}{\pi^*},$$

$$TB = b_h \left(1 - \frac{1}{\beta} \right) + Q b_f \left(1 - \frac{1}{\beta} \right).$$

Substituting equation (61) into equation (58), we obtain in steady state:

$$C = gdp - I - p_h G - TB.$$

From the first-order condition for consumption:

$$\lambda = C^{-\gamma_c}.$$

Using equation (19), we can retrieve real money demand:

$$m^o = (\chi_m)^{\frac{1}{\gamma_m}} \left(\lambda - \beta \frac{\lambda}{\pi} \right)^{-\frac{1}{\gamma_m}}.$$

Rearranging equations (39) and (49) we can recover the value for χ_l:

$$\chi_l = (1-\alpha) \frac{(\epsilon_w - 1)}{\epsilon_w} \frac{mc}{C^{\gamma_c}} \frac{Y_h}{L^{1+\gamma_l}}.$$

Using the first-order condition for labour demand (39) we retrieve the steady-state wage value:

$$W = (1-\alpha) mc \frac{Y_h}{L}.$$

We can recover the value for the calibration of $\overline{A}$ from the production function (37):

$$\overline{A} = \frac{Y_h}{K^\alpha L^{1-\alpha}}.$$

From the budget constraint of the ROT household we find T^r:

$$T^r = WL - C.$$

Combining equations (50) and (51) to obtain T^o:

$$T_t^o = \frac{p_h G - \Phi T^r}{1 - \Phi}.$$

Finally, from the fiscal policy rule we obtain:

$$\overline{T^o} = T_t^o \quad and \quad \overline{T^r} = T_t^r.$$

3.11 Inspecting the Mechanism

Model Parameters. Our aim is to investigate the role of IST, MEI, and MON shocks in explaining CT returns. Therefore, to discipline our estimation, our parameterization closely follows the literature associated with DSGE modelling. Table (5) in Appendix A.2 presents the parameter values used in the estimation of our baseline model. We consider a period of time to be a quarter. We follow Gali et al. (2007) and use standard parameter values from the literature in setting the values of α, δ_0, and β. In a steady state the share of government spending of GDP is 0.20, the same value used by Gali et al. (2007). Ravn et al. (2007) report an average value of 20% of the observed government spending share of GDP for the US, UK, Canada, and Australia between 1975 and 2005. However, in contrast with Gali et al. (2007), the government always maintains a balanced budget ($\phi_g = 1$) in our model.

The calibrated or prior value used for the share of ROT consumers varies substantially in the literature. For example, Drautzburg and Uhlig (2015) use 0.25, Leeper et al. (2015) employ 0.30, Kriwoluzky (2012) use 0.40, and Colciago (2011), Gali et al. (2007), and Furlanetto et al. (2013) use 0.50, and Andrés et al. (2008) employ 0.65. We adopt a value of 0.50 in our baseline estimation. This is the lowest threshold for obtaining a positive aggregate consumption response to positive IST and MEI shocks. Frisch elasticity estimates range from around 0.70-0.75 in microeconomic studies (Chetty et al., 2011a,b) to around 1.9-4 in macroeconomic works (Prescott, 1986; King and Rebelo, 1999; Prescott, 2004; Smets and Wouters, 2007; Justiniano et al., 2011). We follow Furlanetto et al. (2013) and set an intermediate value, $\gamma_l = 1$. We follow Gali et al. (2007) and Furlanetto et al. (2013) and assign the value of ϵ consistent with a steady-state price markup of 20%. We set $\epsilon_w = 4$ implying a steady-state wage markup of 33%. This value is within the range of values for the labour market estimated by Griffin (1992) and is consistent with the calibrations employed by Huang et al. (2004) and Christiano et al. (2005). Furthermore, as emphasized by Furlanetto et al. (2013), this value implies a markup that is in line with DSGE studies.

It is a common strategy followed by the literature to calculate the Rotemberg price and wage adjustment cost parameters ξ_p and ξ_w implied by the respective Calvo price ($\aleph_p$) and wage ($\aleph_w$) duration. Up to the first-order approximation, the models are identical in a zero-trend inflation setting (Nistico, 2007; Lombardo and Vestin, 2008). We use the same value adopted by Furlanetto (2011), Gali et al. (2007), and Galí (2011) and assume $\aleph_p = 0.75$ and $\aleph_w = 0.75$, which correspond to an average duration of price and wage of one year. This value is also consistent with the estimates of Justiniano et al. (2011). Given these values we can back out $\xi_p = \frac{\aleph_p(\epsilon-1)}{(1-\aleph_p)(1-\beta\aleph_p)}$ and $\xi_w = \frac{\aleph_w(\epsilon_w-1)(1+\gamma_{lw})}{(1-\aleph_w)(1-\beta\aleph_w)}$.

We set the values of ϕ_π, ϕ_{gdp}, ϕ_{mg}, and ρ_r close to the parameter estimates reported by studies that include money growth rate in the Taylor rule (Andrés et al., 2009; Canova and Menz, 2011; Castelnuovo, 2012). These values are also consistent with estimates from other studies such as Smets and Wouters (2007), even when the money growth rate is not included in the Taylor rule. Regarding the other parameters associated with money growth, we obtained the values of γ_m, $d1$, and $d2$ from Nelson (2002). As emphasized by Nelson (2002), in the case of no money holding portfolio adjustment cost, $\gamma_m = 5$ implies a steady-state value of the short-term interest rate elasticity of money demand of -0.2 and an income elasticity of 0.4. These values are in line with those estimated in the literature for the US economy (Ball, 2001; Knell and Stix, 2005).

The steady-state value of the investment cost parameter is set equal to the one used by Christiano et al. (2005). We interpret ν_1 as a parameter that controls the influence of the aggregate consumption growth rate on household intertemporal decisions (endogenous discount factor function). Therefore, we consider ν_1 similar to a measure of external habit formation and set its value close to the degree of habit formation used by Christiano et al. (2005) and Smets and Wouters (2007). Regarding ν_1 we follow Schmitt-Grohé and Uribe (2003) and set its value equal to -0.11. There is substantial uncertainty about γ_c which tends to be estimated with very large standard errors. Existing estimates of the relative risk aversion coefficient are very dispersed. For example, estimates fromMehra and Prescott (1985) and Kocherlakota et al. (1996) exceed 10, Szpiro (1986) estimate values between 2 and 10, and Smets and Wouters (2007) obtain a value around 1.38. Many studies implicitly adopt a relative risk aversion coefficient of 1 Prescott (1986); King and Rebelo (1999); Christiano et al. (2005); Justiniano et al. (2011) or 2 Benchimol and Fourçans (2012); Benigno (2009). We set calibrate the relative risk aversion coefficient $\gamma_c = 2$.

As emphasized by Obstfeld and Rogoff (2000), the elasticity of substitution between Home and Foreign goods is a key parameter in open-economy models. In general, the International Real Business Cycle literature assumes values in the range of 0.8-2 (Basu and Thoenissen (2011) set the value equal to 2, Corsetti et al. (2008) use 0.85, Cooke (2010) employ 1.75, and Benigno (2009) consider values between 0.8 and 6). We chose an intermediate value of 1.25. We followed Corsetti et al. (2008) and assumed a degree of consumption home bias of 0.28, which is close to value used by Cooke (2010), which is consistent with the range of values considered by Basu and Thoenissen (2011) and the value of 0.24 estimated by Justiniano and Preston (2010).

The adjustment cost parameter associated with bond holdings is generally calibrated to a small value (see, e.g., Schmitt-Grohé and Uribe (2003), Benigno (2009), and Ghironi et al. (2015)). We set it equal to 0.012 which is in line with the value used by Benigno (2009). We use χ_l to pin down the steady-state hours to L=1/3 of available the time. We set χ_m to obtain a steady-state money stock to GDP ratio around 0.35, which is the average of M1 and M2 to GDP ratio for the US economy. As will be shown, Ξ_1 is set to pin down the steady-state capital utilization at 1. Ξ_2 controls the capital utilization, when \$$\Xi_2 \to \infty$, $u_t = 1$. This parameter helps to control the effect of shocks on output, employment, consumption, and investment. We set $\Xi_2 = 5$ consistent with the value used by Junior (2016). We set the values for the persistence parameters (ρ_A, ρ_G, ρ_v, and ρ_κ) and standard deviations (σ_A, σ_G, and σ_v) for the stochastic processes that govern total factor productivity, government spending, monetary policy innovation, and time preference well within the range of values found in the literature (see, e.g., King and Rebelo (1999); Smets and Wouters (2007); Justiniano and Preston (2010); Justiniano et al. (2011); Benchimol and Fourçans (2012)).

The persistence of the IST and MEI shocks (ρ_ψ and ρ_μ, respectively) are calibrated with values close to the estimates of Smets and Wouters (2007) and the value used by Furlanetto et al. (2013). The persistence of the MON shock (ρ_ι) is set equal to the Castelnuovo (2012) estimate. Finally, we set the standard deviation of the MEI shock equal to 0.01. We set the standard deviation of the IST shock in line with the estimates of **?**, and the standard deviation of the MON shock to a value close to the estimates of (Castelnuovo, 2012).

Macroeconomic Dynamics. We now analyse the shock transmission mechanism. We depict the results of this part of the analysis through a set of Impulse Response Functions (IRFs), considering a temporary positive exogenous shock of one standard deviation in the IST, MEI, and MON processes of the Home country, keeping the Foreign country shocks unchanged.[26]

Figures (13) in Appendix A.3.1 shows the result of the local IST shock. The figure reveals the presence of synchronization of macroeconomic fluctuations between countries. Excluding investment and aggregate consumption, all variables co-move triggered by the transmission of the shock across countries. This is consistent with studies on international comovement of macroeconomic variables, such as Kose et al. (2003a), Ambler et al. (2004), and Justiniano and Preston (2010). In our model, trade in goods and bonds promotes the international transmission of shocks. Which, in turn, is triggered by the IST shock and its effect on time preference of OPT households. Therefore, the model generates a positive relationship between IST shocks and business cycle variables in the Home economy (GDP, aggregate consumption, hours, investment, real interest rate, inflation, wage, and capacity utilization).

The transmission mechanism works as follows. A positive shock increases the return on investment. This attract capital investment. The resulting decline in capital replacement value implies a lower marginal utilization cost. This increases the utilization of existing capital, which leads to increased use of labour, higher wages, and output expansion. The increase in hours worked and wages translates into an expansion of both ROT household consumption and aggregate consumption. ROT households introduce an expansionary effect into the model that causes aggregate consumption to expand. They do not engage in intertemporal substitution but base their decision on present income. Thus, following a local IST shock, they expand their consumption, and if they represent a

[26]We used the Dynare platform to generate the IRFs

sufficiently high fraction of households, aggregate consumption also increases.[27]

The Foreign country is directly affected by two sources of business cycle fluctuations. First, demand for Foreign goods increases through exports to the Home country (increase in the Foreign country's trade balance). Second, the Foreign country's output is also positively affected by the expansion in the Foreign country's OPT consumption driven by a jump in κ_t^*.

As emphasized by Coeurdacier et al. (2010), IST shocks can help explain the countercyclical nature of the trade balance. This is exactly what we observe in our model. The increase in the rate of return on investment leads to higher production, triggers Home country imports, negatively affecting the Home trade balance and the net foreign asset (NFA) position. Note that in the first 10 quarters, the difference between the increase in Home and Foreign investment is high enough to generate a deterioration in Home net exports, regardless of the deterioration in the terms of trade. In short, the local IST shock induces an increase in Home imports and purchases of Home bonds by Foreign households that are high enough to lead respectively to a trade deficit and a deterioration of the NFA. This result is consistent with the counter cyclicality of the trade balance and the NFA found in the data by Coeurdacier et al. (2010) for a set of developed countries. Inflation rate increases in both countries, although to a lesser extent in the Home economy.

The results presented above are in line with those generated by closed-economy models (Greenwood et al., 1992; Fisher, 2006; Justiniano et al., 2011; Furlanetto et al., 2013) and open-economy models (Basu and Thoenissen, 2011; Chen and Wemy, 2015). Banerjee and Basu (2019) is a notable exception. They estimate a small open-economy model for India, considering the period between 1971 and 2010. In their model, a positive IST shock causes a fall in relative price of investment goods triggering new investment. However, the shock also causes a negative income effect due to the fall in income. This is because the IST shock also reduces the rental price of capital, inducing intermediate goods producers to reduce employment in response to a higher wage and rental price of capital. This, in turn, lower wages in the labour market. In general, the negative income effect outweighs the increase in investment resulting in a countercyclical IST shock.

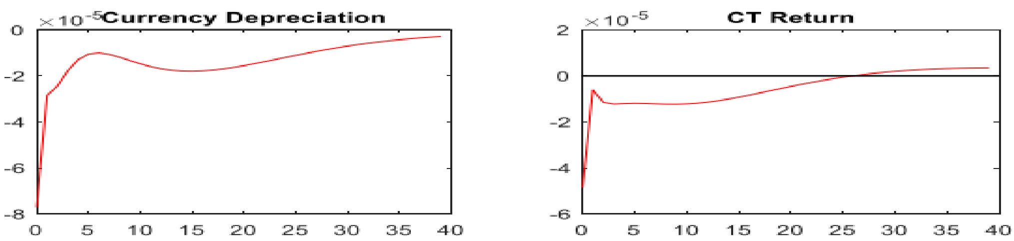

Figure 6: Responses to the local IST shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process.

As shown by figure (6), when there is a positive local IST shock, the Home currency appreciates and CT returns fall on impact. In our model, the rising rate of return on investment that drives business cycle expansions diminishes OPT consumption ("good news for investment"). Therefore, aggregate consumption is procyclical, but OPT household consumption is countercyclical. Local IST shocks lead to a high OPT marginal utility of consumption states and low CT returns, or equivalently, they carry a positive *risk premium*. CT is risky and therefore should offer a positive premium to encourage investors to engage in this type of investment.

The co-movement between equity returns (return on capital investment) and OPT household consumption generated by the model may seem puzzling. The model predicts that investments on equity should be a hedge against falls in consumption. This contradicts the standard prediction of asset pricing literature. We can reconcile our results with the asset pricing literature by arguing that equity and CT investments have different time duration profiles. In general, CT investment tends to have a shorter duration and higher turnover than domestic equity investment. Thus, we should expect different co-movements between the two types of investments with consumption, although both are risky investments.

Jagannathan and Wang (2007) estimate the CCAPM using year-over-year consumption growth and find that it explains the cross-section of stock returns as well as the Fama and French (1993) three-factor model. Jagannathan and Wang (2007) argue that by using year-over-year consumption growth, they can reconcile the CCAPM with the limited empirical evidence supporting the model when applied to stock returns. Parker and Julliard (2005) provide strong evidence against the standard CCAPM, when using contemporaneous consumption growth to explain the cross-section of stock returns. However, when adding cumulative consumption growth over several following quarters,

[27]Note that, as the IST shock acts directly through capital accumulation and not through the production function, a positive IST shock always causes a drop in consumption when prices and wages are flexible, even considering a high fraction of ROT households. The inclusion of nominal rigidities implies a smaller drop in the consumption of OPT households. Which together with the increase in the consumption of ROT households, leads to an increase in aggregate consumption (Furlanetto et al., 2013).

they find strong evidence in favor of the CCAPM. Parker and Julliard (2005) find that adding the three-year cumulative consumption growth explains a large fraction of stock returns variation. These studies provide empirical evidence that suggests a medium to long-run association between stock returns and consumption growth.An alternative interpretation of our findings is provided by Papanikolaou (2011) and Kogan and Papanikolaou (2014). Overall, they show that IST shocks generate differences in *risk premia* due to their heterogeneous impact on firms. The firm's risk premia would depend on the contribution of the technology shock to the firm's value. In the data, Papanikolaou (2011) finds that firms in the investment sector and firms with high growth opportunities earn a lower return, on average, than firms in the consumer sector and firms with low growth opportunities. Returns on the first group of firms are positively affected by IST shocks, providing insurance for households.

The literature on international portfolio diversification provides empirical evidence of the significantly higher turnover in foreign equity and bond holdings relative to the turnover in domestic equity and bond holdings (Tesar and Werner, 1995; Warnock, 2002). Peiris (2010) argues that increased foreign participation in domestic bond markets (both government and corporate) may increase their turnover rate. They compare the turnover rate of a country with high foreign ownership of domestic bond holdings (Australia) with countries with low foreign ownership of domestic bond holdings. The author concludes that the increased participation of foreign investors in the domestic bond market plays a role in increasing the turnover rate. As emphasized by Heath et al. (2007), CT investments are very difficult to track in data. This is because CT can involve transactions in both the bond and foreign exchange markets or just the foreign exchange market. In addition, trades in the foreign exchange market can be settled in different markets (over-the-counter or exchange markets) and through various instruments (forwards, futures, swaps, and options contracts). However, Heath et al. (2007) find a connection between high turnover in the foreign exchange market and the implementation of CT strategies. These findings are consistent with our model estimates. These studies provide empirical evidence to support our conjecture about the different time duration profiles between CT and equity investments.

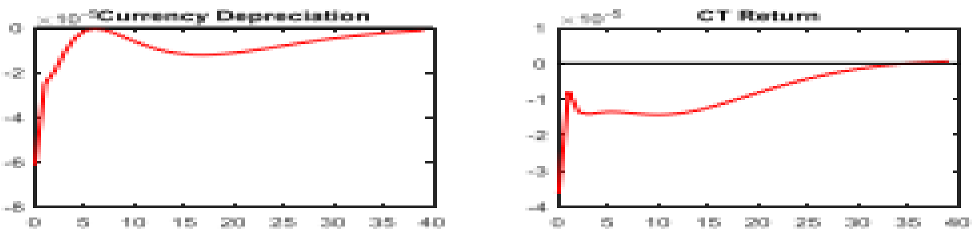

Figure 7: Responses to the local MEI shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MEI process.

Figures (14) in Appendix A.3.2 and (7) report the results of the local MEI shock. The figure shows that the macroeconomic variables follow a dynamic similar to that generated by the local IST shock. This is expected since IST and MEI shocks directly affect capital investment and these shocks are amplified by hours worked and capital utilization. Both shocks lead to capital deepening in the economy. There are only a few differences related to the magnitude of the nominal interest rate, wage and OPT consumption responses in the home country. Overall, our results are consistent with Justiniano et al. (2011) and Hirose and Kurozumi (2012), although there are differences between our model setup and those employed by these authors. Note that, similar to the result of the IST shock, both Home consumption and CT returns fall on impact.

Figures (15) in Appendix A.3.3 and (8) exhibit the results of the local MON shock. We estimated the model with the relative risk aversion coefficient equal to 2. The money transmission mechanism can emphasize the connection between real money balances and uncertainty. Generally, when macroeconomic uncertainty increases, individuals may wish to hold more money balances to optimize their consumption over time. As individuals rebalance their portfolio of assets, the behaviour of real money balances provokes changes in the relative prices of financial and real assets. In the process, aggregate demand changes, and therefore output Benchimol and Fourçans (2012). In our model, a positive local MON shock in the Home country has a direct negative impact on OPT household consumption and a positive on investment. This means a rise in uncertainty encourages households to increase investment today to smooth consumption in the future.

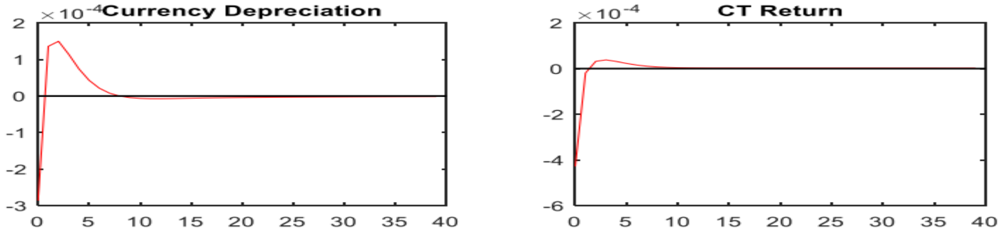

Figure 8: Responses to the local MON shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MON process.

Note that the increase in Home investment is not strong enough to offset the drop in aggregate Home consumption, hence Home output declines. The depressed level of Home demand promotes an improvement in the Home trade balance, via a reduction in imports. The combination of depressed consumption and increased investment and money holdings lead to a reduction in bond holdings (issued at Home and abroad) and a deterioration in the position of the NFA in the Home country. On the other hand, a combination of lower wages and lower hours worked has a direct effect on reducing ROT and OPT household consumption in the Home country. Overall, our results are in line with Castelnuovo (2012) and Benchimol and Fourçans (2012), although they work with a closed-economy model. They also find that output and nominal interest rate decline following a positive shock to money demand. An interesting common conclusion reached by Castelnuovo (2012) and Canova and Menz (2011) is that, regardless of the money demand shock, the omission of money in the model can bias the estimated responses of the variables in an economically relevant way. In the absence of money, the magnitude of the effects of monetary policy, preference, and technological shocks on the economy can be damped.

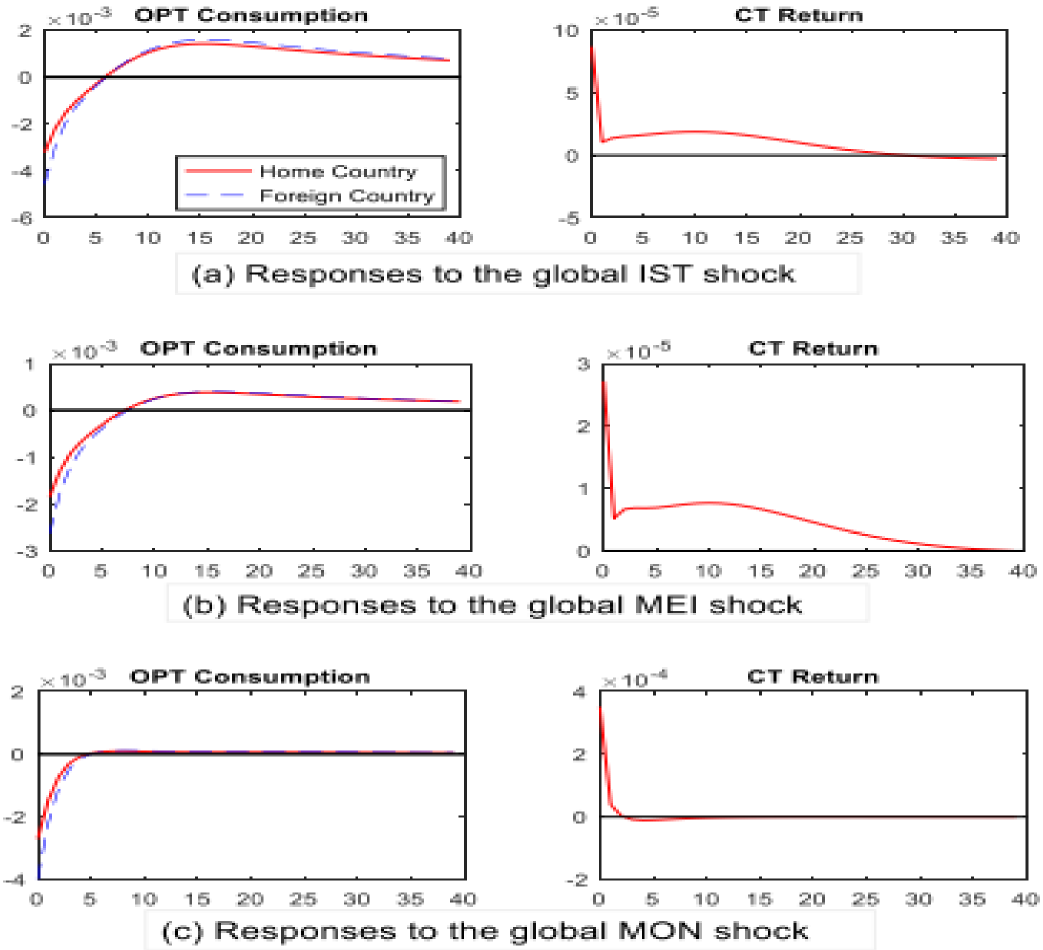

Figure 9: Responses to the global shocks. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the global IST, MEI, and MON processes.

A closer inspection of the figure (15) reveals that the co-movement between countries' macroeconomic variables is smaller than the co-movement produced by the local IST and MEI shocks. The dynamics followed by hours, investment, capacity utilization, and OPT consumption are significantly different between countries. We can see that in the Foreign country, the rise in OPT consumption mitigates the negative effect of the drop in investment, ROT consumption and the deterioration of net exports on economic activity. Therefore, the output does not fall on impact. Finally, figure (8) shows that, on impact, we observe a currency depreciation along with a drop in CT returns. The local MON shock generates dynamic responses of model variables that affect both countries' nominal interest rate and the nominal exchange rate resulting in a drop in CT returns. Once again, CT earns a low return for Home investors exactly when they have a high marginal utility of consumption.

Figures (9) show the effects of the respective global IST, MEI, and MON shocks on consumption and CT returns. We set the value of the Home loadings equal to 1 ($\Gamma_{\psi}^{g} = \Gamma_{\mu}^{g} = \Gamma_{\iota}^{g} = 1$) and the Foreign loadings equal to 1.5 ($\Gamma_{\psi}^{*;g} = \Gamma_{\mu}^{*;g} = \Gamma_{\iota}^{*;g} = 1.5$). As can be seen from the figure, on impact, currency excess return increases when Home OPT household consumption falls. Thus, investment in Foreign bonds from countries with high loadings provides a hedge to OPT households against falls in consumption.[28]

Figures (10) show the effects of the respective global IST, MEI, and MON shocks on consumption and CT returns. We set the value of the Home loadings equal to 1 ($\Gamma_{\psi}^{g} = \Gamma_{\mu}^{g} = \Gamma_{\iota}^{g} = 1$) and the Foreign loadings equal to 0.5 ($\Gamma_{\psi}^{*;g} = \Gamma_{\mu}^{*;g} = \Gamma_{\iota}^{*;g} = 0.5$). As can be seen in the figure, on impact, currency excess return decreases when Home OPT household consumption falls. Thus, investing in Foreign bonds from countries with low loadings is risky.

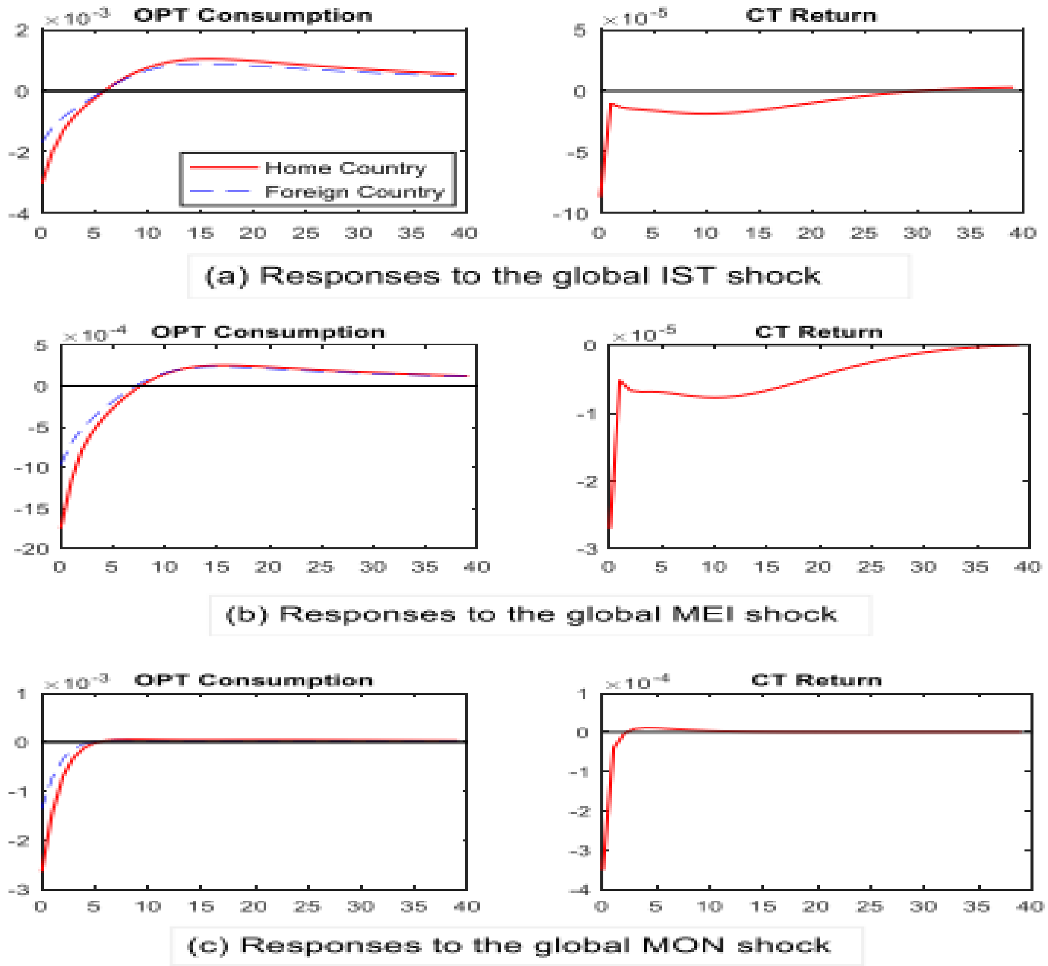

Figure 10: Responses to the global shocks. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process.

The results of this section support our conjecture that the IST, MEI and MON shocks can help explain the decline in CT returns in recent decades. The three shocks can affect CT returns in the short and long term. In the short run, as our model's IRF results show, CT returns depend on the impact of the local and global shocks. We show in Appendix A.3 that, overall, the IST, MEI, and money stock growth rates have declined over time. This

[28] The responses of the other macroeconomic variables are very similar to those obtained with the respective local shocks IST, MEI and MON. The only important difference refers to the magnitude of the responses. The country with the highest global shock loadings has IRFs with more pronounced responses (the results are not reported but are available upon request from the authors).

implies fewer profit opportunities for CT investments. We also show that, overall, the IST and money growth spreads between the US and developed and developing countries narrowed from 1980 to 2019. The MEI spread widened through the mid-1990s, then narrowed through 2010 and has remained constant ever since. In general, the behavior of the three processes is consistent with the downward trend of CT returns found in the data.

In the long run, the investment response to the IST and MEI shocks increases capital *per capita* and the capital-output ratio. Which results in a drop in the MPK and therefore the real interest rate. As both shocks are associated with increases in the supply of goods, it is natural to expect a negative impact on inflation. The combination of lower MPK and inflation leads to a lower nominal interest rate in the long run. Therefore, if high-interest-rate countries are sufficiently affected by the IST and MEI shocks, we can expect a reduction in the nominal interest rate differential vis-a-vis countries with low-interest rates. Furthermore, as discussed earlier, an improvement in the country's financial development (positive MEI shock) can possibly reduce exchange rate volatility. On the other hand, a reduction in the growth rate of money demand (proxied by the MON shock) is an indication of lower macroeconomic uncertainty. Which usually results in lower exchange rate volatility. Our data analysis and the results obtained from the IRFs suggest that the IST, MEI, and MON shocks help to explain the behaviour of CT returns in the short and long term in an economically meaningful way.

4 Asset Pricing Analysis

Motivated by the points discussed in the last subsections, we follow the recent literature and explore our open economy asset pricing model considering currency portfolios. In our asset pricing exercises, we cover the period between 1980:M1 and 2019:M12. We follow most of the literature and work with monthly data. In our analysis, we consider a large panel of sixty countries and a sub-sample of twenty-two developed countries. The total set of countries accounts for more than 90% of world GDP in USD of 2018[29], and for approximately 90% of bilateral foreign currency turnover in April 2019 (Bank for Internatinal Settlements, 2019). The set of developed economies comprises Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The other countries in the sample are: Bangladesh, Bolivia, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Ecuador, Egypt, Hong Kong, Hungary, India, Indonesia, Israel, Lithuania, Malaysia, Mexico, Morocco, Paraguay, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Thailand, Tunisia, Turkey, Ukraine and Uruguay. Some of these economies have pegged their exchange rates partially or fully to the USD at various points in time. These markets differ in the level of economic development, international financial integration, and market liquidity, hence, there are significant cross-sectional differences in the data. The sample period for each country varies and thus, the number of countries in our sample fluctuates across time due to data availability.[30]

We follow Lustig and Verdelhan (2007) and compute real monthly nominal currency excess returns as follows:

$$RX_{t+1}^{j} \equiv \left\{ \left[(1+i_{jt}) \left(\frac{S_{jt+1}}{S_{jt}} \right) - (1+i_t) \right] \left(\frac{P_t}{P_{t+1}} \right) \right\}, \tag{74}$$

where RX_{t+1}^{j} is the real *ex-post* currency excess return obtained by investors who borrow at the US nominal interest rate and purchase a bond issued by country j, considering that both trades are closed at t, with the same maturity; S_{jt} denotes the end of period exchange rate of country j in level, and; P_t is the US CPI. All exchange rates and yields are reported in US dollars and the moments of returns are annualized: we multiply the mean of the monthly data by 12 and the standard deviation by $\sqrt{12}$. Regarding interest rates, treasury bills were the most common rates chosen as a proxy of returns on short-term bonds. When these interest rates were not available, we worked with money market rates. In the absence of the latter, we selected Government Bonds and, finally, if all the aforementioned options were unavailable, we used Deposit Rates. As discussed in section 2, we implemented two additional adjustments in our dataset: i) the exclusion of countries during periods when they experience states of very low international financial openness or sovereign default, and ii) the exclusion of European countries in their months of entry into the Eurozone, due to the change in the currency denomination.

Currency Portfolios. We employ two strategies to build our currency portfolios. First, we use the values of the IST, MEI, and MON processes, proxied by the relative price of an investment, the Index of Financial Development (IFD) developed by the IMF (Svirydzenka, 2016), and the growth rate of M1 and M3. Second, we use the values of the country's exposure to the global component of each shock process. If the IST, MEI, and MON values are priced as risk factors, currencies sorted according to these two strategies are expected to yield a cross-section of portfolios with a reasonable spread in mean returns (Menkhoff et al., 2012a; Corte et al., 2016).[31]

[29] Based on information published by the IMF.

[30] The availability of information is greater for the more recent periods and for developed countries when compared to the first years of the sample, especially for developing economies, resulting in an unbalanced panel (see details in Appendix A.1).

[31] We also sorted currencies according to the growth rate of the IST and MEI processes, however they did not yield a , of portfolios with a significant spread in mean returns.

We employ two variables to compute the country's exposure to the global component of the shock processes: i) the Global Competitive Index (Sala-i Martin and Artadi, 2004) reported by the World Economic Forum for every year since 2005, and; ii) the commonality (proportion of the common variance found in a given country) of each country extracted from the principal component analysis of the values of the IST, MEI, and MON processes. We followed two steps to obtain the country's exposure to the global component of each process. First, we apply principal component analysis to compute the communality of each country for each year from 2005 to 2018. We used a rolling window of 26 annual observations, for the IST and MEI, and 104 quarterly observations for the MON (the growth rate of M1 and M3), starting in 1980. We chose the number of common factors (between 2 and 5) to reach a minimum of 50% explanation of data variance. In the second step, we multiplied the commonality of each country year by its respective Global Competitive Index value. This strategy generates the country's exposure to the global component of each process every year.

At the end of each month t, we allocate all foreign currencies into six portfolios based on their IST, MEI, and MON (the growth rate of M1 and M3) values. Portfolios are rebalanced at the end of each year (IST and MEI) or quarter (MON). IST and MEI portfolios are ranked from high to low values: portfolio one contains the countries with the highest IST and MEI values, while portfolio six comprises the countries with the lowest IST and MEI values. MON portfolios are ranked from low to high values: portfolio one contains the countries with the lowest M1 (M3) growth rates, while portfolio six comprises the countries with the highest M1 (M3) growth rates. We compute portfolio returns as an equally weighted average of the currency excess returns within each portfolio. The total number of currencies in each portfolio varies over time due to data availability. We also apply the same methodology to build portfolios based on nominal interest rates. As data on nominal interest rates are monthly, portfolios are rebalanced at the end of each month. Therefore, we built six portfolios ranked from the lowest to the highest nominal interest rate.

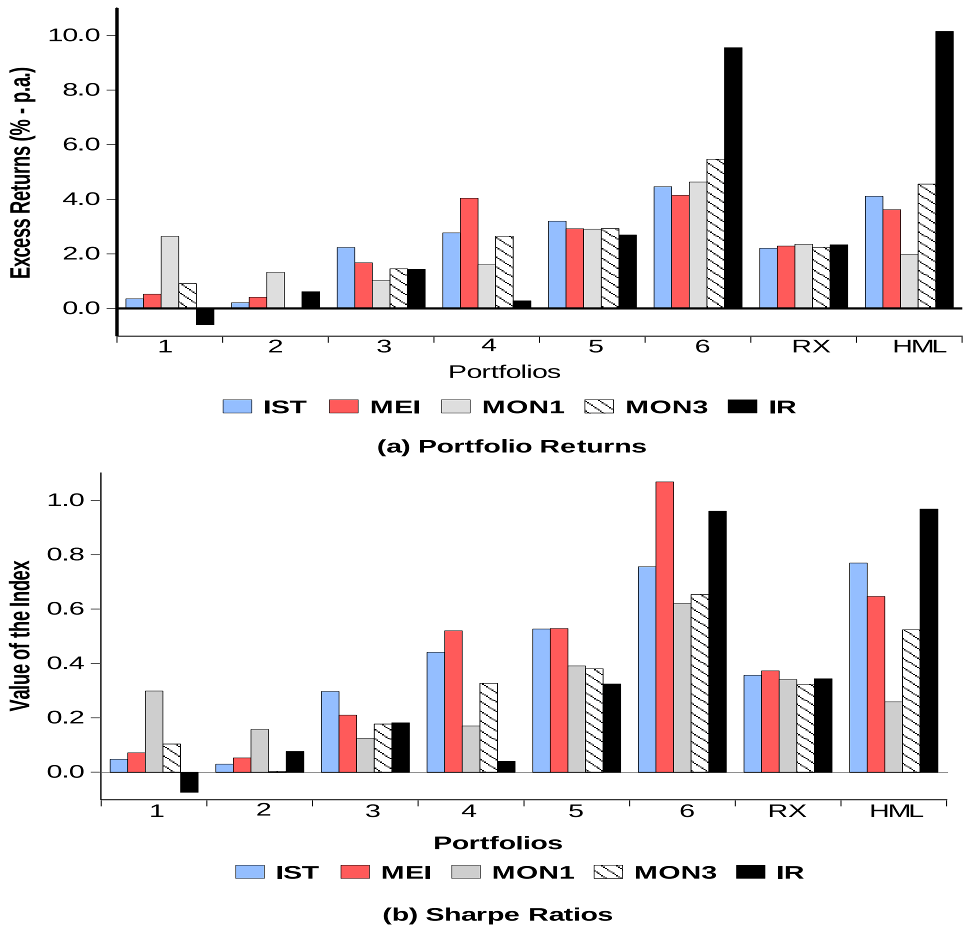

Figure 11: Currency Portfolio Returns: Total. The figure presents portfolio returns (Panel (a)) and Sharpe ratios (Panel (b)) for currency returns sorted by the IST, MEI, M1 growth rate (MON1), M3 growth rate (MON3), and the nominal interest rates (IR). The RX portfolio corresponds to the average of returns among the six portfolios. The HML portfolio corresponds to the difference between the returns of portfolios six and one. All returns are annualized. The sample period is 1995:M01-2019:M12.

Similarly, at the end of each month t, we allocate all foreign currencies into six portfolios based on the country's exposure to the global component of the shock processes. Portfolios are rebalanced at the end of each year. They are ranked from high to low values: portfolio one contains the countries with the highest exposures to each shock, while portfolio six comprises the countries with the lowest exposures to each shock. As the Global Competitive Index is available only from 2005 onward, we restrict our asset pricing exercises with these portfolios between 2006 and 2019. The total number of currencies in each portfolio is constant.

We construct our risk factors following Lustig et al. (2011): the average of returns among the six portfolios (denoted by RX); and the difference in returns between portfolios six and one (denoted by HML), both at each point in time. Thus, we refer to HML^{ist}, HML^{mei}, HML^{mon1}, HML^{mon3} for factors built on the basis of portfolios sorted by countries' IST value, MEI value, M1 growth rate, and M3 growth rate. We followed the same procedure regarding to the country's exposure to the global component of the shock processes. HML^{ir} denotes the factor based on portfolios sorted by the nominal interest rates.

Sorting countries by the shock processes is different from sorting them by their nominal interest rates. To show this, we first regressed each risk factor (HML^{ist}, HML^{mei}, HML^{mon1}, HML^{mon3}) on the HML^{ir} factor and a constant term. The Newey and West (1987) heteroskedasticity-consistent standard errors were used to compute the t-statistics of the estimates. We found the following values for the slope coefficient of the HML^{ir}, 0.35, 0.31, 0.13, and 0.49, for the HML^{ist}, HML^{mei}, HML^{mon1}, HML^{mon3}, respectively. All coefficients are statistically different from zero at the 10% significance level, and the adjusted R^2 reached 0.16, 0.11, 0.01, and 0.14, respectively.

We performed the same analysis considering regressions between the risk factors generated by the country's exposure to the global component of the shock processes and the HML^{ir} factor. All slope coefficients (0.37, 0.25, 0.41, and 0.63) are statistically different from zero at the 10% significance level, and the adjusted R^2 reached 0.18, 0.12, 0.21, and 0.33, respectively. Note that all slope coefficients are statistically different from unity.

Figure 11 provides a visual summary of portfolio returns and Sharpe ratios for each portfolio, considering the period from 1995:M01 to 2019:M12. We found similar results when considering the whole sample period, however, as will be discussed below, portfolio returns before 1995 may not provide a clear picture of currency excess returns due to data availability (especially for developing countries). The figure also shows the results for two currency strategies: i) the RX, where a US investor buys all foreign currencies, and; ii) the HML, in which a US investor goes long in portfolio six and short in portfolio one. The returns of these two strategies correspond to our risk factors. To compute the Sharpe ratio, we divide the portfolio's annualized currency excess return by the annualized standard deviation of the portfolio's excess return.

Three main features are noteworthy in Panel (a) of the figure. First, overall currency excess returns increase from portfolio one to six. Second, the average excess returns across the entire set of countries (RX portfolios) is approximately 2.00%. Third, the spread between portfolios six and one (HML portfolio) is considerably larger when currencies are sorted by nominal interest rate (approximately 10.00%) when compared to the other risk factors (approximately between 1.99% and 4.55%).[32] Panel (b) of the figure indicates that, in general, the Sharpe ratio also increases from portfolio one to six. Note that, although portfolio 6 sorted by the MEI value does not present the highest return, it generates the highest value of the Sharpe ratio index. This, by itself, indicates the relevance of using this shock process in the formation of currency portfolios.

Figure 12 displays portfolio returns and Sharpe ratios for currency returns sorted by the country's exposure to the global component of the shock processes - IST, MEI, M1 growth rate (MON1), and M3 growth rate (MON3) - and the nominal interest rates. The period runs from 2006:M01 to 2019:M12. Overall, despite differences in magnitude, portfolio returns and Sharpe ratios show a similar pattern identified in figure 11. However, although portfolio 6 ordered by the IST value does not show the highest return, it generates the highest value of the Sharpe ratio index. This reinforces the relevance of using this shock process in the formation of currency portfolios.

Our results are in line with Lustig et al. (2011). They sort portfolios based on interest rates and find: i) the same pattern of increase in excess returns and Sharpe ratios from portfolio one to six; ii) the return on the RX portfolio of approximately 1.90%, and; iii) the return on the HML portfolio of approximately 4.54% (for a set of thirty-five countries spanning the period 1983:M11 to 2009:M12). Colacito et al. (2020) find similar results for portfolios sorted by interest rates: portfolio returns and Sharpe ratios ranging from -0.63% to 7.17% and from -0.06 to 0.68, respectively (for a set of twenty-seven countries covering the period from 1983:M10 to 2016:M1). These results are nominal and net transaction costs (measured as the bid and ask spread of spot and forward rates). Our results are presented in real terms (net of the US inflation rate) and do not take transaction costs into consideration. In the literature, transaction costs reduce the average currency return by an annualized value between 0.95% (Colacito et al., 2020) and 1.50% (Lustig et al., 2011). The average inflation in the US reached 2.16% p.a between 1995:M8 and 2019:M12 and 1.91% between 2006:M1 and 2019:M12. Therefore, bearing in mind methodological differences in the calculation of currency excess returns, our results can be compared to those documented in the literature.[33]

[32] This finding is consistent with Menkhoff et al. (2012a) and Corte et al. (2016). They also find lower values for their HML (4.11% and 4.40%, respectively) for currency excess returns sorted by alternative measures rather than interest rates.

[33] Due to lack of data of bid and ask spreads, we computed currency returns without transaction costs. Note that transaction costs increase with the frequency of portfolio re-balancing. Both Lustig et al. (2011) and Colacito et al. (2020) re-balance their portfolios monthly. Since, our IST, MEI, and MON portfolios require annual or quarterly re-balancing, transaction costs are likely to be small. Moreover, bid-ask spreads from financial information providers (e.g., Reuters and Barclays) are for quoted and not effective spreads. Since quoted spreads are much higher than effective ones, transaction costs tend to be overestimated in the literature (Lyons, 2001; Menkhoff et al., 2012b; Colacito et al., 2020). Finally, Menkhoff et al. (2012b) show that the bid-ask spread in the FX market has

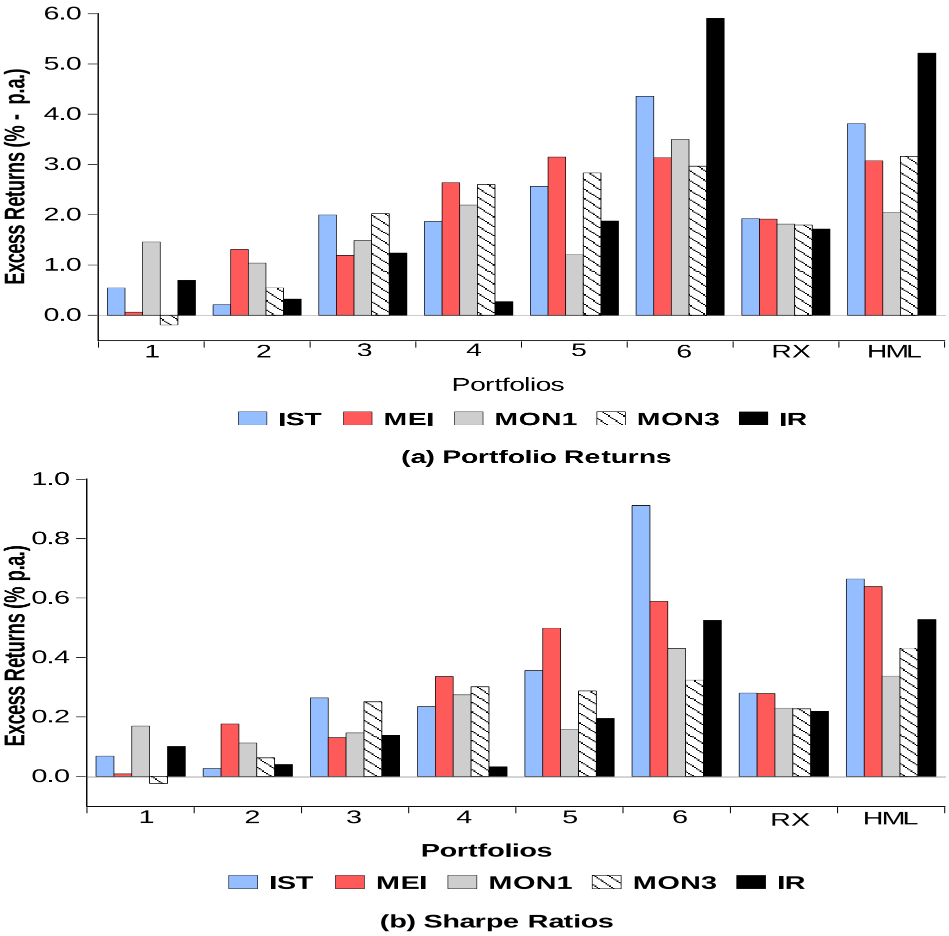

Figure 12: Currency Portfolio Returns: Global. The figure presents portfolio returns (Panel (a)) and Sharpe ratios (Panel (b)) for currency returns sorted by country's exposure to the global component of the shock processes - IST, MEI, M1 growth rate (MON1), and M3 growth rate (MON3) - and the nominal interest rates (IR). The RX portfolio corresponds to the average of returns among the six portfolios. The HML portfolio corresponds to the difference between the returns of portfolios six and one. All returns are annualized. The sample period is 2006:M01-2019:M12.

Time-series Regressions. We now analyze the covariance between portfolio excess returns and the risk factors. To estimate portfolio betas, we ran the following time-series regressions by OLS: i) $RX_t^{p,\iota} = \gamma_0 + \gamma_1 RX_t + \gamma_2^{\iota} HML_t^{\iota} + \tau_t$. $RX_t^{p,i}$ is the currency excess return for portfolio one to six; $p \in \{1,2,3,4,5,6\}$; $\iota \in \{IST, MEI, MON1, MON3, IR\}$, indicates the variable used to sort currencies and generate the risk factors, and; τ_t is a white noise error term. The sample period runs from 1995:M8 to 2019:M12 for regressions involving the risk factors generated by the IST, MEI, and MON values and from 2006:M01 to 2019:M12 for regressions involving the country's exposure to the global component of the shock processes.

Table 6 in Appendix A.3.1 reports the results of the beta estimates. Applying the portfolio betas presented in panel (a) of table 6 to the risk factors (returns of the RX and HML portfolios), we can recover the returns of the six portfolios. For example, for portfolio one, we obtained 0.39%, 0.55%, 2.43%, and 0.87%; for portfolio six, we got 4.54%, 4.17%, 4.42%, and 5.43% (for currencies sorted by the IST, MEI, M1 growth, and M3 growth values, respectively). These values are very close to the portfolio returns shown in panel (a) of figure 11. Similar considerations apply when considering the results presented in panel (b) of table 6 and figure 12.

Our time-series results are similar to those reported by Lustig et al. (2011). First, overall, the estimated coefficients associated with the risk factors (HML_t^{ist}, HML_t^{mei}, HML_t^{mon1}, HML_t^{mon3}, and HML_t^{ir}) increase from portfolio one to six. Second, since the RX and HML factors are orthogonal, the sum of the absolute values of the $\gamma_2 s$ of portfolios one and six must equal one, and all the values of $\gamma_1 s$ must be close to one, as indicated in Panels (a) and (b) of the table.

Cross-sectional Regressions. Following the recent literature (see, e.g., Corte et al. (2016) and Colacito et al. (2020)) we constructed twenty-four currency portfolios to be used as test assets in our asset pricing analysis, along with six portfolios sorted by the IST values, six by the MEI values, six by M1 growth rates, and six by M3 growth

declined over the past few decades.

rates. The twenty-four test assets are referred to in the asset pricing literature as "momentum","value", and "volatility" portfolios. Following Menkhoff et al. (2012b), at the end of each month t, we allocate currencies into six portfolios based on the returns of the previous m months. We assign the currencies with the lowest lagged returns to portfolio one and those with the highest lagged returns to portfolio six. Portfolios are rebalanced at the end of every month. We build six short-term momentum (m=3 months) and six long-term momenta (m=12 months) portfolios.[34]

Additionally, at the end of each month t, we construct six portfolios based on the value of the five-year lagged real exchange rate return following the strategy adopted by Asness et al. (2013). Their value measure is the negative five-year return on the exchange rate, measured as the log of the average spot exchange rate from 4.5 to 5.5 years ago divided by the spot exchange rate today minus the log difference in the change in the CPI in the foreign country relative to the US over the same period. We assign the currencies with the highest real exchange rate return to portfolio one and those with the lowest lagged real exchange rate return to portfolio six. The strategy employed to generate these portfolios constrains our empirical asset pricing exercise between 1985:M08 and 2019:M12.

Finally, we also build portfolios based on the innovation to global FX volatility. We follow Menkhoff et al. (2012a) to construct our proxy for realized global FX volatility. We calculate the absolute daily log return for each currency on each day of our sample. We then average daily returns across all currencies (equally weighted). Finally, we use average daily returns to calculate the measure of volatility with monthly frequency. To compute the innovation for volatility, we take the first differences in the series. Finally, we regress the country-specific currency excess returns at time t on a constant and the proxy for the innovation of global FX volatility, using a thirty-six rolling window ending in period $t-1$. This strategy provides the country's exposure to global FX volatility using information available at time t (the time-varying coefficients associated with the global FX volatility variable). We assign countries with the highest exposures to global currency volatility (high values of estimated betas) to portfolio one and economies with the lowest exposures to portfolio six (low values of estimated betas). Portfolios are rebalanced at the end of each month.[35]

The most recent papers on asset pricing in currency markets have focused on a two-factor model. The first is the expected market excess return, represented by the RX factor. Regarding the second risk factor, the literature has proposed several alternatives: the slope factor (Lustig et al., 2011), the volatility factor (Menkhoff et al., 2012a), the global imbalance factor (Corte et al., 2016), the GDP Gap factor (Colacito et al., 2020), among others. Following this literature, we employ a two-factor model with RX as the first factor and one of our proposed risk factors (HML^{ist}, HML^{mei}, HML^{mon1}, and HML^{mon3}) as the second element. We also explore the results of a three-factor SDF, combining the RX, one of our proposed risk factors and the slope factor proposed by (Lustig et al., 2011), the HML^{ir}.

Table 7 in Appendix A.3.2 exhibits the results from the (Fama and MacBeth, 1973) two-pass OLS procedure used to estimate portfolio betas and risk factor prices. We show the results for two sample periods: from 1985:M08 to 2019:M12 and from 1995:M08 to 2019:M12. As detailed in Appendix A.1, there are countries that were excluded from our sample due to their degree of financial openness and episodes of sovereign default. These exclusions occur mainly before mid-1995. Therefore, we report results for two sample periods: from 1985:M08 to 2019:M12 and from 1995:M01 to 2019:M12 (the latter period has a more complete dataset). We follow the literature and do not include a constant in the second stage of our cross-sectional asset pricing estimation (Lustig et al., 2011; Menkhoff et al., 2012a; Corte et al., 2016; Colacito et al., 2020). The test assets include fifty-four portfolios: six sorted by the IST values, six by the MEI values, six by M1 growth rates, six by M3 growth rates, six by nominal interest rate, six by past three-month currency excess return (short-term momentum), six by past one-year currency excess return (long-term momentum), six by past five-year exchange rate return (value), and six by country exposure to global FX volatility. If the market price of risk is statistically significant, then we understand that the factor is priced Cochrane (2005a).

We employ this broad set of currency portfolios rather than simply focusing on the six portfolios sorted by our proposed risk factors as a robustness test. We aim to avoid misleading conclusions that might arise by imposing a strong factor structure in testing asset returns (Lewellen et al., 2010). Furthermore, Lewellen et al. (2010) suggest including risk factors as test assets to ensure that the factors price themselves. Since our proposed risk factors

[34] We used the first three and twelve months of data to calculate the short and long-term momentum portfolios, respectively. This resulted in a decrease in our sample period.

[35] Daily data on exchange rates are from Thomson Reuters. Due to data availability, only the following countries were used to compute the global FX volatility index: Australia (1980:M01-2019:M12), Bangladesh (1994:M09-2019:M12), Bolivia (1994:M09-2019:M12), Brazil (1994:M07-2019:M12), Canada (1980:M01-2019:M12), Chile (1990:M12-2019:M12), Colombia (1989:M11-2019:M12), Croatia (1994:M09-2019:M12), Czech Republic (1991:M01-2019:M12), Denmark (1980:M01-2019:M12), Hong Kong (1980:M01-2019:M12), Hungary (1993:M07-2019:M12), Iceland (1992:M03-2019:M12), India (1980:M01-2019:M12), Indonesia (1988:M01-2019:M12), Israel (1980:M01-2019:M12), Japan (1980:M01-2019:M12), Lithuania (1995:M05-2019:M12), Malaysia (1980:M01-2019:M12), Mexico (1989:M11-2019:M12), New Zealand (1980:M01-2019:M12), Norway (1980:M01-2019:M12), Paraguay (1990:M12-2019:M12), Peru (1991:M02-2019:M12), Philippines (1992:M06-2019:M12), Poland (1993:M07-2019:M12), Romania (1994:M09-2019:M12), Russia (19940:M07-2019:M12), Singapore (1981:M01-2019:M12), South Africa (1980:M01-2019:M12), South Korea (1981:M04-2019:M12), Sweden (1980:M01-2019:M12), Switzerland (1980:M01-2019:M12), Thailand (1981:M01-2019:M12), the United Kingdom (1980:M01-2019:M12), Tunisia (1990:M10-2019:M12), Turkey (1989:M11-2019:M12), Ukraine (1994:M09-2019:M12), and Uruguay (1992:M02-2019:M12). The euro was included in the calculation from 1999:M01 onward. However, we computed country's exposure to global FX volatility for all countries in our dataset.

are tradable factors, we also report results when the risk factors are included in the set of test assets. Due to the strategy employed to construct the test assets, we have to restrict our sample from 1985:M08 to 2019:M12.

We focus on the sign and the statistical significance of the market price of risk associated with our proposed risk factors: λ^{ist}_{HML}, λ^{mei}_{HML}, λ^{mon1}_{HML}, and λ^{mon3}_{HML}. A positive value for the estimated factor price of risk is associated with higher *risk premia* for portfolio returns with a higher positive correlation with the risk factor and lower risk premia for those with a lower positive correlation with it (or for those negatively correlated with it). The Table reveals that our three factors are priced in a large cross-section of currency portfolios. The prices of risk associated with the IST, MEI, and MON risk factors are positive and significant. This indicates that currencies from countries with low IST values, low MEI values and high money growth rates earn higher excess returns.

Panels (a) and (b) in the table reveal that λ^{ist}_{HML} has positive and statistically significant coefficients ranging between 2.66% and 6.02% p.a. The adjusted R^2s vary between 0.08 and 0.62. The λ^{mei}_{HML} has positive and statistically significant coefficients ranging between 2.50% and 5.73% p.a. The adjusted R^2s vary between 0.08 and 0.62. The λ^{mon1}_{HML} has positive and statistically significant coefficients ranging between 3.06% and 5.64% p.a. The adjusted R^2s vary between -0.20 and -0.08. On the other hand, the other variable used to proxy for the MON process, the M3 growth rate, has positive and statistically significant coefficients ranging between 2.74% and 8.01% p.a. The adjusted R^2s vary between -0.12 and 0.62. Note that the estimates for the period 1995:M01 to 2019:M12 have a higher adjusted R^2.

Table 8 in Appendix A.3.2 reproduces the results when we apply the country's exposure to the global component of each shock process (IST, MEI, and MON) to build the currency portfolios used as test assets and risk factors. Therefore, the test assets include fifty-four portfolios: six sorted by country's exposure to the global component of the IST values, six by country's exposure to the global component of MEI values, six by country's exposure to the global component of M1 growth rate, six by country's exposure to the global component of M3 growth rate, six by nominal interest rate, six by past three-month currency excess return (short-term momentum), six by past one-year currency excess return (long-term momentum), six by past five-year exchange rate return (value), and six by country exposure to global FX volatility. Due to the inclusion of a short window of data before the start of the GFC (from 2006 to 2008), we estimated our model considering two sample periods: from 2006:M01 to 2019:M12 and from 2009:M01 to 2019:M12. This is a way to analyze the sensibility of our results to the GFC outbreak.

The Table reveals that our three factors are priced in a large cross-section of currency portfolios. The prices of risk associated with the country's exposure to the global component of the IST, MEI, and MON risk factors are positive and significant. This indicates that currencies from countries with low exposure to these global components earn higher excess returns. The λ^{ist}_{HML} has positive and statistically significant coefficients ranging between 2.63% and 3.98% p.a. The adjusted R^2s vary between 0.43 and 0.71. The λ^{mei}_{HML} has positive and statistically significant coefficients ranging between 2.29% and 3.99% p.a. The adjusted R^2s vary between 0.46 and 0.64. The λ^{mon1}_{HML} has positive and statistically significant coefficients ranging between 3.42% and 4.61% p.a. The adjusted R^2s vary between 0.14 and 0.28. On the other hand, the other variable used to proxy for the MON process, the M3 growth rate, has positive and statistically significant coefficients ranging between 3.13% and 5.70% p.a. The adjusted R^2s vary between 0.26 and 0.51. Note that the inclusion of a short window of data before the GFC outbreak reduces the overall statistical significance of the estimated coefficients and the adjusted R^2s.

We also performed the same regression exercises considering only the set of twenty-two developed countries. Due to the smaller number of countries, we included only forty-one portfolios in our estimation exercises: five sorted by the IST values, five by the MEI values, three by M1 growth rates, three by M3 growth rates, five by nominal interest rate, five by past three-month currency excess return (short-term momentum), five by past one-year currency excess return (long-term momentum), five by past five-year exchange rate return (value), and five by country exposure to global FX volatility. As most information on developed countries is available from the beginning of our sample period, our asset pricing estimation covers the entire period. Despite the differences in magnitude when compared with our full set of country estimates, overall the coefficients of the *risk premia* are also positive and statistically significant (these results are not reported but are available from the authors upon request).

The main insight arising from our results is that countries with low levels of IST and MEI are relatively rich in growth opportunities and have greater demand for new capital goods. As a result, positive IST and MEI shocks have a greater positive impact in these countries because firms must invest to take advantage of their growth opportunities. At the same time, these countries are also relatively more likely to suffer from macroeconomic uncertainty. They have lower levels of economic and financial development. In addition, they experience higher rates of money growth, typically associated with domestic turmoil. Therefore, investors demand a higher risk premium to hold bonds issued by countries with low IST and MEI levels and high money growth. The cross-sectional differences in the values of the IST, MEI, and MON processes generate differences in *risk premium* among countries.

On the other hand, US investors value the currencies that benefit most from IST, MEI, and MON global shocks. Currencies from countries with high exposure to global shocks tend to appreciate, driven by the shocks. In contrast, currencies from countries with low exposure tend to depreciate. This is motivated by episodes of capital flows from low to high-exposure countries after the materialization of the shocks. Therefore, US investors are willing to accept a lower *risk premium* to hold bonds issued by countries with high exposure to global shocks.

Taken together, these results provide further evidence on the relevance of our three proposed risk factors in pricing currency excess returns. They imply that the factor models incorporating risk factors derived from the

IST, MEI, and MON processes can price the cross-section of currency excess returns. Furthermore, part of the results indicate that our proposed factors are priced regardless of the inclusion of the HML^{ir} in the model. This reinforces the fact that the factors associated with the three shock processes convey different information than the factor derived from the nominal interest rate.

Country-level Analysis. To assess the performance of our proposed risk factors in pricing bilateral currency excess returns, we follow the strategy employed by (Verdelhan, 2018). The author builds two risk factors from currency portfolios and works with a sample of developed and developing countries, spanning the period 1983:M11 to 2010:M12. (Verdelhan, 2018) runs OLS regressions to estimate the responses of bilateral exchange rates to their two factors.

Table 9 presents the country-level results of the OLS regression of the time-series of currency excess returns for each country "j" on our risk factors: $RX_t^j = \phi_0 + \phi_1 RX_t + \phi_2^\iota HML_t^\iota + e_t$. ι stands for the IST, MEI, MON1, and MON3; e_t is a white noise error term. The Table also presents the results of a second OLS regression: i) $RX_t^j = \psi_0 + \psi_1 HML_t^\iota + e_t$. Table 10 reports the results for our risk factors built based on the country's exposure to the global component of the IST, MEI, and MON processes.

Overall, we find that both factors appear highly statistically significant -approximately 75% (table 9) and 64% (table 10) of the estimated coefficients associated with the IST, MEI, and MON risk factors are statistically significant at the 15% level. The adjusted R^2s range from 0.05 to 0.69 (table 9) and from 0 to 0.78 (table 10). These results imply that our proposed risk factors help explain currency excess return at the country-level. Verdelhan (2018) finds similar results: adjusted R^2s ranging from 0.20 to 0.90 (developed countries) and from 0.10 to 0.75 (developing economies) for the model with the two factors. Most importantly, both tables make clear the distinction between funding and target countries for CT investments. For example, funding countries (such Switzerland and the United Kingdom) have lower estimated coefficients for the risk factor associated with the IST process than target countries (such as Brazil and Turkey). Overall, all other estimated coefficients follow a similar pattern. These results corroborate our previous findings and confirm that our proposed risk factors are priced in FX markets.

A natural way of relating our empirical results to the prediction of our theoretical model can be done by jointly analyzing equations (68) and (73). Based on equation (68), we can state that if the unconditional correlation between the excess return of a currency and the variation in the intertemporal preference shock process is positive, that currency will serve as a hedge for the Home agent. A necessary condition to this would be that the Foreign country's exposure to the global component of the shocks is larger than the Home country's exposure to it. (see equation (73)). A sufficient condition would be that the difference between the Foreign and Home country's exposure to the global component of the shocks be large enough to generate a positive currency excess return when consumption is low in the Home country.

For example, Japan and Switzerland are normally at the top of the Global Competitiveness Index. They are also countries with an IST and MEI level higher than the average of the set formed by all countries in our sample and with a lower money growth rate than the average of the set formed by all countries in our sample. Their average excess return from 1985:M08 to 2019:M12 were 0.74% and 2.47%, respectively. On the other hand, Brazil and Turkey have a low position in the Global competitiveness index (positions 71 and 61 in 2019, respectively). They are also a country with a lower level of IST and MEI than the average of the set formed by all countries in our sample and with a higher money growth rate than the average of the set formed by all countries in our sample. Turkey's average excess return from 1985:M08 to 2019:M12 was 12.01%. Brazil's average excess return from 1998:M01 to 2019:M12 was 8.43%. The US is also at the top of the Global Competitiveness Index. Our computation of each country's exposure to the global component of the shock processes reveals that Japan, Switzerland, and the USA take turns in terms of position (depending on the year and the shock each one has a greater exposure than the others). However, the USA has always had a higher exposure than Brazil and Turkey. Thus, from the point of view of a US investor, currency investments in Brazil and Turkey can never candidates to be a hedge. On the other hand, currency investments in Japan and Switzerland may be a hedge against moments of low US consumption. As shown by equation (73) this would depend directly on the difference between both countries and the US exposure to the global component of the shocks.

5 Concluding Remarks

We develop an open-economy DSGE model in which CT returns are explained by investment-specific technology, the marginal efficiency of investment, and money demand shocks. In our model, there are two types of households. Those with access to financial markets (Optimizing) and those without access to it (Rule-of-thumb). Our shocks directly affect households' consumption and saving decisions. An indirect effect on the Optimizing household's behaviour occurs through the intertemporal time preference shock. This shock is derived from the investment-specific technology, the marginal efficiency of investment, and the money demand shocks. The interaction between the three fundamental shocks and the time preference shock is behind the dynamics of economic variables in our model. More precisely, the model generates macroeconomic movements that drive CT returns through nominal interest rates and exchange rate fluctuations. We connect the fundamental sources of risk with currency excess returns. In our setting, local and global shocks drive business cycle fluctuations and currency excess returns. These represent new findings in the international finance literature.

We also provide empirical evidence suggesting that the investment-specific technology, the marginal efficiency of investment, and the growth rate of money help to explain currency excess returns. Specifically, we constructed portfolio-based factors for our three shock processes. Our findings suggest that these factors are priced in a cross-section of currency excess returns, and that the prices of risk are positive and significant. We also find evidence that our proposed risk factors are important in explaining country-level excess returns. Overall, the results suggest the promising use of factors based on these three shock processes by the financial industry.

A limitation of the current research is that it does not consider the role of household heterogeneity in depth. In our model, there are only two distinct agents. Heterogeneity could arise from various sources, such as household risk aversion, wealth, and tastes. Thus, many types of agents could be distinguished from heterogeneous sources. Future developments in this literature should consider a model in which household heterogeneity drives CT portfolio decisions. This could be a way to rationalize the existence of carry traders in countries with low-interest rates, despite the fact that most of these economies assume aggregate positions with a bias towards domestic assets, which can be government bonds. In addition, this line of research could also benefit the financial industry, indicating important risk factors that drive household portfolio formation.

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Appendix

A.1 Data Refinements and CT Fundamentals

A.1.1 Data

Financial Openness. As highlighted by Lustig and Verdelhan (2007) engaging in CT investments involves cross-border capital flows and transactions in domestic and foreign currencies. Hence, these operations require a certain degree of financial openness to guarantee the fulfilment of purchases and sales of securities by non-residents. They also emphasized the restrictions imposed by the Euler equation on the joint distribution of exchange rates and interest rates make sense only if foreign investors are not prevented from purchasing local securities. Chinn and Ito (2006) have built a capital account openness measurement index based on the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) published by the IMF. The index ranks countries with a binary range from 2 (full capital account openness) to -2 (lowest level of capital account openness). Intermediate values (1, 0 and -1) indicate economies with varying degrees of capital account liberalization. The last report released by the authors covers 182 countries from 1970 to 2017. We chose to eliminate countries in the years in which their classification reached -2. Under these circumstances the approval of both capital payments and receipts is rare or infrequently granted.[36]

Sovereign Default. Defaults may affect the returns on foreign currency investments, thereby, we chose to remove countries in periods of default from the sample. The data compiled by Reinhart (2010) was used to define the default intervals for each economy. The database covers different periods for each country, in an annual frequency, ranging from 1821 to 2009. As we work with month currency excess returns, we had to choose the start and end month of the sovereign default period within the annual data. In our dataset all periods of sovereign defaults are marked by stop losses.[37] Therefore, we could circumvent this issue by choosing the month of the occurrence of the first stop loss as the beginning of the default interval (within the year attested by the database). In addition, we assigned the month of December of the last default year as the end month of the non-payment period. We assumed the absence of default periods from 2009 onward.[38] of default periods within our sample from 2009 onward.

Entry of European Countries. The entry of European countries into the Eurozone has been accomplished through the substitution of the respective local currency by the euro. The change in currency denomination prevented us to compute the exchange rate change in the month of the adoption of the new currency. We, therefore, removed these observations.

Our panel includes 60 countries. We include each of the following countries for the dates noted in parentheses: Australia (1980:M01-2019:M12), Austria (1980:M01-1998:M12, 1999:M02-2019:M12), Bangladesh (1992:M01-2019:M12), Belgium (1980:M01-1998:M12, 1999:M01-2019:M12), Bolivia (1998:M01-2019:M12), Brazil (1998:M01-2019:M12), Canada (1980:M01-2019:M12), Chile (1995:M01-1995:M12, 1999:M01-2019:M12), Colombia (1990:M01-1992:M12, 1996:M01-2019:M12), Costa Rica (1982:M01-1984:M12, 1991:M01-2019:M12), Croatia (1993:M11-2019:M12), Czech Republic (1993:M02-2019:M12), Denmark (1982:M04-2019:M12), Ecuador (2007:M09-2019:M12), Egypt (1994:M01-2019:M12), Finland (1980:M01-1998M:12, 1999:M02-2019:M12), France (1980:M01-1998M:12, 1999:M02-2019:M12), Germany (1980:M01-1998M:12, 1999:M02-2019:M12), Greece (1980:M06-2000:M12, 2001:M02-2019:M12), Hong Kong (1980:M01-2019:M12), Hungary (1993:M01-2019:M12), Iceland (1986:M11-2019:M12), India (1980:M01-2019:M12), Indonesia (1983:M01-2019:M12), Ireland (1980:M01-1998:M12, 1999:M02-2019:M12), Israel (1992:M01-2019:M12), Italy (1982:M01-1998:M12, 1999:M02-2019:M12), Japan (1980:M01-2019:M12), Lithuania (1994:M07-2014:M12, 2015:M02-2019:M12), Luxembourg (1980:M01-1998:M12-1999:M02-2017:M05), Malaysia (1980:M01-2019:M12), Mexico (1980:M01-1982:M02, 1991:M01-2019:M12), Morocco (1986:M01-2019:M12), New Zealand (1980:M01:2019:M12), Norway (1980:M01-2019:M12), Paraguay (1989:M12-2017:M03), Peru (1998:M01-2019:M12), Poland (1994:M01-2019:M12), Portugal (1980:M01-1998:M12, 1999:M02-2019:M12), Romania (1993:M12-2019:M12), Russia (1995:M03-2019:M12), Saudi Arabia (1982:M01-1984:M12, 1993:M01-2019:M12), Serbia (2001:M12-2019:M12), Singapore (1980:M01-2019:M12), Slovakia (1995:M07-2008:M12, 2009:M02-2019:M12), Slovenia

[36] All countries selected for this study are included in the Chinn and Ito (2006) dataset. For 2018, we considered that our entire sample countries were rated above -2.

[37] Imposing a limit on losses and gains is a common practice adopted by financial market professionals when designing portfolios with risky assets. The most common stop-loss and take-profit strategies are based on orders placed to buy or sell an asset once its price reaches a pre-specified level (See, e.g., Osler (2005), Richards et al. (2017) and Fischbacher et al. (2017) and the literature there in, for a discussion regarding the use of these practices among FX and stock market participants.). We adopted a stop-loss of 15% per month (180% per year) and a take-profit of 30% per month (360% per year) in order to mimic this common practice of the FX market. Hence, we consider that all operations are automatically settled on reaching a pre-specified gain or loss limit, imposing an upper bound on both the losses and gains from CT investments. If the limit is hit, the investor closes out all positions.

[38] Reinhart (2002) demonstrates that the probability of a significant exchange rate depreciation episode is approximately 85% in periods marked by sovereign defaults. This outcome is ratified by Herz and Tong (2008) and Na et al. (2018) reinforcing the existence of a direct relationship between sovereign credit problems and the occurrence of sudden movements in exchange rates.

(1992:M11-2007:M02, 2007:M04-2019:M12), South Africa (1982:M01-1984:M12, 1993:M01-2019:M12), South Korea (1980:M01-1997:M11, 1999:M01-2019:M12), Spain (1980:M01-1998M:12, 1999:M02-2019:M12), Sri Lanka (1999:M03-2019:M12), Sweden (1980:M01-2019:M12), Switzerland (1980:M01-2019:M12), Thailand (1980:M01-2019:M12), the United Kingdom (1980:M01-2019:M12), the Netherlands (1980:M01-1998:M12, 1999:M02-2019:M12), the Philippines (1980:M01-1983:M10, 1993:M01-2019:M12), the United States (1980:M01-2019:M12), Tunisia (1987:M01-2019:M12), Turkey (1982:M01-2019:M12), Ukraine (1995:M01-1996:M12, 1998:M01-2019:M12), and Uruguay (1980:M01:1982:M11, 1986:M01-2019:M12).

The time period for each country is determined by data availability, the openness of the financial markets (according to Chinn and Ito's (2006) index), the occurrence of default states (according to Reinhart's (2010) report) and the dates of entry into the Eurozone of European countries.

A.1.2 Openness of Financial Markets

We eliminated the following countries in the years (noted in parentheses) in which their classification reached -2, according to the Chinn and Ito's (2006) index: Bangladesh (1980-1991), Bolivia (1984-1985), Brazil (1980-1997), Chile (1982-1994, 1996-1998), Colombia (1980-1989, 1993-1995), Costa Rica (1985-1990), Egypt (1980-1993), Hungary (1986-1992), Iceland (1980-1982), Italy (1980-1981), Mexico (1985-1986), Morocco (1980-1985), Paraguay (1982, 1987-1988), Peru (1987-1990), Poland (1986-1993), Romania (1980-1991, 1993-1995), Russia (1999, 2001), South Africa (1980-1981, 1985-1992), Turkey (1980-1981), and Ukraine (1997, 2009-2017).

A.1.3 Default States

We excluded the following countries during the period (noted in parentheses) in which they were classified as in a default state, according to the Reinhart's (2010) report: Bolivia (1980-1997), Brazil (1983-1990), Chile (1983-1990), Costa Rica (1981, 1983-1990), Ecuador (1982-1995, 1999-2000, 2008), Egypt (1984), Indonesia (1998-2000, 2002), Korea (1997-1998), Mexico (1982-1990), Morocco (1983, 1986-1990), Paraguay (1986-1992, 2003-2004), Peru (1980, 1984-1997), Philippines (1983-1992), Poland (1981-1993), Romania (1981-1983, 1986), Russia (1991-2000), South Africa (1985-1987, 1989, 1993), Sri Lanka (1981-1983), Thailand (1997-1998), Tunisia (1980-1982), Turkey (1982, 2000-2001), and Uruguay (1983-1985, 1987, 1990-1991, 2003).

A.1.4 Dates of Entry into the Eurozone

We eliminated the following countries in their month of entry in the Eurozone (noted in parentheses): Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Portugal, Spain, and the Netherlands, (1999:M01); Greece (2001:M01); Lithuania (2015:M01); Slovakia (2009:M01); and Slovenia (2007:M03).

A.1.5 Data Source

Table 4
Data Source

The table describe the variables used in this study. Our data come from the following sources: Organization for Economic Cooperation and Development (OECD), International Monetary Fund (IMF), FRED (Federal Reserve Bank of St. Louis), US Bureau of labour Statistics (BLS), European Central Bank (ECB), Thompson Reuters (TR), Penn World Table 10.0 (PWT), US Bureau of Economic Analysis (BEA). Note that D denotes daily, M monthly, Q quarterly, and A annual frequency.

Description	Frequency	Sources
Nominal interest rates	M	IMF, OECD, and ECB
Consumer price index all items	M	IMF
Monetary aggregate M1	Q	IMF and OECD
Monetary aggregate M3	Q	IMF and OECD
USD spot exchange rate (end of period)	M	IMF
USD sport exchange rate (end of period)	D	TR
USD forward exchange rate (end of period)	D	TR
Price level of consumption	A	PWT
Price level of capital formation	A	PWT

A.1.6 CT Returns and the Fundamental Sources of Risk

It is helpful to start with an explanation of the CT strategy. Risk-neutral rational investors should expect the foreign currency to depreciate by the difference between the two nominal interest rates when the foreign interest rate is higher than its domestic counterpart. Thereby, borrowing at home and investing abroad should produce zero excess return in terms of the domestic interest rate. This is the conventional UIP condition. Nevertheless, empirical evidence suggests that investors systematically earn excess returns in high interest-rate-bearing currencies. This strategy is profitable given the frequently observed violation of the UIP condition, as emphasized by several authors (see, e.g., Hansen and Hodrick (1980); Fama (1984b); Evans and Lewis (1995); Lustig and Verdelhan (2007); Frankel and Poonawala (2010)). The failure of the UIP, presumably due an embedded risk factor, gives rise to a range of speculative opportunities. We focus our attention on CT, the most widely investment strategy employed by FX market professionals. The excess return, RX_{t+1}, obtained from the purchase of a unit of foreign currency in the forward market in period t and the consecutive sale on the spot market at $t+1$ is given by:

$$RX_{t+1} \equiv f_t - s_{t+1}, \tag{75}$$

where f_t is the log of the forward exchange rate and s_{t+1} is the log of the spot exchange rate, both denominated in units of foreign currency per US dollar. An increase in s_t represents an appreciation of the US dollar. Notice that the excess return can also be defined as: $RX_{t+1} \equiv f_t - s_t - \Delta s_{t+1}$. Under normal circumstances, forward rates satisfy the Covered Interest Rate Parity (CIP) condition: $f_t - s_t \approx i_t^* - i_t$, where i_t^* and i_t denote the respective foreign and domestic risk-free nominal interest rates, paid by a bond with the same maturity of the currency forward contract (Lustig and Verdelhan, 2009).[39] Hence, the excess return approximately equals the interest rate differential between the foreign and the domestic countries net of foreign currency depreciation:[40]

$$RX_{t+1} \approx i_t^* - i_t - \Delta s_{t+1}, \tag{76}$$

where $\Delta s_{t+1} \approx \frac{S_{t+1}-S_t}{S_t}$. Typically, CT consists of taking long positions in high nominal interest-rate currencies and short positions in low nominal-interest rate currencies. The positive payoff from this strategy is certain if, over the maturity of the investment, the depreciation of the high interest-rate currency is lower than the cross-currency nominal interest rate differential.

The Fisher's relation. Given that nominal interest rates are an important component of CT returns, a natural starting point for analyzing them is the *ex-ante* Fisher's (1930) equation. In what follows, we connect CT returns with both the MPK and inflation rate differentials across countries along with exchange rate depreciation. To understand the basic argument, we follow Fisher (1930) and decompose the one-period nominal interest rate into a real interest rate and inflation:

$$r_t \equiv i_t - \mathbb{E}_t \pi_{t+1} \quad \text{and} \quad r_t^* \equiv i_t^* - \mathbb{E}_t \pi_{t+1}^*, \tag{77}$$

where r_t and r_t^* represent the domestic and foreign risk-free real interest rates, respectively; $\mathbb{E}_t$ is the expectation operator, and; π_{t+1} and π_{t+1}^* denote the respective inflation rates. Equation (77) describes the relationship between nominal interest rates, real interest rates and expected inflation. Now consider the standard neoclassical one-sector model with a constant return production function and perfectly competitive capital markets. In this setting, the rental rate of capital (real interest rate) equals the marginal Product of Capital (MPK) net of physical depreciation.[41] It follows that, the nominal interest rate is tied to the MPK, the depreciation rate, and inflation. The rearranged *ex-post* version of equation (77) yields the following expressions:

$$i_t \equiv MPK_t - \delta + \pi_{t+1} \quad \text{and} \quad i_t^* \equiv MPK_t^* - \delta^* + \pi_{t+1}^*, \tag{78}$$

where MPK_t and MPK_t^* stand for the domestic and foreign MPK, respectively; δ and δ^* are the respective domestic and foreign depreciation rate of physical capital. Note that, the equations above are linear approximations of the *ex-post* Fischer relation. Thus, i_t (i_t^*) and MPK_t (MPK_t^*) are known at t; π_{t+1} (π_{t+1}^*) is the change in the general price level bounded by t and $t+1$, whose value is revealed only at $t+1$. Combining equations (76) and (78) renders the fundamental expression that connects CT returns to economic fundamentals:

[39] Throughout the paper, we use the asterisk superscript to denote variables and parameters of the foreign economy.

[40] Notice that while CIP approximately holds before the GFC (see, e.g., Akram et al. (2008)), the departures from CIP have risen since the outbreak of the crisis (see, e.g., Andersen et al. (2019)). In the latter case, the forward discount accounts for both interest rate differentials and CIP deviations (Colacito et al., 2019).

[41] Note that market power can drive a wedge between the MPK and the real interest rate. However, market power is not observable. Recent literature has chosen the least ambiguous measure to investigate market power, the markup over marginal cost, and has been applying different methodologies to obtain empirical estimates (Hall, 2018; Barkai, 2020; De Loecker et al., 2020). However, as emphasized by Basu (2019), the estimates reported by the literature cannot be reconciled with patterns seen in recent US data. The author shows why many studies find implausible markup estimates. The main reasons lie in the unrealistic assumptions used by authors, the implausible estimation procedures, and the difficulty in calculating the values of variables (e.g., economic profits, market value of capital, etc.) necessary to compute the markup. Consequently, recent empirical estimates vary substantially across studies. Basu (2019) shows that recent literature has found markup estimates suggesting that it implies: i) a much larger increase than would be necessary to explain the decline in labour share; ii) negative technological progress in the US in recent decades; iii) that about 70% of US GDP is pure economic profit, and; iv) an increase in US inflation rate in recent decades. Due to the difficulty of measuring markups, we do not analyze their evolution over time and abstract from their possible implications for CT returns.

$$RX_{t+1} \approx (MPK_t^* - MPK_t) + (\pi_{t+1}^* - \pi_{t+1}) - \Delta s_{t+1}. \tag{79}$$

To preserve the parsimony of our model, we assume that $\delta = \delta^*$. In light of equation (79), a possible explanation for the large average CT returns is that they reward individuals for taking risks associated with changes in domestic and foreign macroeconomic fundamentals. These changes can affect cross-country differentials in the MPK and inflation rates, as well as trigger currency fluctuations.

There are three important aspects of equation (79) worth highlighting. First, although this equation is an *ex-post* expression of CT returns, in reality, π_{t+1} is not known by domestic agents at t. This implies that real CT returns, which is what matters for consumers, is often unknown at t, even if S_{t+1} is fixed. Therefore, there is a risk associated with changes in prices between period t and $t+1$. Second, if $\Delta s_{t+1} = 0$, CT returns depend only on the differential between nominal interest rates. Therefore, the magnitude of CT returns depends on exchange rate growth, regardless of whether the return is positive or negative. Third, CT returns decline with i) a narrowing spread in the MPK and inflation, and; ii) exchange rate appreciation of the funding currency. These three aspects are important because, as will be shown in the following subsections, in general, the downward trend in CT returns is associated with declining values of both nominal interest rate differentials between countries and exchange rate variation. Furthermore, in our model economy, the fundamental shocks that shape business cycle fluctuations also explain the expected returns from CT.

As will be shown in our International Real Business Cycle model, the fundamental determinants of output growth, the real interest rate, inflation, and exchange rate are technology shocks and money supply. Therefore, it is natural to expect that these shocks can also explain CT returns. A combination of the investment-specific technology (IST), marginal efficiency of investment (MEI), and monetary growth (MON) shocks can generate movements in the MPK, inflation and exchange rates which rationalize currency excess returns in the short and long-term. The connection between the IST and MEI shocks with nominal interest rates is straightforward in our model. Since the realization of these shocks triggers changes in the MPK and inflation rates. Both components of equation (79). The motivation for including money growth shocks in our model stems from the central role played by changes in the money stock in models of exchange rate determination. For example, in Dornbusch's (1976) overshooting model, unanticipated monetary changes generate fluctuations in nominal interest and exchange rates. In the next section, we will discuss the mechanism by which the three shocks can directly affect both nominal interest and exchange rates. Typically, these shocks cause short-term business cycle fluctuations and potentially influence the long-term trend of economic variables.

A.2 Model Parameters

Table 5
Structural Model Parameter Values

The table shows the calibrated values of the parameters used in the simulation and in calculating the steady state value of the model variables.

Parameter	Description	Value
γ	Share of Foreign good in the Home basket	0.28
γ^*	Share of Home good in the Foreign basket	0.28
η	Elasticity of substitution between Home and Foreign goods	1.25
β	Exogenous part of discount factor	0.99
ν_1	Endogenous discount factor parameter 1	0.65
ν_2	Endogenous discount factor parameter 2	-0.11
d1	Parameter of adjustment cost of real asset portfolio 1	0.86
d2	Parameter of adjustment cost of real asset portfolio 2	0.43
δ_0	Depreciation rate	0.025
ξ_b	Bond portfolio adjustment cost parameter	0.012
ξ_I	Investment adjustment cost parameter	2.48
χ_l	labour preference scale parameter	10.325
χ_m	Real asset preference scale parameter	0.00015
γ_c	Relative risk aversion coefficient	2
γ_l	Inverse of the Frisch elasticity coefficient	1
γ_m	Inverse of the elasticity between money holdings and the interest rate	5
ϵ	Elasticity of substitution between intermediate goods	6
α	Elasticity of production with respect to capital	0.33
ϵ_w	Elasticity of substitution between labour types	4
ξ_p	Price adjustment cost parameter	58.25
ξ_w	Wage adjustment cost parameter	174.70
Φ	Share of ROT households	0.50
ϕ_g	Tax reaction to government spending	1
ϕ_π	Monetary policy response to inflation	1.5
ϕ_{gdp}	Monetary policy response to output	0.125
ϕ_m	Monetary policy response to real money growth	0.35
ρ_r	Monetary policy inertia	0.80
ρ_ψ	IST persistence	0.70
ρ_μ	MEI persistence	0.60
ρ_ι	MON persistence	0.79
ρ_κ	Time preference persistence	0.50
ρ_A	Total factor productivity persistence	0.90
ρ_G	Public spending persistence	0.90
ρ_v	Monetary policy persistence	0.50
σ_A	Total factor productivity standard deviation	0.007
σ_G	Public spending standard deviation	0.0045
σ_v	Monetary policy standard deviation	0.0025
σ_ψ	IST standard deviation	0.018
σ_μ	MEI standard deviation	0.010
σ_ι	MON standard deviation	0.0175
Ξ_1	Capital utilization parameter 1	0.0351
$\Xi 2$	Capital utilization parameter 2	5

A.3 Responses of Macroeconomic Variables

A.3.1 Local IST Shock

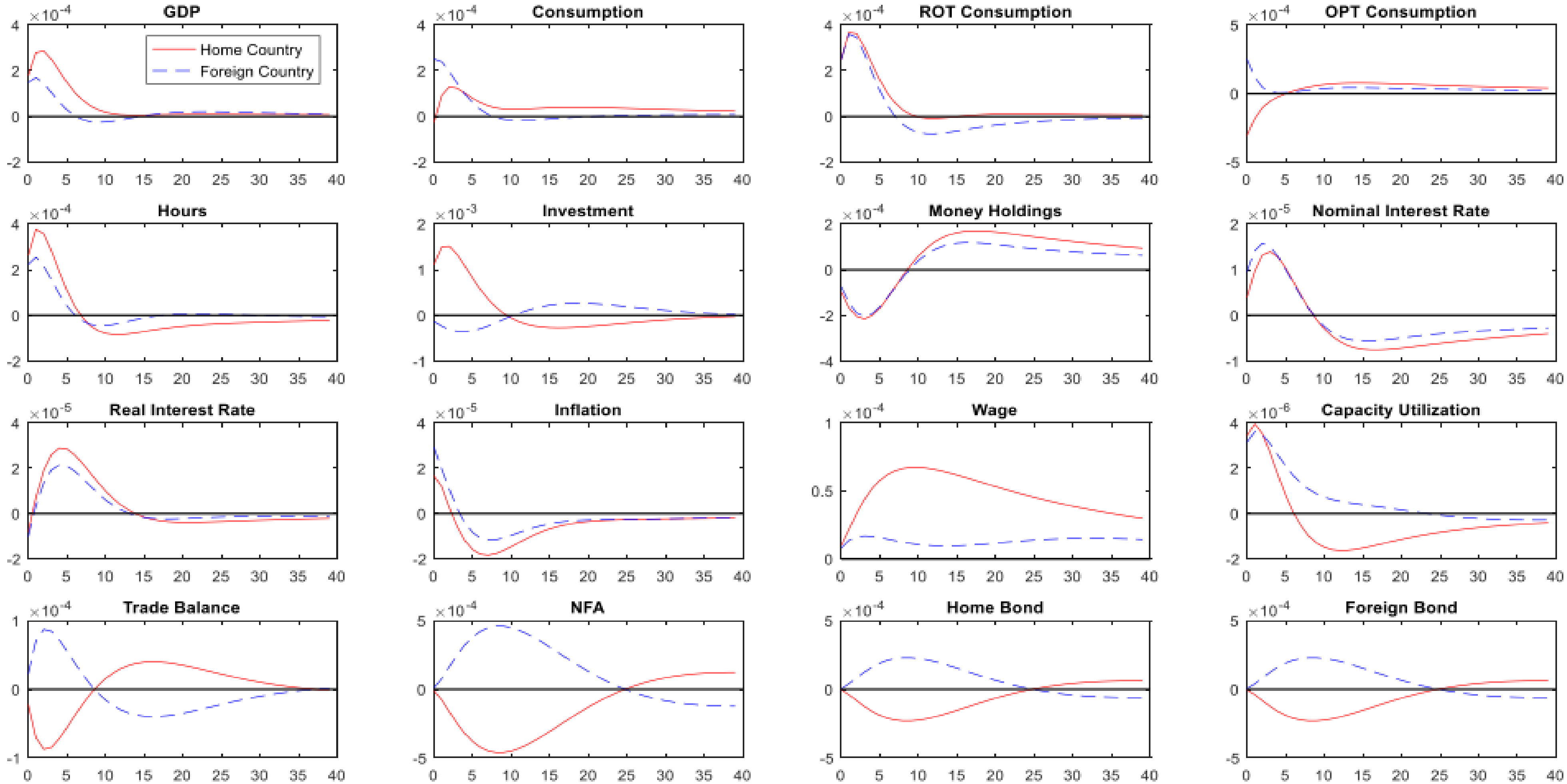

Figure 13: Responses to the local IST shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process.

A.3.2 Local MEI Shock

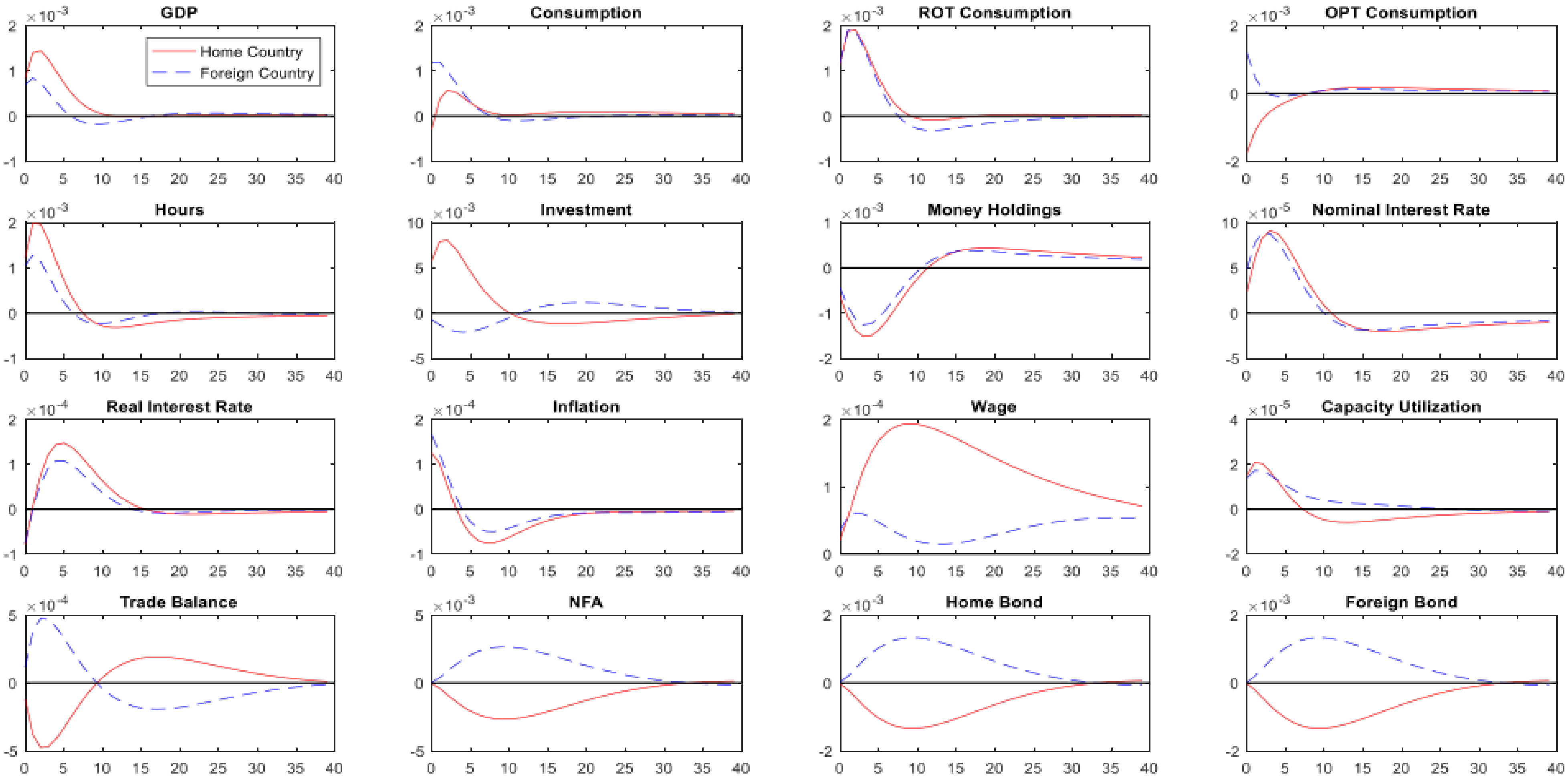

Figure 14: Responses to the local MEI shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MEI process.

A.3.3 Local MON Shock

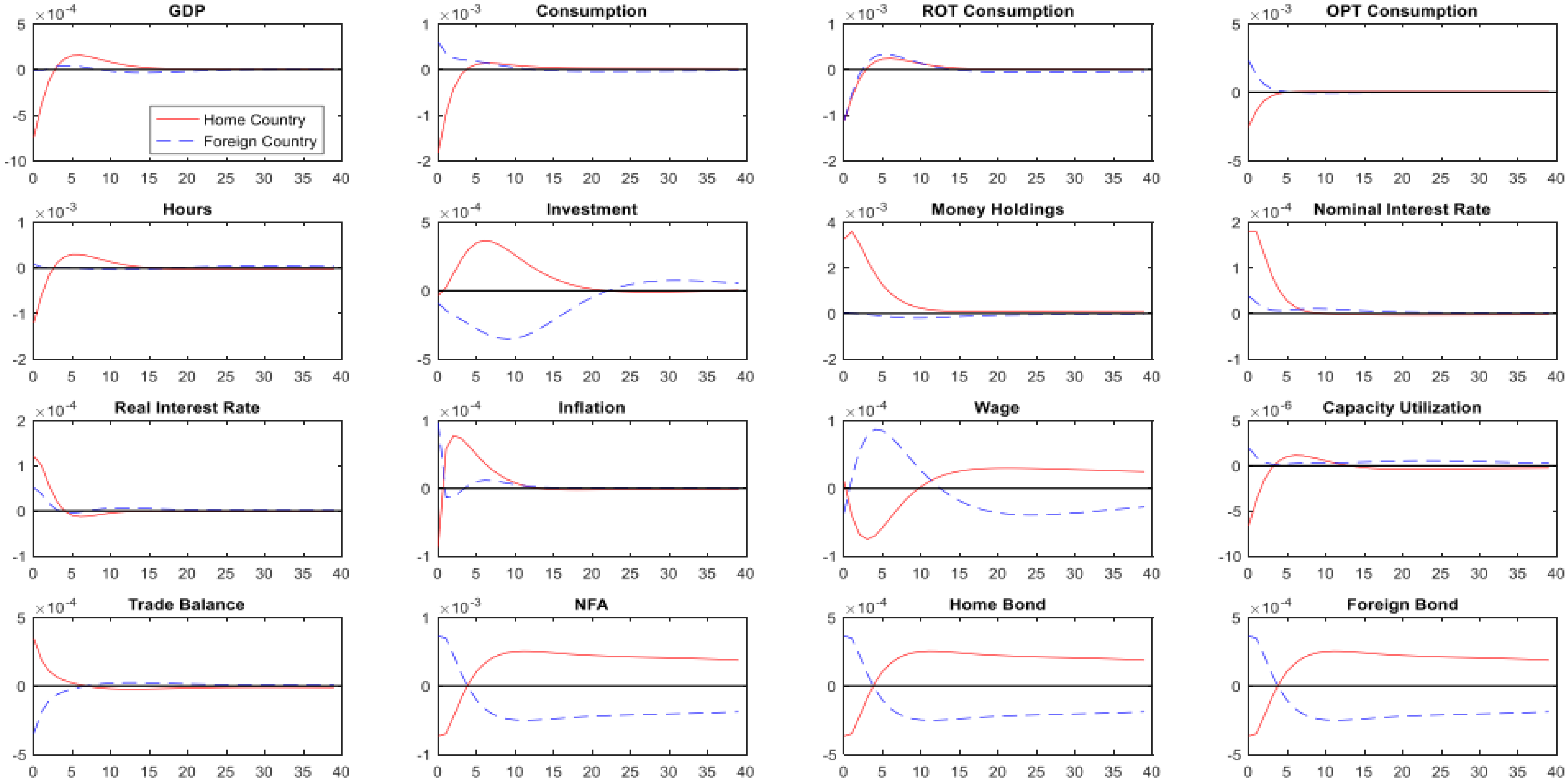

Figure 15: Responses to the local MON shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MON process.

A.3 Asset Pricing Exercises

A.3.1 Time-series

Table 6
Currency Portfolio Betas: GDP Growth and Interest Rates

The table reports the betas obtained from the OLS regressions of the time-series of currency excess returns of each portfolio "p" on two risk factors: $RX_t^{p,\iota} = \gamma_0 + \gamma_1 RX_t + \gamma_2^{\iota} HML_t^{\iota} + \tau_t$. $RX_t^{p,i}$ is the currency excess return for portfolio one to six; $p \in \{1,2,3,4,5,6\}$; $\iota \in \{IST, MEI, MON1, MON3, IR\}$, indicates the variable used to sort currencies and generate the risk factors, and; τ_t is a white noise error term. R^2 is the adjusted R-squared of each model. All excess returns are annualized. Note that a, b, c, and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively. The Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors were used to compute the t-statistics of the estimates. The sample period runs from 1995:M8 to 2019:M12 for regressions involving the risk factors generated by the IST, MEI, and MON values (Panel (a))and from 2006:M01 to 2019:M12 for regressions involving the country's exposure to the global component of the shock processes (Panel (b)).

Panel (a): 1995:M8-2019:M12

Portfolio	γ_0	γ_1	γ_2^{ist}	R^2	γ_0	γ_1	γ_2^{mei}	R^2
1	0.06	0.99^a	-0.45^a	0.96	0.42	0.82^a	-0.48^a	0.96
2	-1.79^a	1.08^a	-0.10^a	0.92	-1.23^a	1.08^a	-0.22^a	0.91
3	0.14	1.11^a	-0.08^b	0.89	-0.62	1.17^a	-0.09^d	0.89
4	0.49	0.95^a	0.07^c	0.85	0.17	1.24^a	0.21^a	0.79
5	1.03^d	0.86^a	0.01	0.78	0.84^c	0.86^a	0.06	0.84
6	0.06	0.99^a	0.55^a	0.94	0.42	0.82^a	0.52^a	0.86

	γ_0	γ_1	γ_2^{mon1}	R^2	γ_0	γ_1	γ_2^{mon3}	R^2	γ_0	γ_1	γ_2^{ir}	R^2
1	1.33^b	0.95^a	-0.57^a	0.90	1.01^d	0.98^a	-0.51^a	0.89	0.15	0.91^a	-0.33^a	0.93
2	-0.84	1.00^a	-0.03	0.68	-2.15^b	0.99^a	-0.04	0.72	-0.42	1.19^a	-0.22^a	0.93
3	-1.49^d	1.01^a	0.02	0.72	-0.74	1.07^a	-0.03	0.81	0.85^b	1.14^a	-0.15^a	0.93
4	-0.99	1.16^a	0.06	0.71	0.43	1.04^a	0.03	0.80	-0.25	0.94^a	-0.04^d	0.89
5	0.66	0.92^a	0.08^b	0.72	0.42	0.94^a	0.07^b	0.71	-0.48	0.90^a	0.09^a	0.80
6	1.33^b	0.95^a	0.43^a	0.86	1.01^d	0.98^a	0.49^a	0.87	0.15	0.91^a	0.66^a	0.95

Panel (b): 2006:M1-2019:M12

Portfolio	γ_0	γ_1	γ_2^{ist}	R^2	γ_0	γ_1	γ_2^{mei}	R^2
1	0.73^b	0.86^a	-0.48^a	0.97	0.44	0.90^a	-0.40^a	0.97
2	-1.35^b	1.07^a	-0.13^a	0.94	-0.10	0.99^a	-0.15^a	0.95
3	0.71	0.98^a	-0.16^a	0.94	-0.72	1.23^a	-0.14^a	0.96
4	-0.94	1.17^a	0.14^a	0.90	0.13	1.12^a	0.12^b	0.88
5	0.12^d	1.05^a	0.10^a	0.91	1.59^b	0.85^a	-0.21	0.86
6	0.73^b	0.86^a	0.52^a	0.93	-0.44	0.90^a	0.60^a	0.95

	γ_0	γ_1	γ_2^{mon1}	R^2	γ_0	γ_1	γ_2^{mon3}	R^2	γ_0	γ_1	γ_2^{ir}	R^2
1	0.68	0.96^a	-0.47^a	0.94	-0.60	0.94^a	-0.40^a	0.93	0.83^c	0.90^a	-0.37^a	0.94
2	-1.01	1.09^a	0.03	0.86	-0.73	1.03^a	-0.18^a	0.88	-1.18^b	1.15^a	-0.22^a	0.94
3	-0.94	1.21^a	0.11^b	0.88	0.63	0.94^a	-0.10^a	0.85	0.96^c	1.16^a	-0.19^a	0.94
4	0.53	0.93^a	-0.02	0.84	0.81	1.01^a	0.00	0.86	-0.68^d	0.95^a	0.00^d	0.94
5	0.04	0.85^a	-0.18^a	0.82	0.50	1.12^a	0.10^b	0.83	-0.76	0.92^a	0.16^a	0.87
6	0.68	0.96^a	0.52^a	0.94	-0.60	0.94^a	0.60^a	0.94	0.83^c	0.90^a	0.63^a	0.96

A.3.2 Cross-section: All Countries

Table 7
Asset Pricing Tests: All Countries

The Table presents the results for currency portfolios sorted based on time $t-1$ information. The test assets include fifty-four portfolios: six sorted by the IST values, six by the MEI values, six by M1 growth rates, six by M3 growth rates, six by nominal interest rate, six by past three-month currency excess return (short-term momentum), six by past one-year currency excess return (long-term momentum), six by past five-year exchange rate return (value), and six by country exposure to global FX volatility. The set of pricing factors includes the RX, HML^{ist}, HML^{mei}, HML^{mon1}, HML^{mon3}, and HML^{ir}. We report the market price of risk λ and the cross-sectional adjusted R-squared (R^2) obtained from the second pass of the Fama and MacBeth (1973) approach. The portfolios are rebalanced monthly and all excess returns are annualized. Note that a, b, c, and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively. The Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors were used to compute t-statistics.

Excluding Price Factors as Test Assets							Including Price Factors as Test Assets						
λ_{RX}	λ^{ist}_{HML}	λ^{mei}_{HML}	λ^{mon1}_{HML}	λ^{mon3}_{HML}	λ^{ir}_{HML}	R^2	λ_{RX}	λ^{ist}_{HML}	λ^{mei}_{HML}	λ^{mon1}_{HML}	λ^{mon3}_{HML}	λ^{ir}_{HML}	R^2
Panel (a): 1985:M8-2019:M12													
3.29^{a}	4.62^{a}					0.10	3.30^{a}	3.84^{a}					0.08
3.50^{a}		5.73^{a}				0.25	3.47^{a}		4.44^{a}				0.24
3.32^{a}			4.71^{a}			-0.20	3.32^{a}			3.06^{b}			-0.20
3.28^{a}				5.45^{a}		-0.12	3.29^{a}				4.18^{b}		-0.14
3.19^{a}					8.70^{a}	0.34	3.18^{a}					9.30^{a}	0.46
3.15^{a}	-0.42				9.84^{a}	0.35	3.15^{a}	0.75				9.85^{a}	0.46
3.29^{a}		2.50^{c}			8.48^{a}	0.36	3.29^{a}		2.90^{b}			9.19^{a}	0.47
3.19^{a}			0.36		8.68^{a}	0.33	3.18^{a}			1.15		9.24^{a}	0.45
3.17^{a}				0.36	8.55^{a}	0.36	3.18^{a}				1.85	9.85^{a}	0.47
3.48^{a}	2.89^{b}	4.70^{a}				0.24	3.48^{a}	2.66^{b}	4.08^{a}				0.24
3.29^{a}	4.51^{a}		1.42			0.08	3.31^{a}	3.71^{a}		1.74			0.08
3.29^{a}	4.70^{a}			1.81		0.08	3.30^{a}	3.65^{a}			2.65		0.07
3.50^{a}		5.22^{a}	0.81			0.24	3.50^{a}		4.47^{a}	1.48			0.24
3.51^{a}		5.25^{a}		2.27		0.24	3.49^{a}		4.43^{a}		2.74^{c}		0.24
Panel (b): 1995:M01-2019:M12													
1.89^{d}	6.02^{a}					0.48	1.91^{d}	5.49^{a}					0.47
2.12^{c}		5.26^{a}				0.50	2.12^{c}		4.83^{a}				0.50
1.97^{d}			5.64^{b}			-0.04	1.98^{d}			3.55^{b}			-0.08
1.92^{d}				8.01^{a}		0.15	1.94^{d}				6.20^{a}		0.15
1.83^{d}					8.16^{a}	0.52	1.82^{d}					8.49^{a}	0.62
1.84^{d}	3.83^{b}				7.61^{a}	0.52	1.83^{d}	3.83^{a}				8.20^{a}	0.62
1.96^{d}		3.59^{b}			8.25^{a}	0.56	1.96^{d}		3.66^{b}			8.53^{a}	0.65
1.83^{d}			1.71		7.94^{a}	0.52	1.83^{d}			1.82		8.34^{a}	0.62
1.83^{d}				3.55^{c}	8.18^{a}	0.51	1.82^{d}				4.13^{b}	8.51^{a}	0.62
2.02^{d}	4.88^{a}	3.85^{b}				0.55	2.03^{d}	4.64^{a}	3.78^{b}				0.56
1.89^{d}	5.90^{a}		2.18			0.47	1.91^{d}	5.39^{a}		2.11			0.47
1.88^{d}	5.66^{a}			3.82^{c}		0.47	1.89^{d}	5.12^{a}			4.34^{b}		0.49
2.11^{c}		5.17^{a}	1.99			0.50	2.12^{c}		4.74^{a}	2.05			0.51
2.09^{c}		4.86^{a}		4.98^{b}		0.51	2.09^{c}		4.50^{a}		4.79^{b}		0.52

Table 8
Asset Pricing Tests: All Countries - Global

The Table presents the results for currency portfolios sorted based on time $t-1$ information. The test assets include fifty-four portfolios: six sorted by country's exposure to the global component of the IST values, six by country's exposure to the global component of MEI values, six by country's exposure to the global component of M1 growth rate, six by country's exposure to the global component of M3 growth rate, six by nominal interest rate, six by past three-month currency excess return (short-term momentum), six by past one-year currency excess return (long-term momentum), six by past five-year exchange rate return (value), and six by country exposure to global FX volatility. The set of pricing factors includes the RX, HML^{ist}, HML^{mei}, HML^{mon1}, HML^{mon3}, and HML^{ir}. We report the market price of risk λ and the cross-sectional adjusted R-squared (R^2) obtained from the second pass of the Fama and MacBeth (1973) approach. The portfolios are rebalanced monthly and all excess returns are annualized. Note that a, b, c, and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively. The Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors were used to compute t-statistics.

Excluding Price Factors as Test Assets							**Including Price Factors as Test Assets**						
λ_{RX}	λ_{HML}^{ist}	λ_{HML}^{mei}	λ_{HML}^{mon1}	λ_{HML}^{mon3}	λ_{HML}^{ir}	R^2	λ_{RX}	λ_{HML}^{ist}	λ_{HML}^{mei}	λ_{HML}^{mon1}	λ_{HML}^{mon3}	λ_{HML}^{ir}	R^2
Panel (a): 2006:M1-2019:M12													
1.68	3.06^{c}					0.43	1.67	3.23^{b}					0.45
1.71		3.39^{b}				0.47	1.71		3.32^{b}				0.48
1.60			4.17^{c}			0.19	1.62			3.42^{c}			0.14
1.59				5.29^{b}		0.28	1.161				4.46^{b}		0.26
1.60					5.04^{b}	0.36	1.60					5.17^{a}	0.44
1.68	3.16^{c}				4.43^{b}	0.42	1.67	3.42^{b}				4.79^{b}	0.50
1.69		3.18^{b}			4.19^{b}	0.47	1.68^{a}		3.12^{b}			4.62^{b}	0.52
1.61			1.30		5.25^{a}	0.35	1.60			1.67		5.29^{a}	0.43
1.59				3.52^{c}	5.12^{b}	0.35	1.59				3.31^{c}	5.09^{a}	0.44
1.70	2.63^{d}	3.28^{b}				0.46	1.69	2.92^{c}	3.23^{b}				0.48
1.69	3.20^{b}		1.31			0.43	1.68	3.39^{b}		1.62			0.44
1.67	2.96^{c}			3.13^{d}		0.42	1.66	3.22^{b}			3.09^{d}		0.45
1.73		3.68^{a}	1.38			0.46	1.72		3.45^{a}	1.72			0.47
1.73		3.64^{b}		3.82^{c}		0.46	1.72		3.46^{a}		3.54^{c}		0.47
Panel (b): 2009:M01-2019:M12													
1.10	3.73^{b}					0.62	1.11	3.69^{b}					0.64
1.13		3.82^{b}				0.52	1.12		3.99^{b}				0.53
1.00			4.61^{c}			0.28	1.04			3.52^{c}			0.22
0.98				5.70^{b}		0.39	1.01				4.56^{c}		0.35
1.01					5.78^{b}	0.62	1.00					5.98^{a}	0.69
1.05	2.99^{c}				5.42^{b}	0.63	1.05	3.20^{c}				5.75^{b}	0.71
1.03		2.29^{d}			5.52^{b}	0.62	1.03		2.53^{c}			5.82^{a}	0.69
1.02			1.15		6.08^{a}	0.62	1.01			1.39		6.18^{a}	0.70
1.03				2.95	6.41^{a}	0.63	1.03				2.85	6.42^{a}	0.71
1.10	3.98^{b}	2.51^{d}				0.62	1.10	3.89^{a}	2.65^{c}				0.64
1.11	3.76^{b}		1.75			0.61	1.10	3.71^{b}		1.74			0.63
1.11	3.80^{b}			3.29		0.61	1.12	3.76^{b}			3.05		0.64
1.12		3.71^{b}	2.16			0.51	1.13		3.55^{b}	1.99			0.52
1.11		3.66^{b}		4.66^{c}		0.51	1.14		3.44^{b}		3.87^{c}		0.51

A.3.4 Country-level Estimates

Table 9
Country-level Betas

The Table reports the results of the OLS regression of the time-series of currency excess returns for each country "j" on our proposed risk factors: $RX_t^j = \phi_0 + \phi_1 RX_t + \phi_2^{\iota} HML_t^{\iota} + e_t$. ι stands for the IST, MEI, MON1, and MON3; e_t is a white noise error term. The Table also presents the results of a second OLS regression: i) $RX_t^j = \psi_0 + \psi_1 HML_t^{\iota} + e_t$. R^2 is the adjusted R-squared. All excess returns are annualized. Note that a, b, c, and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively. The Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors were used to compute t-statistics. The sample period is 1985:M01-2019:M12.

Panel (a)	ϕ_0	ϕ_1	ϕ_2^{ist}	R^2	ψ_0	ψ_1^{ist}	R^2	ϕ_0	ϕ_1	ϕ_2^{mei}	R^2	ψ_0	ψ_1^{mei}	R^2
Brazil	2.94	1.44^a	0.59^a	0.19	9.01^b	-0.04	0.00	2.69	1.67^a	0.61^b	0.18	10.97^a	-0.67^a	0.04
Switzerland	-1.64	1.24^a	-0.36^a	0.69	4.49^a	-1.11^a	0.32	0.84	0.93^a	-0.67^a	0.73	6.53^a	-1.35^a	0.60
Turkey	5.44^b	1.34^a	0.73^a	0.23	12.07^a	-0.06	0.00	4.74^c	1.44^a	0.55^a	0.20	13.56^a	-0.50^a	0.04
United Kingdom	-0.95	0.93^a	-0.28^b	0.53	3.66^b	-0.83^a	0.24	0.22	0.78^a	-0.39^a	0.54	5.01^a	-0.97^a	0.41
Panel (b)	ϕ_0	ϕ_1	ϕ_2^{mon1}	R^2	ψ_0	ψ_1^{mon1}	R^2	ϕ_0	ϕ_1	ϕ_2^{mon3}	R^2	ψ_0	ψ_1^{mon3}	R^2
Brazil	5.29^c	1.39^a	-0.22	0.28	9.21^b	-0.36	0.02	4.67^d	1.33^a	0.21	0.25	8.18^b	0.19	0.00
Switzerland	-1.28	1.13^a	-0.27^a	0.59	3.02^c	-0.49^a	0.11	-0.85	1.15^a	-0.31^a	0.66	3.61^b	-0.49^a	0.16
Turkey	6.95^a	1.19^a	0.49^a	0.29	11.46^a	0.25^c	0.01	5.96^b	1.18^a	0.65^a	0.36	10.54^a	0.46^b	0.07
United Kingdom	-1.12	0.92^a	-0.08^c	0.46	2.36	-0.27^a	0.04	-0.89	0.92^a	-0.13^b	0.49	2.67^d	-0.26^a	0.06

Table 10
Country-level Betas - Global

The Table reports the results of the OLS regression of the time-series of currency excess returns for each country "j" on our proposed risk factors: $RX_t^j = \phi_0 + \phi_1 RX_t + \phi_2^{\iota} HML_t^{\iota} + e_t$. ι stands for country's exposure to the global component of the IST, MEI, MON1, and MON3; e_t is a white noise error term. The Table also presents the results of a second OLS regression: i) $RX_t^j = \psi_0 + \psi_1 HML_t^{\iota} + e_t$. R^2 is the adjusted R-squared. All excess returns are annualized. Note that a, b, c, and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively. The Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors were used to compute t-statistics. The sample period is 2006:M01-2019:M12.

Panel (a)	ϕ_0	ϕ_1	ϕ_2^{ist}	R^2	ψ_0	ψ_1^{ist}	R^2	ϕ_0	ϕ_1	ϕ_2^{mei}	R^2	ψ_0	ψ_1^{mei}	R^2
Brazil	0.47	1.83^a	0.77^a	0.41	9.29^b	-0.61^b	0.04	1.46	1.70^a	0.72^a	0.39	8.87^b	-0.62^b	0.03
Switzerland	3.16^d	0.71^a	-0.70^a	0.65	6.62^a	-1.24^a	0.50	0.54	1.01^a	-0.20	0.56	4.95^b	-1.00^a	0.22
Turkey	-2.15	2.06^a	1.55^a	0.48	7.77^c	-0.01	0.00	0.51	1.73^a	1.26^a	0.39	8.05^c	-0.10	0.00
United Kingdom	-1.13	0.64^a	-0.37^b	0.44	1.95^b	-0.87^a	0.30	-0.99	0.64^a	-0.50^a	0.46	1.79	-1.01^a	0.30
Panel (b)	ϕ_0	ϕ_1	ϕ_2^{mon1}	R^2	ψ_0	ψ_1^{mon1}	R^2	ϕ_0	ϕ_1	ϕ_2^{mon3}	R^2	ψ_0	ψ_1^{mon3}	R^2
Switzerland	1.27	0.87^a	-0.48^a	0.59	3.10	-0.60^a	0.13	-1.16	0.92^a	-0.30^a	0.55	2.59	-0.23^c	0.02
Turkey	2.96	1.29^a	1.18^a	0.57	5.68^d	0.99^a	0.14	2.63	1.12^a	0.96^a	0.56	4.37	1.06^a	0.24
United Kingdom	-2.34	0.71^a	-0.13	0.41	-0.84	-0.23	0.02	-1.99	0.73^a	-0.20^a	0.43	-0.85	-0.15^d	0.01