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Currency Returns and Fundamental Sources of Risk

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Abstract

We provide evidence that uncertainty regarding investment-specific technology, the marginal efficiency of investment, and the growth of the money stock are 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, with positive and significant risk prices associated with them. We find that currencies from countries with low levels of investment-specific technologies, low levels of the marginal efficiency of investment, and high money growth rates earn higher excess returns. Furthermore, we show that currencies from countries with low exposure to the global component of these three processes earn higher excess returns. Our empirical evidence accounts for both the cross-section of average excess returns (portfolios) and individual currency returns. Furthermore, we reveal a downward trend in carry trade returns over the period from 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 drive 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, leaving the quest 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 incorporates 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 demand (MON) processes; 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 alter the value of the time preference parameter used to discount the future utility of Ricardian households.[2] This, in turn, affects the relative demand for each available asset in the economy. Consequently, the IST, MEI, and MON shocks 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 involves borrowing from low-interest rate currencies to invest in high-interest rate currencies. In equilibrium, CT appears to be a profitable investment, as high-interest-rate currencies tend to appreciate over low-interest-rate ones. This also corresponds to the well-known *forward premium puzzle*, an anomaly extensively studied in the literature (Fama, 1984; Evans and Lewis, 1995).

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 a dataset from 1980 to 2019, we examine the behaviour of CT returns and our three shock processes across a large sample of countries. Our investigation reveals a downward trend in CT returns, with an average decline of approximately 7% over the period. This trend is consistent with the cross-country behaviour of nominal interest rates, exchange rates, inflation rates, and the marginal products of capital identified in the data. Additionally, we find a similar downward trend 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 MON processes help to explain currency excess returns. Our findings indicate that these factors are priced in a cross-section of currency excess returns, and the *risk premia* associated with them are positive and significant, ranging from 2.66% to 8.01% p.a. We also find evidence that our proposed factors are important to explain country-level excess returns. Additionally, our results indicate that the risk factors associated with the IST, MEI, and MON processes are also relevant in explaining equity returns. Overall, these results can be interesting to academics, policymakers, and financial professionals alike. Detecting the fundamental sources of risk is crucial for explaining the dynamics and differences in real interest rates across countries. Properly understanding currency risk is important for effective portfolio allocation, and identifying 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 and examines the evolution of CT returns and shock processes in recent decades. Section 3 introduces our economic model, while section 4 presents the results of our asset pricing exercises. Finally, we conclude with our final remarks.

2 Currency Excess Returns and Risk Factors

The literature investigating asset pricing in the foreign exchange market can be classified into two main categories. The first approach, known as Macro-Finance, centers on assessing the link between asset pricing and economic fluctuations (Cochrane, 2017). The second approach focuses on empirical analysis, examining the connection between risk factors and moments of exchange rate distributions. The following is a review of recent papers within these two lines of research.

An early contribution to the literature is given by the work of Lustig and Verdelhan (2007). They 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. Their primary focus is to explain CT returns through the Consumption-based Capital

[2] There are several papers that consider preferences or "taste shocks" in asset pricing (Stockman and Tesar, 1995; Maurer, 2012; Albuquerque et al., 2016; Chen and Yang, 2019; Gomez-Cram and Yaron, 2021). Our model can deliver an asset pricing equation with a risk factor associated with time preference shocks, similar to the "Valuation risk" explored in the asset pricing literature (Albuquerque et al., 2016).

Asset Pricing Model (CCAPM), using consumption growth of durable and non-durable goods as risk factors. In contrast, 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. Similarly, 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 for currency excess returns. Our work complements this literature by expanding the CCAPM with a risk factor associated with changes in household time preference. 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, which in turn depend on the IST, MEI, and MON shocks. This extension provides a more comprehensive framework to understand the risk factors driving currency excess returns and their link to household consumption and intertemporal preferences

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 capable of capturing most of the data variance. The first component, labeled as the RX factor, represents the average yield on portfolios, while the second component, labeled as the HML factor, represents the slope 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),

Menkhoff et al. (2012a) propose a novel measure of global volatility risk that comes from FX markets. Their empirical results corroborate the evidence found by Lustig et al. (2011). High-interest rate currencies are negatively correlated with global exchange rate volatility, offering lower returns in times of unexpected high volatility. Our study also complements this literature by revealing three new risk factors priced in currency markets. These risk factors stem from fundamental macroeconomic sources of risk associated with the IST, MEI, and MON processes. By incorporating these factors into the analysis, we provide a more comprehensive understanding of the risk factors driving currency excess returns and their link to macroeconomic fundamentals.

A growing number of papers have yielded alternative explanations to the *forward premium puzzle* and the high average payoffs from CT. The works of Berg and Mark (2019) and Backus et al. (2013) establish connections between technology shocks, monetary policy, and empirical regularities observed in currency markets. Berg and Mark (2019) develop a two-country DSGE model to investigate the forward premium bias, the returns from CT, and the long-run risk reversal. They demonstrate that heterogeneity between countries in total factor productivity can generate 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 objective is to examine which specification of Taylor's rule can resolve the *forward premium puzzle*. Similar to 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.

In their work, Lustig et al. (2014) propose a novel currency investment strategy called the "dollar carry trade". This strategy involves taking 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. Conversely, when the average foreign nominal interest rate is below the US nominal interest rate, they short all foreign currencies and take a long position in the US dollar. 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. They find that the "dollar carry trade" generates a Sharpe ratio of around 0.50. Using their no-arbitrage model, they show that currency excess returns compensate 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 becomes a key driver of currency and interest rate movements. They argue that the exposures of country endowments to global growth news capture fundamental differences across countries, such as 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 by leading central banks (Calomiris and Mamaysky, 2019), fluctuations in sovereign credit default swaps (Della Corte et al., 2022), and the strength of countries' business cycles measured by the output gap (Colacito et al., 2020). From the international finance literature, two important insights have emerged regarding currency returns. Firstly, understanding currency *risk premia* requires considering the differences in macroeconomic fundamentals among countries (Backus et al., 2013; Berg and Mark, 2019; Colacito et al., 2020). Secondly, both currency-specific and global risks are compensated in currency excess returns (Lustig et al., 2011, 2014; Colacito et al., 2018; Verdelhan, 2018). In general, the literature has associated changes in global risks to several factors, such as macroeconomic fluctuations, shifts in risk aversion, changes in expectations, and catastrophic episodes (crash risk). Our work complements the existing literature by providing a risk-based explanation for currency excess returns derived from two key sources: i) cross-country differences in the local IST, MEI, and MON shocks, and; ii) the heterogeneous exposure of countries to global IST, MEI, and MON shocks. Notably, we reconcile exchange rate risk factors with these three sources of macroeconomic fluctuations, presenting a novel contribution to the literature in this area.

IST, MEI, and MON Shock Processes. One of the most contentious issues among macroeconomists concerns the origins of business cycle fluctuations. The debate centers on identifying the most relevant shocks capable of explaining the variability of output and hours worked during business cycles. In open economy models, the international flow of goods and capital becomes a crucial driving force behind the transmission of these disturbances. The protracted recession that began with 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 influences the transformation of consumption into investment goods, while the MEI shock impacts the process by which investment goods are transformed into physical capital. In their model, the IST process is equal to the inverse of the price of investment relative to consumption. Additionally, they propose that the MEI shock might 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 MEI are crucial in producing fluctuations in output. In their model, positive shocks to the MEI 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. (1997).

Since the work Greenwood et al. (1988) and Greenwood et al. (1997) several papers incorporated investment shocks into their DSGE models in order to: i) analyze business cycle fluctuations (Hirose and Kurozumi, 2012; 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 models (Fisher, 2006), and; iv) 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 employs IST and MEI shocks to explain macroeconomic fluctuations and the dynamics of the balance of payments. An early contribution to this literature includes the work of Finn (1999). More recently, Jacob and Peersman (2013) estimate a two-country DSGE model and find that the MEI shock accounts for nearly 50% of the variance in the US business cycle fluctuations. They also demonstrate that IST shocks can have a negative effect on the trade balance. These results are consistent with the findings of Raffo (2010). Although the two models have different features and transmission channels for investment shocks, a local positive investment shock in the domestic economy generally leads to: i) an increase in output, investment, consumption, and imports, and; ii) an appreciation of the terms of trade (an increase in domestic prices). Consequently, the investment shock is associated with a trade deficit. Furthermore, Dogan (2019) explores the spillover effect of IST shocks originating in advanced economies (such as the US) on emerging countries (like Mexico). The author sets up a two-country economy and assumes that IST shocks originate 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. Khan and Tsoukalas (2012) 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 resolving the puzzles of international real business cycle models, such as 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 serve as a proxy to measure the IST in an open-economy setting. In contrast, 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 significant implications for macroeconomic fluctuations and asset prices. This extension adds to the understanding of the mechanisms by which investment shocks affect the economy and provides a comprehensive framework for analyzing currency excess returns.

Investment shocks play a crucial role in the finance literature as well. The work of Papanikolaou (2011) employs 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. Furthermore, Papanikolaou (2011) demonstrates that 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. Several other papers, such as Kogan and Papanikolaou (2013) and Kogan and Papanikolaou (2014), 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 IST and MEI shocks. By analyzing the impact of these shocks on interest rates and exchange rates, we offer insights into the factors that drive currency returns, providing a comprehensive risk-based explanation for carry trade returns.

Our study is also related to the literature investigating money's role in business cycle fluctuations. Typically, in models analyzing the effects of monetary policy on macroeconomic variables and asset pricing, monetary shocks are often assumed to stem from an interest-rate rule or a money supply equation. Conversely, 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 adopts different approaches to investigate the idea that real money growth is a priced risk factor in asset markets. An ongoing debate in the literature concerns the sign of the *risk premium* associated with money in the stock market (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 Carry Trade Returns and Fundamental Shocks

In our model, there are two types of households: Rule-of-thumb (ROT) and Optimizing (OPT). The first type does not have access to financial markets and spend all its disposable income on consumption. The second type has access to capital and financial markets and allocates income optimally between consumption and savings. The IST, MEI, and MON shocks are the fundamental sources of risk that affect the consumption and saving decisions of OPT households. Furthermore, these shocks drive currency excess returns through changes in nominal interest rates and the exchange rate.

Next, we investigate the behavior of CT returns and their components: i) nominal interest rate differentials; and ii) exchange rate variations. We also examine the first and second moments of the IST, MEI, and MON processes. We aim to evaluate the evolution over time of these variables in order to explore the link between CT returns and the IST, MEI, and MON processes. This is important because, in our model, currency excess returns are driven by these shocks.

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, 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, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sri Lanka, Thailand, Tunisia, Turkey, Ukraine, and Uruguay. We also highlight in our analysis the set of G-10 countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland and the United Kingdom. We work with monthly, quarterly and annual data from various sources. When necessary, we annualized the data to facilitate analysis (e.g., monthly data is multiplied by twelve). Appendix A.1 provides a description our dataset.

Our study consider a sample of 60 countries and covers the period between 1980 and 2019. As pointed out by Lustig and Verdelhan (2007), the conditions derived from Euler's equation on the joint distribution of exchange rates and interest rates are consistent only if foreign investors are given unrestricted permission to buy local assets. Increased global financial integration, fueled by lower capital controls, has led to significant growth in cross-country asset trading (Lane and Ferretti, 2003). Most of the reduction in impediments to international trade in assets occurred from the 1980s onwards (Coeurdacier and Rey, 2013). Several studies provide empirical evidence of the growth in cross-border financial diversification in recent decades (Tesar and Werner, 1995; Lane and Ferretti, 2003; Coeurdacier and Rey, 2013). Therefore, we believe that our sample period is adequate for our investigation.

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 A.1 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.1.1 to A.1.4 provides a detailed description of these refinements.

Most data on nominal interest rates are from the International Monetary Fund (IFS). The choice of interest rates used to compute CT returns was as follows. First, we used treasury bill rates whenever available. Second, in the absence of treasury bill rates, we worked with money market rates. Third, if these two alternative were not available, we used government bond rates. Finally, in the absence of these three options, we employed deposit rates.

CT are typically short-term investments, which explains our choice.[3]

We followed Greenwood et al. (1992), Greenwood et al. (1997), and Justiniano et al. (2011), and used 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. We obtained the investment and consumer prices from the PWT 10, which provides annual measures for all countries in our sample. To obtain the relative price of investment that a domestic producer faces, we followed Karabarbounis and Neiman (2014). We divided the relative investment price of each country by the relative investment price of the US. We then multiplied this ratio by the ratio of the US investment price deflator to the US personal consumption expenditure deflator, obtained from the Bureau of Economy Analysis (BEA). Karabarbounis and Neiman (2014) show that this adjusted measure calculated from the PWT dataset is consistent with other alternative measures, effectively capturing the behavior of the relative price of investment in recent decades. They compare the relative price of investment obtained from the PWT with two alternative measures. First, they construct a country-level measure based on data from the World Bank's Development Indicators. Second, they employ the EU KLEMS dataset to calculate the relative price of investment at the country level. They demonstrate that: i) the behavior of the three measures is very similar between 1970 and 2010; and ii) overall, the three measures exhibit a high degree of correlation (ranging between 0.60 and 0.75).

As emphasized by Justiniano et al. (2011), the financial system plays a crucial role in the process of producing physical capital. They argue that the MEI shock might reflect fundamental disturbances in the ability of the financial system to intermediate capital investments. To measure the MEI process, they use the external finance premium, proxied by the spread between high-yield and AAA corporate bond returns. We used 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, such as the ratio of private credit to GDP and the stock market capitalization to GDP, but also a set of nine sub-indicators that summarize the depth, access, and efficiency of financial institutions and financial markets.

As a proxy for the MON process, we chose to use both M1 and M3 as measures of the money stock. By utilizing a narrow and a broad money measure, we can assess whether the difference in liquidity plays a role in our asset pricing exercises.[4]

2.1.1 Carry Trade Returns

To establish our claims, we begin by analyzing our CT return series. 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. Panels (c) and (d) consider only Germany as a country adopting the euro, therefore we exclude all Eurozone countries after their date of entry into the membership. The portfolio returns shown in Panels (b) and (d) are obtained by applying the high-minus-low strategy for constructing CT portfolios, following the methodology applied by Lustig et al. (2011), Menkhoff et al. (2012a), Corte et al. (2016), and Colacito et al. (2020). In this case, currency excess returns are constructed from sorting countries based on nominal interest rates and dividing them into six portfolios: portfolio one with countries having the lowest interest rates and portfolio six with countries having the highest interest rates. The returns of CT portfolios correspond to the difference between the return of each portfolio (portfolios two to six) and the return of portfolio one (high-minus-low). We apply the same methodology to analyze CT returns of a sample formed only by developed countries. Due to the smaller number of countries, we form five portfolios and only display the result of the CT portfolio formed by the difference between portfolio five and one (denoted as "P5-P1" in the figure).

The most significant feature of Figure (1) is the clear downward trend in CT returns observed between 1980 and 2019. Panels (a) and (c) illustrate that the high average returns in the 1980s (close to 7% p.a.) collapse to approximately zero in the late 2010s. The qualitative result displayed in Panels (b) and (d) of the figure is consistent with that presented in Panels (a) and (c), showing a decline in CT returns over recent decades. For example, average returns decrease from 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 rates differentials and a decrease in the growth rate of exchange rates across countries.

Table (1) provides a comprehensive summary of the 5-year average of CT returns by country groups (All, Developed, Developing, and G10) and the high-minus-low (HML) portfolio strategy (portfolio return six minus portfolio return one). The table reveals that, in general, the average of CT returns decreases over time. However, it is worth noting that CT returns across all country groups experience a sharp increase in 2002 and 2003. It is informative to compare the returns of these two years with those reported in the table. CT returns reached $11.12\%, 16.31\%, 7.89\%$ and 10.70% in 2002 and $14.70\%, 17.29\%, 13.08\%$ and 14.44% in 2003, for the respective groups of All, Developed, Developing, and G10 countries. The increase in returns over the period 2000-2004 can be attributed to these two

[3] We filled in the missing values from the IFS database with data from the OECD and the European Central Bank (ECB). We used OECD 3-month money market rate data for the following countries: Canada (2017:M05 to 2019:M12), Japan (2017:M07 to 2019:M12), Sweden (2017:M06 to 2019:M12), Belgium (2017:M12 to 2019:M12), Finland (2018:M02 to 2019:M12), France (2017:M06 to 2019:M12), Ireland (2017:M04 to 2019:M12), Lithuania (2017:M06 to 2019:M12), Luxembourg (2017:M06 to 2019:M12), Netherlands (2019:M07 to 2019:M12), Portugal (2017:M06 to 2019:M12), and Paraguay (2017:M04 to 2019:M12). We used 3-month money market rate data from the ECB for the following countries: Croatia (2014:M02 to 2019:M12) and India (1991:M01 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, allowing us to better capture liquidity differences by comparing the results between M1 and M3; and ii) we were unable to find M0 data for our period of investigation.

unconventional years. This is important because if we remove these two years from our sample, the downward trend in CT returns becomes even clearer.

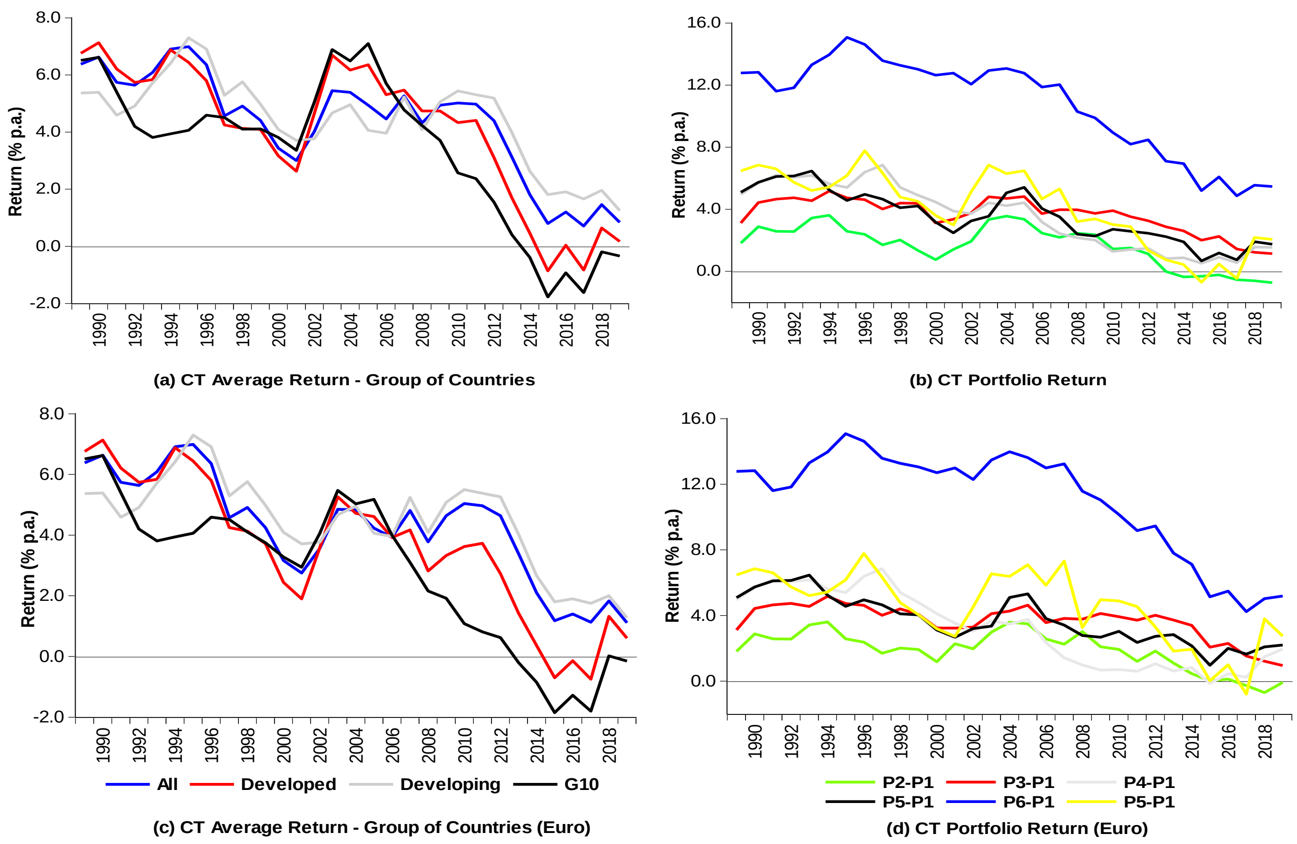


Figure 1: CT Return. The figure shows the evolution over time of the 10-year moving average of CT returns. Panels (a) and (b) consider the entire dataset. Panels (c) and (d) consider only Germany as a country adopting the euro, therefore we exclude all Eurozone countries after their dates of entry into the membership. 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., 2020). To obtain the 10-year moving average values, we first computed the cross-sectional mean of the monthly data for each group of countries (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. Monthly returns are annualized (multiplied by twelve). The sample period is 1980-2019.

To complement our analysis, we also conducted a time-series linear regression of annualized CT returns by group of countries on a constant and a time trend. We find that in all cases the estimated trend parameter is statistically significant at the 1% level. The parameter estimates and the adjusted R^2s values 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. These results align with the findings reported in Table (1).

As discussed earlier, CT returns come from two sources: the nominal interest rate differential and changes in the exchange rate. To gain a better understanding of the downward trend in CT returns, it is crucial to examine the behavior of both sources over the period investigated. Table (2) provides a breakdown of CT returns into their components: the nominal interest rate differential (denoted by 'IR') and the exchange rate return (denoted by 'FX'). Three main findings emerge from this table. First, reading down the columns of the table, we observe a decrease in average 'IR' returns across all country groups. Second, we find that average 'FX' returns increased between the periods of 1980-1999 (with an average of -8.42% p.a.) and 2000-2019 (with an average of -1.39% p.a.) for the group of Developing countries. The surge in 'FX' returns during the 2002-2003 interval played a significant role in driving atypical returns during that period. Moreover, the average returns of the 2000-2004 period were greatly influenced by the rise in 'FX' returns in both developed and developing countries compared to previous periods. For instance, in developed countries, 'FX' returns increased from 2.00% p.a. to 6.65% p.a. between 1995-1999 and 2000-2004. Third, reading across the rows of the table, we find that, in general, the absolute values of the average 'IR' and 'FX' returns 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 group of countries (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. Monthly CT returns are annualized (multiplied by twelve). 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

Table 2
CT Return Decomposition

The table shows the decomposition of CT returns between the FX return (denoted by 'FX') and the nominal interest rate differential (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 group of countries (All, Developed, Developing, and G10). Monthly CT returns are annualized (multiplied by twelve). The sample period is 1980-2019.

	All		**Developed**		**Developing**		**G10**	
Period	**IR**	**FX**	**IR**	**FX**	**IR**	**FX**	**IR**	**FX**
1980-1984	6.07	-1.93	3.65	0.36	10.19	-5.83	3.29	4.81
1985-1989	7.78	0.74	4.82	4.61	13.01	-6.72	2.66	2.22
1990-1994	10.18	-4.89	4.72	-0.41	16.27	-9.74	3.45	-0.46
1995-1999	9.48	-5.97	1.85	2.00	14.59	-11.18	1.91	3.31
2000-2004	5.30	1.96	1.83	6.65	7.56	-1.05	1.57	6.19
2005-2009	3.24	-0.63	2.05	-1.06	3.87	-0.26	1.49	-1.82
2010-2014	3.36	-2.37	1.69	-1.75	4.16	-2.53	0.93	-1.36
2015-2019	2.64	-1.96	1.23	-0.83	3.43	-2.58	1.12	-1.36

Figure (2) provides further insights into the decomposition of CT returns between 'IR' and 'FX'. In all panels of this figure, the left axis represents changes in the All and Developing groups, while the right axis represents changes in the Developed and G10 groups. Panels (a) and (b) present the 10-year moving average of 'IR' and 'FX' returns, respectively. Panel (a) reveals that 'FX' returns are almost always negative and increase over time in developing countries. Conversely, in Developed and G10 countries, 'FX' returns are generally positive and decline over time. Notably, there is a downward trend in 'FX' returns until 2001, followed by a peak of approximately 7% around 2002 and 2003, and then a new downward trend. Panel (b) of the figure confirms the decline in CT returns associated with nominal interest rate differentials for all groups of countries. Importantly, Panels (a) and (b) reveal a downward trend in both 'FX' and 'IR' returns in absolute terms between 1980 and 2019. These findings emphasize the significance of both 'IR' and 'FX' returns in explaining the behavior of CT returns over the analyzed period.

Panels (c) and (d) of the figure display the 10-year moving averages of the cross-sectional standard deviations of 'FX' and 'IR' returns by group of countries. These figures were obtained by calculating the cross-sectional standard deviations using monthly data from each country group and then averaging them over a 10-year window. Panel (c) provides insights into the behavior of the standard deviation of 'FX' returns. It shows a decreasing trend in the standard deviation for both Developed and G10 countries between 1990 and 2019. Additionally, for developing countries, there is a noticeable decline in the standard deviation of 'FX' returns from around 2000 onwards. In Panel (d), the standard deviation of 'IR' returns is examined. The results indicate a decrease in the standard deviation of 'IR' returns for all groups of countries. Overall, the findings from Panels (c) and (d) suggest that the downward trend in CT returns is accompanied by a convergence in the values of 'FX' and 'IR' returns across countries. This convergence is reflected in the decreasing standard deviations of both 'FX' and 'IR' returns.

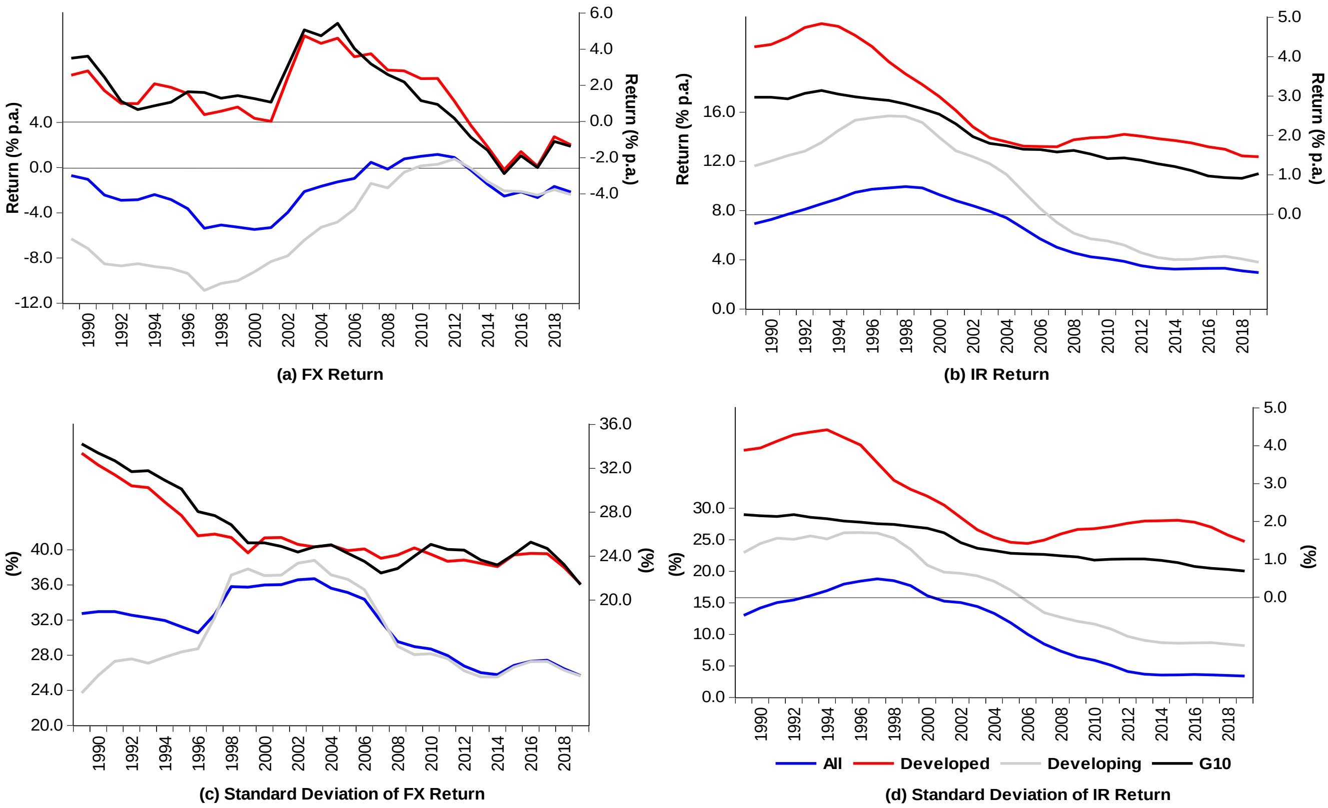


Figure 2: Decomposition of CT Returns. The figure shows the 10-year moving averages of the decomposition of CT returns between 'FX' and 'IR' returns (Panels (a)) and (b)) and of the cross-sectional standard deviations of 'FX' and 'IR' returns by group of countries (Panels (c) and (d)). In all panels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

Panels (c) and (d) of the figure display the 10-year moving averages of the cross-sectional standard deviations of 'FX' and 'IR' returns by group of countries. These figures were obtained by calculating the cross-sectional standard deviations using monthly data from each country group and then averaging them over a 10-year window. Panel (c) provides insights into the behavior of the standard deviation of 'FX' returns. It shows a decreasing trend in the standard deviation for both Developed and G10 countries between 1990 and 2019. Additionally, for developing countries, there is a noticeable decline in the standard deviation of 'FX' returns from around 2000 onwards. In Panel (d), the standard deviation of 'IR' returns is examined. The results indicate a decrease in the standard deviation of 'IR' returns for all groups of countries. Overall, the findings from Panels (c) and (d) suggest that the downward trend in CT returns is accompanied by a convergence in the values of 'FX' and 'IR' returns across countries. This convergence is reflected in the decreasing standard deviations of both 'FX' and 'IR' returns.

We also computed the 10-year moving average of the percentage of countries that experienced positive annual 'FX' returns between 1980 and 2019. Developed and G10 countries consistently maintained a stable range of $50\% - 55\%$ positive 'FX' returns throughout the period. In contrast, the number Developing countries with positive 'FX' returns increased from approximately 10% in 1990 to 45% in 2019 (the results are not reported but are available from the authors upon request).

Overall, our findings provide empirical evidence supporting the downward trend in CT returns. The evolution over time of 'FX' and 'IR' returns helps explain this downward trend. In what follows, we reveal the existence of a similar trend for nominal interest rates, inflation rates, MPKs and exchange rate growth rates. Finally, we analyze the crucial aspect of the growth rates of the IST, MEI, and MON processes in recent decades. This analysis is significant as these shocks play a pivotal role in business cycle fluctuations and asset pricing within our theoretical model.

2.2 IST, MEI, and MON Processes

In what follows, we examine the behavior of the IST, MEI, and MON processes in recent decades. An increase in the consumption-to-investment price ratio represents a positive shock to the IST, leading to an immediate rise in the marginal return on investment in physical capital. Similarly, a positive shock to the MEI occurs with an increase in the level of financial development within a country, reducing investment adjustment costs. Both the IST and MEI shocks directly influence the growth rate of investment in physical capital. Furthermore, an increase in money demand corresponds to a positive shock to the MON, resulting in a boost to the money stock.

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, we first computed the cross-sectional mean of the annual data by country group. We then used these values to calculate the mean and standard deviation considering a five-year data window. Money growth rates were computed as the log difference of money stocks M1 and M3 between periods $t+1$ and t. M1 and M3 growth rates are annualized. The sample period is 1980-2019 (IST and MEI).

	All		**Developed**		**Developing**		**G10**		**US**	
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

We follow the literature and provide results in terms of the inverse of the IST process (P_t^i/P_t^c). Throughout this section, we use the term 'IST' to mean the inverse of the IST. Table (3) reports the mean and standard deviation of the IST (Panel (a)), MEI (Panel (b)), and MON (Panels (c) and (d)) by group of countries considering a five-year data window. Money growth rates were computed as the log difference of money stocks M1 and M3 between periods $t+1$ and t.[5]

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

Overall, when reading down the columns of Panel (a) (Panel (b)), the IST (MEI) values decrease (increase) over time for all country groups. Panel (c) and (d) show a significant level of uncertainty regarding the direction of changes in money growth over the period 1980 to 2019. On the one hand, the mean (standard deviation) of Developing countries declines sharply 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 a peak of 10.87% (standard deviation of 5.80%) in 2010-2014. The M1 growth rate of the Developed and the G10 groups fluctuates over the period without a clear trend. However, overall, all groups of countries show a decline in the rate of M3 growth.

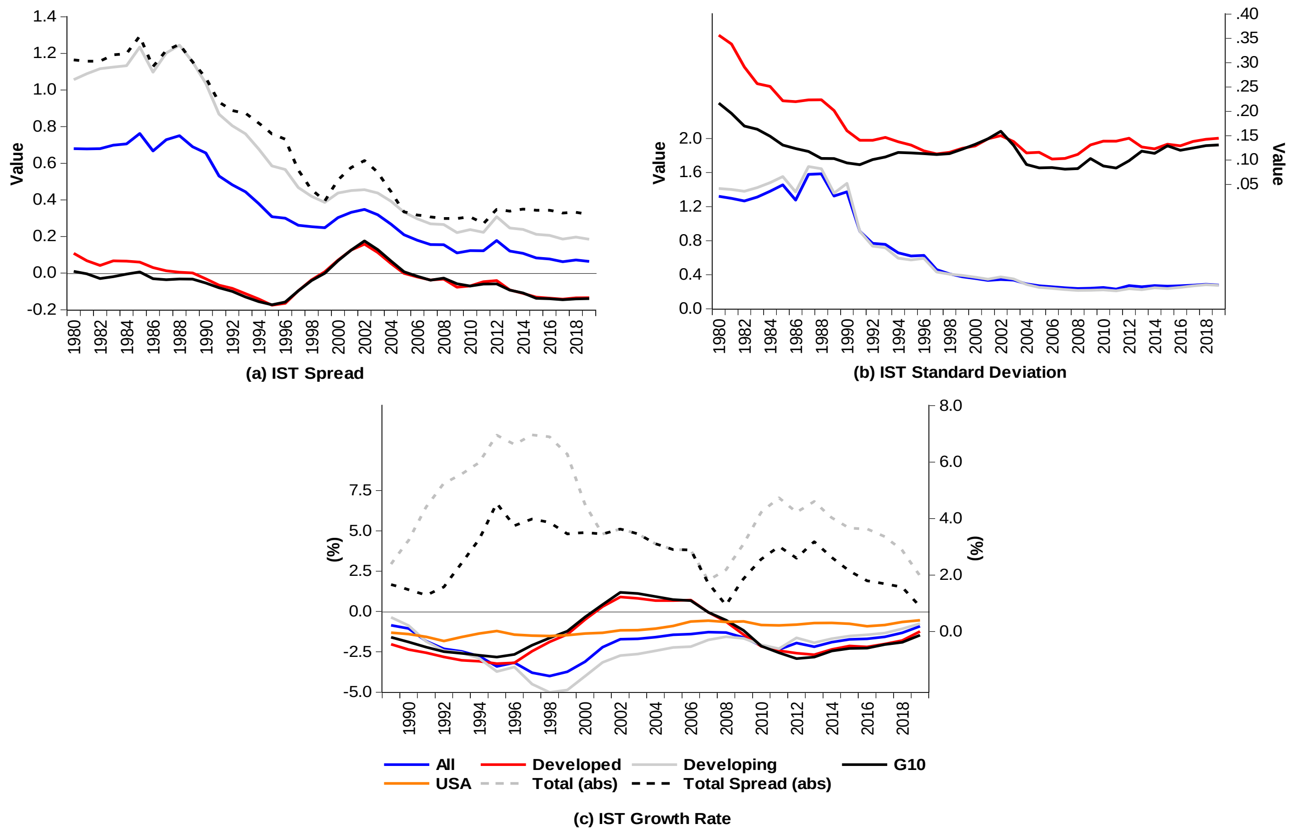


Figure 3: Evolution of IST. The figure shows the evolution of the spread (Panel (a)), cross-sectional standard deviation (Panel (b)) and growth rate (Panel (c)) of the IST process, by group of countries, . The spread is the difference between each country's value and that of the US. The values in Panel (a) are cross-sectional averages by group of countries. Panel (c) values are 10-year moving averages of the cross-sectional averages of the IST growth rate by group of countries. IST growth rates were computed as the log difference between periods $t+1$ and t. In Panel (b), the left axis represents values for the All and Developing groups, while the right axis represents values for Developed and G10 groups. In Panel (c), the left axis represents values for country groups (All, Developing, Developed, and G10), while the right axis represents values for Total (abs) and Total Spread (abs). The sample period is 1980-2019.

The behavior of the three processes can be better evaluated through graphical analysis, as they demonstrate the evolution of values gradually over time. We begin by looking at the IST spread shown in Panel (a) of Figure (3). It is noteworthy that the IST spread in the Developing group declines from a peak of 1.20 to a low of approximately 0.20. On the other hand, the IST spreads in the Developed and G10 groups fluctuate around the zero line without a clear trend. Overall, the 'Total Spread (abs)' - which represents the sum of the absolute values of the spreads in Developed and Developing countries - also decreases from the 1980s to the 2010s.

To generate Panel (b) of Figure (3), we followed the same methodology used in constructing Panel (c) of Figure (2). In this panel, the left axis represents the standard deviation of the IST process for the All and Developing groups, while the right axis represents values for the Developed and G10 groups. Overall, the standard deviation for all groups decreases from the 1980s through the early 2000s and then remains relatively stable. It is important to

(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 US (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).

note that this decline is similar to the observed patterns in the standard deviations of 'FX' and 'IR' returns shown in Panels (c) and (d) of Figure (2).

Panel (c) displays 10-year moving averages of cross-sectional means of the IST growth rate by group of countries. The left axis represents IST growth rates and the right axis represents 'Total (abs)' and 'Total Spread (abs)'. 'Total (abs)' represents the sum of the absolute values of the IST growth rates of Developed and Developing countries. 'Total Spread (abs)' represents the sum of the absolute values of the difference in the IST growth rates between Developed and Developing countries and the US. This panel shows that the IST growth rate in developing countries decreases between 1990 and 1999 and then increases from 2000 ownwards. The growth rates of developed and the G10 countries fluctuate over the period. It is informative to compare Panel (c) of Figure (3) with Panel (a) of Figure (1). Overall, both panels point to similar downward trends in CT returns and in 'Total (abs)'/'Total Spread (abs)'. This comparison is important because in our model currency excess returns are associate with IST growth rates.

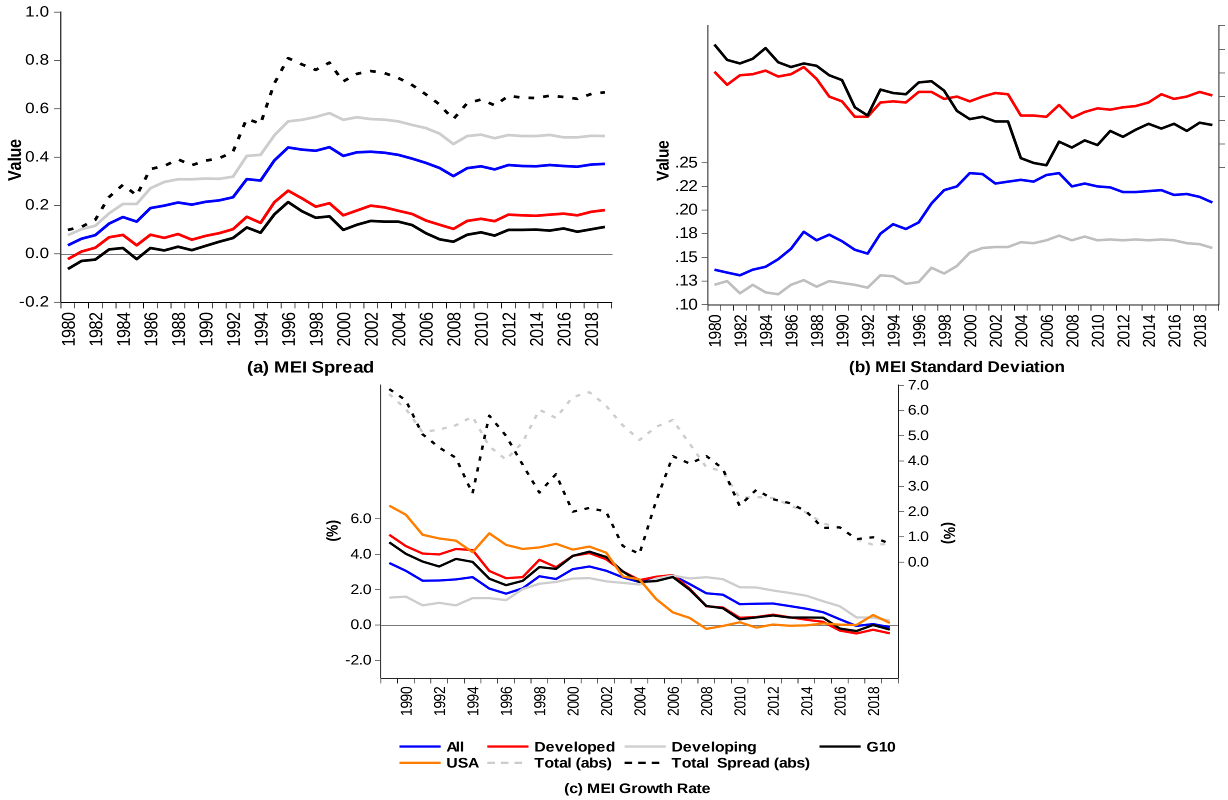


Figure 4: Evolution of MEI. The figure shows the evolution of the spread (Panel (a)), cross-sectional standard deviation (Panel (b)) and growth rate (Panel (c)) of the MEI process, by group of countries. The spread is the difference between the US value and that of each country. MEI growth rates were computed as the log difference 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 group of countries. In Panel (b), the left axis represents values for the All and Developing groups, while the right axis represents values for the Developed and G10 groups. In Panel (c), the left axis represents values for country groups (All, Developing, Developed, and G10), while the right axis represents values for Total (abs) and Total Spread (abs). The sample period is 1980-2019.

Panels (a) to (c) of Figure (4) were generated using the same methodology as Panels (a) to (c) of Figure (3). As can be seen from Panel (a), the MEI spread increases from 1980 to the late 1990s, decreases from then until the end of the 2000s, and stabilizes thereafter for all groups of countries. However, the most significant finding is the downward trend depicted in Panel (c) for the 'Total (abs)'/'Total Spread (abs)' values. A comparison between this panel and Panel (a) of Figure (1) reveals that from the early 1990s through 2002, both 'Total (abs)'/'Total Spread (abs)' and CT returns are large and decreasing. Between 2003 and the late 2000s, we observe a hump-shaped increase in both 'Total (abs)'/'Total Spread (abs)' and CT returns. From the end of the 2000s, both values decline sharply. Furthermore, it is important to note that the growth rate of the MEI process in the US and in Developed countries decreased over the period. This downward trend has also been observed in Developing countries since the mid-2000. Assuming that the Financial Development Index is an appropriate proxy for the MEI process, the results of Panel (c) imply a reduction in the magnitude of the shocks associated with this process. Once again, this comparison is important because, in our model, currency excess returns are also associated with MEI growth rates.

Overall, Panel (b) of Figure (4) documents a decline (rise) in the cross-sectional standard deviation of the MEI process for Developed and G10 (Developing) countries from 1980 to the early 2000s, followed by a period of slight increase (decrease) until 2019.

As a robustness exercise, we constructed an alternative to the Financial Development Index proposed by Svirydzenka (2016). We applied the methodology developed by Svirydzenka (2016) to the World Bank Financial

Development and Structure dataset. However, instead of using nine indicators as in Svirydzenka (2016), we employed the thirty-one indicators available in the World Bank dataset. These indicators aim to capture the size, activity, and efficiency of financial intermediaries and markets (Beck et al., 2010). Covering 213 countries with annual frequency between 1960 and 2017, allowing for a comprehensive comparison of countries' financial development over time. The sources and methodology for constructing the indicators are described in Beck et al. (2010). We constructed our index for the 60 countries included in our sample (the results are not reported but are available upon request). Overall, we find results similar to those reported above for the Financial Development Index of Svirydzenka (2016).

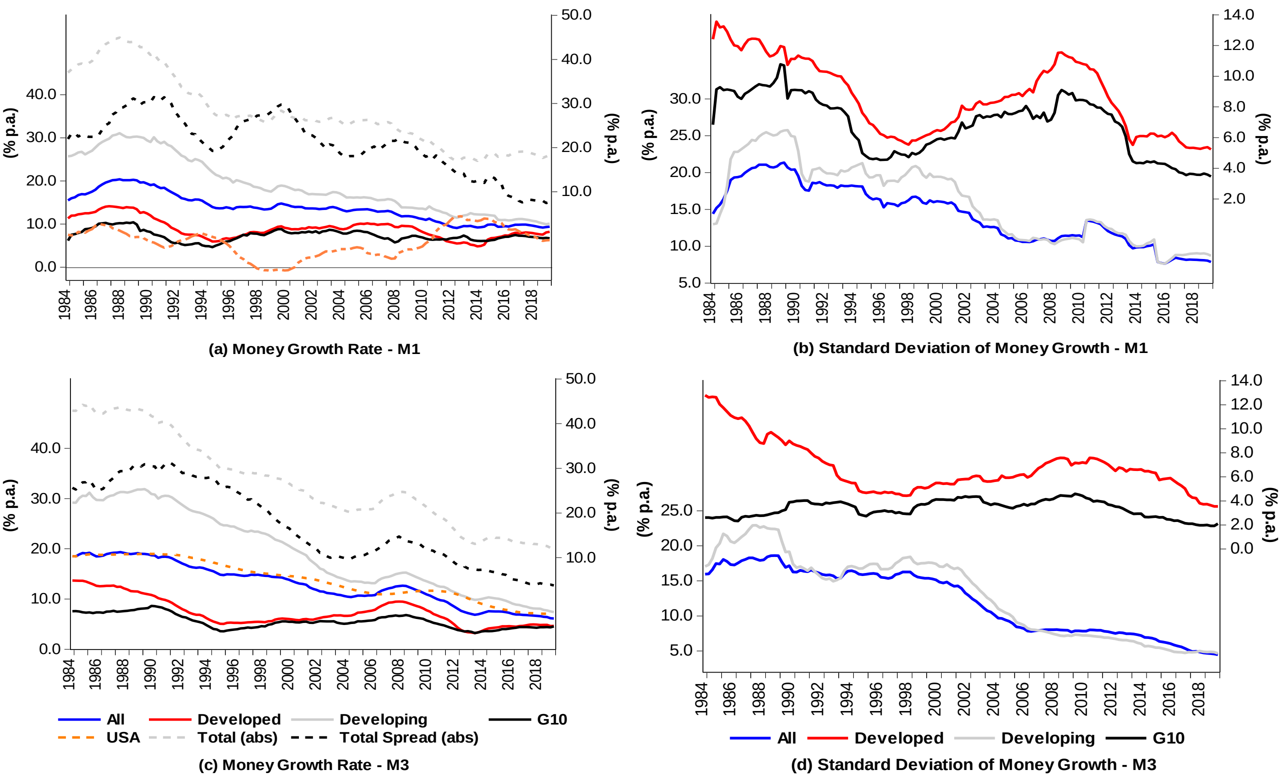


Figure 5: Evolution of MON. The figure presents the evolution of the money growth rate (Panels (a) and (c)) and its standard deviation (Panels (b) and (d)). In Panel (a) and (c), the left axis represents the money growth rate for country groups (All, Developing, Developed, and G10) and the right axis represents values for the 'Total (abs)' and 'Total Spread (abs)'. Money growth rates were computed as the log difference between periods $t+1$ and t. The values in Panel (a) and (c) are 20-quarter moving averages of the cross-section means of the growth rate of money. The values in Panel (b) and (d) are 20-quarter moving averages of the cross-sectional standard deviation of money growth rates. In Panels (b) and (d), the left axis represents the values for the All and Developing groups, while the right axis represents values for the Developed, and G10 groups. In Panels (a) and (c), the left axis represents values for country groups (All, Developing, Developed, and G10), while the right axis represents values for Total (abs) and Total Spread (abs). The sample period is 1980-2019.

Panels (a) to (d) of Figure (5) were generated using the same methodology applied as Panels (a) to (c) of Figure (3). Panel (a) reveals that the decline in the money growth rate in Developing countries since 1990 and the increase in the US money growth rate since the late 1990s are the primary drivers behind the downward trend in 'Total Spread (abs)' over the period. The panel also shows that between 1984 and the end of the 1990s, the growth rate of money in Developed countries gradually slows down and then stabilizes. Panel (c) of the figure shows that the main difference between the behavior of M3 and M1 growth rates is associated with the US. The M3 growth rate of Developed countries is consistently lower than that of the US. Moreover, Panels (a) and (c) reveal that 'Total Spread (abs)' follows a similar downward trend to that of CT returns displayed in Panel (a) of Figure (1). Moving on to the other two panels, we observe that: i) overall, the standard deviation of M1 (Panel (b)) and M3 (Panel (d)) growth rates in Developing countries decreases over the period; and ii) the standard deviation of M1 and M3 growth rates in Developed countries trend downwards until the end of the 1990s, followed by an increase from that period until the late 2000s, and then subsequent decline until 2019.[6]

[6] In addition to the analysis of the IST, MEI, and MON processes, we explored the behavior of several other key variables: nominal interest rate, inflation rate, the marginal product of capital (MPK), exchange rate, and capital stock. We employed our complete set of countries covering the period between 1980 and 2019 (the results are not reported but are available from the authors upon request). Our main findings can be summarized as follows: i) nominal interest rates, inflation rates, and MPKs showed a downward trend, particularly among Developing countries. We also found a convergence process between Developed/Developing countries and the US, resulting in a reduction in the differentials of nominal interest rates and inflation rates across countries. The gap between Developing countries and the US in terms of the MPK also decreased.; ii) the standard deviation of exchange rate growth exhibited a downward trend in Developing

The results presented thus far suggest that there may be a common underlying factor driving the variation in macroeconomic variables, including the nominal interest rate, inflation rate, and exchange rate. This implies that a global factor could potentially account for part of the fluctuations observed in these variables. The same reasoning applies to the IST, MEI, and MON processes. Motivated by these findings, we we conducted principal component analysis to assess the covariance matrix of each shock process dataset.

In our analysis, two notable findings emerge. First, a small number of factors can account for a significant portion of the variation observed in the data. The first two factors explain 76.58% and 78.43% of the total variance in the IST and MEI data, respectively. For the growth rates of M1 and M3, the first five factors explain 50.85% and 52.56% of the total variance, respectively. This suggests that a relatively small number of factors can capture the main sources of variation in these shock processes. Second, there is a considerable dispersion in the communality values across countries. The communality, which represents the proportion of each country's shock process that can be explained by the identified factors, varies widely. For the IST, the communality ranges from 3.94% to 98.48%, while for the MEI it varies between 5.94% and 99.54%. In the case of M1, the communality ranges from 8.61% to 69.97%, and for M3 it varies between 21.08% and 72.85%. These results suggest the existence of a global component in each shock process. Furthermore, the dispersion in communality values suggests that the role played by the global component of the shocks varies across countries. In our model, the IST, MEI, and MON shocks are driven by both local and global components, which is crucial for explaining currency excess returns.

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

1. We observed a downward trend in CT returns across different country groups and portfolios. This was accompanied by a reduction in the values and standard deviation of both components of CT returns, namely 'FX' and 'IR'.

2. The relative price of investment experienced a downward trend across all country groups, accompanied by a narrowing gap between Developed and Developing countries. Furthermore, the IST growth rate spread (in absolute terms) between Developing/Developed countries and the US decreased.

3. The MEI process showed an upward trend across all country groups from 1980 to 2019. The gap between Developed and Developing countries in terms of MEI values increased until the late 1990s, then decreased until the late 2000s, and has remained relatively constant since. Additionally, the MEI growth rate spread (in absolute terms) between Developing/Developed countries and the US declined.

4. The M1 and M3 growth rates of Developing countries exhibited a downward trend from 1980 to 2019. Generally, there was a decline in the M1 and M3 growth rate spreads (in absolute terms) between Developing/Developed countries and the US.

The results presented in this section highlight several stylized facts related to CT returns, the IST, MEI, and MON processes. The aim was to establish a connection between CT returns, macroeconomic variables, and the shock processes by analyzing their evolution in recent decades. Our key findings suggest that the IST, MEI, and MON shocks play a crucial role in explaining the downward trend observed in CT returns. These shocks operate through various channels in the economy, leading to fluctuations in macroeconomic variables and shaping currency excess returns in both the short and long term. In the following section, we present an open economy DSGE model that incorporates the IST, MEI, and MON shocks as the main drivers to account for fluctuations in macroeconomic variables and currency excess 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. (1997), Nelson (2002), Schmitt-Grohé and Uribe (2003), Gali et al. (2007), Gali et al. (2007), Andrés et al. (2009), Coeurdacier et al. (2010), Justiniano et al. (2011), Canova and Menz (2011), and 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-goods sector and monopolistic competition in the intermediate-goods sector. In each period, each economy produces a country-specific internationally tradable good. 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, 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

countries from 1980 to 2019. Similarly, the standard deviation of exchange rate growth in Developed countries declined from 1980 to the early 2000s.; iii) in general, exchange rate growth rates decreased in both Developed and Developing countries; and iv) capital stock and capital stock *per capita* increased between 1980 and 2019, particularly among Developing countries. However, the growth rate of capital stock and capital stock *per capita* decreased across all country groups during this period.

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 the investment-specific technology (IST), and 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 affected by total factor productivity, government spending and monetary shocks. The IST, MEI, and MON processes are disturbed by both local shocks and global shocks. Local shocks stem from domestic changes in each of the three processes, while global shocks emanate 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 this parameter depends on OPT households' expectations regarding the future economic development of 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 raising taxes on households. Thus, OPT households do not consider that government shocks convey relevant information for the formation of expectations about the future economic development of countries. On the monetary side, in our model, monetary policy decisions follow an adjusted Taylor rule. Monetary policy shocks reflect factors that affect the nominal interest rate beyond those related to the targets included in our Taylor rule (inflation, GDP, 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. As a result, central bank changes in rule-based nominal interest rate affect the dynamics of the economy, but OPT households do not consider monetary shocks when forming their expectations about the future evolution of the economies.

Since all countries are symmetrical, we restrict our analysis to two countries (denoted by Home and Foreign). The inclusion of time-varying stochastic time preference introduces a new source of risk. IST, MEI, and MON shocks are sources of business cycle fluctuations and can impact foreign currency returns. Their occurrence has the potential to induce movements in nominal interest rates and exchange rates. By utilizing our model, we can also conjecture on 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, where $N = 0, 1, 2....$ Time is discrete and indexed by $t = 0, 1, 2....$ All economies are characterized by incomplete financial markets and have symmetric technologies, preferences, and market structures, even though the disturbances affecting each economy may differ. In each country, households consume a bundle consisting of two final goods. One of the final goods is produced by perfectly competitive final-good firms in the Home country, while the other is produced by perfectly competitive final-good firms in the Foreign country. Within each country, the final good is formed by aggregating differentiated intermediate goods. These intermediate goods are produced by intermediate firms that operate under monopolistic competition and are subject to price adjustment costs. Output can be either consumed or transformed into capital using a linear technology. The two final goods are imperfect substitutes.

In all countries, a floating exchange rate system is in place, and there are barriers to international trade in goods (we assume the existence of consumption home bias), which implies that PPP does not hold.[8]

Households. A fraction Φ of households are rule-of-thumb consumers who simply consume their respective disposable income each period. The remaining fraction $(1 - \Phi)$ of households are optimizing consumers 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 the firms. Additionally, we assume that the depreciation rate is a function of the level of capital utilization. This structure implicitly assumes that foreign households cannot hold the local capital stock. OPT households are risk averse and make decisions regarding consumption, labor, investment, and bond holdings to maximize their lifetime utility. Each consumer type

[7] As highlighted by Miranda-Agrippino and Ricco (2021), analyzing the effect of monetary policy is a difficult exercise. 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 in order to track 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; ii) generate responses of macroeconomic variables over time using an econometric model that can summarize 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) and (Miranda-Agrippino and Ricco, 2021) for a discussion on measuring and identifying monetary policy shocks).

[8] Indeed, there is a large body of literature that aims to explain both consumption and asset home bias. Various factors have been proposed to account for these biases, such as transaction costs in international trading of assets and goods, lack of information about foreign assets, capital controls, moral hazard, etc. (see, among others, Tesar and Werner (1995) and Engel and Matsumoto (2005)). Moreover, empirical evidence on both consumption and asset home bias has been found by researchers.

consists 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, which can be allocated to either work or leisure.

In each period, OPT households receive income from various sources, including wages, profits from intermediate-good firms, and capital rents. They also make payments for government taxes, union fees, and pay or receive interest from the bond market. They can either spend their income on a consumption basket or invest in a portfolio of assets. This portfolio includes the capital stock, which is rented out to domestic intermediate-good firms, and bonds that can be issued domestically or abroad. Similarly, ROT households receive wages and pay government taxes. They allocate their resources on a consumption basket made up of domestically produced and imported goods. To access consumer goods, OPT and ROT households have the option to engage in barter trading or make purchases using cash. The use of money reduces the transaction and search costs associated with barter trading. Furthermore, real balances enter the utility function of OPT households to provide for emergencies (e.g., illness, accidents etc.).[9].

Following Gali et al. (2007), our model assumes a monopolistic competitive labor market. Workers provide differentiated labor types that are sold by unions to perfectly competitive labor packers. Monopolistic competitive firms hire labor pooled by packers to produce differentiated intermediate goods. Wages are centrally set by unions. Hours worked are determined by firms, rather than optimally chosen by households, based on the wage set by unions. Households provide the amount of labor demanded by firms, given that wages are always above households' marginal rate of substitution. As in Furlanetto (2011), we do not explicitly model the wage negotiation process. Instead, we assume that wage adjustments are costly, reflecting the fact that unions expend economic resources during wage negotiations with firms. The greater the wage increase sought by unions, the more effort they would need exert in the negotiation process, as emphasized by Furlanetto (2011).

OPT households are subject to exogenous shocks that have the potential to affect their allocations of consumption, labor supply, and savings. They construct their asset portfolios to smooth intertemporal consumption and to hedge against adverse fluctuations prompted by the shocks (precautionary and purchasing power motives). As households of each type are identical, we can assume, without loss of generality, that there is only one representative household of each type in each country.

Firms. The production sector of the economy consists of two components: the intermediate-goods sector and the final-goods sector. The intermediate-goods sector comprises numerous firms, each producing a differentiated good under monopolistic competition. In each period intermediate-good firms face a two-step problem. In the first step, they need to hire local labor and rent capital in perfectly competitive factor markets to minimize their real production costs. In the second step, they need to determine their selling price that maximizes discounted real profits, subject to the demand conditions prevailing in the final-goods sector. In addition, intermediate firms incur adjustment costs whenever they make price changes relative to the inflation target set by the monetary authority. The adjustment cost reflect the negative consequences of price changes on the relationship between the firm and its customers. The costs account for factors such as the disruption in customer-firm relationships and potential adjustment frictions.

In the final-goods sector, there exists a large number of identical firms. These firms aggregate the intermediate goods produced by the intermediate-goods sector into a single final good, utilizing a specific technology. The final good can be sold at Home, exported to foreign markets, or invested locally to expand the capital stock. The inclusion of two distinct production sectors, each characterized by different technologies and market structures, is essential for capturing and explaining the comovement of macroeconomic variables in response to fundamental shocks within our model. This framework allows us to analyze how these shocks propagate through the economy, affecting the production and consumption decisions of households and firms, as well as currency excess returns.

Government and Monetary Authority. Local government enters the economy with three main roles: i) to receive bond transaction costs from the foreign country; ii) collect lump-sum taxes from households, which may differ between OPT and ROT; and iii) consume exclusively domestically produced goods. Local government spending is fully funded by transaction costs received from the foreign country and lump-sum taxes levied on both types of households. This implies that the local government maintains a balanced budget constraint in each period. Following Nelson (2002) and Andrés et al. (2009), we assume that the monetary authority operates under a set of rules, whereby the current nominal interest rate depends on the past value of the nominal interest rate, current output values, 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. They are default risk-free, one-period zero-coupon bonds that pay with certainty one currency unit at maturity. These bonds can be purchased by both local and foreign investors. However, the yield on foreign bonds held by home investors is known only on the redemption date, at time $t + 1$ when the exchange rate is revealed.

[9] The inclusion of money in the utility function has been explored in various studies, including Brock (1974) and Feenstra (1986).These studies provide additional insights and rationale for incorporating money as a utility-enhancing factor in economic models.

For simplicity, we abstract from population growth. Next, we present the model with a focus on the Home country. Identical expressions apply to the Foreign country.

3.1 Households

There is a continuum of infinitely lived households. A fraction $1-\Phi$ of households have access to capital markets where they can engate in bond trading and buy and sell physical capital (OPT households). The remaining fraction λ of households consume their disposable income each period and do not possess any assets or 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:

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

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); γ 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:

$$I_t^o = \left[(1-\gamma)^{\frac{1}{\eta}} \left(I_{h,t}\right)^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} \left(I_{f,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \quad I_t^{o,*} = \left[\gamma^{*\frac{1}{\eta}} \left(I_{h,t}^*\right)^{\frac{\eta-1}{\eta}} + (1-\gamma^*)^{\frac{1}{\eta}} \left(I_{f,t}^*\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}. \tag{2}$$

In our environment, both the Home consumption and investment bundles 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 identical within each country. The consumer price indices (CPI) that corresponds to the preferences for both consumption and investment bundles are given by:

$$P_t = \left[(1-\gamma)\left(P_{h,t}\right)^{1-\eta} + \gamma\left(P_{f,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}, \quad P_t^* = \left[\gamma^*\left(P_{h,t}^*\right)^{1-\eta} + (1-\gamma^*)\left(P_{f,t}^*\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{3}$$

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 the Foreign-produced good 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:

$$C_{h,t}^i = (1-\gamma)\left(\frac{P_{h,t}}{P_t}\right)^{-\eta} C_t^i, \qquad C_{f,t}^i = \gamma\left(\frac{P_{f,t}}{P_t}\right)^{-\eta} C_t^i. \tag{4}$$

$$C_{h,t}^{i,*} = \gamma^*\left(\frac{P_{h,t}^*}{P_t^*}\right)^{-\eta} C_t^{i,*}, \qquad C_{f,t}^{i,*} = (1-\gamma^*)\left(\frac{P_{f,t}^*}{P_t^*}\right)^{-\eta} C_t^{i,*}. \tag{5}$$

The investment baskets are defined analogously for the optimzing 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:

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

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

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

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:

$$tot_t = \frac{p_{f,t}}{p_{h,t}}, \quad Q_t = \frac{S_t P_t^*}{P_t}. \tag{7}$$

As the law of one price holds $p_{f,t} = Q_t p_{f,t}^*$ and $p_{h,t} = Q_t p_{h,t}^*$. In the second step the OPT household problem is to maximize:

$$u_t^o = E_0 \sum_{t=0}^{\infty} \theta_t \kappa_t U^o(C_t^o, \iota_t M_t^o/P_t, L_t^o) - MAC_t, \tag{8}$$

$$\theta_0 = 1,$$

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

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

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

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 per capita 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 (MON) 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 the portfolio adjustment cost in our model is based on the formulation proposed 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. By adopting this functional form, our model incorporates a forward-looking money demand that aligns with empirical evidence from various studies (Andrés et al., 2009). Furthermore, Andrés et al. (2009) show that even in New-Keynesian models with separability between consumption and money in the utility function, this functional form of adjustment costs allows money to play a significant role in macroeconomic dynamics. The capital stock evolves according to the following equation of motion:

$$K_t^o = (1-\delta(u_t)K_{t-1}^o) + \left[1 - \frac{\Xi_I}{2}\left(\frac{I_t^o}{\mu_t I_{t-1}^o} - 1\right)^2\right]\psi_t I_t^o, \tag{9}$$

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 represents 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 (4). Therefore, the price index associated with the capital stock is also given by P_t. The evolution of capital accumulation described by equation (9) can be affected by two types of disturbances: the IST and MEI shocks, denoted by ψ_t and μ_t, respectively. The IST shock has a direct effect on investment, while the MEI shock affects the value of investment adjustment costs.

External adjustment costs arise when firms seek a supply of physical capital that is perfectly elastic. However, in the real world, the availability of capital goods varies in terms of speed and depends on numerous factors. One critical factor in this process is the financial system. When capital producers rely on loans to carry out their activities, the production of capital goods becomes influenced by their ability to secure financing and the effectiveness of the financial system in allocating loans (Justiniano et al., 2011). Although our model does not explicitly include financial intermediation agents, the conversion of real savings into physical capital is influenced by MEI process. Negative shocks to the MEI have the effect of reducing the amount of effective physical capital that can be obtained per unit of forgone consumption. This implies an increase in the adjustment cost of investment, as the efficiency of converting savings into productive capital decreases. By incorporating the impact of MEI shocks on investment adjustment costs, our model captures the relationship between investment decisions, savings, and the overall efficiency of capital allocation. Therefore, a possible interpretation of the MEI process is as a proxy for the effectiveness of the financial sector in directing household savings towards the production of physical capital. As discussed later, we utilize a measure of financial development as a proxy for the MEI shock in our asset pricing exercises.

In our model, the MEI process performs a similar function to that of entrepreneurs' net worth in Carlstrom and Fuerst (1997). In their model, entrepreneurs borrow funds from households to finance the production of physical capital, but lenders are uncertain about the individual productivity of the entrepreneurs. As a consequence, monitoring costs arise due to the need to oversee the projects undertaken by the entrepreneurs. This results in a partial loss of investment goods, which represents a leakage in the capital production process. Similarly, in our model, the MEI process captures the inefficiencies and frictions associated with the transformation of savings into physical capital, resulting in a potential loss or leakage in the capital production operation. In their model, the capital evolves according to the following equation:

[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 household's real money holding generates utility at the end of period t, after they finish purchasing consumption goods.

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

where Υ_t is the aggregate amount of new capital lost by the monitoring activity. 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. In a recent paper, Hirose and Kurozumi (2012) found that investment fluctuations in Japan are primarily driven by investment adjustment cost shocks. The estimated a series of investment adjustment cost shocks from their model, and interestingly, these shocks showed a high correlation with the Financial Position Diffusion Index reported by the "Tankan" survey, which is an economic survey conducted among Japanese firms. This finding provides additional support for the link between the MEI process and financial constraints for investment spending.

In our economy, there is variable capital utilization. The depreciation rate is a function of it. OPT Households can 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:

$$\delta(u_t) = \delta_0 + \Xi_1(u_t - 1) + \frac{\Xi_2}{2}(u_t - 1)^2, \tag{10}$$

$\delta_0 \in [0,1]$ is the depreciation rate in steady state, when $u_t = 1$; and Ξ_1 and Ξ_2 are positive parameters.

The representative OPT household faces the following sequential budget constraint:

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

$$S_t R_{t-1}^* B_{f,t-1}^o + M_{t-1}^o - P_t T_t^o - P_t Z_t + P_t \Gamma_t^o, \tag{11}$$

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^o 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 real 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. Ξ_b is a non-negative parameter that represents 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:

$$\max_{\left\{C_t^o, M_t^o/P_t, L_t^o, I_t^o, K_t^o, u_t, B_{h,t}^o, B_{f,t}^o\right\}_{t=0}^{\infty}} u_t^o = \mathbb{E}_0 \sum_{t=0}^{\infty} \theta_t \kappa_t U^o(C_t^o, \iota_t M_t^o/P_t, L_t^o) - MAC_t \tag{12}$$

s.t

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

$$S_t R_{t-1}^* B_{f,t-1}^o - M_{t-1}^o + P_t T_t^o + P_t Z_t - P_t \Gamma_t^o = 0,$$

$$K_t^o = (1 - \delta(u_t) K_{t-1}^o) + \left[1 - \frac{\Xi_I}{2}\left(\frac{I_t^o}{\mu_t I_{t-1}^o} - 1\right)^2\right] \psi_t I_t^o,$$

$C_t^o, K_t^o, W_t, P_t, M_t^o, \geq 0, \qquad 0 \leq L_t^o \leq 1,$

$\theta_0 = 1,$

Given K_{-1}, $B_{h,-1}^o$, $B_{f,-1}^o$, M_{-1}^o.

Households are subject to an individual borrowing constraint, which prevents Ponzi schemes. The representative household selects her portfolio, consumption, and labor supply that maximize her lifetime utility (8), while satisfying the budget constraint (11). The budget constraint of the OPT household problem can be rewritten in terms of the domestic CPI:

[12] This assumption ensures a stationary solution and determinate steady state. See Schmitt-Grohé and Uribe (2003) for a thorough analysis on this issue.

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

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

Substituting price terms by inflation, we obtain:

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

$$\frac{m_{t-1}^o}{\pi_t} - T_t^o - Z_t + \Gamma_t^o,$$

where $b_{h,t}^o = \frac{B_{h,t}^o}{P_t}$; $b_{f,t}^o = \frac{B_{f,t}^o}{P_t^*}$; $\pi_t = \frac{P_t}{P_{t-1}}$; and $\pi_t^* = \frac{P_t^*}{P_{t-1}^*}$. The Lagrangian corresponding to the utility maximization problem of the representative OPT household is as follows:

$$L^c = I\!E_0\sum_{t=0}^{\infty}\theta_t\Bigg\{\kappa_t U^o(C_t^o, \iota_t M_t^o/P_t, L_t^o) - MAC_t - \vartheta_t\lambda_t\Bigg[K_t^o - (1-\delta(u_t)K_{t-1}^o - \left(1 - \frac{\Xi_I}{2}\left(\frac{I_t^o}{\mu_t I_{t-1}^o} - 1\right)^2\right)$$

$$\psi_t I_t^o\Bigg] - \lambda_t\Bigg[C_t^o + b_{h,t}^o + Q_t b_{f,t}^o + I_t^o + m_t^o + \frac{\Xi_b}{2}Q_t\left(b_{f,t}^o - \bar{b}_f\right)^2 - W_t L_t^o - r_t^k u_t K_{t-1}^o - \frac{R_{t-1}b_{h,t-1}^o}{\pi_t} -$$

$$Q_t\frac{R_{t-1}^* b_{f,t-1}^o}{\pi_t^*} - \frac{m_{t-1}^o}{\pi_t} + T_t^o + Z_t - \Gamma_t^o\Bigg]\Bigg\},$$

where λ_t is the Lagrangian multiplier associated with the budget constraint and $\vartheta_t\lambda_t$ is the Lagrangian multiplier associated with installed capital. ϑ_t is the marginal Tobin's Q. We assume that the OPT representative household has the period utility function given by:

$$U_t^o = \frac{(C_t^o)^{1-\gamma_c}}{1-\gamma_c} + \chi_m\frac{\iota_t(M_t^o/P_t)^{1-\gamma_m}}{1-\gamma_m} - \chi_l\frac{(L_t^o)^{1+\gamma_l}}{1+\gamma_l}. \tag{13}$$

where $\gamma_c > 0$ is the risk aversion coefficient; $\gamma_m > 0$ denotes the inverse of the elasticity of money holdings with respect to 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 labor, respectively. Real cash holdings depend positively on consumption with an elasticity equal to γ_c/γ_m and negatively on nominal interest rate. The necessary first-order conditions for the OPT household decision problem are given by equation (11) together with the following equations:
First-order condition with respect to consumption:

$$C_t^o = \left(\frac{\lambda_t}{\kappa_t}\right)^{-\frac{1}{\gamma_c}}, \tag{14}$$

First-order condition with respect to real money:

$$m_t^o = \iota_t\left(\kappa_t\chi_m\right)^{\frac{1}{\gamma_m}}\Bigg\{\lambda_t - \beta^c(\Delta\tilde{C}_t)I\!E_t\left(\frac{\lambda_{t+1}}{\pi_{t+1}}\right) + \frac{d1}{2}\Bigg\{\frac{d2}{m_{t-1}^o}\exp\left(d2\left[\frac{m_t^o}{m_{t-1}^o} - 1\right]\right) - \frac{d2}{m_{t-1}^o}\exp\left(-d2\left[\frac{m_t^o}{m_{t-1}^o} - 1\right]\right)\Bigg\} +$$

$$\beta^c(\Delta\tilde{C}_t)I\!E_t\frac{d1}{2}\Bigg\{d2\frac{m_{t+1}}{(m_t^o)^2}\exp\left(-d2\left[\frac{m_{t+1}^o}{m_t^o} - 1\right]\right) - d2\frac{m_{t+1}}{(m_t^o)^2}\exp\left(d2\left[\frac{m_{t+1}^o}{m_t^o} - 1\right]\right)\Bigg\}\Bigg\}^{-\frac{1}{\gamma_m}}, \tag{15}$$

First-order condition with respect to investment:

$$1 = \psi_t\vartheta_t\left[1 - \frac{\Xi_I}{2}\left(\frac{I_t^o}{\mu_t I_{t-1}^o} - 1\right)^2 - \Xi_I\left(\frac{I_t^o}{\mu_t I_{t-1}^o}\right)\left(\frac{I_t^o}{\mu_t I_{t-1}^o} - 1\right)\right] +$$

$$\beta^c(\Delta\tilde{C}_t)I\!E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\vartheta_{t+1}\psi_{t+1}\Xi_I\left[\left(\frac{I_{t+1}^o}{\mu_{t+1}I_t^o}\right)^2\left(\frac{I_{t+1}^o}{\mu_{t+1}I_t^o} - 1\right)\right]\right\}, \tag{16}$$

First-order condition with respect to capital:

$$1=\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\frac{\left[r^k_{t+1}u_{t+1}+(1-\delta(u_{t+1})\vartheta_{t+1}\right]}{\vartheta_t}\right\}, \tag{17}$$

First-order condition with respect to capital utilization:

$$\vartheta_t(\Xi_1+\Xi_2(u_t-1)=r^k_t, \tag{18}$$

First-order condition with respect to Home bond:

$$1=\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\lambda_t}\frac{R_t}{\pi_{t+1}}\right), \tag{19}$$

First-order condition with respect to Foreign bond:

$$1+\Xi_b\left(b^o_{f,t}-\bar{b}_f\right)=\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\lambda_t}\frac{Q_{t+1}}{Q_t}\frac{R^*_t}{\pi^*_{t+1}}\right). \tag{20}$$

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 disposable current labor income and do not engage in consumption smoothing. Their period utility is as follows:

$$\max_{\{C^r_t,L^r_t\}^\infty_{t=0}} u^r_t=\mathbb{E}_t\sum_{t=0}^{\infty}\theta_t\kappa_t\left(\frac{(C^r_t)^{1-\gamma_c}}{1-\gamma_c}-\chi_l\frac{(L^r_t)^{1+\gamma_l}}{1+\gamma_l}\right), \tag{21}$$

s.t

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

Since ROT households simply consume their current income, we can obtain their consumption directly from the budget constraint.

3.2 Final-Good Producers

The final-good producers function as retail firms, where they aggregate a large quantity of intermediate goods to produce the final output. We assume a perfect competition market structure in the final-good sector. Consequently, the intermediate goods serve as inputs in the production process of the final-good producers. The result is an aggregate good that is sold to households. Moreover, 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, who combine the intermediate inputs to create a final output denoted as $Y_{h,t}$. This production process follows a constant return to scale technology:

$$Y_{h,t}=\left(\int_0^1 Y_{h,t}(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}} \tag{22}$$

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 maximize profits subject to the production function (22), 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:

$$\max_{Y_{h,t},\{Y_{h,t}(i)\}_{i\in[0,1]}} P_{h,t}Y_{h,t}-\int_0^1 P_{h,t}(i)Y_{h,t}(i)di \tag{23}$$

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:

$$Y_{h,t}(i)=\left(\frac{p_{h,t}(i)}{p_{h,t}}\right)^{-\epsilon}Y_{h,t}, \tag{24}$$

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:

$$P_{h,t}=\min_{\{Y_{h,t}(i)\}_{i\in[0,1]}}\left(\int_0^1 P_{h,t}(i)Y_{h,t}(i)di\right), \tag{25}$$

s.t

$$Y_{h,t} = 1. \tag{26}$$

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

$$P_{h,t} = \left(\int_0^1 P_{h,t}(i)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}. \tag{27}$$

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 employs an identical technology to produce a differentiated good. All firms face an identical demand curve 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:

$$Y_t(i) = A_t \left(\widehat{K^o}_{t-1}(i) \right)_t^{\alpha} (L_t(i))^{1-\alpha}, \tag{28}$$

where A_t is the total factor productivity; and $\alpha \in (0,1)$. $L_t(i)$ is an aggregator of the different labor 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 labor variate j used by firm i; and ϵ_w is the elasticity of substitution between labor types. We follow Gali et al. (2007), and assume that the fraction of ROT an OPT consumers is uniformly distributed across worker types and therefore across unions. Firms allocate labor demand in a proportional manner accordingly.

Firms operate under monopolistic competition, implying that they possess some level of market power. They set their prices based on the demand from final-good firms (see equation (24)). Due to the downward-sloping nature of their demand curves, firms always face marginal revenue curves that lie below their demand curves. Consequently, the solution to the firms' profit maximization problem leads to prices that exceed marginal cost. As emphasized by Rotemberg (1982), changing prices incurs various costs. These costs include administrative expenses associated with modifying price lists, informing clients, and other related tasks. Additionally, there is an implicit cost resulting from clients' negative reactions to significant price changes. Clients may prefer small and frequent price adjustments over infrequent large ones (Rotemberg, 1982). Therefore, in line with Rotemberg (1982), we assume that firms face a nominal price adjustment cost relative to the benchmark $\overline{\pi}$:[13]

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

Taking input prices W_t and r_t^k as given, intermediate-good firms hire labor and rent capital in perfectly competitive factor markets. They also determine the price of the intermediate good that maximizes discounted real profits. The problem, expressed in terms of the domestic CPI, can be formulated as follows:

$$\max_{\left\{P_{h,t}(i), L_t(i), \widehat{K^o}_{t-1}(i), Y_{h,t}(i)\right\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \theta_t \frac{\lambda_t}{\lambda_0} \left[\frac{P_{h,t}(i)}{P_t} Y_{h,t}(i) - W_t L_t(i) - r_t^k \widehat{K^o}_{t-1}(i) - \frac{PAC_t(i)}{P_t} \right] \right\}, \tag{29}$$

s.t

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

[13] The two most widely used approaches in modeling price setting are the Rotemberg (1982) and Calvo (1983) ones. Under the Calvo approach, firms face an exogenously fixed probability of adjusting their prices each period, while under the Rotemberg approach, firms incur a quadratic adjustment cost for changing prices. 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 (Roberts, 1995). We chose the Rotemberg model for pricing due to three important reasons. First, 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 evidence. Second, unlike the Calvo model, an increase in trend inflation in the Rotemberg model expands the region of determinacy for steady states in models with monetary and fiscal policy rules. This means that a wider range of implementable monetary and fiscal rules can be accommodated under Rotemberg pricing (Schmitt-Grohé and Uribe, 2007). Third, the Rotemberg model generates more volatility at the Zero Lower Bound compared to the Calvo model, which helps to explain the fluctuations observed in the US data during the GFC (Richter and Throckmorton, 2016).

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

The first-order conditions for this problem are:

First-order condition with respect to capital:

$$r_t^k = mc_t(i)\alpha A_t \left(\widehat{K^o}_{t-1}(i)\right)^{\alpha-1} (L_t(i))^{1-\alpha}. \tag{30}$$

First-order condition with respect to labour:

$$W_t = mc_t(i)(1-\alpha) A_t \left(\widehat{K^o}_{t-1}(i)\right)^{\alpha} (L_t(i))^{-\alpha}. \tag{31}$$

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

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

$$\beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\Xi_p\frac{P_{h,t+1}(i)}{P_{h,t}(i)^2}\left(\frac{P_{h,t+1}(i)}{P_{h,t}(i)} - \overline{\pi}\right)\frac{P_{h,t+1}Y_{h,t+1}}{P_{t+1}}\right] = 0 \tag{32}$$

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:

$$Y_t = A_t \left(\widehat{K^o}_{t-1}\right)^{\alpha} (L_t)^{1-\alpha}. \tag{33}$$

$$r_t^k = mc_t\alpha\frac{Y_{h,t}}{\widehat{K^o}_{t-1}}. \tag{34}$$

$$W_t = mc_t(1-\alpha)\frac{Y_{h,t}}{L_t}. \tag{35}$$

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

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

We can rearrange the pricing condition to obtain:

$$\pi_{h,t}\left(\pi_{h,t} - \overline{\pi}\right) = \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\pi_{h,t+1}\left(\pi_{h,t+1} - \overline{\pi}\right)\frac{p_{h,t+1}Y_{h,t+1}}{p_{h,t}Y_{h,t}}\right] + \frac{\epsilon}{\Xi_p}\left(\frac{mc_t}{p_{h,t}} - \frac{\epsilon-1}{\epsilon}\right). \tag{37}$$

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:

$$\Gamma_t = p_{h,t}Y_{h,t} - W_tL_t - r_t^rK_{t-1} - \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 p_{h,t}Y_{h,t}. \tag{38}$$

3.4 Packers and Unions

Workers supply differentiated types of labor, which are sold by unions to perfectly competitive labor packers. These labor packers assemble the different types of labor and sell homogeneous labor to intermediate-goods firms. Packers use the following technology to aggregate labor:

$$L_t = \left(\int_0^1 L_t(j)^{\frac{\epsilon_w-1}{\epsilon_w}} dj\right)^{\frac{\epsilon_w}{\epsilon_w-1}}, \tag{39}$$

where $L_t(j)$ is labor of type j. Packers maximize profits subject to the aggregation function (39), 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:

$$\max_{L_t, \{L_t(j)\}_{j\in[0,1]}} P_t W_t L_t - \int_0^1 P_t W_t(j) L_t(j) dj, \tag{40}$$

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 above to obtain the first-order condition with respect to the generic labor type j:

$$L_t(j) = \left(\frac{W_t(j)}{W_t}\right)^{-\epsilon_w} N_t. \tag{41}$$

Similarly, the wage index is given by:

$$W_t = \left(\int_0^1 W_t(j)^{1-\epsilon_w} dj\right)^{\frac{1}{1-\epsilon_w}}. \tag{42}$$

There is a continuum of unions, each representing a continuum of workers, according to the fraction of worker type (OPT and ROT). Each union sets the wage rate for its members, who satisfy the labor demand of any firm at the chosen cost. Workers within each union perform the same type of work, regardless of their worker type (OPT or ROT), which is 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 labor demand across different workers of type j, regardless of their worker type. Thus, in the aggregate, $L_t^r = L_t^o = L_t$ for all t. As a result, all workers earn the same wages and work the same number of hours. Each union sets nominal wages for its members by maximizing their utility, taking into account the downward-sloping demand and quadratic adjustment costs (Rotemberg (1982)). We assume that unions face adjustment costs relative to the benchmark $\overline{\pi}_t$ and charge each member lump-sum fees to cover the adjustment costs. Following Furlanetto (2011), we 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:

$$\max_{\{W_t(j)\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{\sum_{t=0}^{\infty} \theta_t \left[UM_t\left(\frac{P_t W_t(j) N_t(j)}{P_t} - \frac{UAC_t(j)}{P_t}\right) - \frac{\chi_l N_t(j)^{(1+\gamma_l)}}{1+\gamma_l}\right]\right\}, \tag{43}$$

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:

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

$$\left[-\epsilon_w\left(\frac{W_t(j)}{W_t}\right)^{(-1-\epsilon_w)}\frac{N_t}{W_t}\right] + \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[UM_{t+1}\Xi_w\left(\frac{P_{t+1}}{P_t}\frac{W_{t+1}(j)}{W_t(j)} - \overline{\pi}\right)\frac{P_{t+1}}{P_t}\frac{W_{t+1}W_{t+1}(j)}{W_t(j)^2} N_{t+1}\right] = 0. \tag{44}$$

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

$$\pi_t \pi_t^w (\pi_t \pi_t^w - \overline{\pi}) = \beta^c(\Delta\tilde{C}_t)\mathbb{E}_t\left[\frac{UM_{t+1}}{UM_t}\left(\pi_{t+1}\pi_{t+1}^w - \overline{\pi}\right)\pi_{t+1}(\pi_{t+1}^w)^2\frac{N_{t+1}}{N_t}\right] + \frac{\epsilon_w}{\Xi_w}\left(\frac{N_t^{\gamma_l}\chi_l}{UM_t W_t} - \frac{\epsilon_w - 1}{\epsilon_w}\right). \tag{45}$$

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:

$$p_{h,t}G_t = T_t + \frac{\Xi_b}{2}\left(b_{h,t}^{o,*} - \bar{b}_h^*\right)^2. \tag{46}$$

Since both types of households pay lump-sum taxes:

$$T_t = (1-\Phi)T_t^o + \Phi T_t^r. \tag{47}$$

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:

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\rho_r}\left[\left(\frac{\pi_t}{\overline{\pi}}\right)^{\phi_\pi}\left(\frac{gdp_t}{\overline{gdp}}\right)^{\phi_{gdp}}\left(\frac{mg_t}{\overline{mg}}\right)^{\phi_m}\right]^{1-\rho_r}\exp(gc_t), \tag{48}$$

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 justified by both the usefulness of money in forecasting inflation and by considering that the variability of money growth appears in the central bank's loss function. In our specification, we include a lagged nominal interest rate term, which allows for interest rate smoothing. This implies a gradual adjustment of policy rates towards 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:

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

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

$$\Gamma_t = (1-\Phi)\Gamma_t^o, \qquad I_t = (1-\Phi)I_t^o. \tag{49}$$

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

$$Y_{h,t} = C_{h,t} + I_{h,t} + G_t + C_{h,t}^* + I_{h,t}^* + \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 Y_{h,t} + \frac{\Xi_w}{2}\left(\pi_t\pi_t^w - \overline{\pi}\right)^2 W_t N_t. \tag{50}$$

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

$$b_{h,t} + b_{h,t}^* = 0, \qquad b_{f,t} + b_{f,t}^* = 0. \tag{51}$$

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

$$TB_t = EXP_t - IMPt \tag{52}$$

$EXP_t = p_{h,t}\left(C_{h,t}^* + I_{h,t}^*\right)$ 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 (49) with equations (38), (46), (47) to obtain:

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

$$\frac{\Xi_b}{2}Q_t\left(b_{f,t} - \bar{b}_f\right)^2 + p_{h,t}Y_{h,t} - \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 p_{h,t}Y_{h,t} - \frac{\Xi_w}{2}\left(\pi_t\pi_t^w - \overline{\pi}\right)^2 W_t N_t. \tag{53}$$

In order to derive an expression for the trade balance, we need to adjust equation (53) to account for changes in Foreign money holdings:

$$C_t + I_t + p_{h,t}G_t + b_{h,t} + Q_t b_{f,t} + m_t - Q_t m_t^* = \frac{R_{t-1}b_{h,t-1}}{\pi_t} + Q_t \frac{R_{t-1}^* b_{f,t-1}}{\pi_t^*} + \frac{m_{t-1}}{\pi_t} - Q_t \frac{m_{t-1}^*}{\pi_t^*} +$$

$$\frac{\Xi_b}{2}\left(b_{h,t}^{o,*} - \bar{b}_h^*\right)^2 - \frac{\Xi_b}{2} Q_t \left(b_{f,t} - \bar{b}_f\right)^2 + p_{h,t}Y_{h,t} - \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 p_{h,t}Y_{h,t} - \frac{\Xi_w}{2}\left(\pi_t \pi_t^w - \overline{\pi}\right)^2 W_t N_t. \tag{54}$$

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:

$$p_{h,t}\left[C_{h,t} + I_{h,t} + G_t + \frac{\Xi_p}{2}\left(\pi_{h,t} - \overline{\pi}\right)^2 p_{h,t}Y_{h,t} + \frac{\Xi_w}{2}\left(\pi_t \pi_t^w - \overline{\pi}\right)^2 W_t N_t - Y_{h,t}\right] + p_{f,t}(C_{f,t} + I_{f,t}) = \frac{R_{t-1}b_{h,t-1}}{\pi_t} +$$

$$Q_t \frac{R_{t-1}^* b_{f,t-1}}{\pi_t^*} + \frac{m_{t-1}}{\pi_t} - Q_t \frac{m_{t-1}^*}{\pi^*} - b_{h,t} - Q_t b_{f,t} - m_t + Q_t m_t^* + \frac{\Xi_b}{2}\left(b_{h,t}^* - \bar{b}_h^*\right)^2 - \frac{\Xi_b}{2} Q_t \left(b_{f,t} - \bar{b}_f\right)^2. \tag{55}$$

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

$$-EXP_t + IMP_t = \frac{R_{t-1}b_{h,t-1}}{\pi_t} - b_{h,t} + Q_t \frac{R_{t-1}^* b_{f,t-1}}{\pi_t^*} - Q_t b_{f,t} + \frac{m_{t-1}}{\pi_t} - m_t - Q_t \frac{m_{t-1}^*}{\pi_t^*} + Q_t m_t^* +$$

$$\frac{\Xi_b}{2}\left(b_{h,t}^* - \bar{b}_h^*\right)^2 - \frac{\Xi_b}{2} Q_t \left(b_{f,t} - \bar{b}_f\right)^2. \tag{56}$$

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

$$\frac{\Xi_b}{2} Q_t \left(b_{f,t} - \bar{b}_f\right)^2. \tag{57}$$

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

$$CA_t = TB_t + b_{h,t-1}\left(\frac{R_{t-1}}{\pi_t} - 1\right) + Q_t b_{f,t-1}\left(\frac{R_{t-1}^*}{\pi_t^*} - 1\right) + \frac{\Xi_b}{2}\left(b_{h,t}^* - \bar{b}_h^*\right)^2 - \frac{\Xi_b}{2} Q_t \left(b_{f,t} - \bar{b}_f\right)^2. \tag{58}$$

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 (19) from (20) we obtain the following no-arbitrage condition:[14]

$$TC_t = \mathbb{E}_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(\frac{C_{t+1}^o}{C_t^o}\right)^{-\gamma_c} \frac{P_t}{P_{t+1}}\left(\frac{S_{t+1}}{S_t} R_t^* - R_t\right)\right], \tag{59}$$

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 (59) 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:

$$TC_t = \mathbb{E}_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(\frac{C_{t+1}^o}{C_t^o}\right)^{-\gamma_c} RX_{t+1}\right], \tag{60}$$

where $RX_{t+1} = \frac{P_t}{P_{t+1}}\left(\frac{S_{t+1}}{S_t} R_t^* - R_t\right)$. Equation (60) 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:

$$\frac{U_c^o(C_{t+1}^o, M_{t+1}^o/P_{t+1}, L_{t+1}^o)}{U_c^o(C_t^o, M_t^o/P_t, L_t^o)} = \frac{f(C_{t+1})}{f(C_t)}. \tag{61}$$

Using a first order Taylor expansion around C_t^o and assuming the power utility function given by equation (13) yields the following expression:

$$\frac{U_c^o(C_{t+1}^o, M_{t+1}^o/P_{t+1}, L_{t+1}^o)}{U_c^o(C_t^o, M_t^o/P_t, L_t^o)} = 1 - \gamma_c \Delta C_{t+1}^o. \tag{62}$$

Combining equations (60) and (62) yields the subsequent expression:

$$\mathbb{E}_t\left[\frac{\kappa_{t+1}}{\kappa_t}\left(1 - \gamma_c \Delta C_{t+1}^o\right) RX_{t+1}\right] = TC_t. \tag{63}$$

We can derive the beta representation of equation (63) by following Cochrane (2005) and Bohrnstedt and Goldberger (1969):[15]

$$\begin{aligned}\mathbb{E}_t(RX_{t+1}) = & \left(\frac{\gamma_c \mathbb{E}_t(\kappa_{t+1}^p)\,\mathrm{Var}_t(\Delta C_{t+1}^o)}{\mathbb{E}_t\left[\kappa_{t+1}^p(1-\gamma_c \Delta C_{t+1}^o)\right]}\right)\left(\frac{\mathrm{Cov}_t(\Delta C_{t+1}^o, RX_{t+1})}{\mathrm{Var}_t(\Delta C_{t+1}^o)}\right) \\ & + \left(\frac{\left[1-\gamma_c \mathbb{E}_t(\Delta C_{t+1}^o)\right]\mathrm{Var}_t(\kappa_{t+1}^p)}{\mathbb{E}_t\left[\kappa_{t+1}^p(1-\gamma_c \Delta C_{t+1}^o)\right]}\right)\left(\frac{\mathrm{Cov}_t(-\kappa_{t+1}^p, RX_{t+1})}{\mathrm{Var}_t(\kappa_{t+1}^p)}\right) - TC_t,\end{aligned} \tag{64}$$

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

$$\mathbb{E}_t\left(RX_{t+1}\right) = \lambda_c \beta_c + \lambda_\kappa \beta_\kappa - TC_t, \tag{65}$$

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:

$$\begin{aligned}\lambda_c &= \left(\frac{\gamma_c \mathbb{E}_t(\kappa_{t+1}^p)\,\mathrm{Var}_t(\Delta C_{t+1}^o)}{\mathbb{E}_t\left[\kappa_{t+1}^p(1-\gamma_c \Delta C_{t+1}^o)\right]}\right); & \lambda_\kappa &= \left(\frac{\left[1-\gamma_c \mathbb{E}_t(\Delta C_{t+1}^o)\right]\mathrm{Var}_t(\kappa_{t+1}^*)}{\mathbb{E}_t\left[\kappa_{t+1}^p(1-\gamma_c \Delta C_{t+1}^o)\right]}\right) \\ \beta_c &= \left(\frac{\mathrm{Cov}_t(\Delta C_{t+1}^o, RX_{t+1})}{\mathrm{Var}_t(\Delta C_{t+1}^o)}\right); & \beta_\kappa &= \left(\frac{\mathrm{Cov}_t(-\kappa_{t+1}^p, RX_{t+1})}{\mathrm{Var}_t(\kappa_{t+1}^p)}\right)\end{aligned} \tag{66}$$

Equation (64) represents the fundamental asset pricing condition to foreign assets in our economy. The relation between the components of asset returns and aggregate consumption growth precisely measures their relevant risks. In particular, the model formally implies that the excess return on any asset or portfolio should be a compensation for risks associated with consumption growth and changes in household preferences.

3.9 Structural Shocks and CT Returns

IST, MEI, and MON Shocks Definition. In the model of Justiniano et al. (2011), the IST shock influences the conversion of final goods into investment goods and is related to the relative price of investment goods compared to consumption goods. Conversely, the MEI shock affects the production of installed capital from investment goods. The authors demonstrate that their multi-sector model, which includes intermediate-goods producers, final-goods producers, investment-goods producers, and capital producers, can be simplified into a model where the capital accumulation process is centralized in a single sector. They argue that this modelling strategy is necessary to distinguish the two disturbances that affect capital investment.

In our model, the IST shock directly influences investment, while the MEI shock operates by reducing investment adjustment costs. This differentiation between the two shocks is crucial as they capture distinct aspects of capital

[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.

investment behavior. The MON shock affects the stock of money held by households. This choice is motivated by empirical evidence suggesting the relevance of money demand in explaining fluctuations in macroeconomic variables and asset prices. The implementation of quantitative easing programs by central banks in response to the Lehman bankruptcy further emphasizes the importance of investigating the role of money stock in the economy. Lastly, we combine the IST, MEI, and MON shocks to derive the time preference shock.

In line with the findings and methodology of Greenwood et al. (1992), Greenwood et al. (1997), Justiniano et al. (2011) and Dogan (2019), we adopt the use of the relative price of investment as a proxy for the IST process in our model. By examining changes in the relative price of equipment, we can directly capture the effects of IST shocks on capital costs and the subsequent impact on investment decisions. This approach allows us to effectively analyze the role of IST in driving capital accumulation and its contribution to output growth and the overall dynamics of the economy.[16]

As highlighted 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 can reflect structural disturbances in the ability of the financial system to facilitate capital investments. Specifically, when capital producers require financing for the purchase of investment goods, the production of physical capital is influenced by their access to financial resources and the efficiency with which the financial system channels credit. More efficient financial systems can reduce external costs associated with investment adjustment by increasing financing options for capital goods production and improving the speed at which capital becomes available. While our model does not directly incorporate financial intermediation agents, it does recognize the role of the MEI shock in the transformation of real savings into physical capital. Negative shocks to the MEI can lead to a decrease in the quantity of effective physical capital installed relative to the amount of forgone consumption, thus increasing investment adjustment costs. This reflects a less efficient utilization of savings for productive purposes. In this sense, the MEI process can be interpreted as a proxy for the efficiency with which the financial sector channels household savings towards the production of physical capital.

In contrast to Justiniano et al. (2011), who use the spread between high-yield and AAA corporate bond returns as a measure of the MEI process, we adopt a broader measure in our asset pricing exercises. We employ the Index of Financial Development (IFD) developed by the IMF (Svirydzenka, 2016) as a proxy for the MEI process. The IFD incorporates not only the conventional measures of financial development, such as the ratio of private credit to GDP and the stock market capitalization to GDP, but also nine sub-indicators that capture various dimensions of financial institutions and markets, including their depth, access, and efficiency. Importantly, the IFD provides extensive coverage of 183 countries from 1980 onwards. The advantage of using the IFD is that it captures a comprehensive range of features of financial markets beyond just the corporate bond market. This is particularly relevant for our empirical analysis, as we consider countries with diverse financial structures. Some countries in our sample may have experienced significant improvements in their financial sector without relying heavily on a well-developed corporate bond market. Instead, these improvements could have been achieved through the development of the stock market or the banking system, among other factors.

In our model, MON shocks represent real money demand shocks and can generate business cycle fluctuations. As highlighted by Andrés et al. (2009), money demand can have both 'direct' and policy effects on the economy. The direct effect arises from the presence of portfolio adjustment costs, which directly impacts agents' utility. These adjustment costs make the money demand equation dynamic, introducing a forward-looking aspect to it. The interest-elastic and forward-looking nature 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 context, money demand contains important information besides that obtained from its responses to current income and nominal interest rate. It also varies in reaction to movements in expected future natural real rates, which are not captured by short-term nominal interest rates. These variations in money demand reflect expectations about future output and inflation. The policy effect pertains to the reaction of the monetary authority to changes in 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, movements in real balances can be influenced by monetary policy actions aimed at stabilizing 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), Andrés et al. (2009), Canova and Menz (2011), Castelnuovo (2012) and Benchimol and Fourçans (2012)). 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., El-Shagi et al. (2015)).

In general, the literature that explores the role of money demand shocks in the economy assumes the existence of exogenous disturbances reflecting macroeconomic uncertainties and financial innovations, in addition to the endogenous determinants of real balances. Typically, increases in uncertainty are positively associated with money demand (precautionary reasons). Conversely, financial innovations are negatively associated with money demand

[16] The link between the relative price of investment and the IST may not hold in two specific cases: 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 introduce a wedge between the relative price of investment and the IST. Note that our model abstracts from both features. Furthermore, in our asset pricing exercises, we make the assumption that any potential wedge between the relative price of investment and the IST is equal across countries, regardless of its magnitude. As a result, the results of our asset pricing estimation remain invariant to the presence of the wedge.

(reduction of losses arising from the opportunity cost of holding money). We assume that the MON shock captures the combined effect of macroeconomic uncertainties and financial innovations.[17]

Short-term and Long-term Effects of IST, MEI, and MON Shocks. IST and MEI shocks have impacts on both the short-term business cycle fluctuations and long-term trend evolution of economic variables. When a positive innovation occurs in the IST or MEI process, it leads to an increase in the return on capital investment, thereby immediately stimulating new capital investments. These shocks contribute to explaining business cycle fluctuations by boosting investment demand and triggering short-term output growth. Consequently, the IST and MEI shocks play crucial roles in understanding the dynamics of the business cycle. Furthermore, the effects of these shocks extend to the long term. The process of capital accumulation, driven by the IST/MEI shock, results in an expanded capital stock, which in turn reduces the MPK (real interest rate). Simultaneously, the IST/MEI shock promotes the expansion of the supply of goods, leading to lower inflation rates. As a result, both shocks contribute to explaining the downward trend observed in the MPK and inflation rates, particularly among developing countries. 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-up 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' 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 in Section 2 the behavior of exchange rates between 1980 and 2019. We find that, in general: i) the growth of exchange rates has generally slowed down in developing countries in recent decades, while it fluctuates between -4% and +4% in developed countries; ii) the absolute value of exchange rate growth has declined in both developing and developed countries in recent decades; and iii) the standard deviation of the exchange rate growth and its absolute value decreased in developing countries between 1980 and 2019 (these results are not reported but are available from the authors upon request).

The reduction in the growth rate and standard deviation of exchange rates can also affect CT returns. The IST, MEI, and MON shocks can help explain the behavior of exchange rates through three possible channels. The first channel is associated with the magnitude of the shocks. As will be shown next, these shocks affect the nominal exchange rate and currency excess returns. Larger shocks tend to lead to greater variations in currency excess returns. In Section 2, we present evidence that supports these findings. Specifically, we show that the growth rates of the IST, MEI, and MON processes generally decreased between 1980 and 2019, particularly in developing countries. This suggests a moderation in the volatility of these shocks over time. Additionally, we find that the spread between developed/developing countries and the US in terms of the growth rates of the IST, MEI, and MON processes decreased during the same period. These findings suggest that the changing dynamics of the IST, MEI, and MON shocks contribute to the evolution of exchange rates and their influence on CT returns.

The second channel is linked to the change in the standard deviation of the IST, MEI, and MON values. If the distribution of these shock values is highly dispersed, the flows between countries influenced by these shocks are likely to exhibit greater volatility. It is reasonable to expect that more volatile capital flows would contribute to increased exchange rate variation. Thus, we can attribute the decline in the standard deviation of exchange rate growth of developing countries, to the decrease in the standard deviation of the IST and MON values as reported in Section 2. By observing the reduced dispersion in the IST and MON values, we can infer that capital flows associated with these shocks have become more stable. This has likely contributed to a decline in exchange rate volatility.

The third channel to explain the decrease in the standard deviation of exchange rate growth is related to the characteristics of the MEI and MON processes. In the short term, a positive MEI shock can lead to exchange rate volatility due to capital flows between countries. However, in the long term, positive MEI shocks that improve financial development can mitigate the effects of macroeconomic uncertainty and contribute to a reduction in exchange rate variance. The strengthening of the financial system, increased liquidity, and greater availability of credit enhance growth prospects and dampen the impact of uncertainty on the economy. During periods of uncertainty, economies with underdeveloped financial sectors are more prone to credit constraints for firms and households, resulting in higher costs of external financing. As a consequence, these economies experience higher levels of volatility in GDP, inflation, interest rates, and exchange rates compared to economies with more developed financial sectors. On the other hand, a decrease in money demand (captured by the MON shock) indicates lower macroeconomic uncertainty and reduced exchange rate volatility. This suggests a natural link between the MEI and

[17] Many empirical studies examine the relationship between money demand and macroeconomic uncertainty. For instance, 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. Bahmani-Oskooee and Nayeri (2018) analyze the impact of a broad measure of macroeconomic uncertainty on money demand in Australia between 1998 and 2016. Overall, they find that increased uncertainty induces the public to hold more cash to cover themselves against an uncertain future.

MON processes and exchange rates, as the financial sector's stability and the level of macroeconomic uncertainty can impact the 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. These models revolve around the dynamic decisions made by agents regarding their consumption and saving behavior, driven by the intertemporal trade-offs between present and future consumption. One crucial element within 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. By incorporating these adjustments, we capture the dynamic nature of time preference, which plays a pivotal role in shaping agents' decisions concerning consumption and saving over time.

The inclusion of time preference as a variable that adjusts over time in our model captures two important aspects of OPT agents' behavior in their intertemporal consumption decisions. 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. Fluctuations in the macroeconomic environment can lead to adjustments in agents' expectations about future income and economic conditions, which, in turn, affect their intertemporal consumption choices.

Our choice of the time preference parameter is grounded in existing literature that models discount factors as time-varying variables. Numerous theoretical and empirical studies have raised concerns about the widespread use of fixed discount factors and have highlighted the importance of considering time-varying discounting patterns in economic analysis (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] By incorporating these elements into our model, we provide a framework that captures the dynamics of time preference and its implications for consumption behavior and asset pricing. This allows us to study how changes in intertemporal preferences, driven by consumption externalities and macroeconomic shocks, affect individuals' decisions, economic outcomes, and the pricing of financial assets.

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 has explored several potential determinants of time preference, such as educational attainment, changes in life expectancy and mortality rates, consumption habits, considerations of one's present and future "self", uncertainty about future outcomes in uncertain environments, and changes in the stock of wealth (Becker and Mulligan, 1997; Frederick et al., 2002). Early contributions to the theory of time-varying preferences focused on the endogeneity of agents' discount rates. These studies assumed that time preference is an increasing function of the level of utility and, consequently, consumption flows (Uzawa, 1968; 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) and the stock of capital (Erol et al., 2011). On the other hand, Chen and Yang (2019) associate time-varying discount factor with agent's longevity[20] and other authors consider a pure stochastic discount factor (Maurer, 2012; Gomez-Cram and Yaron, 2021).[21]

In contrast to the studies that maintain the assumption of consistent preferences, another body of literature challenges this traditional view by suggesting that discount rates are not constant over time. These authors propose alternative discount functions that allow for decreasing discount rates (hyperbolic discounting), which contradicts the time consistency assumption (see, e.g., Luttmer and Mariotti (2003)).

[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; Bloom et al., 2018). 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 (Stockman and Tesar, 1995; Maurer, 2012; 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 effects of time preference shocks associated with changes in longevity on the cross-sectional asset pricing of US equity returns. They find that agents become impatient following a negative longevity shock. They construct 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) develops an asset pricing model that highlights the significance of shocks to the agent's subjective time discount rate as a driving force in asset pricing. The author demonstrates that uncertainty in the time discount rate leads to a substantial risk premium. Furthermore, Maurer (2012) generates a time series of the time discount rate from the model and finds that it is highly positively correlated with the price-earnings ratio of US stocks. As emphasized by the author, this is important because the price-earnings ratio reveals valuable information about financial and macroeconomic variables. On the other hand, Gomez-Cram and Yaron (2021) find highly negative correlation between the time series of the time discount rate generated by their model and measures of the degree of financial stress in the US market.

The time discount factor represents the degree to which the individual values future utility when making present decisions. OPT households consider savings necessary to increase future production and consumption. In addition to the traditional neoclassical motives that determine the subjective discount factor, we also incorporate a “long-term" and a “short-term" factor. These factors stem from households’ expectation regarding the future prospects of the Home and Foreign economies. The "long-term" factor may be associated with the impact of longer life expectancy and lower death probabilities on households’ plans for future consumption (Becker and Mulligan, 1997). In our model, individuals perceive future utility from consumption as uncertain. Consequently, they save in the present to mitigate consumption fluctuations in the future and secure resources for retirement.

The “short-term" factor can be associated with the “keeping 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. An alternative model considered by Schmitt-Grohé and Uribe (2003) takes into account that time preference depends on average per capita consumption. In our model, we assume that time preference depends on average per capita consumption growth. In particular, it can be seen as a simple case of “keeping up with the Joneses", where a household’s impatience to consume increases as the average per capita 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 per capita consumption growth, the lower the household discount factor.

Our model connects local (Home and Foreign) and global IST, MEI, and MON shocks with good news about investment and consumption. Global shocks have the potential to influence all economies, capturing waves of world economic growth resulting from positive global investment shocks (IST and MEI), or economic slowdowns caused by increases in money demand (MON) due to greater global uncertainty. Since global shocks affect all countries simultaneously, they can impact household consumption in all economies. This can occur either because OPT households can seize higher investment opportunities or because they face higher levels of macroeconomic uncertainty. However, due to heterogeneity across countries in terms of shock absorption, global shocks can have different effects across countries.

Local disturbances have a direct effect on the domestic economy only. When the Home economy becomes more competitive than the Foreign economy, Home agents become optimistic about its future prospects. These agents recognize that future developments in the domestic economy depend on physical capital investment, which, in turn, determines the level of future consumption. To form their expectations about the future developments of both economies, domestic agents compare the local IST, MEI, and MON shocks that hit each economy. They take into account the different shocks and their impact on investment opportunities and macroeconomic uncertainty. These expectations play a crucial role in shaping the decisions of Home agents regarding consumption and saving, as well as their assessments of investment opportunities in the Home economy.[22]

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 fall in κ_t, triggered by a positive IST or MEI shock, means that Home agents become more confident, leading to positive expectations about the future (greater investment opportunity relative to the Foreign economy). A fall in κ_t, triggered by a positive MON shock, means a higher level of macroeconomic uncertainty, prompting Home agents to reduce current consumption to smooth future consumption. This creates an incentive to savings (“good news for investment" or “bad news for consumption"), 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 (indicating less investment opportunity relative to the Foreign economy) or may signal a lower level of macroeconomic uncertainty. This works to persuade Home agents to increase present consumption and reduce savings (“bad news for investment" or "good news for consumption"), with the “short-term factor" dominating the agents’ decision.

Home Households’ expectations about the prospects on future developments in both countries are driven by the effect of local shocks on κ_t. As positive local IST and MEI shocks indicate improvements within the production sector of the economy, which are interpreted as “good news for investment". Conversely, a positive local MON shock indicates the dominance of increases in macroeconomic uncertainty when compared to current financial innovations, leading to an increase in money demand. Households perceive this shock as “bad news for consumption", which increases savings. In contrast, negative news to local investment or decreases in macroeconomic uncertainty reinforces the *consumption externality* associated with “keeping up with the Joneses". Home households become more impatient about consuming right now. On the other hand, a positive global IST or MEI shock (or a negative global MON shock) are interpreted as “good news for investment" in both economies. As a result, both Home and Foreign households become more patient about consuming right now. Importantly, both local and global shocks drive currency excess returns in both countries.

Asset Pricing and Time Preference. Currency excess returns are linked to the IST, MEI, and MON processes through time preference shocks. Three important points can be made regarding the role of the time preference channel in transmitting shocks:

[22] Suppose there is a positive technology shock in both the Home and Foreign economies, and the magnitude of the shock in the Foreign economy is greater than in the Home economy. Despite the positive economic effect caused by the local shock on the return on capital investment in the Home economy, time preference decreases, and Home households become less patient, leading to a boost in Home consumption. It is important to note that these results depend solely on the magnitudes of the shocks, given that the Home and Foreign economies are symmetric.

1. Our model predicts that currency excess returns depend on two key factors: i) the difference between local Home and Foreign IST, MEI, and MON shocks; and ii) the heterogeneous effect of the global IST, MEI, and MON shocks on each country.

2. Incorporating time preference shocks is crucial for 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 and a low level of consumption. Low payoff occurs when the OPT agent values even more the additional dollar of return. 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. As CT returns are decreasing in patience, the agent requires a positive compensation to engage in such an investment.

3. Positive news about currency excess returns is associated with an increase in OPT households' consumption. Therefore, we expect OPT households to become less patient when facing a positive increase in Foreign bond returns because they have the opportunity to widen the gap between their level of consumption and that of the average individual. As a result, the time preference shock affects the consumer's saving decision and acts as an intertemporal asset demand shifter.[23]

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

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

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

$$gc_t = \rho_{gc} gc_{t-1} + \epsilon_{gc,t}, \tag{67}$$

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 $i \in \{A, G, gc\}$; Cov$(\epsilon_{i,t}, \epsilon_{j,t}) = 0$ and Cov$(\epsilon_{i,t}, \epsilon^*_{j,t}) = 0$, where (i, j) $\in \{A, G, gc\}$ 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 assume that there is no correlation within countries and between countries between: i) factor productivity, government spending and monetary policy processes; and ii) the IST, MEI, and MON processes.

We follow the literature and assume that currency excess returns are compensation to households for bearing 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. We assume that the IST, MEI, and MON follow the joint process:

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

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

where $\overline{\psi}$, $\overline{\mu}$ and $\overline{\iota}$ 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 Cov$(\epsilon^g_{i,t}, \epsilon_{j,t}) = 0$, where (i, j) $\in \{\psi, \mu, \iota\}$ for all t ≥ 0. 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). Γ^g_ψ,Γ^g_μ and Γ^g_ι represent the country's weights attached to the global shocks. The greater the weight, the greater the impact of the global shocks on the country.

As emphasized by Colacito et al. (2018), the heterogeneous loadings associated with global shocks (Γ^g_ψ, Γ^g_μ and Γ^g_ι) can be seen as a reduced form way of capturing a mix of fundamental differences across countries such as size, commodity intensity, financial integration and trade openness. As in our model macroeconomic fluctuations are mainly driven by changes in households' time preference and in the IST, MEI, and MON processes, countries' heterogeneous exposures to global shocks end up being important drivers of households' consumption-saving decisions and currency excess returns. This is because global shocks affect the evolution of IST, MEI, MON and household's

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

time preference, which, in turn, helps determine consumer decisions and asset prices. We assume that innovations to time preference are combinations of the Home and Foreign IST, MEI, and MON shocks:

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

$$\epsilon_{\kappa,t} = \gamma\left[(\epsilon^*_{\psi,t} - \epsilon_{\psi,t}) + (\epsilon^*_{\mu,t} - \epsilon_{\mu,t}) + (\epsilon^*_{\iota,t} - \epsilon_{\iota,t}) - (\Gamma^g_\psi \epsilon^g_{\psi,t} + \Gamma^g_\mu \epsilon^g_{\mu,t} + \Gamma^g_\iota \epsilon^g_{\iota,t})\right]. \tag{67}$$

Households reason that the lower the degree of home bias, captured by $(1-\gamma)$, the greater should be the impact of global shocks and differentials between local Foreign and Home shocks on households' time preference. This is because the home bias is directly associated with international trade, which is an important transmission channel in our model. As global shocks affect both countries, when they occur, we observe shifts in the same direction in OPT household consumption in both countries. However, the effect of global shocks on currency excess returns depends on countries' heterogeneous loadings. Thus, the covariance between currency excess returns and κ_t also depends on the values of the heterogeneous loadings attached to each country. As will be shown next, if the Foreign country has larger loadings than the Home country, from the perspective of an OPT Home household, the Foreign bond will provide a hedge against drops in consumption. Otherwise, such investments will be risky.

Heterogeneous loadings capture each country's exposure to global shocks. A country's exposure depends on 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 ones. They have more diversified economies (they produce and export more products) and are more technologically advanced than developing economies. 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., 2003). 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.[24] 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, because in moments of greater global uncertainty, capital moves away from emerging countries and towards advanced economies (see, e.g., Obstfeld et al. (2009)). This is an additional source of money demand in advanced economies during periods of heightened 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 the MON shocks. However, we consider that much of the increase in money demand in these countries is driven by local rather than global disturbances. This is justified, for instance, because developing countries are more subject to the occurrence of revolutions, wars, political instability and have less effective stabilizing macroeconomic policies (Koren and Tenreyro, 2007).

In our model, the local and global IST, MEI, and MON shocks affect not only the IST, MEI, and MON processes, but also households' time preference. They trigger business cycle fluctuations and asset price changes. Not only the magnitude of the shocks, but also countries' heterogeneous exposure to global shocks is critical to understanding changes in nominal exchange rates and interest rates that drive currency excess returns. Next, we analyze the macroeconomic implications of our model setup. We begin by deriving the deterministic steady state.

3.10 Deterministic Steady State

Variables with no time index denote the steady-state level. 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 $\overline{\psi} = \overline{\mu} = \overline{\iota} = \overline{\kappa} = 1$. 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, $b^o_h = b^o_f = 0$. 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 (18), (16), (19), and (20) 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:

[24] Factor, efficiency and innovation-driven are growing degrees of complexity in economic activities. 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.

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

Given the value for p_h, we obtain p_f from equation (6):

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

We obtain the real exchange rate by combining the law of one price with equation (6):

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

By equation (37) we obtain:

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

Using the definition of GDP and rearranging equation 34:

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

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

$$I = \delta_0 K$$

Using equation (57) we obtain the trade balance:

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

Substituting equation (57) into equation (54), 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 (15), 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 (35) and (45) 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 (35) 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 (33):

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

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

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

Combining equations (46) and (47) to obtain T^o:

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

Finally, from the fiscal policy rule we obtain:

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

3.11 Inspecting the Mechanism

Model Parameters. Our aim is to investigate the role of IST, MEI, and MON shocks in explaining currency excess returns. Our parameterization closely follows the literature associated with DSGE modeling. Table (5) in Appendix A.1 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 for α, δ_0 and β. In steady state, the share of government spending in GDP is 0.20, the same value used by Gali et al. (2007). Ravn et al. (2007) report an average value of 20% for the share of government spending in GDP for the US, UK, Canada and Australia between 1975 and 2005. However, in contrast to Gali et al. (2007), the government always maintains a balanced budget in our model ($\phi_g = 1$).

The calibrated value used for the share of ROT consumers varies substantially in the literature. For example, 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., 2011) to around 1.9-4.0 in macroeconomic works (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 labor market estimated by Griffin (1992) and is consistent with the calibration employed by 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 values of 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). We use the same value adopted by Gali et al. (2007) and Furlanetto (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 $\xi_w = \frac{\aleph_w(\epsilon_w-1)(1+\gamma_l w)}{(1-\aleph_w)(1-\beta\aleph_w)}$.

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, we use the values of γ_m (period utility function), $d1$ and $d2$ (portfolio adjustment cost of real assets) applied by 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 (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_2 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 from Mehra and Prescott (1985) exceed 10 and Smets and Wouters (2007) obtain a value around 1.38. Many studies implicitly adopt a relative risk aversion coefficient of 1 (Christiano et al., 2005; Justiniano et al., 2011) or 2 (Benigno, 2009; Benchimol and Fourçans, 2012). We set the relative risk aversion coefficient to $\gamma_c = 2$.

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 0.8-2.0. For instance, Corsetti et al. (2008) use 0.85, Benigno (2009) consider values between 0.8 and 6 and Basu and Thoenissen (2011) set the value equal to 2. We chose an intermediate value of 1.25. We follow Corsetti et al. (2008), and assume a degree of consumption home bias of 0.28, which is consistent with the range of values considered by Basu and Thoenissen (2011), as well as 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 in the literature (see, e.g., Schmitt-Grohé and Uribe (2003) and Benigno (2009)). 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 the available time. We set χ_m to obtain a steady-state money stock to GDP ratio of around 0.35, which is roughly the average of M1 and M2 to GDP for the US economy between 1980 and 2019. As discussed in the last subsection, Ξ_1 is defined to pin down the steady-state capital utilization at 1. The parameter Ξ_2 controls the capital utilization; when $\Xi_2 \rightarrow \infty$, $u_t = 1$. 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). The values chosen 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 are well within the range of values found in the literature (see, e.g., Smets and Wouters (2007), Justiniano and Preston (2010), Justiniano et al. (2011) and 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) was chosen equal to the Castelnuovo (2012) estimate. We calibrate 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 Smets and Wouters (2007), 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.[25]

Figure (13) in Appendix A.3.1 displays the result of the local IST shock. The figure reveal a certain degree of synchronization of macroeconomic fluctuations between countries. Variables such as GDP, Aggregate Consumption, ROT Consumption, Hours, Inflation, and Interest Rates co-move in both countries as a result of the local Home IST shock. This finding is consistent with previous studies on international comovement of macroeconomic variables (see, e.g., 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 the time preference of OPT households. Consequently, the model generates a positive relationship between IST shocks and macroeconomic variables in the Home economy, such as GDP, Aggregate Consumption, Hours, Investment, and Capacity Utilization.

The transmission mechanism operates as follows. A positive local Home IST shock boosts the return on investment, attracting capital investment from Home OPT households and leading to a higher capital stock in the subsequent period. As a result, the capital replacement value declines, reducing the marginal utilization cost. This prompts a more intensive utilization of existing capital, resulting in increased labor usage, higher wages, and output expansion. The increase in hours worked and wages translates into an expansion of aggregate consumption and ROT household consumption. ROT households do not engage in intertemporal substitution; rather, they base their consumption decision on present income. Consequently, following a local IST shock, they expand their consumption, and if they represent a sufficiently high fraction of households, aggregate consumption also increases.[26]

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

As emphasized by Coeurdacier et al. (2010), IST shocks can help explain the countercyclical nature of the trade balance. This is precisely what we observe in our model. The increase in the rate of return on investment leads to higher production, triggering Home country imports, which negatively affects 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. In summary, the local IST shock induces an increase in Home imports and trade deficit. This is followed by purchases of Home bonds by Foreign OPT households that lead to a deterioration of the NFA. This result is consistent with the countercyclicality of the trade balance and the NFA found in the data by Coeurdacier et al. (2010) for a set of developed countries. The inflation rate increases in both countries, though 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) as well as 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, leading intermediate-goods producers to reduce employment in response to a higher wage and rental price of capital. This, in turn, lower wages in the labor market. In general, the negative income effect outweighs the increase in investment, resulting in a countercyclical IST shock.

As shown by figure (6), when a positive local Home IST shock occurs, the Home currency appreciates, and currency excess returns decrease on impact. In our model, the increased return on investment that drives business cycle expansions reduces Home OPT household consumption ("good news for investment"). Consequently, Home OPT household consumption is countercyclical, while Home ROT household consumption is procyclical. The behavior of Home aggregate consumption can be either procyclical or countercyclical, depending on the share of Home ROT households in the economy. Local Home IST shocks lead to a high Home OPT marginal utility of consumption and low currency excess returns, or equivalently, they carry a positive *risk premium.* CT investments are risky, and thus they must offer a positive premium to encourage investors to engage in this type of investment.

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

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

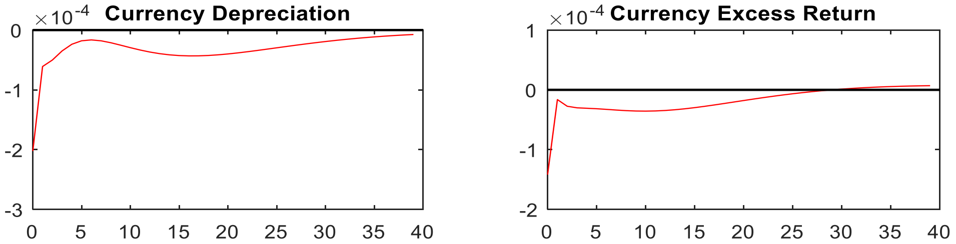


Figure 6: Responses to the local IST shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process.

Figure (14) in Appendix A.3.2 and figure (7) below display the results of the local Home MEI shock. The figures show a similar dynamic to those obtained with the local IST shock, which is expected since both shocks directly impact capital investment, with these shocks being further amplified by hours worked and capital utilization. Consequently, 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 findings align with previous studies such as Justiniano et al. (2011) and Hirose and Kurozumi (2012), although differences exist between our model setup and those employed by these authors. Note that, similar to the result of the IST shock, both Home consumption and currency excess returns fall on impact.

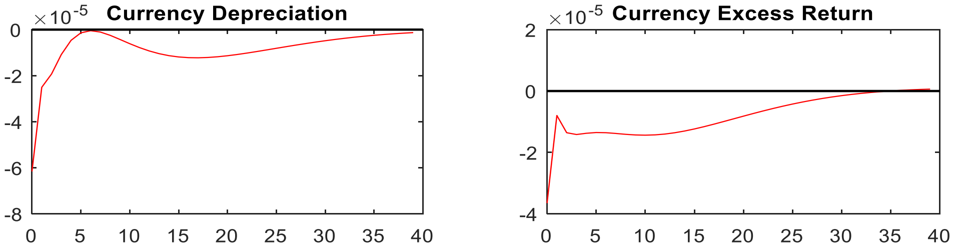


Figure 7: Responses to the local MEI shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MEI process.

Figure (15) in Appendix A.3.3 and figure (8) below display the results of the local Home MON shock. In our model, money demand shocks are linked to macroeconomic uncertainty and financial innovations. When uncertainty increases, individuals tend to hold more money balances to optimize their consumption over time, leading to shifts in real money balances and changes in the relative prices of financial and real assets. Consequently, aggregate demand and output are affected (Benchimol and Fourçans, 2012). In our model, a positive local MON shock in the Home country negatively impacts Home OPT household's consumption and positively affects Home investment. This means that an increase in macroeconomic uncertainty encourages OPT households to invest more in capital today to smooth consumption in the future.

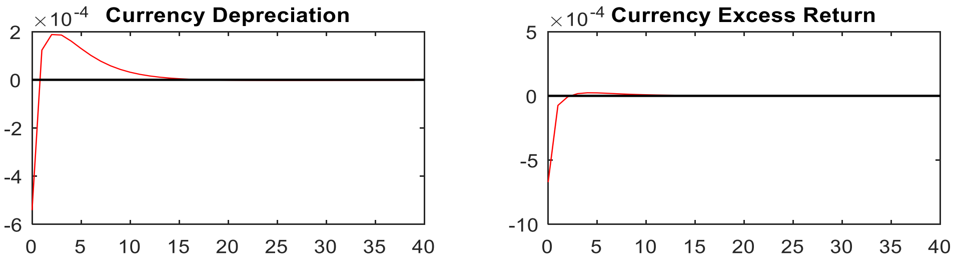
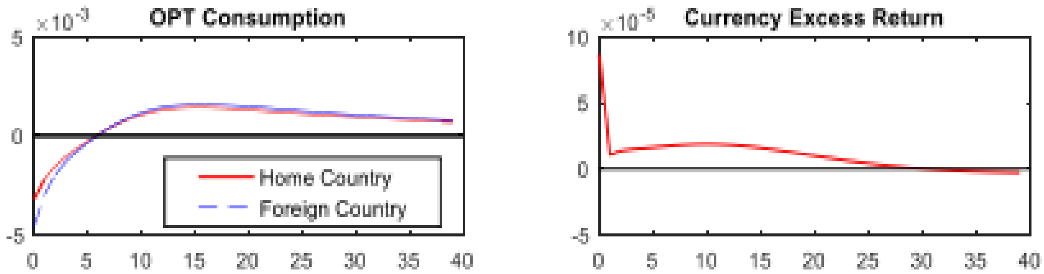


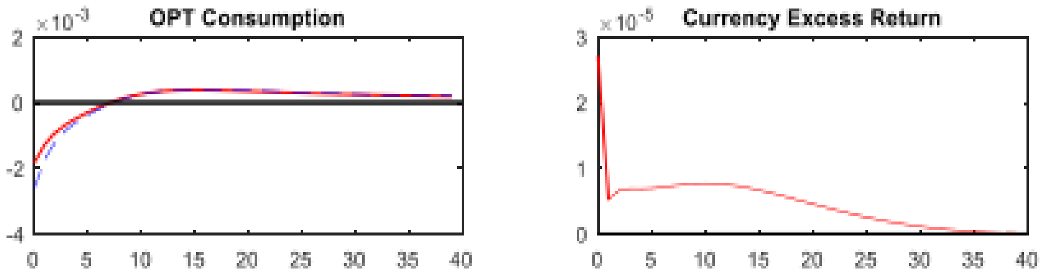
Figure 8: Responses to the local MON shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MON process.

Note that the increase in Home investment is not strong enough to offset the drop in aggregate Home consumption, resulting in a decline in Home output. The decrease in Home demand leads to an improvement in the Home trade balance through reduced imports. The combination of depressed consumption and rising investment and money holdings leads to a reduction in bond holdings (issued at Home and abroad) and a deterioration of the NFA position in the Home country. On the other hand, a combination of lower wages and fewer hours worked has a direct effect on reducing OPT and ROT household consumption in the Home country. Overall, our results are in line with Castelnuovo (2012), and Benchimol and Fourçans (2012), although they work with closed-economy models. They also find that output declines 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 technology, preference and monetary policy shocks on the economy can be damped.

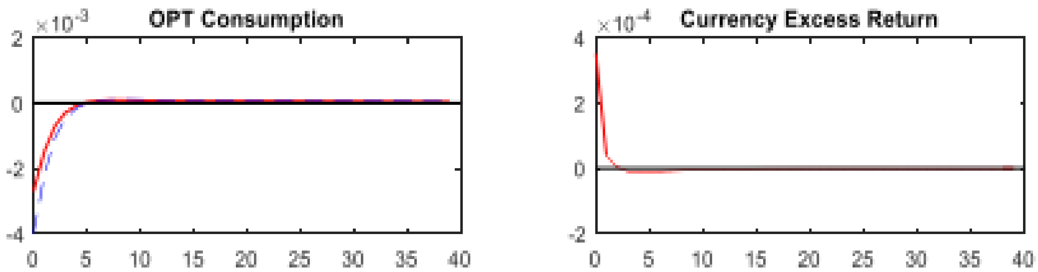
A closer inspection of Figure (15) reveals that the co-movement between countries' macroeconomic variables is smaller than the co-movement produced by the local IST and MEI shocks. Notably, the dynamics observed for hours, investment, capacity utilization, and OPT consumption are significantly different between countries. In the Foreign country, the increase in OPT consumption counteracts the negative effects of the fall in investment, ROT consumption, and the deterioration of net exports on economic activity. As a result, output does not fall on impact. A closer analysis of Figure (15) highlights that the co-movement between countries' macroeconomic variables is smaller compared to the co-movement produced by the local IST and MEI shocks. Notably, the dynamics observed for hours, investment, capacity utilization, and OPT consumption are significantly different between countries.



(a) Responses to the Global IST Shock



(b) Responses to the Global MEI Shock



(c) Responses to the Global MON Shock

Figure 9: Responses to Global Shocks I. 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. The values of the Home loadings are equal to 1 ($\Gamma_{\psi}^{g} = \Gamma_{\mu}^{g} = \Gamma_{\iota}^{g} = 1$) and the Foreign loadings are equal to 1.5 ($\Gamma_{\psi}^{*,g} = \Gamma_{\mu}^{*,g} = \Gamma_{\iota}^{*,g} = 1.5$).

Figure (9) displays the effects of the respective global IST, MEI, and MON shocks on consumption and currency excess returns. It is important to note that countries' exposures to the global shocks (the respective Home - Γ_{ψ}^{g},Γ_{μ}^{g}, and Γ_{ι}^{g} - and Foreign - $\Gamma_{\psi}^{*,g}$,$\Gamma_{\mu}^{*,g}$, and $\Gamma_{\iota}^{*,g}$ - loadings) are crucial in determining currency excess returns. These loadings govern the direction and magnitude of changes in exchange rates and nominal interest rates when global shocks hit economies. We set the values 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 returns increase when Home OPT household consumption falls. Thus, Home investment in Foreign bonds from countries with higher loadings than the Home country provides a hedge for OPT Home households against falls in consumption.[27]

Figure (10) shows the effects of the respective global IST, MEI, and MON shocks on consumption and currency excess returns. We set the values 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 ($\Gamma_{\psi}^{*,g} = \Gamma_{\mu}^{*,g} = \Gamma_{\iota}^{*,g} = 0.5$). The figure reveals that, on impact, currency excess return decreases when Home

[27] The responses of the other macroeconomic variables are very similar to those reported for the respective local IST, MEI, and MON shocks. The only important differences concerns the responses of investment, wage, and output (each country's money aggregate also responds differently to the global MON shock). As Home loadings are smaller than Foreign ones, Home investment and GDP increase less than Foreign ones when the global IST and MEI shocks hit both economies (the results are not reported but are available upon request from the authors).

OPT household consumption falls. Thus, Home investment in Foreign bonds from countries with lower loadings than the Home country is risky.[28]

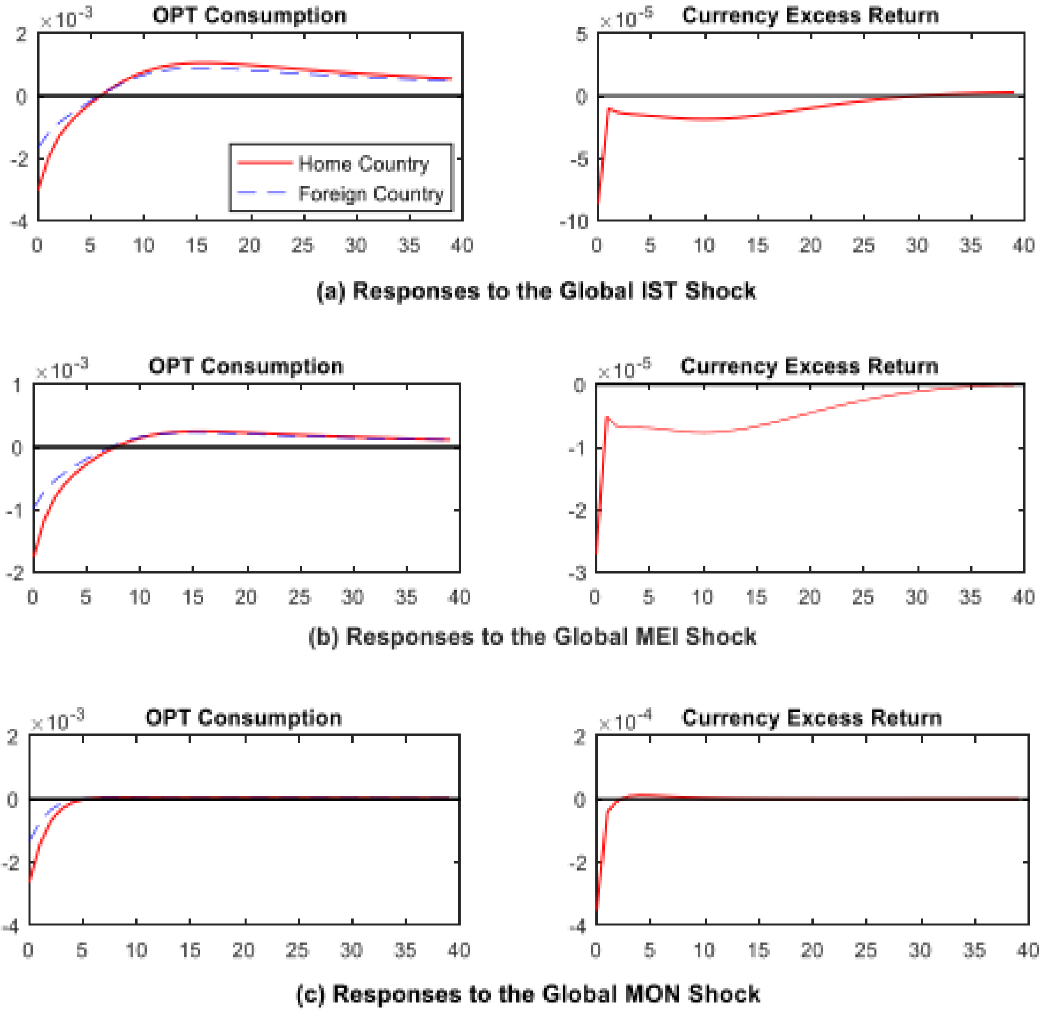


Figure 10: Responses to Global Shocks II. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process. The values of the Home loadings are equal to 1 ($\Gamma_{\psi}^{g} = \Gamma_{\mu}^{g} = \Gamma_{\iota}^{g} = 1$) and the Foreign loadings are equal to 0.5 ($\Gamma_{\psi}^{*,g} = \Gamma_{\mu}^{*,g} = \Gamma_{\iota}^{*,g} = 0.5$).

Overall, our results suggest a reduction in the magnitudes of the IST, MEI, and MON shocks and a convergence between developed and developing countries in the levels of these shocks. These shocks play a crucial role in explaining movements in nominal interest rates and exchange rates. Consequently, we would expect smaller fluctuations in these variables, which is consistent with lower profit opportunities for CT investments. This finding aligns with the downward trend of CT returns observed in the data. Our model's prediction is consistent with this observation, as CT returns are shown to be dependent on the magnitudes of these shocks. As the shocks decrease in magnitude and the gaps between countries narrow, the impact on CT returns becomes less pronounced, leading to reduced profit opportunities for CT investments over time.[29]

In the long term, the IST and MEI shocks lead to an increase in investment, which in turn increases the capital stock. This results in a decline in the marginal product of capital (MPK) and, consequently, the real interest rate. Both shocks also contribute to an increase in the supply of goods, leading to a dampening effect on inflation. The

[28]The responses of the other macroeconomic variables are very similar to those reported for the respective local IST, MEI, and MON shocks. The only important differences concern the responses of investment, wage, and output (each country's money aggregate also responds differently to the global MON shock). As Home loadings are greater than Foreign ones, Home investment and GDP increase more than Foreign ones when the global IST and MEI shocks hit both economies (the results are not reported but are available upon request from the authors).

[29]In our model, currency excess returns also depend on countries' exposure to global shocks. Generally, developed countries have greater exposure to global shocks than developing countries. However, our results so far indicate that changes in countries' exposure to global shocks in recent decades have helped to reduce the gap between developed and developing countries in terms of IST, MEI, and MON levels. There are several reasons to expect this reduction in the gap. First, the empirical evidence provided in Section 2 concerning with the three shock processes and main macroeconomic variables (interest rate, inflation rate, exchange rate, capital stock, etc.) points to an increase in the productivity of developing countries. Secondly, as highlighted in the literature, developing countries have benefited most from the massive wave of trade and financial openness observed over recent decades. This has led to tighter trade and financial linkages, making developing countries more globally interconnected. As highlighted in the last section, these two aspects are main determinants of country's exposure to global shocks.

combination of lower MPK and inflation results in a lower nominal interest rate in the long run. Furthermore, as discussed earlier, improvements in the country's financial development (positive MEI shock) may reduce exchange rate volatility. Additionally, reductions in the growth rate of the money stock triggered by decreases in macroeconomic uncertainty can also act to reduce exchange rate volatility.

As discussed earlier, our data analysis revealed a narrowing of the gap between developed and developing countries and the US in terms of inflation and nominal interest rates in recent decades. Furthermore, the level of inflation and nominal interest rates has declined in both developing and developed countries. Additionally, the level of the MPK in developing countries has also decreased during this period, with the gap between developing countries and the US in terms of the MPK narrowing between 1980 and 2019. In summary, the downward trend in CT returns is consistent with: i) the combination of falling nominal interest rates and growth rates of exchange rates across countries over the last decades; ii) the fluctuations of the IST, MEI, and MON processes across countries over the last decades; and iii) the long-term effect of the shock processes on macroeconomic variables. We now complement our analysis by assessing the explanatory power of risk factors derived from the IST, MEI, and MON processes in our asset pricing exercises.

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[30], 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, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sri Lanka, 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.[31]

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

$$RX^{j}_{t+1} \equiv \left\{ \left[(1+i_{jt}) \left(\frac{S_{jt+1}}{S_{jt}} \right) - (1+i_t) \right] \left(\frac{P_t}{P_{t+1}} \right) \right\}, \tag{67}$$

where RX^{j}_{t+1} 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 construct our currency portfolios using two strategies. First, we use the values of the IST, MEI, and MON processes, which are proxied by the relative price of 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 each country's exposure to the global component of each shock process. If the IST, MEI, and MON values are priced as risk factors, the 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).[32]

To compute each country's exposure to the global component of the shock processes, we used two variables: i) the Global Competitive Index (Sala-i Martin and Artadi, 2004) reported by the World Economic Forum for every

[30] Based on information published by the IMF.

[31] 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).

[32] We also sorted currencies according to the growth rate of the IST and MEI processes, however they generated a cross section of portfolios with a very low spread between portfolio returns.

year since 2005; and ii) the commonality (proportion of the variance explained by the common factors) of each country extracted from the principal component analysis applied separately to the dataset of each of the processes (IST, MEI, and MON).We followed a two-step process to obtain the country's exposure to the global component of each process. In the first step, we applied principal component analysis to calculate each country's communality for each year from 2005 to 2018. For the IST and MEI, we used a rolling window of 26 annual observations, and for the MON (the growth rate of M1 and M3), we used 104 quarterly observations, starting in 1980. We selected the number of common factors (between 2 and 5) to explain at least 50% of the data variance. In the second step, we multiplied each country's annual commonality value by its respective annual Global Competitive Index value. This strategy allowed us to calculate each country's exposure to the global component of each process for each year between 2005 and 2018.

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. The 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. The same strategy is applied to generate portfolios ordered by nominal interest rates, and these portfolios are rebalanced monthly. This process results in six portfolios ranked from the lowest to the highest nominal interest rates. Portfolio returns are calculated as an equally weighted average of the currency excess returns within each portfolio. It is important to note that the number of countries in each portfolio varies over time due to data availability and adjustments made to the dataset, as discussed in the last section.

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 reorganized 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. Since the Global Competitive Index is available only from 2005 onwards, we restrict our asset pricing exercises between 2006 and 2019. It is worth noting that the number of countries in each portfolio varies over time due to data availability and adjustments made to the dataset, as discussed in the last section.

We construct our risk factors following Lustig et al. (2011): the average of currency excess returns considering all countries (labeled as RX); and the difference in returns between portfolios six and one (labeled as HML). Thus, we denote HML^{ist}, HML^{mei}, HML^{mon1}, and HML^{mon3} for factors built from portfolios ranked by countries' IST value, MEI value, M1 growth rate, and M3 growth rate. HML^{ir} is the factor built from portfolios sorted by countries' nominal interest rates. We followed the same procedure regarding the country's exposure to the global component of the shock processes to construct the respective risk factors.

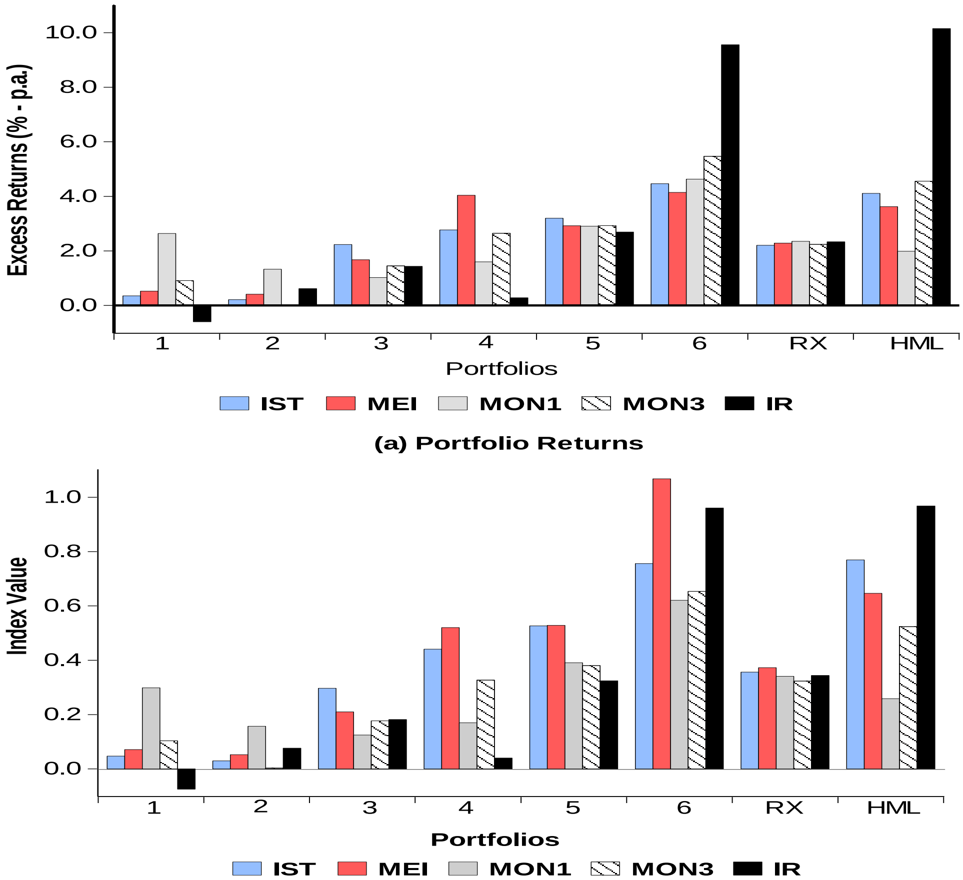
To assess whether sorting countries by nominal interest rates is equivalent to sorting them by the shock processes, we regressed each risk factor (HML^{ist}, HML^{mei}, HML^{mon1}, and HML^{mon3}) onto the HML^{ir} factor and a constant. We used the Newey and West (1987) heteroskedasticity-consistent standard errors to obtain the t-statistics. The slope coefficient estimates reached: 0.35, 0.31, 0.13 and 0.49, for the HML^{ist}, HML^{mei}, HML^{mon1} and HML^{mon3}, respectively. All coefficients are statistically different from zero at the 10% significance level and the adjusted R^2 values reached 0.16, 0.11, 0.01, and 0.14, respectively. We ran the same regressions for the risk factors generated by the country's exposure to the global component of the shock processes. 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 values reached 0.18, 0.12, 0.21, and 0.33, respectively. Note that all slope coefficients are statistically different from unity. Therefore, sorting currencies by nominal interest rates is not the same as by the shock processes. The information from the IST, MEI, and MON processes matters for for currency returns.

Figure (11) presents the values of portfolio returns and Sharpe ratios for each portfolio over the period from 1995:M01 to 2019:M12. We found similar results when considering the entire sample period, however, as will be discussed below, portfolio returns before 1995 may not provide a clear picture of currency excess returns due to the availability of data (especially for developing countries). The figure also includes the returns of two currency strategies: i) the RX, where a US investor goes long in all foreign currencies; and ii) the HML, where a US investor goes long in portfolio six and short in portfolio one. We follow the finance literature and assume that the returns from these two portfolios are the risk factors to be used in our asset pricing exercises. To calculate the Sharpe ratio for each portfolio, we divided its annualized excess return by its annualized standard deviation.

The main points to take away from Panel (a) of the figure are as follows. First, overall currency excess returns decline from the portfolio six to one. Second, the return on the RX portfolio is lower than the return on the HML portfolio (except in the case of the MON1 portfolio). Third, the return on the HML portfolio is higher when currencies are sorted by nominal interest rates (approximately 10.00%) than when sorted by the other risk factors (approximately between 1.99% and 4.55%).[33] Overall, Panel (b) of the figure reveals that the Sharpe ratio decreases from portfolio six to one. Note that, although portfolio six sorted by the MEI value, while not having the highest return among the portfolio six returns, generates the highest Sharpe ratio value. This finding highlights the importance of using information from the MEI process for constructing currency portfolios. The higher Sharpe ratio

[33] Our results are in line with the findings of Menkhoff et al. (2012a) and Corte et al. (2016), which reported portfolio returns of 4.11% and 4.40% for their HML factors, respectively.

for the MEI-sorted portfolio suggests that currencies selected based on the MEI process offer a better risk-adjusted performance compared to other risk factors. This indicates that the MEI process captures valuable information that helps to identify currencies with attractive risk-return profiles, making it a relevant factor for currency portfolio construction.



(a) Portfolio Returns

(b) Sharpe Ratios

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.

Figure (12) presents portfolio returns and Sharpe ratios for currency returns sorted by the country's exposure to the global component of the shock processes - IST, MEI, and MON (M1 and M3 growth rates) - and the nominal interest rates. Overall, despite differences in magnitude, portfolio returns and Sharpe ratios exhibit a pattern similar to that identified in Figure (11). One interesting observation is that portfolio six, which is ordered by the IST value, does not have the highest return when compared to the other returns of portfolio six. However, it generates the highest Sharpe ratio value, indicating that using information from the IST process is valuable for constructing currency portfolios with better risk-adjusted performance. This further emphasizes the importance of considering the IST process as a relevant factor for currency portfolio construction.

To put our results into perspective, we compare them with Lustig et al. (2011) and Colacito et al. (2020). Lustig et al. (2011) work with a set of 35 countries covering the period from 1983:M11 to 2009:M12. They construct currency portfolios based on nominal interest rates and find results similar to ours: i) currency excess returns and Sharpe ratios decline from portfolio six to one; and ii) the annual return of the RX portfolio (1.90%) is lower than the annual return of the HML portfolio (4.54%). Our results are also in line with those reported by Colacito et al. (2020). They consider 27 countries spanning the period from 1983:M10 to 2016:M01. Portfolios sorted by nominal interest rates reached excess returns and Sharpe ratios between -0.63% to 7.17% and -0.06 to 0.68, respectively.

It is important to note that Lustig et al. (2011) and Colacito et al. (2020) work with nominal currency excess returns net of transaction costs (bid/ask spread of spot and forward exchange rates). On the other hand, our analysis focuses on real currency excess returns and does not include transaction costs in constructing portfolio returns. The finance literature reports a reduction ranging from 0.95% (Colacito et al., 2020) to 1.50% (Lustig et al., 2011) in the average currency portfolio return caused by transaction costs. On the other hand, the average annual inflation rate in the US oscillates between 1.91% (for 2006:M01-2019:M12 interval) and 2.16% (for 1995:M08-2019:M12 interval). These results indicate that, despite methodological differences in the calculation of currency portfolio returns, our results remain comparable to those reported in the literature.[34]

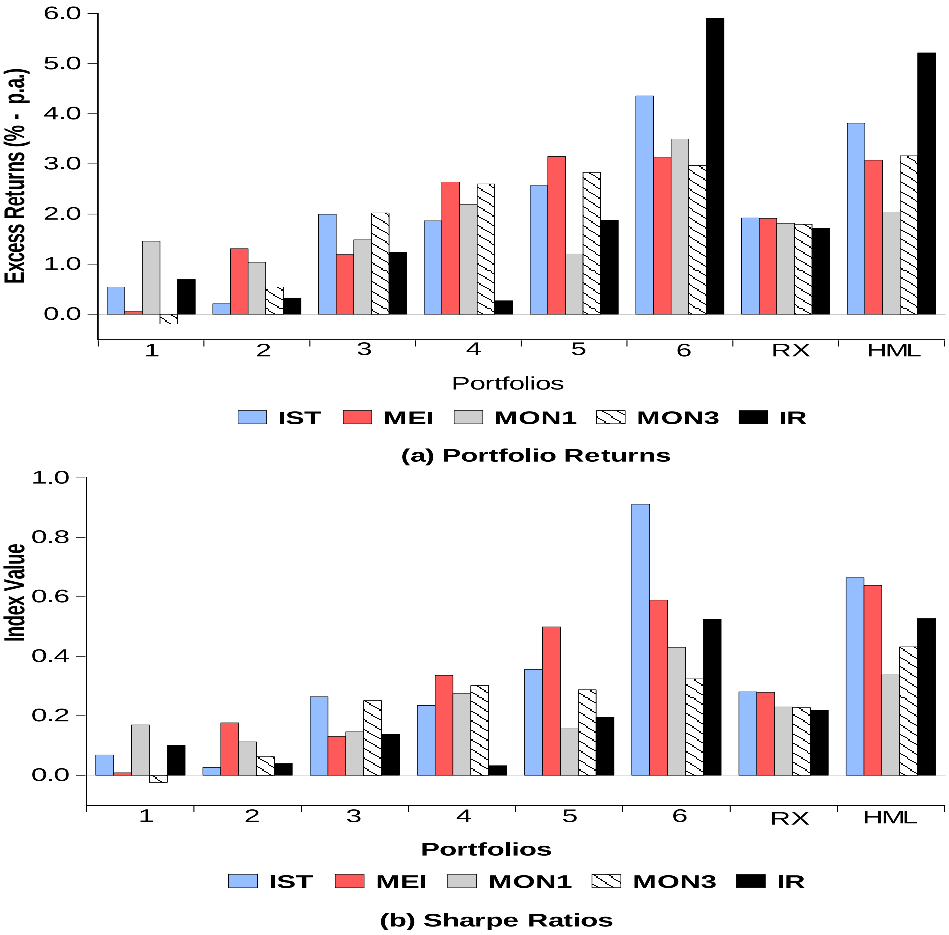


Figure 12: Currency Portfolio Returns: Global. The figure presents portfolio returns (Panel (a)) and Sharpe ratios (Panel (b)) for currency returns sorted by country's exposure to the global component of the shock processes - IST, MEI, M1 growth rate (MON1), and M3 growth rate (MON3) - and the nominal 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 examine the time series properties of our portfolio returns. To obtain the sensibility of each portfolio's return to the risk factors, we performed the following OLS regression: $RX_t^{p,\iota} = \gamma_0 + \gamma_1 RX_t + \gamma_2^{\iota} HML_t^{\iota} + \tau_t$. $RX_t^{p,\iota}$ is the currency excess return for portfolio one to six; $p \in \{1,2,3,4,5,6\}$; $\iota \in \{IST, MEI, MON1, MON3, IR\}$, denotes the variable used to order currencies and compute the risk factors; and τ_t is a white noise error term. The sample period covers the interval from 1985: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 these shock processes.

Table 6 in Appendix A.4.1 reports the beta estimates for portfolio returns sorted by the IST, MEI, and MON processes in Panel (a), and by the country's exposure to the global component of the three shock processes in Panel (b). These beta estimates allow us to retrieve portfolio returns by multiplying them by the risk factors (RX and HML portfolio returns). For illustration, we computed the following returns for portfolio one and six, respectively: i) 0.39%, 0.55%, 2.43% and 0.87%; and ii) 4.54%, 4.17%, 4.42% and 5.43% (for currencies ordered by the IST, MEI, M1 growth and M3 growth values, respectively). Note that these returns are in line with those presented 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.

[34] Note that transaction costs increase with the frequency of portfolio rebalancing. Unlike Lustig et al. (2011), and Colacito et al. (2020), we do not rebalance our portfolios on a monthly basis. Therefore, transaction costs are likely to be small. Furthermore, bid/ask spreads used in the literature tend to be overestimated (see, e.g., Menkhoff et al. (2012b) and Colacito et al. (2020)). Finally, Menkhoff et al. (2012b) report a decrease in bid/ask spreads in the foreign exchange market in recent decades.

Cross-sectional Regressions. To explore the cross-sectional properties of portfolios returns we follow the recent literature (see, e.g., Corte et al. (2016) and Colacito et al. (2020)). We construct twenty-four test assets based on portfolio formation strategies developed by the relevant literature in this area (Lustig et al., 2011; Menkhoff et al., 2012a,b; Asness et al., 2013). These portfolios are named in the literature as "momentum","value", and "volatility". They are used as test assets in our empirical analysis, alongside six portfolios sorted by nominal interest rates, six by the IST values, six by the MEI values, six by M1 growth rates, and six by M3 growth rates. Thus, our test asset set comprises a total of fifty-four currency portfolios.

Following the methodology of Menkhoff et al. (2012b), at the end of each month t, we form six portfolios based on currency excess returns for the previous k months. The countries with the lowest lagged returns are placed in portfolio one, while the countries with the highest lagged returns are placed in portfolio six. Portfolios are reorganized at the end of each month. We construct 6 "short-term momentum" (k=3) and 6 "long-term momentum" (k=12) portfolios. We used the first 3 and 12 months of data to calculate the returns for the "short-term momentum" and "long-term momentum" portfolios, respectively. Which shortened our sample period.

At the end of each period t, we construct 6 portfolios sorted by the value of the five-year lagged real exchange rate return, as in Asness et al. (2013). To build the "value" portfolios, we adjust the past five-year average spot exchange rate by the change in the Consumer Price Index (CPI) in the foreign economy relative to the US CPI to recover real exchange rate returns. Countries with the highest real exchange rate return are grouped in portfolio one and countries with the lowest real exchange rate return in portfolio six. Due to the methodology used to obtain the "value" portfolios, we have to restrict our empirical analysis to the period between 1985:M08 and 2019:M12.

We also employ a portfolio construction strategy based on countries' exposure to global exchange rate volatility, as in Menkhoff et al. (2012a). The measure for global FX volatility was computed as follows. First, we calculated the daily log return for each currency. Second, we computed the simple cross-sectional average of the absolute values of these daily log returns across all currencies. Thus, we ended up with one value for each day (daily measure of global exchange rate volatility). Third, we computed the time series simple average of the daily values obtained in the last step. We ended up with one value for each month (monthly measure of global exchange rate volatility). Lastly, we ran OLS regressions of monthly currency excess return on a constant and the first difference of the monthly measure of global exchange rate volatility for each country, considering a rolling window of thirty-six months. The estimate for the slope coefficient is the country's exposure to global exchange rate volatility. This approach allows us to obtain time-varying country's exposure to global exchange rate volatility. At the end of each period t, we group the countries with the highest exposures to global exchange rate volatility in portfolio one and the countries with the lowest exposures in portfolio six.[35]

Empirical analysis on cross-sectional asset pricing in currency markets are typically performed with a two-factor model (Lustig et al., 2011; Menkhoff et al., 2012a). However, recent papers have also considered a three-factor SDF (Corte et al., 2016; Colacito et al., 2020). The latter model is particularly important in our study because we propose three new risk factors. The three-factor model allows evaluating the degree of the additional pricing power brought by each risk factor. The first risk factor is the equally weighted average excess return of a portfolio in which the investor is long in all currencies and short in the domestic currencies. This risk factor corresponds to the RX portfolio return. For the other risk factors, the literature has employed several options, such as the slope factor (Lustig et al., 2011), the global volatility factor (Menkhoff et al., 2012a), the global imbalance factor (Corte et al., 2016) or the output gap factor (Colacito et al., 2020). Following the literature, we work with 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 report results in which the second risk factor is the HML^{ir}. Furthermore, we also explore the results of a three-factor SDF, combining the RX with our proposed risk factors and the slope factor proposed by Lustig et al. (2011), the HML^{ir}.

Table 7 in Appendix A.4.2 exhibits the results from the Fama and MacBeth (1973) two-pass procedure used to estimate the market price of risk associated with our proposed risk factors. We have to restrict our experiment to the period between 1985:M08 and 2019:M12, due to the methodology applied to construct the "value" portfolios. Furthermore, as detailed in Appendix A.1, there are countries that were excluded from our sample due to their degree of financial openness or episodes of sovereign default. These exclusions occur mainly before mid-1995. Therefore, we also report results for a period with a more complete dataset between 1995:M01 and 2019:M12.

We follow the literature (Lustig et al., 2011; Menkhoff et al., 2012a; Corte et al., 2016; Colacito et al., 2020), and do not include a constant in the second step of the (Fama and MacBeth, 1973) procedure. Our set of test

[35] We collected daily data on exchange rates 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 onwards. However, we computed country's exposure to global exchange rate volatility for all countries in our dataset.

assets consists of 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's exposure to global exchange rate volatility. We conduct all of our asset pricing analysis considering this large set of fifty-four test portfolios, rather than just considering portfolios sorted by our shock processes (IST, MEI, and MON). This approach is motivated by the findings of Lewellen et al. (2010), which suggest that a strong factor structure in test assets can lead to misleading results in empirical studies. Additionally, Lewellen et al. (2010) propose adding risk factors as test assets to ensure that they price themselves. This is specially important in cases where the factors are tradable portfolios. Thus, we conducted our analysis by excluding and including the risk factors as test assets.

As pointed by Cochrane (2005), if the market price of risk is statistically significant, then it is priced in the cross section of asset returns. Hence, we focus on the sign and 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 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 indicates that our three factors are priced in the cross-section of currency portfolios. Overall, the prices of risk associated with the IST, MEI, and MON risk factors are positive and statistically significant. This implies that currencies from countries with low IST/MEI values and high M1/M3 growth rates earn higher excess returns on average.

Panels (a) and (b) of the table reveal that λ^{ist}_{HML} has positive and statistically significant coefficients ranging from 2.66% to 6.02%. The adjusted R^2 values vary between 0.08 and 0.62. The λ^{mei}_{HML} has positive and statistically significant coefficients ranging from 2.50% to 5.73%. The adjusted R^2 values vary between 0.08 and 0.62. The λ^{mon1}_{HML} has positive and statistically significant coefficients ranging from 3.06% to 5.64%. The adjusted R^2 values vary between -0.20 and -0.08. Additionally, the M3 growth rate, used as a proxy for the MON process, yields positive and statistically significant coefficients ranging from 2.74% to 8.01%, with adjusted R^2 values between -0.12 and 0.62. Note that the estimates for the period 1995:M01 to 2019:M12 show higher adjusted R^2 values, indicating a better fit for the model during this more recent period.

Table (8) presents the results obtained when using the country's exposure to the global component of each shock process (IST, MEI, and MON) to construct the currency portfolios. Therefore, the test assets include fifty-four portfolios: six sorted by countries' exposure to the global component of the IST values, six by countries' exposure to the global component of MEI values, six by countries' exposure to the global component of M1 growth rate, six by countries' 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 exchange rate 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 positive and significant prices of risk associated with the country's exposure to the global component of the IST, MEI, and MON factors suggest that currencies from countries with low exposure to these global components tend to earn higher excess returns on average. The λ^{ist}_{HML} has positive and statistically significant coefficients ranging from 2.63% to 3.98%, with adjusted R^2 values between 0.43 and 0.71. The λ^{mei}_{HML} has positive and statistically significant coefficients ranging from 2.29% to 3.99%, with adjusted R^2 values between 0.46 and 0.64. The λ^{mon1}_{HML} has positive and statistically significant coefficients ranging from 3.42% to 4.61%, with adjusted R^2 values between 0.14 and 0.28. Additionally, the M3 growth rate, used as a proxy for the MON process, yields positive and statistically significant coefficients ranging from 3.13% to 5.70%, with adjusted R^2 values 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^2 values.

We conducted additional regression exercises focusing on a subset of twenty-two developed countries. With a smaller number of countries, we included forty-one portfolios as test assets in our estimation: 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 exchange rate volatility. As most information on developed countries is available from the beginning of our sample period, our asset pricing estimation covers the entire period (these results are not reported but are available from the authors upon request). Despite the magnitudes being lower compared to Table (7), we still find positive and statistically significant risk price estimates. Overall, the findings are consistent with those presented in Table (8).

To put our results into perspective, we compare them with Corte et al. (2016). Their study shares similarities with ours in terms of country and time coverage. Corte et al. (2016) work with a sample of 55 countries over the period from 1983:M10 to 2014:M06. They also report separate results for a subset of developed countries. In their study, Corte et al. (2016) find a positive and significant estimate for the price of risk associated with their proposed risk factor, known as the "global imbalance risk factor". The adjusted R^2 ranges from 0.49 to 0.65. Notably, the estimates for the price of risk for the set of developed countries (ranging between 3% and 6% p.a.) were lower than those obtained for the set of all countries (ranging between 4% and 8% p.a.), which is consistent with our results.

The key insight from our results is that countries with low IST and MEI levels have greater growth opportunities and higher demand for new capital goods. Positive IST and MEI shocks have a more significant positive impact on these countries as their firms invest to capitalize on growth prospects. However, they are also more susceptible to macroeconomic uncertainty, typically associated with domestic turmoil (higher rates of money growth). They have lower levels of economic and financial development. Consequently, investors perceive higher risk in holding bonds issued by these countries, leading to a higher *risk premium* demanded by investors to compensate for uncertainty and potential volatility in these markets. The cross-sectional differences in IST, MEI, and MON values lead to variations in *risk premium* among countries. The combination of growth opportunities and macroeconomic uncertainty shapes the risk-return profiles of different currency portfolios, affecting their excess returns and Sharpe ratios.

On the other hand, US investors place higher value on currencies that benefit the most from IST, MEI, and MON global shocks. Currencies from countries with high exposure to these global shocks tend to appreciate, driven by the shocks. In contrast, currencies from countries with low exposure tend to depreciate. As a result, US investors are willing to accept a lower *risk premium* to hold bonds issued by countries with high exposure to the global shocks.

Taken together, these results provide evidence on the relevance of our three proposed risk factors in pricing currency excess returns. They imply that factor models incorporating risk factors derived from the IST, MEI, and MON processes can price the cross-section of currency excess returns. A two-factor model that includes a risk factor associated with the IST, MEI or the MON processes performs well in our asset pricing exercises. Furthermore, part of the results reveal that our proposed risk factors are priced regardless of whether the HML^{ir} is added to the model. This suggest that our proposed risk factors convey additional information that is important for pricing currency excess returns.

Country-level Analysis. We adopt the methodology employed by (Verdelhan, 2018) to test the prediction of our proposed risk factors when applied to individual currencies. The author works with a sample of developed and developing countries, covering the period between 1983:M11 and 2010:M12. (Verdelhan, 2018) constructs two risk factors and runs OLS regressions of individual exchange rate returns on the these risk factors.

We performed OLS regressions of the time-series of currency excess returns for each country on our proposed risk factors (the IST, MEI, MON1 and MON3). We also ran similar exercises considering our risk factors built based on each country's exposure to the global components of the IST, MEI, and MON processes.

Overall, we observed both sets of factors to exhibit high statistical significance at the 15% level. The adjusted R^2 values varied between 0.00 and 0.78. These outcomes suggest the relevance of our proposed risk factors in explaining currency excess returns at the country level (these results are not reported but are available from the authors upon request). Verdelhan (2018) finds analogous results, with adjusted R^2 values ranging from 0.20 to 0.90 for developed countries and from 0.10 to 0.75 for developing economies in the model incorporating the two factors.

Most notably, our findings distinctly delineate funding and target countries in CT investments. For instance, funding countries like Switzerland tend to exhibit lower estimated coefficients for risk factors associated with the IST process, while target countries like Brazil and Turkey demonstrate higher estimated coefficients. Similar patterns emerge for the other risk factors. These results reinforce our earlier findings, confirming that our proposed risk factors are priced in foreign exchange markets.

Unifying Risk-Based Explanation. An important topic explored in the finance literature concerns the identification of risk factors capable of explaining the excess returns of different types of assets such as stocks and bonds. Burnside (2011a) investigates whether traditional CAPM risk factors, based on the three factors of Fama and French (1992), as well as the extended CAPM with industrial production and US stock market volatility, can explain currency excess returns. The author find that none of these models has sufficient explanatory power for currency excess returns. Additionally, jointly estimated models containing currency and equity portfolios are also rejected, indicating that the conventional risk factors that have success in explaining stock returns fail to explain currency returns. As a result, Burnside (2011a) concludes that there is no unifying risk-based explanation for excess returns in the stock and FX markets. Motivated by this gap in the literature, we aim to examine whether our proposed risk factors reflect common sources of systematic risk in equity markets.

Appendix A.5.1, we describe our dataset and provide a summary of the behavior of the international equity market in recent decades. Tables (9) and (10) in Appendix A.5.2 present the results of our asset pricing exercises for the equity market. The tables indicate that our three factors are priced in the cross-section of equity portfolios. In general, the prices of risk associated with the IST, MEI, and MON risk factors are positive and statistically significant. This implies that stock market indices from countries with low IST/MEI values and high M1/M3 growth rates earn higher excess returns on average. We also constructed the portfolios based on the country's exposure to the global component of each shock process. However, the overall results indicate weaker evidence regarding the explanatory power of the risk factors associated with countries' exposures.

Overall, our results suggest a significant link between currency and equity returns. The risk factors associated with the IST, MEI, and MON values also play a relevant role in explaining equity excess returns. The risk prices associated with our proposed risk factors are positive and statistically significant at conventional confidence levels. Additionally, our analysis demonstrates a satisfactory cross-sectional fit in terms of R^2 values, indicating that currency and equity market returns share common sources of variation.

However, the analysis regarding the country's exposure to the global component of the IST, MEI, and MON processes yields less clear results. We find only weak evidence supporting the explanatory power of the risk factors associated with country's exposure to the global component of the shocks in the international stock market. A possible explanation for this outcome could be that global shocks can have different effects on currency excess returns, which may not necessarily occur with equity excess returns. For example, a global IST shock may lead to either positive or negative currency excess returns in the Home country. This depends on the degree of exposure of both Home and Foreign countries to the global IST shock. In contrast, investment and output increase in both countries, leading to higher equity excess returns. As a result, from the Home investor's perspective, global shocks can cause currency and equity excess returns to exhibit either positive or negative correlation.

5 Concluding Remarks

Motivated by our findings in Section 2, we develop an open economy DSGE model in which currency excess returns are explained by investment-specific technology, marginal efficiency of investment and money demand shocks. In our model, there are two types of households. Those with access to financial markets (Optmizing) and those without access to it (Rule-of-thumb). The shocks directly influence households' consumption and saving decisions. An additional effect on the behavior of Optimizing households occurs through changes in intertemporal time preference. These changes in time preference are influenced by the investment-specific technology, the marginal efficiency of investment, and the money demand shocks. The interaction between these three fundamental shocks and time preference changes is the driving force behind the dynamics of economic variables in our model. Specifically, the model generates macroeconomic movements that impact currency excess returns through changes in nominal interest rates and exchange rates. By connecting the fundamental sources of risk originating from these shocks with currency excess returns, our model sheds light on the relationship between business cycle fluctuations and currency returns. These findings represent new contributions to the field of international finance literature.

We also present 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 each of these shock processes. Our findings indicate that these factors are priced in the cross-section of currency excess returns, and the prices of risk associated with them are positive and statistically significant. We also find evidence supporting the importance of our proposed risk factors in explaining country-level excess returns. Additionally, our results indicate that the risk factors associated with the IST, MEI, and MON values are also relevant to explain equity 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 its lack of consideration of household heterogeneity in depth. In our model, there are only two distinct households (Optmizing and Rule-of-thumb), and this simplicity may not fully capture the complexity of real-world households. Heterogeneity could arise from various sources, such as household risk aversion, wealth levels, and individual tastes, leading to different types of agents with distinct behaviors and preferences.

In future developments of this literature, it would be valuable to incorporate a more detailed model that accounts for household heterogeneity, as it can significantly impact currency portfolio decisions. By understanding how different types of agents make their investment choices, we can better rationalize the existence of carry traders in countries with low interest rates, despite the tendency of these economies to have aggregate positions biased towards domestic assets, such as government bonds. Moreover, exploring the role of household heterogeneity in currency portfolio formation could yield valuable insights for the financial industry. Identifying and understanding the important risk factors that drive household's portfolio decisions can inform investment strategies and risk management practices. By incorporating such heterogeneity, future research can provide a more comprehensive understanding of currency markets and improve the practical applications for investors and financial institutions.

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A 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 (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

[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 (Richards et al., 2017). 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 Na et al. (2018) reinforcing the existence of a direct relationship between sovereign credit problems and the occurrence of sudden movements in exchange rates.

(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), 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
Price level of consumption	A	PWT
Price level of capital formation	A	PWT

A.1.6 CT Returns and the Fundamental Sources of Risk

Uncovered Interest Rate Parity Condition. It is helpful to start by introducing the mechanics of CT investments. Standard economic theory predicts that when the foreign country's nominal interest rate is higher than the home country's nominal interest rate, rational investors should expect a depreciation of the foreign currency to exactly offset the difference in interest rates. Therefore, the home investor should expect to earn zero profit by borrowing at home and investing in foreign bonds. However, empirical evidence points out that investors commonly make profits by investing in currencies with high interest rates. This strategy is only profitable due to UIP violations that generate investment opportunities in the foreign exchange market (see, e.g., Fama (1984), Evans and Lewis (1995), Lustig and Verdelhan (2007)).[39] The excess return, RX_{t+1}, obtained by buying a unit of foreign currency in the forward market at t and subsequently selling it in the spot market at $t+1$ is given by:

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

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 home currency. An increase in s_t represents an appreciation of the home currency. An alternative definition of currency excess return is as follows: $RX_{t+1} \equiv f_t - s_t - \Delta s_{t+1}$. Generally, forward exchange rates satisfy the Covered Interest Rate Parity (CIP) condition: $f_t - s_t \approx i_t^* - i_t$, where i_t^* and i_t are the foreign and

[39] The literature has suggested several risk factors associated with the non-diversifiable risk of foreign exchange investments (Lustig and Verdelhan, 2007; Lustig et al., 2011; Menkhoff et al., 2012a; Colacito et al., 2020).

domestic risk-free nominal interest rates, paid by a bond with the same maturity of the currency forward contract.[40] Therefore, the currency excess return is approximately equal to the interest rate differential between the foreign and home countries, net of foreign currency depreciation:[41]

$$RX_{t+1} \approx i_t^* - i_t - \Delta s_{t+1}, \tag{A.2}$$

where $\Delta s_{t+1} \approx \frac{S_{t+1}-S_t}{S_t}$. As highlighted by Gonçalves et al. (2022), CT consists of taking long positions in currencies with high nominal interest rates and short positions in currencies with low nominal interest rates. This strategy yields a positive return if the depreciation of the high-interest rate currency is not sufficient to offset the interest rate differential.

The Fisher's Relation. Given the connection between interest rate differentials and CT returns, a natural starting point for analyzing these returns is Fisher's (1930) ex-ante equation. We associate CT returns with the MPK and inflation rate differentials between countries, along with exchange rate changes. To formulate the basic argument, we follow Fisher (1930) and decompose the nominal interest rate into a real interest rate and an inflation rate:

$$r_t \equiv i_t - \mathbb{E}_t \pi_{t+1} \quad \text{and} \quad r_t^* \equiv i_t^* - \mathbb{E}_t \pi_{t+1}^*, \tag{A.3}$$

where r_t and r_t^* represent the home 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 home and foreign inflation rates, respectively. Equation (A.1.6) 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.[42] Thus, the nominal interest rate can be linked to the MPK, the depreciation rate, and inflation. The rearranged *ex-post* version of equation (A.1.6) yields the following expressions:

$$i_t \equiv MPK_t - \delta + \pi_{t+1} \quad \text{and} \quad i_t^* \equiv MPK_t^* - \delta^* + \pi_{t+1}^*, \tag{A.4}$$

where MPK_t and MPK_t^* stand for the home and foreign MPK, respectively; δ and δ^* are the respective home and foreign depreciation rate of physical capital. Note that i_t (i_t^*) and the MPK_t (MPK_t^*) are known at t; π_{t+1} (π_{t+1}^*) is the change in the general price level between t and $t+1$, whose value is revealed only at $t+1$. By combining equations (A.1.6) and (A.1.6) we obtain the following expression:

$$RX_{t+1} \approx (MPK_t^* - MPK_t) + (\pi_{t+1}^* - \pi_{t+1}) - \Delta s_{t+1}. \tag{A.5}$$

where we assume that $\delta = \delta^*$ to preserve the parsimony of our analysis. In light of equation (A.1.6), a possible explanation for 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 (A.1.6) worth highlighting. First, although this equation is an *ex-post* expression of currency excess returns, in reality π_{t+1} is not know by domestic agents at t. This implies that real currency excess return, which is what matters to investors, is unknown at t, even if there is no change in the exchange rate. Therefore, there is a risk associated with changes in prices between period t and $t+1$. Second, if $\Delta s_{t+1} = 0$, currency excess returns are given by the difference between foreign and home nominal interest rates. Otherwise, the magnitude of currency excess returns depends on the growth rate of exchange rates. Third, currency excess returns decrease with: i) the reduction of the MPK differential and the inflation rate differential between the foreign and home country; and ii) the appreciation of the home currency. These three aspects are crucial because, in our model, the macroeconomic shocks that influence business cycle fluctuations and currency excess returns also impact inflation, exchange rates, and nominal interest rates across countries.

In our model, the fundamental determinants of inflation, exchange rates, and interest rates are investment and money demand shocks. Therefore, it is natural to expect that these shocks can also explain the behavior of CT returns. A combination of investment-specific technology (IST), marginal efficiency of investment (MEI), and money

[40] Throughout this thesis, we use the asterisk superscript to denote variables and parameters of the foreign economy.

[41] It is important to point out that the CIP typically holds until the outbreak of the GFC but its deviations have increased since then (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., 2020).

[42] Note that market power can create a wedge between the MPK and the real interest rate. However, market power is not observable. Recent literature has chosen the least dubious measure to investigate market power: the markup over marginal cost. Different methodologies have been applied to obtain empirical estimates (Hall, 2018; De Loecker et al., 2020). However, as emphasized by Basu (2019), the estimates reported by the literature cannot be reconciled with patterns found in recent US data. The author shows why many studies find implausible markup estimates. The main reasons are the unreal assumptions applied by the authors, the implausible estimation procedures, and the difficulty in calculating the values of variables necessary to compute the markup (e.g., economic profits, market value of capital, etc.). Consequently, recent empirical estimates vary substantially across studies. Basu (2019) shows that the markup estimates found in the literature would imply: i) a much larger increase in markups than would be necessary to explain the reduction in labor share; ii) negative technological progress in the US in recent decades; iii) that about 70% of US GDP is derived from pure economic profit; and iv) an increase, rather than a decrease, in US inflation rate over 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.

demand (MON) shocks can drive changes in inflation, exchange rates, and interest rates which can help explain short-term fluctuations and the long-term trend of CT returns.

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

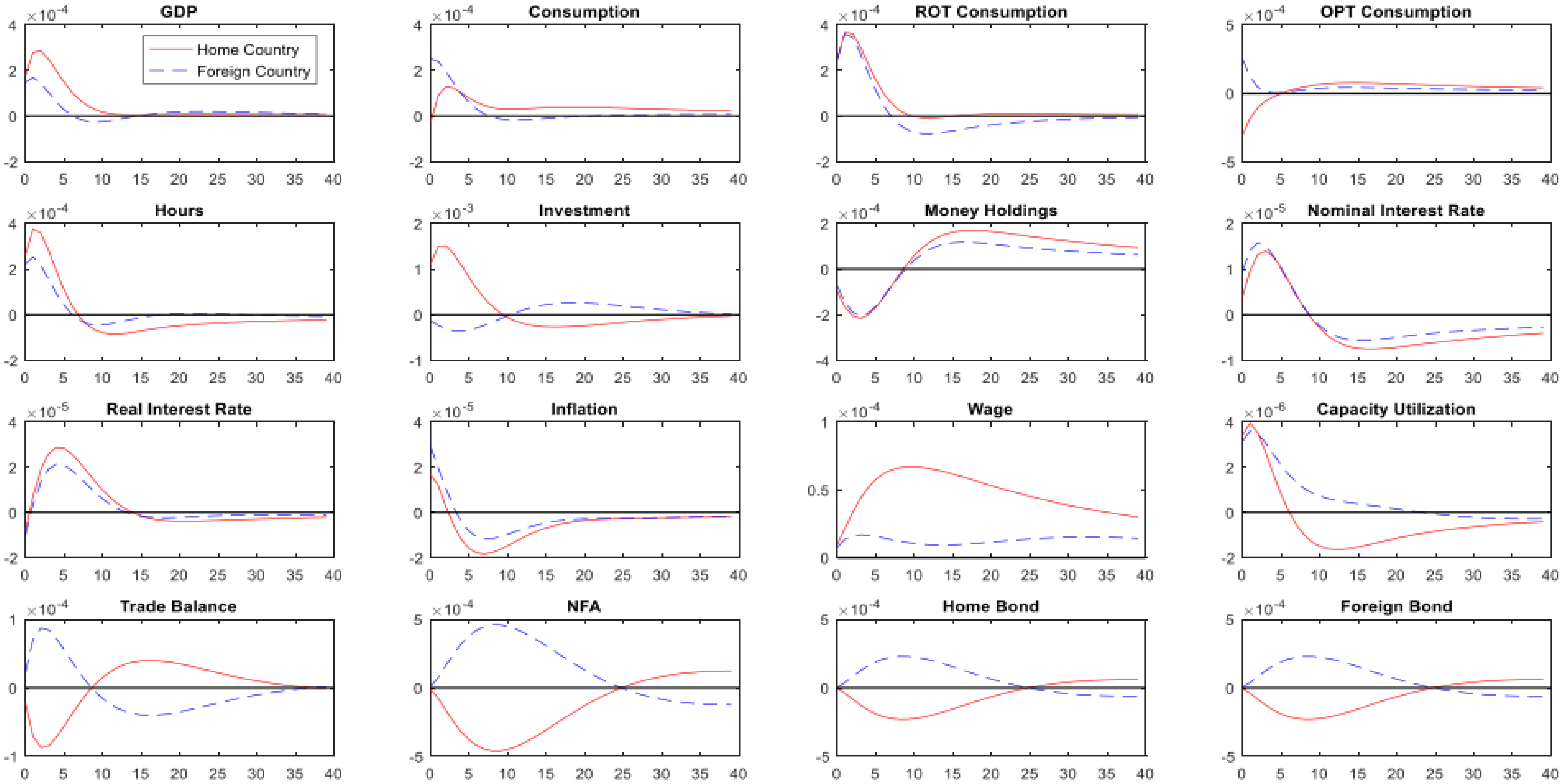

Figure 13: Responses to the local IST shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local IST process.

A.3.2 Local MEI Shock

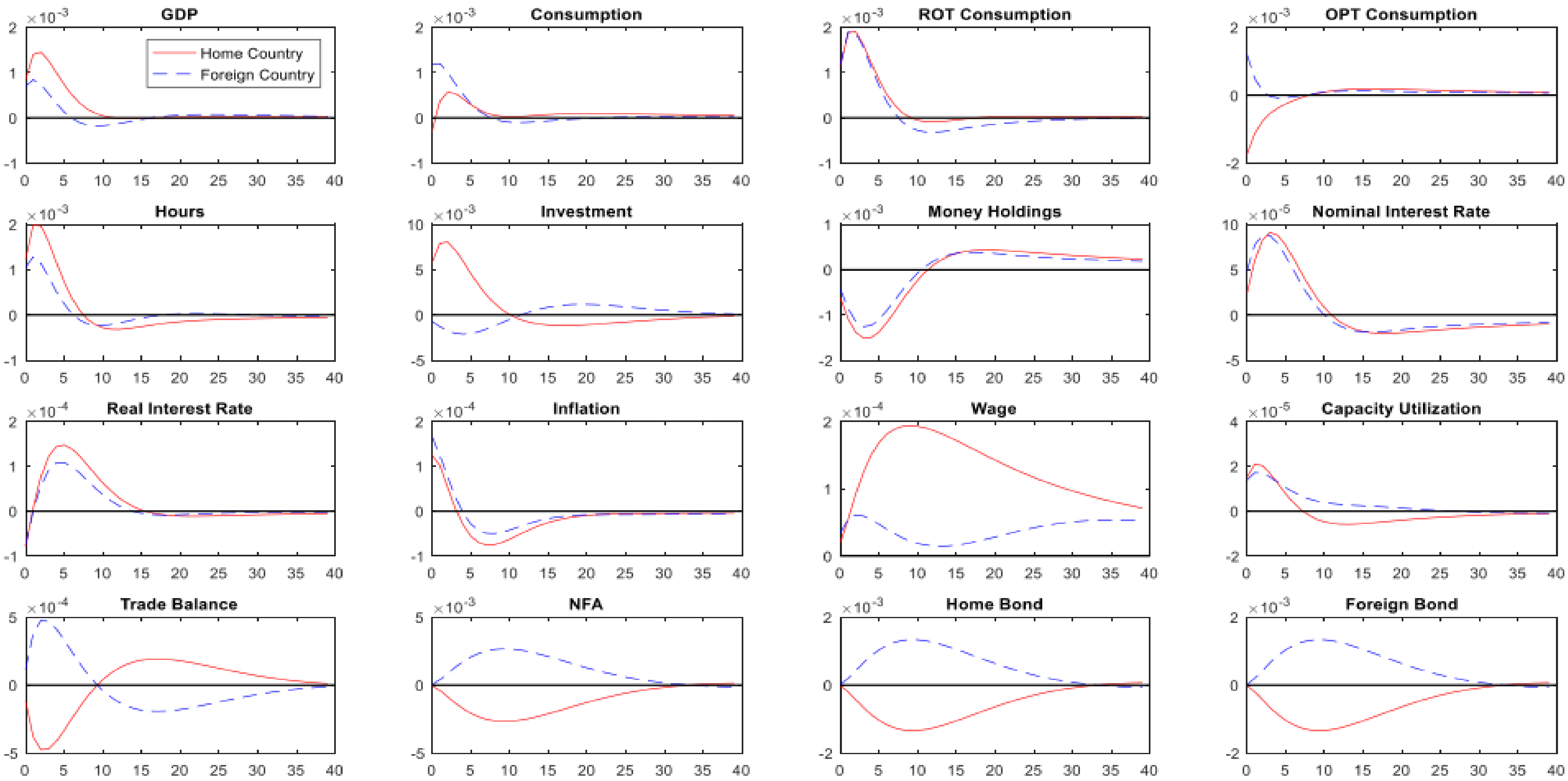

Figure 14: Responses to the local MEI shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MEI process.

A.3.3 Local MON Shock

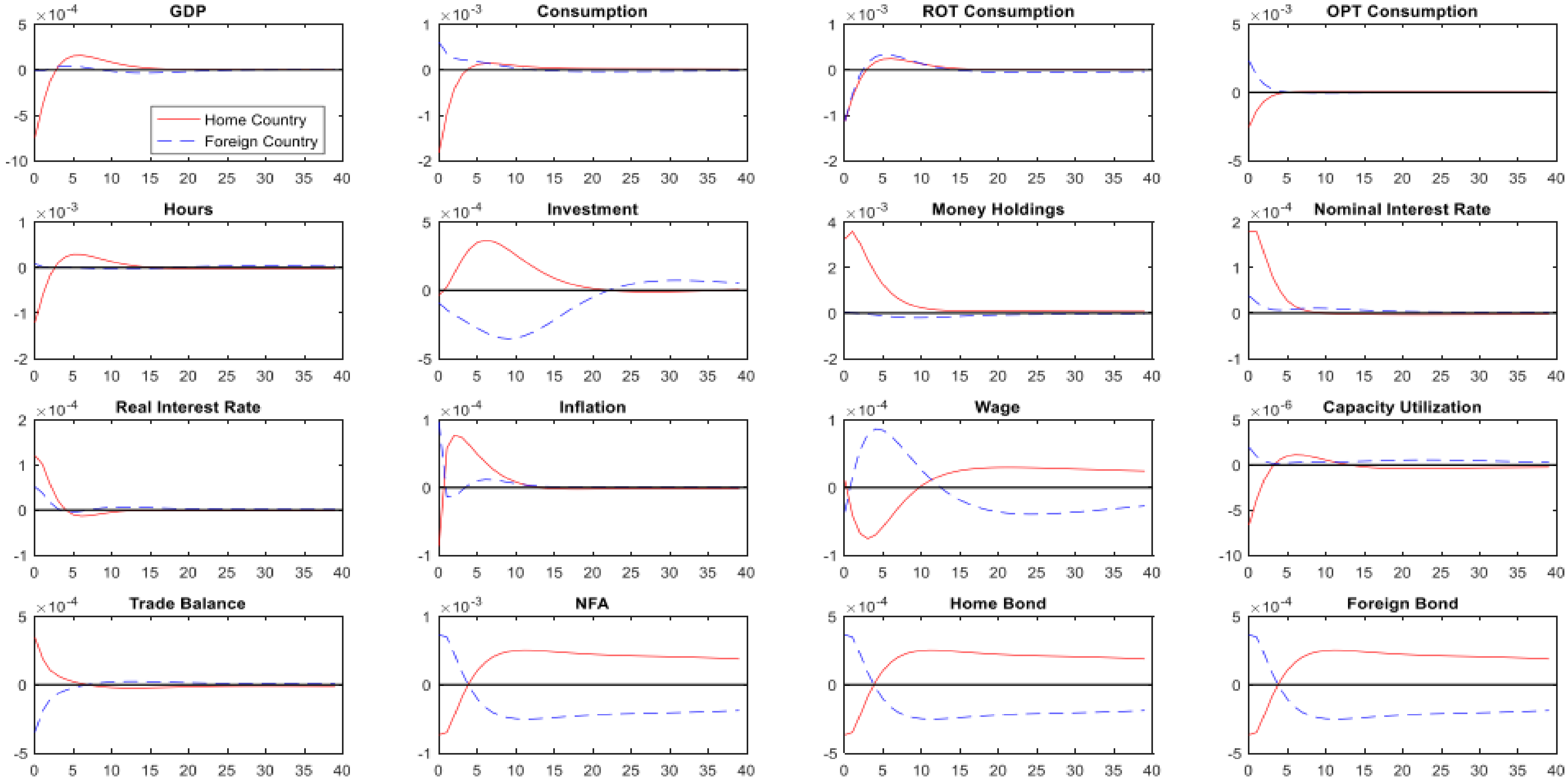

Figure 15: Responses to the local MON shock. The figure shows the Impulse Response Functions of a selected set of variables to an exogenous one standard deviation shock in the local MON process.

A.4 Asset Pricing Exercises - Currency Markets

A.4.1 Time-series Estimates

Table 6
Currency Portfolio Betas: Fundamental Risk Factors

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.4.2 Cross-sectional Estimates

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.5 Asset Pricing Exercises - Stock Markets

A.5.1 Stock Market Indices Return Behavior

Equity excess returns are computed according to equation (A.1.6), but the US investor always buys the foreign country stock index and not the foreign bond, regardless of the nominal interest rates in both countries. Therefore, equity excess returns from investing in foreign country stock indices are net of exchange rate depreciation. To complement our analysis, we also explore the behavior of simple equity returns computed from the same foreign country stock indices. It is worth mentioning that the payoff of the first investment is denominated in US dollars. Thus, its return is sensitive to the correlation between the foreign currency and the foreign stock index. On the other hand, the simple equity return arises from a foreign-currency-denominated claim on the foreign stock market index. In the following, to ease of comparison, we will refer the first type of excess return as "excess returns" and the foreign-currency-denominated claim on the foreign stock market index as "returns", despite the fact that both represent excess returns from a US investor's perspective.

We implemented two additional adjustments to 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 entry months into the Eurozone. Data on stock market indices come from two data sources: Investing.com and Yahoo Finance. The set of foreign country stock market indices consists of the main stock index of each of the following fifty-two countries:

1. Investing.com - DSE30 (Bangladesh, 2013:M01-2019:M12), S&P/TSX (Canada, 1985:M01-2019:M12), S&P CLX IPSA (Chile, 1993:M09-2019:M12), COLCAP (Colombia, 1998:M01-2019M12), CROBEX (Croatia, 2001:M01-2019:M12), PX (Czech Republic, 2012:M01-2019:M12), OMX20 (Denmark, 2001:M02-2019:M12), Guayaquil Select (2011:M11-2019:M12), EGX30 (Egypt, 1998:M01-2019:M12), OMX Helsinki 25 (Finland, 2001:M03-2019:M12), CAC40 (France, 1987:M07-2019:M12), Athenas General Composite (Greece, 2013:M10-2019:M12), Budapest SE (Hungary, 2011:M03-2019:M12), ICEX Main (Iceland, 2001:M01-2019:M12), Vilnius SE General (Lithuania, 2000:M01-2019:M12), S&P/BMV IPC (Mexico, 1987:M01-2019:M12), Moroccan All Shares (Morocco, 2002:M01-2019:M12), AEX (Netherlands, 1985:M01-2019:M12), NZX50 (New Zealand, 2001:M01-2019:M12), Oslo OBX (1999:M09-2019:M12), PSI (Portugal, 2010:M09-2019:M12), BET (Romania, 2010:M02-2019:M12), MOEX (Russia, 1997:M09-2019:M12), Tadawul All Shares (Saudi Arabia, 1998:M10-2019:M12), Belex 15 (Serbia, 2012:M12-2019:M12), SAX (Slovakia, 2011:M10-2019:M12), Blue-Chip SBITOP (Slovenia, 2006:M06-2019:M12), South Africa Top 40 (South Africa, 1995:M06-2019:M12), KOSPI (South Korea, 1985:M01-2019:M12), IBEX35 (Spain, 1991:M09-2019:M12), CSE All-Shares (Sri Lanka, 1993:M06-2019:M12), OMXS30 (Sweden, 1986:M09-2019:M12), SMI (Switzerland, 1988:M01-2019:M12), SET (Thailand, 1985:M01-2019:M12), Tunindex (Tunisia, 1998:M01-2019:M12), BIST100 (Turkey, 1995:M01-2019:M12), PFTS (Ukraine, 1997:M10-2018:M12); and

2. Yahoo Finance - S&P/ASX200 (Australia, 1992:M11-2019:M12), BEL20 (Belgium, 1991:M04-2019:M12), IBOVESPA (Brazil, 1994:M03-2019:M12), DAX (Germany, 1987:M12-2019:M12), Hang Seng (Hong Kong, 1987:M01-2019:M12), S&P BSE Sensex (India, 1997:M07-2019:M12), IDX Composite (Indonesia, 1990:M04-2019:M12), ISEQ ALL Shares (Ireland, 1997:M07-2019:M12), TA-125 (Israel, 1992:M10-2019:M12), Nikkei225 (Japan, 1985:M01-2019:M12), FTSE Bursa KLCI (Malaysia, 1993:M12-2019:M12), S&P/BVL Peru General TR (Peru, 1997:M03-2019:M12), STI (Singapore, 1988:M01-2019:M12), PSEi (the Philippines, 1987:M01-2019:M12), FSTE100 (the United Kingdom, 1985:M01-2019:M12).[43]

Following Asness et al. (2013), we also used foreign country stock indices obtained from Morgan Stanley Capital International (MSCI).[44] The set of country equity indices covers forty-one economies spanning the following periods: Australia (1985:M01-2019:M12), Austria (1985:M01-2019:M12), Belgium (1985:M01-2019:M12), Brazil (1998:M01-2019:M12), Canada (1985:M01-2019:M12), Chile (1995:M01-2019:M12), Colombia (1990:M01-2019:M12), Czech Republic (1995:M01-2019:M12), Denmark (1985:M01-2019:M12), Egypt (1995:M01-2019:M12), Finland (1985:M01-2019:M12), France (1985:M01-2019:M12), Germany (1985:M01-2019:M12), Greece (1985:M01-2019:M12), Hong Kong (1985:M01-2019:M12), Hungary (1995:M01-2019:M12), Italy (1985:M01-2019:M12), India (1993:M01-2019:M12), Indonesia (1993:M01-2019:M12), Ireland (1988:M01-2019:M12), Israel (1993:M01-2019:M12), Japan (1985:M01-2019:M12), Malaysia (1993:M01-2019:M12), Mexico (1993:M01-2019:M12), Netherlands (1985:M01-2019:M12), New Zealand (1985:M01-2019:M12), Norway (1985:M01-2019:M12), Peru (1998:M01-2019:M12), Portugal (1988:M01-2019:M12), Poland (1994:M01-2019:M12), Saudi Arabia (2005:M06-2019:M12), Singapore (1985:M01-2019:M12), South Africa (1993:M01-2019:M12), South Korea (1993:M01-2019:M12), Spain (1985:M01-2019:M12), Sweden (1985:M01-2019:M12), Switzerland (1985:M01-2019:M12), Thailand (1988:M01-2019:M12), the Philippines (1993:M01-2019:M12), the United Kingdom (1985:M01-2019:M12), and Turkey (1988:M01-2019:M12).

Figure (16) displays the evolution of the 10-year moving average of equity excess returns and equity returns by country groups (All, Developed, Developing, and G10). In all panels of this figure, the left axis represents values for the All and Developing country groups, while the right axis represents values for the Developed and G10 country groups. Two main results emerge from Panels (a) and (b) of the figure. First, most of the time, US investors realize greater equity excess returns when they invest in developing countries compared to Developed and G10 countries. Second, average excess returns fluctuate without a clear trend. On the other hand, Panels (c) and (d) reveal the existence of a downward trend in average stock returns. As we can see in Panel (c), average returns fall from around 12% p.a. (1994) to about 8% p.a. (2019) in Developed and G10 countries. Similarly, average returns decline from around 30% p.a. (1994) to about to 8% p.a. (2019) in developing countries. The downward trend is even stronger when we consider the MSCI indices (see Panel (d)). This result indicates that CT investment is not a particular case of the downward trend in returns observed in recent decades.

[43]Due to data availability, we considered the period from 1985:M01 onwards in our analysis. Note that some stock market indices are available on both Investing.com and Yahoo Finance. In these cases, we chose the source with the longest time coverage.

[44]MSCI is an investment research firm that provides stock indices and various analytical tools for asset investment. The MSCI country stock indices are market capitalization weighted indices that track the performance of large and mid-cap firms in each country.

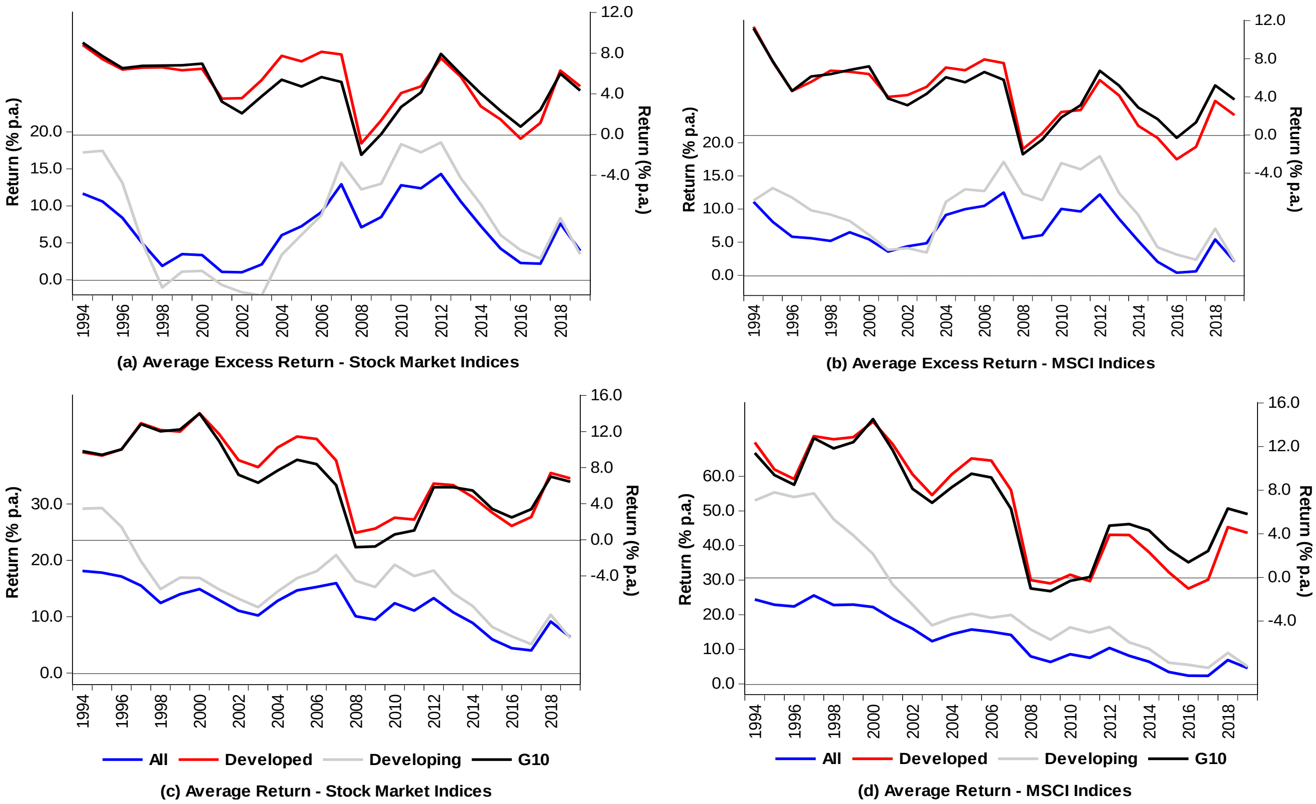

Figure 16: Behavior of Stock Market Indices. The figure shows the evolution over time of the 10-year moving average of the foreign stock indices' excess returns (panels (a) and (b)) and the foreign stock indices' returns (panels (c) and (d)). To obtain the 10-year moving average values, we first computed the cross-sectional mean of the monthly data for each group of countries (All, Developed, Developing, and G10). Then, we used these values to calculate the the 10-year moving average. In all panels of this figure, the left axis represents values for the All and Developing groups, while the right axis represents values for the Developed and G10 groups. The monthly stock indices excess' returns and stock indices' returns are annualized (multiplied by twelve). The sample period is 1985-2019.

A.5.2 Cross-sectional Estimates

Foreign Stock Index Portfolios. In the empirical exercises, we work with monthly returns, covering the period between 1985:M01 and 2019:M12. We perform our analysis for our two datasets separately. Thus, we conduct two asset pricing exercises. The first for portfolio returns derived from foreign stock market indices and the second for portfolio returns derived from MSCI indices. This choice is motivated by differences in the sample of countries and coverage time between the two databases. We compute real equity excess returns as follows:

$$RX^j_{t+1} \equiv \left\{ \left[(1+e_{jt}) \left(\frac{S_{jt+1}}{S_{jt}} \right) - (1+i_t) \right] \left(\frac{P_t}{P_{t+1}} \right) \right\}, \tag{A.6}$$

where RX^j_{t+1} is the real *ex-post* equity excess return obtained by an investor who borrow at the US nominal interest rate and invest in a stock market index of country j, considering that both trades are closed at t; e_{jt} represents the end-of-period return of the stock market index; S_{jt} denotes the end-of-period exchange rate of country j in level; and P_t is the US CPI. The moments of returns are annualized: we multiply the mean of the monthly data by 12 and standard deviation by $\sqrt{12}$.

To assess the explanatory power of our risk factors in the stock market without considering the effect changes in exchange rates, we also compute simple equity excess returns as follows:

$$RX^j_{t+1} \equiv \left\{ [(1+e_{jt}) - (1+i_t)] \left(\frac{P_t}{P_{t+1}} \right) \right\}. \tag{A.7}$$

We call the excess return obtained from equation (A.5.2) "excess returns" and the excess return obtained from equation (A.5.2) "returns". As emphasized above, "excess returns" come from investments in assets that are sensitive to the correlation between the foreign currency and the foreign stock index. These are dollar-denominated claims on the foreign stock index. On the other hand, "returns" are foreign-currency-denominated assets in the foreign stock index.

We employed two strategies to build our equity portfolios. First, we used the values of the IST, MEI, and MON processes, proxied by the relative price of investment, the Index of Financial Development (IFD) developed by the IMF (Svirydzenka, 2016), and the growth rate of M1 and M3. Second, we used the values of country's exposure to the global component of each shock process.

Cross-sectional Regressions. To analyze the cross-sectional properties of equity excess returns (equity returns), we followed the same strategy applied in the analysis of currency excess returns. We built twenty-four test assets ("momentum", "value" and "volatility") and used them as test assets in our empirical analysis, alongside six portfolios sorted by the IST values, six by the MEI values, six by M1 growth rates and six by M3 growth rates. Therefore, our test asset set comprises 48 equity portfolios. Due to the methodology used to obtain the "value" portfolios, we have to restrict our empirical analysis between 1990:M08 and 2019:M12. We work with a two and three-factor SDF. We ran our estimations with the RX factor combined with one or two factors (HML^{ist}, HML^{mei}, HML^{mon1} and HML^{mon3}). In what follows, the tables report the results from the Fama and MacBeth (1973) two-pass procedure used to estimate the market price of risk associated with our proposed risk factors. We report the results for two sample periods: from 1990:M08 to 2019:M12 and from 2000:M01 to 2019:M12. This choice is motivated by the presence of missing data for the period before 2000 (especially in the Investing.com and Yahoo Finance dataset) which can have a significant impact on our estimates. Therefore, we also report results for a period with a more complete dataset between 2000:M01 and 2019:M12.

Table (9) presents the results of our asset pricing exercises for the "excess returns" and Table (10) presents the results for the "returns" computed according to equation (A.5.2). The tables indicate that our three factors are priced in the cross-section of equity portfolios. Overall, the prices of risk associated with the IST, MEI, and MON risk factors are positive and statistically significant. This implies that stock market indices from countries with low IST/MEI values and high M1/M3 growth rates earn higher excess returns on average.

Panels (a) and (b) in Table (9) show that λ^{ist}_{HML} has positive and statistically significant coefficients ranging from 2.72% to 10.64%. The adjusted R^2s reach values between 0.12 and 0.57. The λ^{mei}_{HML} has positive and statistically significant coefficients ranging from 8.79% to 9.48%. The adjusted R^2s reach values between 0.54 and 0.58. The λ^{mon1}_{HML} has positive and statistically significant coefficients ranging from 7.68% to 8.47%. The adjusted R^2s reach values between 0.26 and 0.33. On the other hand, the other variable used to proxy for the MON process, the M3 growth rate, has positive and statistically significant risk prices ranging from 6.45% to 8.21%. The adjusted R^2s reach values between 0.08 and 0.57. Note that the results for the period 2000:M01 to 2019:M12 reports a greater number of statistically significant estimates and higher adjusted R^2. Overall, when statistically significant, the risk price estimates from this period are higher than those presented in Panel (a) of the table.

Two main results emerge from Panels (a) and (b) in Table (10). First, both the two and three-factor SDF models do well in explaining returns from foreign-currency-denominated stock indices. Overall, we observe statistically significant risk prices and a satisfactory cross-sectional fit in terms of adjusted R^2s. Second, as expected, most of the estimated *risk premia* are greater than those obtained for returns on dollar-denominated foreign stock indices. This reflects the effect of exchange rate variation on these latter investments.

We conducted identical estimation exercises using portfolios constructed from the MSCI indices. The results confirmed the findings presented in Tables (9) and (10). However, there was a notable rise in the number of statistically significant coefficients linked to our proposed risk factors and an improvement in the model fit, as indicated by the adjusted R^2s. This enhancement could be attributed to the more comprehensive database of MSCI indices (these results are not reported but are available from the authors upon request).

We also applied the country's exposure to the global component of each shock process to build the portfolios. In this case, the test assets included forty-eight portfolios: six sorted by countries' exposure to the global component of the IST values, six by countries' exposure to the global component of MEI values, six by countries' exposure to the global component of M1 growth rate, six by countries' exposure to the global component of M3 growth rate, six by past three-month equity excess returns (equity returns), six by past one-year equity excess returns (equity returns), six by past five-year equity returns and six by countries' exposure to global stock market 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.

Overall, the results provide weaker evidence on the explanatory power of the risk factors associated with countries' exposure to the global component of the shock processes. However, we find some favorable evidence regarding the explanatory power of the risk factors for foreign-currency-denominated stock market indices. We find positive and statistically significant risk prices. This indicates that stock indices from countries with low exposure to these global components earn higher returns on average. For example, our results reveal that, for foreign-currency-denominated stock market indices, the λ^{ist}_{HML} has statistically significant coefficients ranging from 4.91% to 5.70% with an adjusted R^2 equals to 0.14. The λ^{mei}_{HML} has statistically significant coefficients ranging from 4.66% to 7.30%. The adjusted R^2s reach values between 0.21 and 0.29. The λ^{mon1}_{HML} has statistically significant coefficients ranging from 4.43% to 6.75%. The adjusted R^2s reach values between 0.24 and 0.29 (these results are not reported but are available from the authors upon request).

Table 9
Asset Pricing Tests: Excess Returns (Market Indices)

The Table presents the results for equity portfolios sorted based on time $t-1$ information. The test assets include forty-eight portfolios: six sorted by the IST values, six by the MEI values, six by M1 growth rates, six by M3 growth rates, six by past three-month equity excess returns, six by past one-year equity excess returns, six by past five-year equity returns and six by countries' exposure to global stock market volatility. The set of pricing factors includes the RX, HML^{ist}, HML^{mei}, HML^{mon1}, and the HML^{mon3}. Note that a, b, c and d denote statistical significance at the 1%, 5%, 10%, and 15% levels.

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}	R^2	λ_{RX}	λ_{HML}^{ist}	λ_{HML}^{mei}	λ_{HML}^{mon1}	λ_{HML}^{mon3}	R^2
Panel (a): 1990:M8-2019:M12											
5.52^c	4.05				0.12	5.49^c	3.11				0.17
5.55^c		3.15			0.14	5.54^c		2.85			0.18
6.01^c			8.47^c		0.26	5.96^c			8.04^c		0.27
5.92^c				7.51^d	0.19	5.89^c				6.68^d	0.18
5.55^c	3.35^b	3.13			0.12	5.53^c	2.52	2.74			0.22
5.41	2.72^a		8.21^c		0.26	5.40^d	2.27		7.94^c		0.33
5.43^a	2.46			7.60^c	0.18	5.42^a	2.10			6.64^d	0.24
5.45^d		1.72	7.80^c		0.27	5.46^d		2.00	7.68^c		0.33
5.46^a		1.96		7.17^d	0.18	5.47^d		2.15		6.45^d	0.22
Panel (b): 2000:M01-2019:M12											
6.03^d	10.64^a				0.43	6.00^d	9.24^a				0.42
6.36^d		9.19^a			0.54	6.37^d		9.48^a			0.57
6.37			4.50		-0.02	6.35			3.19		0.02
6.40				8.21^c	0.07	6.39^d				7.73^c	0.08
6.32^d	8.01^b	8.79^a			0.54	6.35^d	7.81^a	9.27^a			0.57
6.07^d	11.03^a		1.32		0.43	6.02^d	9.38^a		1.86		0.45
6.06^d	10.87^a			4.97	0.43	5.99^d	9.27^a			6.25^d	0.41
6.35^d		9.13^a	2.48		0.54	6.36^d		9.45^a	2.26		0.58
6.31^d		8.97^a		5.91	0.54	6.32^d		9.36^a		6.68^c	0.57

Table 10
Asset Pricing Tests: Returns (Market Indices)

The Table presents the results for equity portfolios sorted based on time $t-1$ information. The test assets include forty-eight portfolios: six sorted by the IST values, six by the MEI values, six by M1 growth rates, six by M3 growth rates, six by past three-month equity returns, six by past one-year equity returns, six by past five-year equity returns and six by countries' exposure to global stock market volatility. The set of pricing factors includes the RX, HML^{ist}, HML^{mei}, HML^{mon1}, and the HML^{mon3}. Note that a, b, c and d denote statistical significance at the 1%, 5%, 10%, and 15% levels, respectively.

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}	R^2	λ_{RX}	λ_{HML}^{ist}	λ_{HML}^{mei}	λ_{HML}^{mon1}	λ_{HML}^{mon3}	R^2
Panel (a): 1990:M8-2019:M12											
7.59^a	11.57^a				0.58	7.50^a	9.52^a				0.54
7.63^a		9.77^a			0.53	7.59^a		8.95^a			0.52
7.82^a			16.27^a		0.57	7.76^a			14.33^a		0.59
7.76^a				15.91^a	0.60	7.68^a				12.94^a	0.57
7.59^a	11.58^a	7.29^b			0.57	7.55^a	9.12^a	7.47^b			0.54
7.39^a	9.43^a		13.50^a		0.70	7.33^a	8.20^a		13.17^a		0.71
7.42^a	9.41^a			14.03^a	0.65	7.37^a	7.97^a			11.89^a	0.63
7.42^a		7.39^b	13.68^a		0.71	7.42^a		7.62^b	13.10^a		0.73
7.43^a		7.28^b		14.37^a	0.65	7.44^a		7.54^b		12.05^a	0.64
Panel (b): 2000:M01-2019:M12											
6.54^b	15.24^a				0.53	6.44^b	12.24^a				0.50
6.70^b		12.49^a			0.59	6.69^b		12.32^a			0.62
6.49^c			8.83^b		0.04	6.46^c			6.69^c		0.03
6.47^c				11.55^a	0.13	6.45^c				10.57^a	0.08
6.68^b	11.49^a	11.76^a			0.59	6.66^b	9.88^a	11.85^a			0.62
6.51^b	14.99^a		5.76^d		0.53	6.41^b	12.08^a		5.40^d		0.49
6.48^b	14.74^a			8.24^b	0.54	6.37^b	11.90^a			8.97^a	0.51
6.66^b		12.25^a	5.50		0.59	6.66^b		12.19^a	5.22^d		0.62
6.62^b		12.03^a		8.01^b	0.61	6.61^b		12.04^a		8.86^b	0.64