Trend Shocks, Risk Sharing and Cross-Country Portfolio Holdings

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January 2012

This paper analyzes the dynamics of risk premia, real exchange rates and portfolio movements in a two-country, two-good, two-bond model. We use an asymmetric set-up in the model, where one of the countries is emerging and the other one is developed and both countries issue bonds in domestic currency. The emerging country differs from the developed country in that it is subject to trend shocks and it is more risk averse. We find that the trend shocks produce strong wealth effects for the emerging country, and as a result, the terms of trade and the real exchange rate appreciate. Appreciation of the terms of trade breaks the hedging opportunities coming from international trade in goods. In contrast, the appreciation of the real exchange rate generates new hedging opportunities in international financial markets for both countries. Therefore, our model can endogenously generate large portfolio holdings. And differences in the risk aversion across countries lead to net positive foreign asset positions and significant risk premia in the emerging country. Moreover, the relative volatilities and cyclicalities of risk premia and real exchange rates improve significantly and move closer to the observed values in the data and our model can account for the lack of international risk sharing.

Key words: Risk sharing, Risk premium, Exchange rates, Trend shocks, Portfolio movements

JEL Codes: F34, F41, F44, G15

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1 Introduction

In this paper, we analyze the effects of trend shocks and preference heterogeneity on the portfolio movement, risk premia and real exchange rates in a two-country, two-good, two-bond world economy model. We incorporate three features into an otherwise standard two-country, two good model. First, we assume that the emerging country receives trend shocks, i.e., shocks that affect the growth rate of productivity as in Aguiar and Gopinath (2007). Second, to study the asset pricing and portfolio choice implications of the model, we assume that both countries issue their own bonds. Third, we assume that there is a preference heterogeneity similar to Guvenen (2009). In particular, in our model the developed country is less risk averse than the developing country. We show that the model is successful in matching some key aspects of the international data that proved hard to match in the previous literature. On the financial side, countries hold large amounts of foreign assets similar to the data. In addition, the emerging country's bond premium that the model generates is large, countercyclical and has a high volatility, as in the data.[1] On the real side, the model implies imperfect risk sharing and the volatility of the real exchange rate implied by the model is three times as volatile as output, which matches the data.

To illustrate the mechanism of the model, we first show that if there are only transitory shocks (even with preference heterogeneity), movements in portfolios and risk premiums are very limited. Production sharing and international trade in goods between countries provide a very good hedge against the production risk. When there is a positive transitory shock to the emerging country tradable goods, implying an increase in the supply, the price of this good decreases and the terms of trade (ToT) depreciate. Cheaper inputs in the emerging country help the producers in the developed country to increase their production and consequently there is a high level of risk sharing between countries. Since international trade in goods provides enough of a hedge against production risk, countries do not need international asset markets very much. As a result, there are low levels of portfolio holdings coupled with very low levels of volatility in real exchange rates and spreads.

[1] We use both "bond premium" and "risk premium" when we discuss the return differential between the emerging and the developed country's bonds.

We then show that if there are trend shocks coupled with preference heterogeneity, the risk sharing between countries is impaired and countries hold large amounts of international assets in their portfolios and use international financial markets for hedging purposes. This leads to high levels of volatility in real exchange rates and spreads comparable to the data. The mechanism in the trend shocks case is as follows: When there is a trend shock, emerging country's households expect high levels of income in the current period but even higher levels of income in future periods. The resulting higher level of permanent income or the wealth effect leads the households in the emerging country to increase their net borrowing in the financial markets and demand more of the current period goods. This wealth effect appreciates the ToT and the producers in the developed country are hurt by the higher level of prices in the emerging country. As a result, production sharing or international trade cannot provide risk sharing between countries. In the process, the real exchange rate of emerging country also appreciates from the wealth effect. This appreciation makes the emerging country's bonds an attractive asset for developed country. Therefore, there are high levels of portfolio holdings in the trend shocks case. Moreover, as the emerging country households decrease their net savings during a favorable trend shock, this reduced net savings, in turn, causes spreads to narrow during the boom. Hence, spreads move countercyclical to output in the model, which is consistent with the data.

Our paper contributes to several strands of the literature.[2] First, we show that as opposed to the standard multi-country models of the international economy, conditional on a trend shock our model generates low risk sharing across countries. In addition, our model implies large real exchange rate volatility comparable to the data. While some studies have been successful in matching the real exchange rate volatility, matching low risk sharing together with high real exchange rate volatility has been a challenge for researchers. Another contribution of our paper is that we study the financial implications of our framework in detail (thanks to the computational algorithm that we employ). In particular, we study the gross portfolio positions and return differentials in an incomplete market set-up where we have two bonds and short-selling constraints. We show that the model's implications for the financial side, such as the level of return differential between emerging countries and developed countries, the cyclical properties

[2] A detailed literature review with comparisons to our paper is done in the next section.

of the return differential, the volatility of the return differential and the gross portfolio holdings, are comparable to the data. Finally, we also contribute to the literature that studies the sources of fluctuations in emerging market business cycles. Our results provide additional support to the view that argues the importance of trend shocks as a potential driving force behind the emerging market business cycles.

The plan of the paper is as follows: Section 2 presents the data and the related literature. Section 3 presents the model. Section 4 presents the results with transitory shocks, and Section 5 presents the results with trend shocks. Section 6 contains some robustness analysis and Section 7 concludes. Computation details are provided in the Appendix.

2 Data and Related Literature

In Table 1, we present the business cycle properties of real variables for a group of developed and emerging countries. The first panel of the table shows that emerging country business cycles are more volatile and relative volatilities of consumption and net exports are higher in emerging countries.[3] The relative volatility of real exchange rates[4] is around 3 and of the spread is around 1 for both developed and emerging countries. In the second panel, we present the correlations of real variables with domestic output or U.S. output. We see that the correlation between output in the US and in the emerging country is close to zero, and the correlation between consumption in the US and in the emerging country is negative. Net exports are countercyclical in both country groups. However, there are stark differences in the correlations for real exchange rates and spreads. Real exchange rates are strongly procyclical in emerging countries, i.e. in good times domestic currency appreciates. In contrast, real exchange rates in developed countries are slightly countercyclical. There is a significant difference in the cyclicality of spreads also. Spreads in emerging countries are strongly countercyclical, whereas they are slightly procyclical in developed countries.

[3]Relative with respect to the volatility of output.

[4]We define terms of trade, ToT, from the perspective of the emerging market, as the ratio of its export prices to its import prices; and the real exchange rate, ReR, as the ratio of the emerging country's final goods prices to the developed country's final goods prices

Standard open economy models face some difficulties in accounting for several of these properties as explained below. Even though real variables are studied more frequently in the literature, financial variables are not that studied much. In Table 2, we present the international asset positions of the countries that we obtain by using yearly data between 1990 and 2007 from Lane and Milesi-Ferretti (2007). The first panel of the table presents the international asset positions, and the second panel presents the asset positions excluding foreign direct investment and equity flows of the countries during the 1990s and the 2000s. Figures 1 to 4 present the gross and net portfolio assets of emerging and developed countries. The latest number for gross portfolio holdings is around 70 percent of output for emerging countries as shown in Figure 1 and around 250 percent for developed countries as shown in Figure 3. Latest number for net portfolio holdings is close to 20 percent of output for emerging countries as shown in Figure 2 and is around -20 percent for developed countries as shown in Figure 4. Two points stand out as important dimensions of the international financial markets. First, both emerging and developed countries hold large portfolio positions. Second, emerging countries have a positive net asset position whereas developed countries have a negative net asset position.

Multi-country models of the international economy have been commonly used to address the several features of the world economy since the work of Backus, Kehoe and Kydland (1992, 1995). A standard multi-country model implies a high level of risk-sharing among countries and there is not much holding of foreign assets. For example, Cole and Obstfeld (1991) find that the welfare gains from international financial markets are very small if there is specialization in the production of goods among countries. A productivity shock in one country causes a depreciation in its terms of trade (ToT) and real exchange rate (ReR). Hence, a positive shock in one country is transmitted to the other through the terms of trade channel, providing a natural hedging against production risk in the other country. As a result, this mechanism generates a high level of risk sharing and gains from international financial markets are very small. However, empirical findings point out a low level of risk sharing[5] among countries and large holdings of international financial assets (in Table 2 we find that both developed and emerging countries hold significant amounts of gross portfolios). In Table 1, we see that the correlation between

[5]Using bilateral data, Fitzgerald (2011) shows that financial market frictions impede optimal consumption risk sharing between developed and emerging countries.

the output in the US and in the emerging country is close to zero. We can measure the level of risk sharing also in terms of the correlation between relative consumptions and real exchange rates (or terms of trade). In Table 4, we see that this correlation for the real exchange rate (terms of trade) is 0.71 (0.52). In other words, countries consume relatively more than the rest of the world when their final (tradable) goods are more expensive. This shows the lack of risk sharing in the international markets because, with risk sharing, countries would consume less when the price of their goods is higher and the correlation between relative consumption and the real exchange rate (terms of trade) would be negative.

There have been numerous attempts in the literature to address this puzzle. For example, Corsetti et al. (2008) explain this puzzle by highlighting the wealth effects of productivity shocks using a two-country set up with tradable and non-tradable sectors. In their setting, either a combination of low trade elasticity and incomplete asset markets or a combination of high trade elasticity, persistent productivity shocks and incomplete markets is necessary to induce low risk sharing across countries. In both cases, productivity shocks cause an appreciation in the ToT and the ReR, which exacerbates rather than dampens production risk across countries and induce a low level of risk sharing. In our paper, the wealth effect coming from the trend shocks causes a mechanism similar to that of Corsetti et al. (2008). As we do not need any other source of the wealth effect from specific parameters in the model, the trade elasticities and persistence of productivity shocks that can generate realistic ToT and ReR appreciation in response to a productivity shock are much larger compared to Corsetti et al. (2008).

In addition to the low level of international risk sharing, another puzzling feature indicated by the economic data is that real exchange rates are highly volatile and very persistent in all country groups. Real exchange rates are on average three times more volatile than output in the data, as shown in Table 1. However, in two-country models, a high level of risk sharing also implies a low level of ReR volatility and persistence. There are also attempts in the literature to explain these facts. For example, employing a sticky price assumption, leisure-separable preferences and high risk aversion in an international business cycle model, Chari et al. (2002) are able to generate real exchange rates that are as volatile and persistent as in the data. But they also find that this model still implies a high level of risk sharing across countries.[6]

[6]For other papers on risk sharing and real exchange rates, see Backus and Smith (1993), Baxter and Crucini

One contribution of our paper is that high exchange rate volatility and imperfect risk sharing occur together. Actually, the mechanism that generates imperfect risk sharing in the model (trend shocks and preference heterogeneity) also helps to generate highly volatile and persistent exchange rates.

In the literature, recent studies have analyzed the financial side of open economies in more detail using different solution techniques other than linearization.[7] Some of these papers include Ghironi et al. (2009), Evans and Hnatkovska (2007), Engel and Matsumoto (2006, 2009), Devereux and Sutherland (2006, 2009), Tille and van Wincoop (2010), Pavlova and Rigobon (2007, 2009), Coeurdacier et al. (2009), and Kraay et al. (2005).[8] Also, similar to our study, some papers look at the combination of a developed-emerging country world economy. For example, Devereux and Sutherland (2009) analyze a developed-emerging country model. They compare three financial structures, ranging from no portfolio diversification to a structure close to complete asset markets (two countries trade equities and a non-contingent real bond issued by the developed country). They find that the structure, where the emerging country issues equities and the developed country issues nominal bonds, enables a high degree of risk-sharing across countries. Similar to the papers mentioned, our paper uses nonlinear methods to study the financial implications of the model in detail. Different from these papers, thanks to the interaction of preference heterogeneity with trend shocks, our model is able to generate a sizeable emerging country bond premium that is highly volatile and countercyclical as in the data. In addition, these papers focus on the financial side and are mostly silent about the implications for the real side of the economy such as real exchange rate dynamics, whereas our model closely matches the data.

Recently, Mendoza et al. (2009) and Cabellero et al. (2008) analyze the portfolio choice problem in a developed-emerging country framework. Mendoza et al. (2009) attribute observed global imbalances in portfolio choices to differing levels of domestic financial developments across countries. Cabellero et al. (2009) show that when different regions of the world differ

(1995), Benigno and Thoenissen (2008), Benigno and Küçük (2011), Burstein et al. (2005), Dellas and Stockman (1989), Dotsey and Duarte (2008), Engel and Matsumoto (2009), Heathcote and Perri (2002, 2009), Kehoe and Perri (2002), Kollmann (1995, 1996), Kose et al. (2009), Matsumoto (2007), Palacios-Huerta (2001).

[7] With linearization methods only net positions can be studied.

[8] Pavlova and Rigobon (2010) provide a summary of this so called "international macro-finance" literature.

in their capacity to generate financial assets from real investments, it is possible to rationalize the sustained rise in US current account deficits, the decline in long-run real rates, and the rise in US assets in global portfolios. While we investigate similar questions, in our model there are no differences in the financial development levels or in the capacity to generate financial assets. The difference in risk aversion and the difference in the nature of the shocks are driving forces in our model that generate global imbalances. We show that if we close either the preference heterogeneity or the trend shocks channel, the model cannot match most of the financial statistics of interest to us.

In addition to the large magnitudes of cross-border financial holdings, it has been documented that there is an emerging country bond premium that is highly volatile and countercyclical. Gourinchas et al. (2011) show that US borrows at a lower rate than it lends and that there is a significant bond premium between US bonds and emerging country bonds, which they call "exorbitant privilege." Arellano (2008) shows that if the cost of default is countercyclical, a small open economy model is able to explain the level and the volatility of the bond premium. Yue (2010) argues that if there is debt negotiation after the default, it is possible to obtain volatile bond premia.[9] One common mechanism in these models is that changes in default probabilities are crucial for the results of the papers. In our model, changes in demand and supply of two bonds affect the return on bonds, and hence the bond premia. The baseline calibration of our model generates an average bond premium of 0.83 percent compared to 1.3 in the data (Table 5). The relative volatility of the spread is 1.48 in our model and 0.83 in the data (Table 5). Besides, the spread implied by the model is countercyclical as in the data. To match the level of bond premia and the volatilities of the bond premia, it is crucial to have preference heterogeneity.[10] As the developed country becomes less risk averse, its bond supply and demand become more elastic; this elasticity, in turn, generates volatility in the bond holdings of the two countries.

We identify two mechanisms that generate the significant bond premium in the model. First, due to high uncertainty that the emerging country faces and the higher risk aversion of

[9]Mendoza and Yue (2011) write a general equilbrium model of default and business cycles and show that their model explains several features of the data.

[10]Preference heterogeneity is not necessary to match countercyclicality as can be seen in Table 6.

the emerging country, the emerging country is a net demander of the international bonds. In the equilibrium, the quantity of the developed country's bond that the emerging country holds is larger than the quantity of the bonds that the emerging country issues. As a result, the price of the developed county's bonds is lower than the emerging country's bond which implies the bond premium in the model. Second, firms in the model operate through a constant elasticity of substitution (CES) production function, which implies a constant share of inputs at the efficient allocation. Even though the emerging country is a net saver of the international bonds, because of the return differential of the two bonds, the emerging country is net exporter of the tradable endowment; a mechanism that causes inefficiency in the production process of the developed country. Hence, the developed country asks for extra return.

We also contribute to the literature that studies different properties, which emerging country business cycles exhibit compared to those of developed countries, in some respects. For example, net exports are more countercyclical in emerging countries and consumption is more volatile than output. Also, risk premia (measured by the difference in the bond returns) are countercyclical and real exchange rates are more procyclical for emerging countries. To match these stylized facts for the emerging countries, literature has resorted to analyzing different shocks, such as trend shocks in Aguiar and Gopinath (2006, 2007) and risk premium shocks in Neumeyer and Perri (2005). Garcio-Cicco et al. (2010) compare these different shocks for some emerging countries and conclude that risk premium shocks appear to be more important than trend shocks.[11] In our paper, we also analyze trend shocks for the emerging countries, but we let the risk premium[12] be determined endogenously in the model as opposed to assuming an exogenous shock process for the risk premium. The resulting risk premium in the model is countercyclical, suggesting that trend shocks and risk premium shocks are potentially interdependent processes.

In our model, preference heterogeneity in the form of different risk aversion parameters across countries is crucial.[13] In the literature some recent studies make use of preference heterogeneity,

[11] Recently, Boz, Daude and Durdu (2011) show that a model where the agents in the economy learn about the trend and transitory shocks can explain the emerging markets business cycle properties.

[12] We define the risk premium as the spread between the two country bonds.

[13] There are emprical evidence showing that risk-aversion parameter is decreasing in wealth and as agents get wealthier the share of risky assets increase. See for example, Ogaki and Zhang (2001) and Guiso et al. (1996).

similar to ours, to study several financial factors. Guvenen (2009) writes a general equilibrium model of asset pricing and shows that preference heterogeneity in the form of different elasticity intertemporal of substitution between economic agents and limited stock market participation can explain the equity premium.[14] Borri and Verdelhan (2011) use a two-country world model for developed and emerging countries. They assume trend shocks, default and a lower discount factor for emerging countries. In addition, they assume time-varying risk aversion, similar to Verdelhan (2010) for the developed country, and this assumption is important in explaining sovereign spreads. In contrast to our model, they have a higher level of risk aversion for the developed country. They get positive amounts of spread if the endowment processes of developed and emerging countries are assumed to be positively correlated. However, they find that if the endowment processes are assumed to be negatively correlated, then spreads become negative. In our model, we have a less risk-averse developed country, but the production sharing in intermediate goods leads to a negative correlation between outputs of developed and emerging countries. Therefore, with a less risk-averse developed country, we are able to generate positive spreads for the emerging country. Gourinchas et al. (2011) also use a model with heterogeneity in risk aversion. They have a two country world economy model and, similar to our set-up, assume that the developed country is less risk-averse than the emerging country and that sizes differ across countries. They find that just the variation in risk aversion or sizes alone is insufficient to generate spreads similar to the data. This finding is similar to our result that when shocks are transitory, differences in the risk aversion parameter cannot generate portfolio or spread dynamics similar to data. Then Gourinchas et al. (2011) add long-run risk to their model similar to Barro (2006) and find that long-run risk improves the model's ability to account for portfolio holdings and spreads[15]. But in the model, they do not look at the higher order moments of real and financial variables, whereas we look at both the levels and higher order moments of main economic variables, including net exports, premia, real exchange

[14]Guvenen (2009) solves the model with Epstein-Zin preferences, which enbales him to disentangle the elasticitiy of intertemporal substitution from risk aversion. In this paper we do not separate the effect of risk aversion from the elasticity of intertemporal substitution since we use CRRA utility function for computational convenience.

[15]Bansal and Yaron (2004) put long-run risk into an asset pricing model and show that it accounts for asset pricing puzzles. Colacito and Croce (2011) also use long-run risk to explain real exchange rate dynamics.

rates and portfolio holdings.

3 Model[16]

In this section, we develop a two-country and two-sector endowment economy model with bond holdings in an incomplete asset market structure. The world economy consists of two countries, one representing developed countries and the other representing emerging countries as a bloc. Countries are indexed as $i = D, E$ representing the developed country and emerging country blocs respectively. Each country is endowed with two inputs: tradable and non-tradable. Production sharing takes place in tradable inputs, so countries use both home and foreign tradable inputs to produce their respective tradable outputs. Then, they combine this tradable output with non-tradable input to produce their distinctive final goods, which will later be consumed by the households of both countries.

Our model has a structure similar to that of Backus, Kehoe and Kydland (1995), Stockman and Tesar (1995) and Corsetti et al. (2008), but, apart from these models, we introduce three main differences across countries. First, we allow the emerging country to receive trend shocks similar to Augiar and Gopinath's (2007) framework. In this setting, contrary to transitory shocks, any shock that hits the emerging country affects the growth rate of its endowment evermore. Second, we introduce heterogeneity across countries in terms of risk aversion. We assume that agents in the emerging economy are more risk averse than their counterparts in the developed economy. Third, we allow each country to issue its own bonds instead of an international bond. These main differences from a standard symmetric two-country model help us to analyze a world economy with features of both emerging and developed markets.

[16] In this section a theoretical model with shocks to tradable and nontradable endowments in both countries is specified to be general. In the numerical exercises, we give shocks one at a time or we assume a perfect correlation between shocks (either positive or negative) due to computational difficulties.

3.1 An endowment economy

At the beginning of each period, countries receive stochastic endowments of tradable and non-tradable inputs. Let $E_{i,T,t}$ and $E_{i,N,t}$ be period t stochastic tradable and non-tradable endowments. These endowments are composed of a transitory component z_t and a trend component Γ_t.

$$E_{i,T,t} = e^{z_{iE,T,t}}\Gamma_{i,T,t} \qquad and \qquad E_{i,N,t} = e^{z_{i,N,t}}\Gamma_{i,N,t}, \quad i = D, E \tag{1}$$

Transitory shocks, z_t, propagate as an AR(1) process,

$$z_{i,j,t} = \rho_z z_{i,j,t-1} + \varepsilon_{i,j,t} \tag{2}$$

where tradable and non-tradable endowments are labeled as $j = T, N$ respectively and $|\rho_z| < 1, \varepsilon_{i,j,t} \sim N(0, \sigma_z^2)$. On the other hand, trend shocks follow,

$$\Gamma_{i,j,t} = g_{i,j,t}\Gamma_{i,j,t-1} \tag{3}$$

where the growth rate of trend shocks is demonstrated as $g_{i,j,t}$, with its logarithm following an AR(1) process,

$$\ln(g_{i,j,t}) = (1 - \rho_g)\ln(\mu_g) + \rho_g \ln(g_{i,j,t-1}) + \xi_{i,j,t} \tag{4}$$

where

$$\left|\rho_g\right| < 1, \xi_{i,j,t} \sim N(0, \sigma_g^2).$$

Countries use these endowments directly in production sharing and then later in consumption. Some part of the tradable endowments are used in domestic production and the rest is exported to the other country, implying that:

$$E_{i,T,t} = X_{iD,T,t} + X_{iE,T,t} \qquad i = D, E \tag{5}$$

where the $X_{DD,T,t}$ part of the developed country's endowment $E_{D,T,t}$ is used in home production and the $X_{DE,T,t}$ part is exported to the emerging country. Similarly the emerging country uses the $X_{EE,T,t}$ part of its tradable endowment $E_{E,T,t}$ in its own home production and exports $X_{ED,T,t}$ to the developed country.

3.2 Firms' problem

We assume that there are perfectly competitive intermediate tradable good producers in each country that combine domestic and foreign tradable endowments to produce intermediate tradable goods. Intermediate tradable good producers use a constant elasticity of substitution production technology:

$$Y_{i,T,t} = \left[v_i^{\frac{1}{\kappa_i}} X_{Ei,T,t}^{1-\frac{1}{\kappa_i}} + (1-v_i)^{\frac{1}{\kappa_i}} X_{Di,T,t}^{1-\frac{1}{\kappa_i}} \right]^{\frac{\kappa_i}{\kappa_i - 1}} \qquad i = D, E \tag{6}$$

where κ_i is the elasticity of substitution between the developed country's tradable input $X_{Di,T}$ and the emerging country's tradable input $X_{Ei,T}$, and ν_i is the share of the emerging country's tradable input in country i's intermediate tradable goods production, where $v_E = 1 - v_D$. Taking the emerging country's tradable input price as the numeraire ($P_{E,T} = 1$) and denoting relative prices of developed and emerging country endowments of tradable and non-tradable inputs as $P_{D,T}$, $P_{D,N}$ and $P_{E,N}$, we can derive the tradable price index for developed and emerging countries as follows:

$$P_{i,Tradable,t} = \left[v_i + (1-v_i) P_{D,T,t}^{1-\kappa_i} \right]^{\frac{1}{1-\kappa_i}} \qquad i = D, E \tag{7}$$

Once the sharing of tradable endowments takes place and the production of intermediate tradable goods is carried out, competitive final good producers in each country combine their own intermediate tradable output with their own country's non-tradable endowments to produce final goods. Final good producers also use a constant elasticity of substitution production technology:

$$Y_{i,t} = \left[\theta_i^{\frac{1}{\eta_i}} Y_{i,T,t}^{1-\frac{1}{\eta_i}} + (1-\theta_i)^{\frac{1}{\eta_i}} E_{i,N,t}^{1-\frac{1}{\eta_i}} \right]^{\frac{\eta_i}{\eta_i - 1}} \qquad i = D, E \tag{8}$$

where η_i is the elasticity of substitution between intermediate tradable goods $Y_{i,T}$ and non-tradable endowment $E_{i,N}$, and θ_i is the share of tradable goods in the final goods production. From the optimization problem of the firm, we can derive the final goods price index as follows:

$$P_{i,t} = \left[\theta_i P_{i,Tradable,t}^{1-\eta_i} + (1-\theta_i) P_{i,N,t}^{1-\eta_i} \right]^{\frac{1}{1-\eta_i}} \qquad i = D, E \tag{9}$$

Since, in the model, international trade takes place only in tradable inputs, the final good is consumed totally in each country. This gives us the following resource constraint: $Y_{i,t} = c_{i,t}$ where $c_{i,t}$ is consumption in the country i.

For both countries there are two more relevant prices, i.e., terms of trade and real exchange rates. We define terms of trade, ToT, from the perspective of the emerging country, as the ratio of its export prices to its import prices; and the real exchange rate, ReR, as the ratio of the emerging country's final goods prices to the developed country's final goods prices:

$$ToT_t = \frac{1}{P_{D,T,t}} \quad \text{and} \quad ReR_t = \frac{P_{E,t}}{P_{D,t}} \tag{10}$$

An increase in the ToT means an improvement for the emerging country by making its export prices more expensive or it's import prices less expensive. An increase in ReR means an appreciation for the emerging country and a depreciation for the developed one.

3.3 Asset markets and budget constraints

Both developed and emerging countries issue internationally tradable bonds that pay in units of their own (final) consumption good. Both bonds share similar properties such that they are non-state contingent and have zero net supplies. After the international trade of inputs takes place, the net trade balance is given by $X_{ED,T,t} - P_{D,T,t}X_{DE,T,t}$ for the emerging country and $P_{D,T,t}X_{DE,T,t} - X_{ED,T,t}$ for the developed country. Income from the endowments in the emerging country is given by $E_{E,T,t} + P_{E,N,t}E_{E,N,t}$. This income equals final production plus net trade balance: $P_{E,t}Y_{E,t} + (X_{ED,T,t} - P_{D,T,t}X_{DE,T,t})$. Therefore, the emerging country household faces the following budget constraint:

$$P_{E,t}\ c_{E,t} + Q_{E,t}B_{E,t+1} + Q_{D,t}B_{D,t+1} = P_{E,t}Y_{E,t} + (X_{ED,T,t} - P_{D,T,t}X_{DE,T,t}) + P_{E,t}B_{E,t} + P_{D,t}B_{D,t} \tag{11}$$

where $Q_{D,t}$ and $Q_{E,t}$ are the nominal prices of the developed and emerging country bonds. As each country issues bonds in units of its final goods, the emerging country's bond, which is issued at an amount of $B_{E,t}$ at time $t-1$ at a price of $Q_{E,t-1}$, is supposed to pay $B_{E,t}$ units of

the emerging country's final good at time t. The developed country also faces a similar budget constraint. The budget constraint of the developed country household is as follows:

$$P_{D,t}c_{D,t} + Q_{D,t}B^*_{D,t+1} + Q_{E,t}B^*_{E,t+1} = P_{D,t}Y_{D,t} + (P_{D,T,t}X_{DE,T,t} - X_{ED,T,t}) + P_{D,t}B^*_{D,t} + P_{E,t}B^*_{E,t} \tag{12}$$

The real price of the developed country's bonds in its own units is $\frac{Q_{D,t}}{P_{D,t}}$, the real price of developed bonds in the emerging country's units is $\frac{Q_{D,t}}{P_{E,t}}$ and a similar expression follows for emerging country's bonds. We assume that countries cannot short their own bonds; in other words, they need to supply non-negative amounts of own bonds. This implies that $B_{D,t} \geq 0$ and $B^*_{E,t} \geq 0$. As the market clearing condition for each bond, we have the following expression: $B_{i,t}+B^*_{i,t} = 0$. Then the gross portfolio holdings are defined as $P_{E,t}B^*_{E,t}+P_{D,t}B_{D,t}$. Consequently, the net portfolio holdings of the emerging country are defined as $P_{E,t}B_{E,t} + P_{D,t}B_{D,t}$, where the negative of this expression is the net portfolio position of the developed country.

3.4 Households' problem

Representative agents in both economies have CRRA preferences over consumption of the final goods:

$$U_{i,t} = \frac{c_{i,t}^{1-\gamma_i}}{1-\gamma_i}$$

where γ_i is the risk aversion parameter for country i. Households choose the levels of the next period's emerging and developed country bonds. Hence, the dynamic programming problem of the emerging country's households is as follows;

$$V_{E,t} = \underset{B_{D,t+1},B_{E,t+1}}{Max} \{u(c_{E,t}) + \beta E_t(V_{E,t+1}(E_{E,T,t+1}, E_{E,N,t+1}, E_{D,T,t+1}, E_{D,N,t+1}, B_{D,t+1}, B_{E,t+1}))\} \tag{13}$$

In the problem, state variables are the four endowment processes and the two bonds. Similar to the emerging country's problem, the developed country's household faces the following dynamic programming problem:

$$V_{D,t} = \underset{B^*_{D,t+1}, B^*_{E,t+1}}{Max} \left\{ u(c_{D,t}) + \beta E_t(V_{D,t+1}(E_{D,T,t+1}, E_{D,N,t+1}, E_{E,T,t+1}, E_{E,N,t+1}, B^*_{D,t+1}, B^*_{E,t+1})) \right\} \tag{14}$$

3.5 Calibration

Most of the parameter values are standard and chosen from the literature. We mostly follow Corsetti et al. (2008) and Garcia-Cicco et al. (2010) to calibrate our parameters. The parameter that governs the home input share in intermediate tradables production, v, is chosen to be 0.72, which produces a home bias. The elasticity of substitution between home tradable inputs and imported tradable inputs, κ, is 3/2. The share of intermediate tradables goods in final goods, γ, is 0.55. The elasticity of substitution between tradable intermediate goods and nontradable inputs, η, is 2/5. The discount factor for households, β, is 1/1.04, implying a risk-free interest rate of 4 percent. The time period under this calibration is one year. AR(1) coefficients for shocks are taken from Garcia-Cicco et al. (2010). For the trend shocks, the autoregressive coefficient is 0.828 and for the transitory shock it is 0.765. We approximate the AR(1) processes with a two-state Markov Chain process where the transformation is done using Tauchen and Hussey (1991). The mean growth rate is assumed to be 2 percent a year. Parameters are summarized in Table 3.

The risk aversion parameter, σ, is the standard value of 2 for the emerging country. We choose a lower value of risk aversion for the developed country compared to the emerging country. In our simulations with trend shocks, a value of 1.5 for the developed country's risk aversion is sufficient to generate our result. However, we check even lower values for robustness purposes. In the literature, preference heterogeneity is found to be important to explain equity and risk premia. Guvenen (2009) uses heterogeneity in the elasticity of substitution parameter (in our case, the inverse of the risk aversion parameter) along with limited stock market participation to explain equity premia. Similarly, Borri and Verdelhan (2011) use an endogenously volatile risk aversion parameter for lenders to generate sensible sovereign risk premia. Gourinchas et al. (2011) use a two-country model to explain the US net foreign asset positions and return differentials. They also assume that the foreign country is more risk averse than the US.

4 Transitory Shocks

In this part of the simulations, we consider transitory shocks for the tradable endowment of the emerging country. So there will be no trend shocks an no trend growth. Table 4 presents the basic business cycle properties of these transitory shocks. We look at two main cases. In the first case, we assume that the emerging country is risk averse with an aversion parameter of 2, and the developed country is almost risk neutral with an aversion parameter of 0.01. This case might be seen as corresponding to a structure where the emerging country is modeled as a small open economy instead of a large open economy in terms of financial markets. In other words, the emerging country faces a risk-neutral rest of the world in financial markets. However, it should be kept in mind that production sharing between countries is still in place and in terms of goods trade, the emerging country is still a large open economy. In the second case, both countries are assumed to be risk averse with the same risk aversion parameter of 2. In this specification, the emerging country faces a risk-averse rest of the world in financial markets.

Results in the first case of the risk-neutral developed country in column 2 are the standard results of a small open economy model. The returns on emerging and developed country bonds are the same and there is no spread. When there is a positive shock in the emerging country, the main mechanism works through the consumption smoothing motive. To smooth consumption intertemporally, the emerging country increases its consumption less than its output and accumulates the rest of the output as foreign assets. Therefore, net exports are positively correlated with output, as shown by the correlation coefficient of 0.82 in the 2nd column of Table 4**.** However, this finding is counterfactual, and in the data, both net foreign assets and net exports are negatively correlated with output. One way of getting negative correlations is to add investment into the model. Then with enough persistence in the shock process, the emerging country would want to borrow to finance investment in good states of the tradable endowment, and the model would produce negative correlations between net exports and output. In our paper, we do not add investment, but in the next section with the trend shocks in the tradable endowment, we can also get negative correlations as explained in Aguiar and Gopinath (2007).

Another important mechanism at play is the production sharing between emerging and developed countries. When the emerging country gets a favorable shock in the tradable endow-

ment, the price of this good decreases. Then, the terms of trade depreciate, i.e., the emerging country's exports to the developed country become cheaper. So, the developed country can use inputs, in the form of imports from the emerging country, at a lower price, leading to an increase in the developed country's output level. This produces a positive correlation between the outputs of both countries and generates strong risk sharing in the international markets. This risk sharing from trade between countries is also emphasized by Cole and Obstfeld (1991), who show that there is not much gain from access to international asset markets when there is risk sharing in trade. In this setup, agents hedge against production risk by production sharing and do not need asset markets. Therefore, countries hold zero net foreign asset positions and the gross position is also much less than the value observed in the data. Because of production sharing, we observe a significant negative correlation between the terms of trade and output of -0.93 (not reported in the table). Also the correlation between the terms of trade and relative consumption is -0.47, implying high risk sharing between countries. This number is in large contrast to the value of 0.52 in the data. The correlation of the real exchange rate with output is around 0.05. This low correlation of the real exchange rate comes from the fact that with an increase in supply of tradable inputs, final goods producers increase their demand for non-tradable input, which is fixed in supply. This increase in demand increases the price of nontradable goods, therefore putting upward pressure on the real exchange rate; however, a decrease in the price of tradable inputs decreases the price of tradable inputs in final good and suppresses the upward pressure. Overall real exchange rate appreciation is very limited and the correlation of the real exchange rate with output is low. This finding is also counterfactual, because in the data we observe a significant positive correlation between the real exchange rate and output for emerging countries.

Since, with production sharing in place, countries do not need international asset markets very much, we observe smaller deviations in net exports and net foreign asset positions compared to that of output in the model. The standard deviation of the terms of trade is larger than that of output and the standard deviation of the real exchange rate is smaller than that of output. However, in the data, the standard deviation of the real exchange rate is three times as volatile as output. In our case with transitory shocks only, since the terms of trade and the price of nontradables move in opposite directions, the volatility of exchange rate is low compared to

the data. Also, for spreads, we observe a low correlation with output and a very low standard deviation, coming from the small role of international asset market in the model. In the last column, we look at the case of the risk-averse developed country. Most of the results are very similar to the benchmark case of the risk-neutral developed country. However, with the risk-averse developed country, gross portfolio holdings are lower and the real exchange rate becomes procyclical instead of being acyclical.

5 Trend Shocks

Results with trend shocks in the tradables sector of the emerging country are presented in Table 5. This is our benchmark case, where the developed country's risk aversion is 1.5 and the emerging country's risk aversion is 2. In the second column, the elasticity of substitution between home and foreign tradable inputs (κ) is 3/2 and the elasticity of substitution between tradable and nontradable inputs (η) is 2/5 as the main calibration of Table 3. One of the striking differences between stationary shocks in Table 4 and trend shocks in Table 5 is about the correlations. When emerging country households experience a favorable trend shock, they expect that the effect of this good shock will be long lasting and therefore their future income will be larger than today's. This expected steep income profile leads to an increase in consumption and in net borrowing and a decrease in net exports and net savings[17]. As a result, we get a negative correlation between net exports over output and output as shown by -1.00 in Table 5. Also, the emerging country demands more of both her tradable and nontradable inputs. With persistent trend shocks (as in the data), this increased demand from higher wealth overcomes the current increase in the supply of tradable goods and both the ToT and ReR appreciate. This result is in large contrast to the transitory shock case in Table 4, where the ToT depreciates in response to a favorable shock. Appreciation of the ToT means higher prices for imports and lower prices for exports of the developed country and makes the production risk for the developed country worse. As a result, risk sharing from international trade between countries

[17] As shown in Figure 5, following a positive trend shock emerging country households reduce their gross assets more than they reduce their gross liabilites. As the supply of emerging country bonds decreases, emerging country bond holdings reduce regardless of the demand from the developed country households. Hence, net borrowing increases.

is impaired. Actually, conditional to a trend shock, the correlation between emerging and developed country outputs becomes perfectly negative. Also, the correlation between relative consumptions and the real exchange rate (or the terms of trade) is 0.9, i.e., countries consume relatively more when their final (tradable) goods are relatively more expensive. This result also indicates the absence of risk sharing between countries, which is in line with the data. Here, our results are similar to the results of Corsetti et al. (2008) in the sense that when the ToT depreciate in response to a transitory shock, risk sharing between countries is attained, but when the ToT appreciate in response to a large wealth effect, risk sharing between countries is weakened. In our case, trend shocks are responsible for ToT appreciation. Figure 5 presents the results of an impulse response analysis to a positive trend shock in the tradable endowment of the emerging country.

Since the hedging through production sharing is broken between countries, now financial markets can play a larger role across countries. Our set-up in the international financial markets is such that both countries issue bonds in their currencies. Then the behavior of the ReR is crucial to see whether countries can use financial markets for hedging production risk. In response to a favorable trend shock in the emerging country, the ReR appreciates, making the emerging country's goods relatively more expensive. Since bond payments are in the currencies of the respective countries, appreciation means that the emerging country's bonds held by the developed country pay more. Therefore, the emerging country's bonds offer a good hedge against production risk for the developed country. Similarly, during a negative trend shock in the emerging country, its currency will depreciate and the developed country's bonds held by emerging country will pay more due to the depreciation. As a result, the developed country's bonds also offer a good hedge against production risk for the emerging country. In sum, ReR appreciation (depreciation) in response to a positive (negative) trend shock weakens the risk-sharing channel coming from international trade but creates other hedging opportunities in the international financial markets. Due to these hedging opportunities in the financial markets, the resulting gross portfolio holdings are 147 % of output in column 2 of Table 5. These results show the importance of studying financial markets in detail in the open economy because there might be crucial mechanisms coming from financial markets that affect the overall performance of these models. In addition to a large gross financial asset position, there is a positive net

foreign asset position for the emerging country, which is 4.9 % of output. This comes from the fact that the emerging country is more risk averse and its output is more volatile than that of the developed country. In this case, the emerging country is a net saver and the developed country is a net borrower. There is also a significant spread between home and foreign returns. The ReR is around three times more volatile than output and spread volatility is around 1.5 times of the output volatility.

We check the effects of international trade and the non-tradable sector in the third through fifth columns of Table 5. First we make the elasticity of substitution between home tradable inputs and foreign tradable inputs very large, with $\kappa = 100$ in the third column. This value implies that both inputs are almost perfect substitutes and countries can easily substitute away from imports of tradable inputs. With this calibration, trend shocks still lead to an appreciation of the terms of trade, but the relative volatility of the terms of trade decreases to almost zero. In this case, elasticity between nontradables and tradables is smaller than the one between home and foreign tradables; therefore, with an increase in the supply of home tradable inputs, demand for nontradable goods increases as well. This leads to an appreciation of the domestic currency and still can generate very volatile real exchange rates, with a relative volatility of 2.96. In the fourth column, we keep the original elasticity for tradables but make the elasticity between tradables and nontradables very large with $\eta = 100$. This value implies that tradable and nontradable goods are almost perfect substitutes. Then, when there is a positive trend shock in tradable goods, demand for nontradables will not increase much and there will not be pressure on nontradable good prices. This reduces the relative volatility of the real exchange rate significantly from around 3 to 0.48. This case shows the importance of having a nontradable sector in the model for the dynamics of real exchange rates.

6 Robustness Analysis

To get significant portfolio holdings and large volatilities in spreads and real exchange rates, we use a risk aversion parameter of 2 for the emerging country and 1.5 for the developed country. The difference between risk aversion parameters is important for our results. In Table 6, we check the robustness of our results for several different cases for risk aversion parameters. In the

column with $\sigma = 2.00$ and $\sigma^* = 2.00$, we have the same level of risk aversion for both countries. Then portfolio holdings are very small and relative volatilities of spreads and real exchange rates are small compared to those observed in the data. In this case, even though there is not much risk sharing in the international trade of goods, as trend shocks do appreciate the terms of trade and real exchange rates, countries still do not use financial markets much. Since the developed country is also as risk averse as the emerging country, there is no net foreign asset position in favor of any country. But when we make the developed country less risk averse than the emerging country, in the column with $\sigma^* = 1.50$, then the emerging country households want to hold positive net foreign asset positions and also offer a spread for the emerging country's bonds. Or as developed country households are less risk averse, they want to hold risky assets as well as net negative asset positions and they want a spread for their assets. As a result, both countries hold large amounts of international assets, and the volatilities of real exchange rates and spreads increase significantly. As the risk aversion parameter for the developed country decreases further toward 0.5, the portfolio holdings increase further. Since the emerging country is relatively more risk averse compared to the developed country with lower σ^*, the emerging country households increase their net foreign asset position further and are willing to pay an even a higher spread for their bonds. With $\sigma^* = 0.01$, the gross position increases to 320 % of output, net foreign asset position increases to 40 % of output and the spread for the emerging country bonds increase to 2.1 %. Also, since spreads grow further, the emerging country needs to run a larger net export surplus with lower σ^*. In sum, we need some difference in risk aversion parameters across countries but this difference need not be very large. For example, $\sigma = 2.00$ and $\sigma^* = 1.50$ is enough to generate large portfolio holdings, volatile spreads, volatile real exchange rates and imperfect risk sharing.

One of the main driving forces of our results is that when the economy is hit by a positive trend shock, consumers want to borrow in that period to consume more as they expect even higher output in the upcoming periods. This reasoning is true when the endowment process has some persistence. Consequently, we expect that our results will change when we change the persistence of the underlying endowment process. In Table 7 we report our results for endowment processes with different persistence. Four critical statistics, which match data well when there is some persistence in the endowment process, diverge from the data as persistence

disappears. First, the average spread becomes 0 and the volatility of the spread with respect to output declines to 0.03 when persistence becomes zero. Second, exchange rate volatility with respect to output declines from values larger than 3 to 0.62. Third, relative volatility of the net exports declines from 0.87 to 0.17. Finally, the correlation of the spread with output turns from negative to positive. Our results reveal that while some of the results of the model are still close to the data with small persistence, when the persistence of the shocks declines to zero, most of the success of the model disappears.

Finally, to investigate the sensitivity of our results to the shock process that we used in the model, we solve the model for two different shock specifications. First, we solve the model with trend shocks to the nontradable endowment (no shocks to the tradable endowment), where we keep the properties of the trend shocks the same. As can be seen from Table 8, there are no significant changes in the results (the volatility of output changes but relative volatilities do not). In the second robustness analysis, we assume that the developed country also gets trend shocks to the tradable endowment. For computational reasons, we assume that trend shocks in the emerging country and the developed country are perfectly positively correlated. To be more realistic, we assume that the volatility of trend shocks in the developed country is one third of that of the emerging country. The results that we report in Table 8 show that our baseline results are robust to this extension as well.

7 Conclusion

In this paper, we construct a model of a developed country-emerging country world economy. Both countries have tradable and non-tradable endowments and issue their own bonds. The asymmetries in the form of trend shocks and differences in risk aversion levels provide a relevant framework to study the interactions between countries. The main result is that structural differences in the emerging countries restrict risk sharing and generate significant portfolio holdings along with volatile real exchange rates and risk premia. Trend shocks to the tradable endowment of the emerging country increase the supply of tradable goods, but at the same time, the wealth effect from the trend shock leads to higher demand for current goods financed by borrowing. This wealth effect appreciates the terms of trade and real exchange rates of the

emerging country. When the terms of trade appreciate, the emerging country's goods become more expensive and the developed country's producers are hurt by the higher prices. This breaks the risk sharing coming from the standard production sharing mechanism in international trade. However, the appreciation of real exchange rates generates new hedging opportunities in the financial markets. Foreign currency bonds provide a natural hedge against the production risk as real exchange rates move procyclically. Therefore, with the emerging country being more risk averse than developed country, we find that emerging country holds a net positive asset position along with large international portfolio holdings and relative volatilities and cyclicalities of real exchange rates and risk premia are in line with the data.

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8 Appendix: Computational Algorithm, Tables, and Figures

We use an algorithm similar to the one first introduced by Lustig (2008) and Chien and Lustig (2010) and developed further by Arslan (2008). In a typical general equilibrium numerical solution algorithm, all endogenous variables in the model are formulated as functions of the state variables. In our model relevant state variables are emerging and developed country bond holdings ($B_{E,t}$, $B_{D,t}$) and exogenous shocks to the endowment, (E_t). In the model's formulation, we can state an endogenous variable, say $Q_{E,t}$, as:

$$Q_{E,t}= f(B_{E,t-1}, B_{D,t-1}, E_t)$$

As $B_{E,t-1}$ and $B_{D,t-1}$ are also endogenous variables, they can be further written as functions of past realizations of state variables and past endowment shocks as well.

$$B_{E,t-1} = f_{B_E}(B_{E,t-2}, B_{D,t-2}, E_{t-1})$$

$$B_{D,t-1}= f_{B_D}(B_{E,t-2}, B_{D,t-2}, E_{t-1})$$

Inserting the functions of $B_{E,t-1}, B_{D,t-1}$ into the first equation yields $Q_{E,t}$ as;

$$Q_{E,t}= f(B_{E,t-2}, B_{D,t-2}, E_{t-1}, E_t)$$

Recursive plugging of functions of past endogenous variables into the equation for the current period home bond price function enables us to obtain price as a function of current and past endowment shock realizations.

$$Q_{E,t} = f(E_0, E_1, ..., E_{t-1}, E_t)$$

Applying the same logic to the other endogenous variables makes it possible to use endow-

ment shocks as the sole argument for the functions defining all endogenous variables.[18] Putting it differently, observing the current and past endowment shocks makes it possible to derive current prices and choice variables without the need for any other state variables. Although it is theoretically possible to derive current period endogenous variables as a function of past history of endowment shocks, it is computationally impossible and inefficient to solve for this whole history. Therefore, we suppose that agents are boundedly rational and they only use the information embedded in the recent history, which can be defined as the current and most recent lags of the technology shocks. Although the addition of further lags is always possible, after some history it increases the time and memory required to come up with a numeric solution while not making much contribution to the solution accuracy.

Economies under consideration experience either high or low technology shocks. Combining this with the nine-period history gives 512 (2^9) possible states to solve for. Using Mathematica, we algebraically find first order conditions and market clearing conditions for all of these possible states. Then we use the sum of the squared errors of these first order conditions and market clearing conditions across all states to define the objective function. Having obtained the objective function, we use both global and local minimization algorithms of Mathematica to solve for prices and allocations that minimize the objective function. Simulation errors of the model for Euler equations of bonds in both countries are presented in Figure 6.

[18] Endogenous variables that we solve for in the model are as follows; $Q_{E,t}$, $Q_{D,t}$, $B_{E,t}$, $B_{D,t}$, $P_{E,t}$, $P_{D,t}$, $P_{E,T,t}$, $P_{D,T,t}$, $P_{E,N,t}$, $P_{D,N,t}$, $X_{E,T,t}$, $X_{D,T,t}$.

Table 1: Business Cycle Properties of Real Variables

	$\sigma(Y)$	$\sigma(C)/\sigma(Y)$	$\sigma(I)/\sigma(Y)$	$\sigma(NX/Y)/\sigma(Y)$	$\sigma(ReR)/\sigma(Y)$	$\sigma(Spread)/\sigma(Y)$
Emerging Countries						
Mean	4.05	1.15	3.32	0.86	3.00	0.83
Median	3.91	1.08	3.35	0.81	2.95	
Developed Countries						
Mean	2.25	0.84	2.89	0.54	2.64	1.21
Median	2.05	0.84	2.68	0.54	3.19	
	$\rho(Y, Y^{US})$	$\rho(C, C^{US})$	$\rho(I, I^{US})$	$\rho(NX/Y, Y)$	$\rho(ReR, Y)$	$\rho(Spread, Y)$
Emerging Countries						
Mean	0.01	-0.30	-0.15	-0.53	0.54	-0.55
Median	0.03	-0.35	-0.16	-0.57	0.59	
Developed Countries						
Mean	0.45	0.29	0.22	-0.42	-0.14	0.20
Median	0.43	0.29	0.16	-0.47	-0.13	

Notes: Y is real GDP. C is real consumption. I is real investment. NX/Y is exports minus imports over GDP. Real exchange rate (ReR) is the ratio of emerging country's final goods prices to the developed country's final good prices. Risk premium is the spread between the two country bonds. All series except net exports and spreads are in logs. All series have been Hodrick–Prescott filtered. All statistics are based on yearly data for years between 1970 and 2008. Source is IMF-IFS. Emerging countries are Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Korea, Mexico, Malaysia, Paraguay, Peru, Philippines, Turkey, Uruguay, Venezuela and South Africa. Developed countries are Australia, Canada, England, Finland, France, Germany, Japan, New Zealand, Portugal and the U.S. Spread statistics are from Neumeyer and Perri (2005).

Table 2: International Asset Positions of Countries

	$\frac{GFA}{Y}$		$\frac{NFA}{Y}$		$\frac{\Delta NFA}{Y}$	
Emerging Countries	1990s	2000s	1990s	2000s	1990s	2000s
Mean	88.86	129.60	-25.58	-19.85	-0.79	2.78
Median	90.64	112.32	-25.30	-26.70	-0.93	2.77
China	51.77	86.62	-3.14	11.36	0.26	2.79
Developed Countries						
Mean	187.49	377.32	-18.45	-15.85	-0.79	0.83
Median	156.32	355.53	-11.39	-15.70	-1.00	0.40
US	99.39	185.42	-7.46	-18.18	-0.23	-1.06
	$\frac{GFA\_Portfolio}{Y}$		$\frac{NFA\_Portfolio}{Y}$		$\frac{\Delta NFA\_Portfolio}{Y}$	
Emerging Countries	1990s	2000s	1990s	2000s	1990s	2000s
Mean	66.92	82.49	-13.63	1.05	0.60	3.68
Median	68.34	80.07	-16.48	-1.39	0.77	3.70
China	36.38	58.09	6.27	32.99	1.80	4.38
Developed Countries						
Mean	127.29	229.55	-14.99	-19.81	-0.18	-0.81
Median	106.08	200.46	-11.66	-28.68	-0.53	-1.53
US	58.74	99.84	-12.18	-28.32	-0.98	-2.90

Notes: GFA is the gross financial asset position. NFA is the net financial asset position. ΔNFA is the change in NFA. $\_Portfolio$ measures exclude equity and FDI variables from the calculation. All statistics are based on yearly data between 1990 and 2007. Source is Lane and Milesi-Ferretti (2007).
Emerging countries are Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Israel, Korea, Mexico, Malaysia, Peru, Philippines, Paraguay, Thailand, Turkey, Uruguay, Venezuela and South Africa. Developed countries are Australia, Canada, Finland, France, Germany, Japan, New Zealand, Portugal, United Kingdom and United States.

Table 3: Calibration

Definition	Parameter	Value
Home input share in intermediate tradables production	v	0.72
Elasticity of intertemporal substitution bw home and foreign tradable inputs	κ	3/2
Intermediate tradable goods share in final goods production	γ	0.55
Elasticity of intertemporal substitution bw intermediate tradable and nontradable	η	2/5
Risk aversion parameter for Developed Country	σ^*	1.5
Risk aversion parameter for Emerging Country	σ	2
Discount factor for households	β	1/1.04
AR(1) coefficient for transitory shocks	ρ_z	0.76
AR(1) coefficient for trend shocks	ρ_g	0.83
Mean growth rate	μ_g	1.02

Table 4: Conditional Model Moments with Transitory Shocks in Tradable Endowments

		Model	
	Data	$\sigma = 2, \sigma^* = 0.01$	$\sigma = 2, \sigma^* = 2$
Home Return %	8.4[1]	4.0	4.0
Foreign Return %	7.1[1]	4.0	4.0
Spread	1.3[1]	0.0	0.0
$\frac{Net\ Exports}{Y}$		0.0	-0.2
$\frac{NFA\_Portfolio}{Y}$	17.42	0.0	1.7
$\frac{GFA\_Portfolio}{Y}$	73.39	54.0	47.5
$\sigma(Y)$	4.05	2.75	3.06
$\sigma(C)/\sigma(Y)$	1.15	1.00	1.00
$\sigma(NX/Y)/\sigma(Y)$	0.86	0.58	0.38
$\sigma(\ ToT)/\sigma(Y)$	1.68[2]	1.45	1.17
$\sigma(\ ReR)/\sigma(Y)$	3.00	0.80	0.57
$\sigma(\ Spread)/\sigma(Y)$	0.83[3]	0.05	0.17
$\rho(Y, Y^{US})$	0.01	0.84	0.90
$\rho(C, C^{US})$	-0.30	0.84	0.90
$\rho(C/C^{US}, ReR)$	0.71[2]	0.67	0.86
$\rho(NX/Y, Y)$	-0.53	0.82	0.89
$\rho(C/C^{US}, Tot)$	0.52[2]	-0.47	-0.84
$\rho(ReR, Y)$	0.54	0.05	0.64
$\rho(Spread, Y)$	-0.55[3]	-0.12	-0.15

Notes: [1]Statistics are from Neumeyer and Perri (2005).

All series have been Hodrick–Prescott filtered.

[2]Statistics are from Corsetti et al. (2008). [3]Data are from Curcuru et al. (2008).

Table 5: Conditional Model Moments with Trend Shocks in Tradable Endowments

		Model			
		$\sigma = 2, \quad \sigma^* = 1.5$			
	Data	$\kappa = 3/2, \eta = 2/5$	$\kappa = 100, \eta = 2/5$	$\kappa = 3/2, \eta = 100$	$\kappa = 100, \eta = 100$
Home Return %	8.4[1]	7.96	7.93	7.92	7.86
Foreign Return %	7.1[1]	7.14	7.15	7.10	7.13
Spread	1.3[1]	0.83	0.78	0.82	0.73
$\frac{Net\ Exports}{Y}$		0.63	0.68	0.63	0.52
$\frac{NFA\_Portfolio}{Y}$	17.42	4.9	3.8	4.3	3.1
$\frac{GFA\_Portfolio}{Y}$	73.39	147.3	119.7	147.2	101.7
$\sigma(Y)$	4.05	0.43	0.47	0.74	0.78
$\sigma(C)/\sigma(Y)$	1.15	1.00	1.00	1.00	1.00
$\sigma(NX/Y)/\sigma(Y)$	0.86	0.87	0.87	0.87	0.87
$\sigma(\ ToT)/\sigma(Y)$	1.68[2]	0.37	0.01	0.46	0.01
$\sigma(\ ReR)/\sigma(Y)$	3.00	3.31	2.96	0.48	0.03
$\sigma(\ Spread)/\sigma(Y)$	0.83[3]	1.48	1.43	0.67	0.65
$\rho(Y, Y^{US})$	0.01	-0.98	-0.99	-0.99	-0.99
$\rho(C, C^{US})$	-0.30	-0.98	-0.99	-0.99	-0.99
$\rho(C/C^{US}, ReR)$	0.71[2]	0.90	0.90	0.90	0.90
$\rho(NX/Y, Y)$	-0.53	-1.00	-1.00	-1.00	-1.00
$\rho(C/C^{US}, Tot)$	0.74[2]	0.90	0.90	0.90	0.90
$\rho(ReR, Y)$	0.54	1.00	1.00	1.00	1.00
$\rho(Spread, Y)$	-0.55[3]	-0.77	-0.75	-0.82	-0.71

Notes: [1]Statistics are from Neumeyer and Perri (2005). [2]Statistics are from Corsetti et al. (2008).

[3] Data are from Curcuru et al. (2008). All series have been Hodrick–Prescott filtered.

Table 6: Conditional Model Moments with Trend Shocks: Robustness Analysis wrt Risk Aversion

		Model				
	Data	$\sigma = 2.00$ $\sigma^* = 2.00$	$\sigma = 2.00$ $\sigma^* = 1.50$	$\sigma = 2.00$ $\sigma^* = 1.00$	$\sigma = 2.00$ $\sigma^* = 0.50$	$\sigma = 2.00$ $\sigma^* = 0.01$
$Spread$	1.3[1]	0.00	0.83	1.54	1.81	2.13
$\frac{Net\ Exports}{Y}$		0.05	0.63	1.40	2.57	3.68
$\frac{NFA\_Portfolio}{Y}$	17.42	-0.88	4.9	16.33	27.30	40.7
$\frac{GFA\_Portfolio}{Y}$	73.39	21.06	147.3	213.44	267.49	320.1
$\sigma(Y)$	4.05	0.05	0.43	0.90	1.38	1.83
$\sigma(NX/Y)/\sigma(Y)$	0.86	0.32	0.87	0.89	0.93	0.95
$\sigma(\ ReR)/\sigma(Y)$	3.00	1.25	3.31	3.23	3.12	3.03
$\sigma(\ Spread)/\sigma(Y)$	0.83[2]	0.04	1.48	1.31	1.07	0.87
$\rho(NX/Y, Y)$	-0.53	-0.96	-1.00	-1.00	-1.00	-1.00
$\rho(ReR, Y)$	0.54	0.70	1.00	1.00	1.00	1.00
$\rho(Spread, Y)$	-0.55[2]	-0.17	-0.77	-0.78	-0.73	-0.69

Notes: [1]Statistics are from Neumeyer and Perri (2005). [2]Data are from Curcuru et al. (2008).

All series have been Hodrick–Prescott filtered.

Table 7: Conditional Model Moments with Trend Shocks: Robustness Analysis wrt. the Persistence of the Endowment Process

		Model			
	Data	$\rho = 0.83$	$\rho = 0.6$	$\rho = 0.4$	$\rho = 0$
$Spread$	1.3[1]	0.83	0.52	0.46	0
$\frac{Net\ Exports}{Y}$		0.63	0.13	-0.15	-3.16
$\frac{NFA\_Portfolio}{Y}$	17.42	4.9	6.5	8.9	5.4
$\frac{GFA\_Portfolio}{Y}$	73.39	147.3	172.6	163.8	162.9
$\sigma(NX/Y)/\sigma(Y)$	0.86	0.87	0.84	0.84	0.17
$\sigma(\ ReR)/\sigma(Y)$	3.00	3.31	3.32	3.41	0.62
$\sigma(\ Spread)/\sigma(Y)$	0.83[2]	1.48	1.58	0.84	0.03
$\rho(NX/Y, Y)$	-0.53	-1.00	-1.00	-1.00	-0.97
$\rho(ReR, Y)$	0.54	1.00	1.00	1.00	0.69
$\rho(Spread, Y)$	-0.55[2]	-0.77	-0.81	-0.14	0.27

Notes: [1]Statistics are from Neumeyer and Perri (2005). [2]Data are from Curcuru et al. (2008). All series have been Hodrick–Prescott filtered.

Table 8: Robustness Analysis wrt.Shocks

		Model		
	Data	Baseline	Shocks to the Nontradables	Shocks to the Developed Country
$Spread$	1.3[1]	0.83	0.81	0.82
$\frac{Net\ Exports}{Y}$		0.63	6.4	0.53
$\frac{NFA\_Portfolio}{Y}$	17.42	4.9	4.9	6.8
$\frac{GFA\_Portfolio}{Y}$	73.39	147.3	149.7	148.5
$\sigma(NX/Y)/\sigma(Y)$	0.86	0.87	0.86	0.86
$\sigma(\ ReR)/\sigma(Y)$	3.00	3.31	3.34	3.31
$\sigma(\ Spread)/\sigma(Y)$	0.83[2]	1.48	1.50	1.46
$\rho(NX/Y, Y)$	-0.53	-1.00	-1	-1
$\rho(ReR, Y)$	0.54	1.00	1	1
$\rho(Spread, Y)$	-0.55[2]	-0.77	-0.76	-0.77

Notes: [1]Statistics are from Neumeyer and Perri (2005). [2]Data are from Curcuru et al. (2008) In column 2, the shocks to the tradables is closed. Instead, the same shocks are given to the emerging country nontradable sector. In column 3, in addition to the shocks to the emerging country similar, perfectly positively correlated tradale shocks with smaller variance (one thirds) are given to the developed country. All series have been Hodrick–Prescott filtered.

Figure 1: GFA_Portfolio over GDP in Emerging Countries

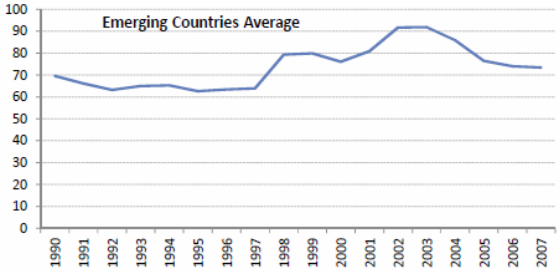


Figure 2: NFA_Portfolio over GDP in Emerging Countries

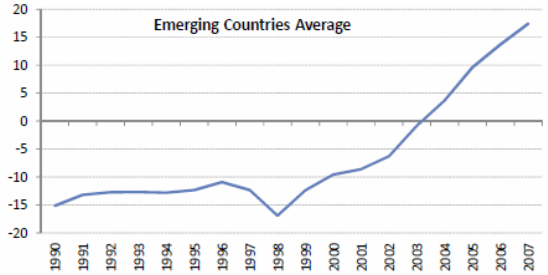


Figure 3: GFA_Portfolio over GDP in Developed Countries

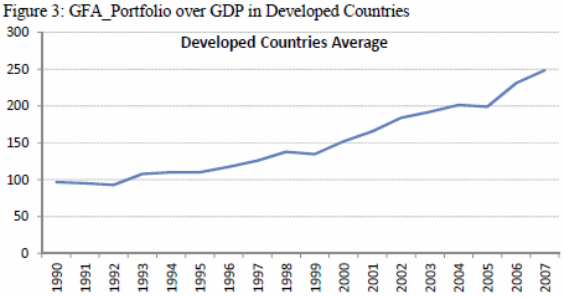


Figure 4: NFA_Portfolio over GDP in Developed Countries

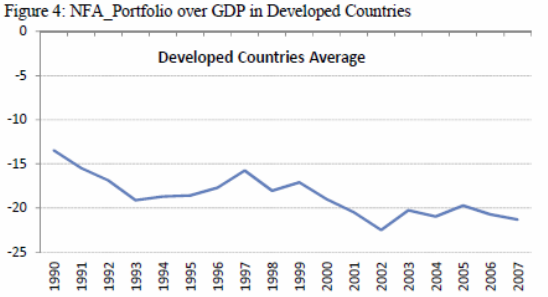
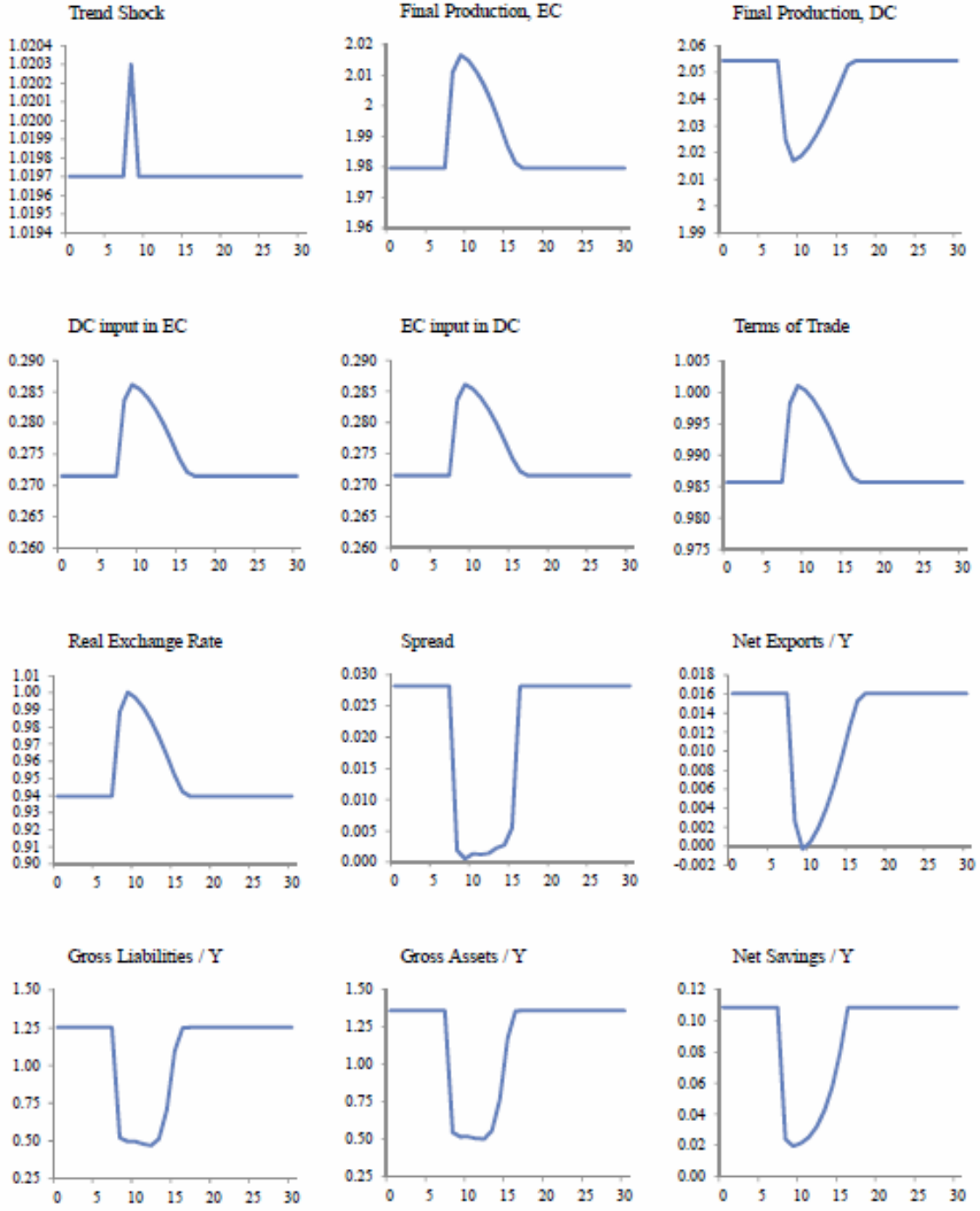


Figure 5: Impulse Responses to a Positive Trend Shock in EC Tradable Endowment



Note: EC is emerging country and DC is developed country.

Figure 6: Errors from Euler Equations of Home (Emerging) and Foreign (Developed) Country