Portfolio choice in a two-country DSGE model: Capital flows in emerging economies

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PRELIMINAR Version. December 2016

Abstract

Over the last decades, financial interactions emerged under the so called financial globalisation have had significant effects on both developed and developing economies. This paper proposes a two-country DSGE model with endogenous portfolio choice, home bias in consumption, Calvo price setting mechanism and incomplete financial markets to analyse the dynamics of foreign direct investment and financial portfolio flows. I first show that the distinction between gross and net capital flows matters when evaluating their impact and dynamics in a general equilibrium model. Then, I characterise how asymmetries between the two countries affect the dynamics of portfolio flows. I argue that portfolio responses to shocks depend on the type of asset (i.e bond vs equity) and the underlying asymmetries regarding Calvo probability, home bias values and the elasticity of substitution between home and foreign produced goods. The resulting framework allows us not only to solve for countries portfolio positions and dynamics, but also to measure capital gains and losses on asset and liabilities positions, which depend on asset price and exchange rate fluctuations.

KEY WORDS: Two-country DSGE models, portfolio choice, capital flows, financial globalisation, country portfolio dynamics

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1 Introduction

Over the past four decades and specially since 1990, countries have experienced a rapid increase in gross capital flows. Such financial globalization has led to an increase in the size and composition of the financial account in the balance of payments for most countries. The gross external positions now exceed 100% of GDP for major industrialized countries and average gross assets doubled from 1/3 to almost 2/3 of GDP for developing countries.[1] (See Figure 1 Appendix B).

Empirical evidence shows heterogenous external position across countries.[2] On the one hand, many developing countries are net importers of foreign direct investment while being net exporters of financial capital. On the other hand, advanced countries such as the United States do exactly the opposite by importing financial capital and exporting FDI.[3] (See Figure 2 Appendix B).

Existent large and heterogenous portfolios might lead to potential wealth transfers across countries when asset prices and exchange rate fluctuates. Valuation effects, capital gains and losses on gross external asset and liabilities, account for an increasing part of the dynamics of net foreign asset positions of countries.[4] (See Figure 3 Appendix B).

These three empirical stylised facts cannot be analysed with the standard open economy macroeconomic model, which in general, abstracts from the analysis of portfolio choice. This paper contributes to the theoretical literature that analyses two-way capital flows by implementing a comprehensive two-country DSGE model with endogenous portfolio choice of foreign direct investment and financial capital between advanced and emerging market economies. I first show that the distinction between gross and net capital flows matters when evaluating their impact and dynamics in a general equilibrium model. Then, I characterise how asymmetries between the two countries affect the dynamics of portfolio flows.

A common assumption in some standard models is to take capital flows as exogenous, which might not the correct approach given these empirical evidence. Capital flows can be seen as a response to country-specific shocks rather than being themselves the driver of the domestic economic activity.

Open economy macroeconomic models mostly rely on financial structures based on international trade of either one non-contingent bond or through Arrow-Debreu securities (i.e complete asset markets). They ignore the analysis of the composition and determinants of country portfolios, focusing instead on net foreign assets and the current account balance analysis. Therefore, these models have not been able to explain either these empirical styled facts or how capital flows behave at the business cycle frequency. The reason has been the technical complexity faced in deriving optimal portfolio positions for general equilibrium models with incomplete markets at the same time retaining enough tractabil-

[1]See Lane Milesi-Ferreti (2008)
[2]See Gourichas and Rey (2013)
[3]See Ju and Wei(2010), Lane and Milesi-Ferretti (2001), Ghironi et al. (2005), Gourinchas and Rey (2007), and Tille (2003, 2008)
[4]See Gourichas and Rey (2013)

ity to explore the responses to macroeconomic shocks and the effects of economic policy. While in most of these open economy models, the representative agent is the owner of the firm, in models with endogenous portfolio choice, ownership might be traded through equities so that agents in each country may hold different portfolios depending on country-specific risk and the returns they encounter.

Nevertheless, there has been some recent research work characterising the portfolio choice with international capital flows in a general equilibrium setup (See Devereux and Sutherland (2009), (2010)). These methodological improvements have given a new life to the literature investigating the origins and the causes of international portfolio choices. The key contribution of this paper is to treat two-way capital flows as endogenous variables in a richer framework than previously done in the literature and check their short-run responses after supply, demand and monetary shocks.

This model is similar to Engel and Matsumoto (2009) paper, which was the starting point for sticky price portfolio models in a fully integrated dynamic stochastic equilibrium model. They developed a model to analyse the factors determining equilibrium portfolio choice in a dynamic setting, while in the model presented here, portfolio dynamics are also analysed. A key difference is that they use a model which mimics the complete financial markets outcome, while the model presented here mimics the incomplete markets version. They use one period in advance price setting mechanism, while I use Calvo price mechanism. They also assume a symmetric distribution of shocks between home and foreign country, while here home country is assumed to be riskier than foreign country, in terms of the volatility of the shocks. Finally, they use money-in-the utility function while this paper takes endogenous monetary policy rules.

This model is also close to Devereux and Sutherland (2009), in the sense that they incorporate portfolio choice in a structural general equilibrium model of two asymmetric countries. However their focus is on risk sharing properties of three different financial structures, (i.e autarky, complete markets and asymmetric financial structure). Also, their framework uses one single good consumption while I assume differentiated goods produced by firms and home bias in consumption, which gives a richer framework to anlyse price and exchange rate effects.

This framework is different from the existing literature in various aspects. First, I use an asymmetric-calibrated two-country DSGE model which incorporates endogenous portfolio choice in equities and bonds and solve for their portfolio positions and dynamics. Second, I am able to disentangle real gross asset and liability movements into price and volume movements. Third, the model allows us to measure valuation effects of gross country portfolio positions. Fourth, we add some important features for DSGE literature, such as Calvo price rigidities, home bias in consumption, Taylor (1993)-type monetary policy rules and shocks on productivity, government spending and monetary policies . Fifth, rather than taking the complete financial market approach, I add enough exogenous shocks so that the model is solved under incomplete markets approach, which is closer to reality. Finally, I compare the effects of exogenous forces in the financial integrated model with those in the financial autarky model to show that the distinction between gross and net capital flows matters when evaluating their impact and dynamics in a general equilibrium model. Also, I characterise how asymmetries between the two countries affect the dynamics of portfolio flows.

The rest of the paper proceeds as follows: In section 2, we lay out a two-country model with international trade in equities and bonds. Section 3 explains some details of the solution procedure used here to solve endogenous portfolio positions and its dynamics. Section 4 gives quantitative results comparing financial autarky and financial integration cases to explain the importance of the latter. Section 5 explains capital flows and gross external positions in the presence of unanticipated shocks and compares different parameterizations for selected parameters. Section 6 concludes.

2 Financial Integration Model

2.1 The framework

This section describes a two-country stochastic dynamic general equilibrium model, with free international trade in goods and assets (i.e. equity and bonds), where equity assets are claims on firms profitability and bonds are claims on each country currencies. Labour is not mobile across countries. I abstract from physical capital accumulation to simplify the intuition and the dynamics. I calibrate the home country as being "developing/emerging", and the foreign country as being "advanced" in two different ways. First, by setting a higher nominal rigidity in the developing country. Second by giving a higher variance of the developing country exogenous shocks.
The exogenous processes are AR(1) shocks. On the demand side (i.e. government expenditure and monetary) and the supply side (i.e. technology shocks).
In the baseline calibrations, I consider countries of equal size for two reasons. On the one hand, I want to focus on the role played by differences in aggregate risk and nominal rigidities, neutralizing any effect driven by the size of countries. On the other hand, the focus of our paper is not the financial integration of small open economies, but asset flows between advanced and emerging markets, which account for a large part of the total volume of transaction since 1990.[5]
The foreign economy is not explicitly displayed here, since it is identical to the one presented in this section, with the specific notation of an asterisk (*).

2.2 Households

There is a continuum of households in the economy indexed by j. The representative households maximizes the following lifetime utility function, which is separable in consumption, C_{jt} and hours worked, N_{jt}:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t U_t(C_{jt}, N_{jt})$$

[5] Courdacier, Rey and Winant (2013)

The instantaneous utility function takes the following form,

$$U_t(C_{jt}, N_{jt}) = \left[\frac{C_{jt}^{1-\sigma}}{1-\sigma} - \chi \frac{N_{jt}^{1+\phi}}{1+\phi}\right] \tag{2.1}$$

where β^t is the discount factor. Following Schmitt-Grohe and Uribe (2003), we assume it is endogenous to ensure a stationary wealth distribution for the linear approximated dynamic model.[6] It is a function of aggregate consumption determined as follows

$$\beta_{t+1} = \beta_t(C_{At}), \beta^0 = 1 \tag{2.2}$$

where (C_{At}) is $(1 + C_{At})^{-\nu}$

The rest of structural parameters are the risk aversion parameter ($\sigma > 0$) and the inverse of Frisch labor supply elasticity ($\phi > 0$). C_t is a CES composite consumption index defined by,

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\theta}}(C_{h,t})^{\frac{\theta-1}{\theta}} + \alpha^{\frac{1}{\theta}}(C_{f,t})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{2.3}$$

where $C_{h,t}$ and $C_{f,t}$ are indexes of consumption of home and foreign goods respectively (i.e the term $C_{f,t}$ refers to imports),

$$C_{h,t} \equiv \left(\int_0^1 C_{h,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}, C_{f,t} \equiv \left(\int_0^1 C_{f,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}$$

Parameter $\alpha \in [0, 1]$ is inversely related to the degree of home bias in preferences. Parameter $\theta > 1$ denotes the elasticity of substitution between domestic and foreign goods from the viewpoint of domestic consumer, and $\epsilon > 1$, denotes the elasticity of substitution between goods produced within the same country. Standard open macroeconomics literature normally sets $\epsilon > \theta$.

Then, the optimal allocation of expenditures between domestic and imported goods is given by

$$C_{h,t} = (1-\alpha)\left(\frac{P_{h,t}}{P_t}\right)^{-\theta} C_t, \quad C_{f,t} = \alpha\left(\frac{P_{f,t}}{P_t}\right)^{-\theta} C_t \tag{2.4}$$

Notice that, when price indexes for domestic and foreign goods are equal (as in the steady state), parameter α corresponds to the share of domestic consumption allocated to imported goods.

The consumption-based price indices that correspond to the above specifications of preferences are given by the following domestic Consumer Price Index (CPI)

$$P_t = \left[(1-\alpha)P_{h,t}^{1-\theta} + \alpha P_{f,t}^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{2.5}$$

where $P_{h,t}$ is the price index for domestically produced goods expressed in domestic currency and $P_{f,t}$ is the price index for foreign produced goods expressed in domestic currency.

[6]They propose five different ways to induce stationarity in an open economy model. I choose the endogenous discount factor for simplicity

The Domestic Household Budget Constraint

Domestic households consume bundles of goods which can be domestically produced ($C_{H,t}$) or produced abroad ($C_{F,t}$). They acquire equity shares to increase their participation in the financial markets and they increase the amount of government bonds held during next period.
As owners of labor services, they obtain real wage (w_t) from hours of labour. As financial capital owners, they obtain returns from last period equity and bond holdings (D_t, D_t^*, $b_{h,t-1}$, $b_{f,t-1}$).
All these magnitudes are expressed in bundles of goods (i.e. divided by domestic CPI). [7]

$$
\begin{aligned}
w_t N_t + \frac{P_{H,t}}{P_t}(D_t + V_t)S_{H,t-1} + \frac{P^*_{Ft}}{P^*_t}Q_t(D^*_t + V^*_t)S_{F,t-1} \\
+\frac{B_{H,t-1}}{P_t} + S_t\frac{B_{F,t-1}}{P_t} = \\
C_t + \frac{P_{H,t}}{P_t}V_t S_{H,t} + Q_t\frac{P^*_{Ft}}{P^*_t}V^*_t S_{F,t} + (r_t)^{-1}\frac{B_{H,t}}{P_t} + S_t(r^*_t)^{-1}\frac{B_{F,t}}{P_t} \\
+(\bar{g})e^{G_t}
\end{aligned}
\tag{2.6}
$$

for $t = 1, 2, 3, ...,$

where V_t refers to domestic equity value, V_t^* to foreign equity value, $S_{H,t}$ refers to the share of domestic equity held by domestic households and $S_{F,t}$ refers to that of foreign equity. r_t is the real interest rate on domestic bonds, r_t^* is the real interest rate on foreign bonds and $b_{H,t}$ and $b_{F,t}$ are the amount of domestic and foreign government bonds purchased by the domestic household in period t to be reimbursed in $t+1$. Q_t refers to real exchange rate defined in terms of foreign currency.

$$
Q_t = \frac{E_t P^*_t}{P_t} \tag{2.7}
$$

where E_t is the nominal exchange rate also in foreign currency terms. Note that P_t and P_t^* refer to CPI level of each country.

Finally, we assume that total government expenditure is exogenous and its subject to an stochastic shock process. In particular we assume that it takes a steady-state value of 20% of GDP (i.e $\bar{g} = 0.2\bar{Y}$) and that G_t is defined with

$$
G_t = \rho^G G_{t-1} + \epsilon^G_t \tag{2.8}
$$

where $0 < \rho^G < 1$ and ϵ_t^G is a zero-mean distributed i.i.d shock with $Var[\epsilon_t^G] = \sigma_G^2$

The key equations coming from first order conditions from the domestic household optimising problem are the following

[7] Real wage is defined as $w_t = \frac{W_t}{P_t}$, where uppercase variables refer to nominal terms

- The FOC for home consumption implies

$$C_t^{-\sigma} = \beta_t \mathbb{E}_t[C_{t+1}^{-\sigma} r_{H,t+1}] \tag{2.9}$$

- For equity and bond portfolio allocation, FOC are

$$\mathbb{E}_t[C_{t+1}^{-\sigma} r_{F,t+1}] = \mathbb{E}_t[C_{t+1}^{-\sigma} r_{H,t+1}] \tag{2.10}$$

$$\mathbb{E}_t[C_{t+1}^{-\sigma} r_{b,F,t+1}] = \mathbb{E}_t[C_{t+1}^{-\sigma} r_{b,H,t+1}] \tag{2.11}$$

- For home labour

$$w_t = \chi C_t^{\sigma} N_t^{\phi}; \tag{2.12}$$

  Note that χ is a fixed parameter obtained from the steady-state resolution of the model.

- For domestic holdings of home and foreign equity, returns in domestic consumption units,

$$r_{H,t+1} = \frac{\pi_{H,t+1}}{\pi_{t+1}} \frac{\mathbb{E}_t(D_{t+1} + V_{t+1})}{V_t}; r_{F,t+1} = \frac{\pi^*_{F,t+1}}{\pi^*_{t+1}} \frac{Q_{t+1}}{Q_t} \frac{\mathbb{E}_t(D^*_{t+1} + V^*_{t+1})}{V^*_t} \tag{2.13}$$

- For domestic holdings of home and foreign bond, returns in domestic consumption units,

$$r_{b,t+1} = \frac{i_t}{\pi_{t+1}}; r_{b,F,t+1} = \frac{i^*_t}{\pi^*_{t+1}} \frac{Q_{t+1}}{Q_t} \tag{2.14}$$

2.3 Firms

There is a continuum of intermediate goods producers that operate under monopolistic competition that maximise their profits $D_t(j)$. In this setup, there is no physical capital. Firms have value because they are monopolistic. Each firm produces a unique differentiate good and earns monopoly profit. Each firm is subject to both domestic and foreign demand for domestic goods and to a technology function with the following form;

$$Y_t(j) = exp(A_t) N_t(j)^{1-\tau} \tag{2.15}$$

where L_t it is the amount of labor input rented by the firm, and where At follows the following process

$$A_t = \rho^A A_{t-1} + \epsilon_t^A \tag{2.16}$$

where $0 < \rho^A < 1$ and ϵ_t^A is a zero-mean distributed i.i.d shock with $Var[\epsilon_t^A] = \sigma_A^2$
It is worth to notice that A_t factor involves any idiosyncratic source that increases marginal product of inputs.

Price stickiness is modelled a la Calvo (1983) with a fixed probability of re-setting price or to maintaining it from last period. Hence, a number of $(1 - \eta)$ randomly selected firms sets new prices each period, with an individual firm's probability of re-setting in any given period being completely independent of the time elapsed since it last re-optimised its price. In comparison with the flexible price setting, now adjusting price firms will recognise that the optimal price chosen will remain effective for a random number of periods so that they will account for expected future marginal costs, instead of looking at the current level only. However, by setting $\eta \rightarrow 0$ the model effectively represents the special case of flexible prices.

Many portfolio models are based on flexible price setting, but having an effective monetary policy rule plays a role in determining gross external positions. However, it may be the case that financial globalisation influences inflation.[8] Also, it may be the case that adding a source of uncertainty of this type may affect directly to the choice of international equity and bonds since under flexible prices, terms of trade fluctuations provide insurance for productivity shocks, even when there is no trade in equity. But the risks encountered under a rigid price setting cannot be insured by terms of trade movements. So these risks may play an important role in portfolio choice because portfolio is the only means of insuring against these shocks .

Intermediate domestic producers take real wage (i.e. w_t) as given, and they solve the following maximisation problem

$$Max \mathbb{E}_t \sum_{t=0}^{\infty} \eta \Theta^t \Big[D_t(j) \Big]$$

$$D_t(j) \equiv \left[\left(\frac{\bar{P}_h(j)}{P_{h,t}} \right)^{1-\epsilon} Y_t - \frac{P_t}{P_{H,t}} \frac{W_t}{P_t} N_t(j) \right] \tag{2.17}$$

s.t

$$exp(A_t) N_t(j)^{1-\tau} - \left(\frac{\bar{P}_H(j)}{P_{H,t}} \right)^{-\epsilon} Y_t = 0 \tag{2.18}$$

where upper case letters denote nominal variables. The key equations coming from first order conditions describe the labour demand,

$$\left(\frac{P_t}{P_{h,t}} \right) w_t = mc_t(j) exp(A_t)(1-\tau) N_t(j)^{-\tau} \tag{2.19}$$

where ψ is the Lagrange Multiplier and it acts as the real marginal cost, which it happens to be the same across firms $\psi_t(j)$=ψ_t=mc_t, Then, optimal price equation is obtained,[9]

$$\bar{P}_h(j) = \left(\frac{\epsilon}{\epsilon - 1} \right) \mathbb{E}_t \sum_{k=0}^{\infty} \Theta^k \eta^k \left[\frac{\big(P_{h,t+k}\big)^{\epsilon} Y_{t+k} mc_{t+k}(j)}{\big(P_{h,t+k}\big)^{\epsilon-1} Y_{t+k}} \right] = 0 \tag{2.20}$$

where $0 < \eta < 1$ is the Calvo probability. $\bar{P}_h$ would be the optimal price obtained from the non-linear maximization problem.[10]

[8] Devereux, Senay and Sutherland (2013)

[9] We follow Schmitt-Grohe-Uribe (2006) way of treating infinite sums.

[10] Real magnitudes from the firm-optimization problem are expressed in domestically produced units,(i.e. nominal terms divided by $P_{h,t}$). Since real wage (w_t) and dividends (d_t) are expressed in CPI units in the household problem (i.e. divided by P_t), to be consistent with notation they are now multiplied by ($\frac{P_t}{P_{h,t}}$).

Θ is the stochastic discount factor to evaluate its dividend stream. This will be no longer related to the household's inter temporal marginal rate of substitution since the firm is now owned by domestic and foreign agents, so we use a weighted combination of the home and foreign discount factors.

Under the assumed price-setting structure, the dynamics of the domestic price index are described by the equation,

$$P_{h,t} = \left[(\eta)P_{h,t-1}^{1-\epsilon} + (1-\eta)\bar{P}_{h,t}^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}} \tag{2.21}$$

Finally, it is needed to define the dividend function for a representative domestic firm (j),

$$D_t(j) \equiv \left[\left(\frac{\bar{P}_h(j)}{P_{h,t}}\right)^{1-\epsilon}(Y_t) - \frac{P_t}{P_{h,t}}W_t\ N_t(j)\right] \tag{2.22}$$

Aggregating across firms, average dividend is obtained,

$$\int_0^1 d_t(j)dj = \int_0^1 \left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{-\epsilon} Y_t(j)dj - \left(\frac{W_t}{P_{h,t}}\right)\int_0^1 N_t(j)dj$$

It is obtained

$$D_t = \int_0^1 \left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{1-\epsilon} Y_t - \left(\frac{W_t}{P_{h,t}}\right)N_t \tag{2.23}$$

where price dispersion PD_t is also modelled following Schmitt-Grohe-Uribe (2006)

$$PD_t \equiv \int_0^1 \left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{-\epsilon} dj \tag{2.24}$$

2.4 Equilibrium Conditions

The goods market clearing conditions takes the form;

$$Y_t = \left(\frac{P_{h,t}}{P_t}\right)^{-\theta}\left[(1-\alpha)C_t + \alpha Q_t^{\theta} C_t^*\right] + (\bar{g}e_t^G)/PD_t \tag{2.25}$$

which has been derived from the following market condition for each firm j

$$Y_t(j) = C_{H,t}(j) + C_{H,t}^*(j) + \bar{g}e_t^G \tag{2.26}$$

where $C_{H,t}(j)$ corresponds to domestic demand for domestic goods and $C_{H,t}^*(j)$ coming from the optimal allocation of home-produced goods for foreign agents is obtained;

$$C_{H,t}^* = \alpha\left(\frac{P_{h,t}^*}{P_t^*}\right)^{-\theta} C_t^*$$

Asset markets clear at all times according to the following equilibrium conditions;

$$S_{H,t} + S_{H,t}^* = S_{F,t} + S_{F,t}^* = 1; b_{H,t} + b_{H,t}^* = b_{F,t} + b_{F,t}^* = 0 \tag{2.27}$$

Note that $S_{H,t}^*$ refers to the foreign share of domestic equity,and $S_{F,t}^*$ would refer to the foreign share of foreign equity. The same applies to $b_{F,t}^*$ and $b_{H,t}^*$

2.5 Monetary policy rules

In this section I describe how interest rate is determined by an empirical reaction function describing monetary policy decisions made by Central Banks. I use a simplified version to that of Fernandez-Villaverde (2006). In contrast with some macroeconomics literature, where monetary policy is introduced by assuming that some monetary aggregate follows an exogenous stochastic process, DSGE literature models monetary policy as endogenous, with a short-term interest rate being the instrument of that policy.[11] Formally, the country specific inflation-based Taylor rule (DITR, for short) are specified as follows:

$$\frac{R_t}{\bar{R}} = \left(\frac{\pi^{CPI_t}}{\pi_{\bar{CPI}}}\right)^{\mu_\pi} \varepsilon_t^R \tag{2.28}$$

$$\frac{R_t^*}{\bar{R}^*} = \left(\frac{\pi^{CPI_t^*}}{\pi_{\bar{CPI}^*}}\right)^{\mu_\pi} \varepsilon_t^{R^*} \tag{2.29}$$

3 Endogenous portfolio choice: Solution Procedure

The portfolio model is a set of 58 equations providing solution paths for the following domestic endogenous variables $\beta_t, \beta_t^f, C_t, Y_t, \pi_t, \pi_{H,t}, \pi_{Opt,t}, RP_t, PD_t, MC_t, EX_t, IM_t, NX_t,$ $R_t, r_t, N_t, w_t, V_t, D_t, NFA_t, VAL_t, CA_t, re1_t, re2_t, S_{h,t}, S_{f,t}, B_{h,t}$ and $B_{f,t}$ and the same for the foreign economy (except for Q_t, E_t, NX and NFA which are unique). There are 2 equations proving international links E_t, Q_t, and 6 exogenous shocks generated with $\epsilon_t^x \sim N(0, \sigma_x^2)$ for any x.

The usual method of solving DSGE models is to take a linear approximation around a non-stochastic steady state, however optimal portfolios are not uniquely defined in a non-stochastic steady state. The reason is that there is no natural point around which to approximate the model.It is because the steady state is free-risk, there is no uncertainty, so any portfolio allocation would be valid. Actually in a non-stochastic world all portfolio allocations are equivalent and can be regarded as valid equilibria.

Also, up to a first order approximation, assets deliver the same expected return, they are perfect substitutes, so portfolio dynamics are not pinned down either. Assets in this type of models are only distinguishable in terms of their risk characteristics and neither the non-stochastic steady state nor a first order approximation captures the different risk characteristics of assets. Therefore, we should consider higher approximation orders in which the effects of the model second moments can be captured.

Based on these properties, there has been some recent developments in macroeconomic modelling allows to characterise portfolio choice with international capital flows. There are two main solution methods based on Judd's 1992 work. First, Michael Devereux and Alan Sutherland develop a perturbation-based novel method, which is used to solve the model presented here. In their 2006 paper, they derive the solution method for an economy with

[11] In fact, this will allow to model alternative monetary regime,which may affect international capital flows. Even though the focus of this paper is not optimal monetary policy I will provide some insights about the effects on portfolio allocation.

incomplete markets but constant portfolio shares and apply it to a two-country endowment model with trade in real bonds. In 2008 they applied this model to a sticky-price monetary model which allows portfolios of bonds and equity trade. Also, they published an extended version of their method to allow for time-varying portfolios and another one focusing on the role of changes in valuation for the international distribution of wealth. Second, Cedric Tille and Wincoop (2010) developed a similar approximation method to examine the responses of current account and net foreign assets to changes in saving in a two country general equilibrium model with capital and trade in equities.

Their solution procedure is novel but its mathematical foundations are already established in the literature, in particular the work of Samuelson (1970), Judd(1998) and Judd and Guu (2001). Samuleson, was the first to establish that in order to derive the $\mathcal{N}$ order component of the portfolio, it is necessary to approximate the portfolio problem up to order $\mathcal{N}+2$. The important innovation in their work is that they find that to derive the $\mathcal{N}$ order accurate solution for portfolio, only the portfolio optimality conditions need to be approximated up to $\mathcal{N}+2$ order. The rest of the non-portfolio optimality and equilibrium conditions need only to be approximated up to $\mathcal{N}+1$, which simplifies the solution considerably.

These methods face some limitations as they rely on local approximations around the deterministic steady state, as any local methods, they are valid around the point of approximation, which is problematic when there are large deviations away from this point. Recent market developments prove the importance to use global solution methods that are increasingly often chosen to solve medium scale models. They can achieve a desired accuracy along the state-space. Rabitsch et al (2015) compare the performance of the local portfolio solution method of Devereux and Sutherland with the global solution method implemented by Stepanchuk and Tsyrennikov (2015). They find that the DS method works very well when focusing in short horizons, especially true where assets returns are similar, whether countries are symmetric or asymmetric.

We follow Devereux - Sutherland solution method for several reasons. It is close to standard approximation methods used in DSGE models and it can be applied to a broad range of environments (complete and incomplete markets models, a potentially large number of shocks and/or securities)

Basically they state that in any 2-country model there will be a set of portfolio optimality conditions for the two countries and a set of equations which may be characterised as

$$E_t(X_{t+1}, X_t, Y_{t+1}, Y_t, Z_{t+1}, Z_t) = 0$$

where X, Y and Z represent respectively a vector of endogenous state variables, control variables and exogenous shock processes.The solution of both set of equations will give a vector of real portfolio holdings for each traded asset.

For the steady state portfolio to be well defined, a 2^{nd} order approximation of the portfolio equations needs to be considered, while only the 1^{st} order dynamics of the other equations of the model are required to pin down steady state portfolios (also called zero-order portfolio).The authors show that in order to solve for the 1^{st} order dynamics of the portfolio, a 2^{nd}-order approximation of the non-portfolio equations of the model is needed, while the portfolio equations need to be approximated to the 3^{rd}-order.

In order to proceed we use a non-stochastic steady state of the model as the approximation point for the non-portfolio variables (See Appendix B for the steady state equations). We use the following combinations of the 2^{nd} order approximation portfolio optimal conditions for home and foreign country.

$$E_t\left[(\hat{C_{t+1}} - \hat{C^*_{t+1}} - \frac{\hat{Q}_t}{\sigma})r_{x,\hat{t+1}}\right] = 0 + O(\epsilon^3) \tag{3.1}$$

$$E_t r_{x,\hat{t+1}} = -\frac{1}{2}E_t[\hat{r^2_{H,t+1}} - \hat{r^2_{F,t+1}}] + \rho\frac{1}{2}E_t\left[(\hat{C_{t+1}} + \hat{C^*_{t+1}} + \frac{\hat{Q}_t}{\sigma})r_{x,\hat{t+1}}\right] + O(\epsilon^3) \tag{3.2}$$

This equations provide sufficient conditions to tie down the zero order component of portfolio. The LHS are key since they shows that it is sufficient to derive expressions for 1^{st} order accurate behaviour of consumption, real exchange rate and excess returns. Since the only terms that appear are products, and 2^{nd} order accurate solution for products can be obtained from 1^{st} order accurate solutions for individual variables.
Equations () and () together with the 1^{st} order approximation of the rest of the model will yield to the solution of portfolio holdings.

$$(\hat{X_{t+1}}, \hat{X}_t, \hat{Y_{t+1}}, \hat{Y}_t)$$

Portfolio changes (around the steady-state portfolios) are driven by changes in second moments (3^{rd}-order terms), which determine changes in expected returns across assets. A 3^{rd} order approximation captures the 1^{st} order effect of state variables on second moments and thus makes it possible to understand how portfolio should be adjusted as state variables evolve.

In order to implement their solution procedure, the household budget constraint needs to be rewritten in terms of net foreign asset position as follows. Domestic agent portfolio holdings of domestic and foreign assets are a combination of $q_{a,t}$, which refers to the price in domestic currency units and the amount of assets they hold (i.e. $S_{H,t}$,$S_{F,t}$ and $B_{H,t}$,$B_{F,t}$), then,

$$\alpha_{H,t} \equiv q_{EH,t}S_{H,t}; \alpha_{F,t} \equiv q_{EF,t}S_{F,t}; \tag{3.3}$$

$$\alpha_{BH,t} \equiv q_{BH,t}\frac{B_{H,t}}{P_t}; \alpha_{BF,t} \equiv q_{BF,t}\frac{B_{F,t}}{P_t}; \tag{3.4}$$

So that the net foreign asset position looks like

$$NFA_t \equiv [\alpha_{F,t} + \alpha_{BF,t} - \alpha^*_{H,t} - \alpha^*_{BH,t}] \tag{3.5}$$

Note that $\alpha^*_{H,t}$ and $\alpha^*_{BH,t}$ denote foreign agent holdings of domestic equity and domestic bonds respectively.

For conveniency we define a vector with the excess return on financial assets relative to domestic equity as in DS(2013).[12]

$$r_{X,t} \equiv [r_{BH,t} - r_{H,t}, r_{BF,t} - r_{H,t}, r_{F,t} - r_{H,t}] \tag{3.6}$$

and a vector with the real holdings of financial assets

$$\alpha_{t-1} \equiv [\alpha_{BH,t-1}, \alpha_{BF,t-1}, \alpha_{F,t-1}] \tag{3.7}$$

Finally, the domestic budget constraint can be rewritten as the following function:[13]

$$C_t + (\bar{g})e^{G_t} + NFA_t = w_t N_t + D_t + r_{X,t}\alpha_{t-1} + r_{H,t}NFA_{t-1}; \tag{3.8}$$

THE CURRENT ACCOUNT AND THE Δ IN NET FOREIGN ASSET POSITION

Standard international macroeconomics uses the following country's Balance of Payments (BoP) definition, in which the LHS of the equation refers to the current account and the RHS to the capital account.

$$CA_t \equiv \Delta NFA_t \tag{3.9}$$

It states that changes in the net foreign asset position (ΔNFA_t)are equivalent to current account (CA_t). Normally, this two terms differ by the capital gains and losses from asset and liability positions. Without a loss of generalisation[14], we can assume the following:

$$CA_t \approx w_t N_T - C_t - (\bar{g})e^{G_t} + D_t + (r_{H,t} - 1)NFA_{t-1} \tag{3.10}$$

Therefore, it is easy to derive from the budget constraint the following definition of the BoP,

$$\Delta NFA_t \equiv CA_t + (r'_{xt}\alpha_{t-1}) \tag{3.11}$$

$$(r'_{xt}\alpha_{t-1}) \equiv VAL_t = \Delta NFA_t - CA_t \tag{3.12}$$

where $(r'_{xt}a_{t-1})$ measure valuation effects.
Net exports are defined as

$$NX_t \equiv \alpha\left(\frac{RP_t}{Q_t}\right)^{-\theta} C_t^* - \left(RP_t^* Q_t\right)^{-\theta} C_t \tag{3.13}$$

where the first term refers to exports and the second one to imports. Note that RP_t (RP_t^*) refers to relative domestic (foreign) price defined as,

$$RP_t \equiv \frac{P_{H,t}}{P_t}; RP_t^* \equiv \frac{P_{F,t}^*}{P_t^*}; \tag{3.14}$$

[12]Without a loss of generalisation we assume that domestic equity is the reference asset.
[13]Due to certain equivalence to compute the model we only need the domestic budget constraint.
[14]See Devereux and Sutherland (2009)

4 Quantitative results: Financial Autarky vs Financial Integration

4.1 Calibration

In order to solve the model, I first need to calibrate its parameters, which are described in Table 1. I choose parameter values similar to those from previous open macroeconomics literature.[15] A period in the model corresponds to one quarter.
In the benchmark model, the discount factor parameter is chosen so that the steady-state real interest rate is 4%. The consumption constant elasticity is set to 1 and labour supply elasticity to 2. Home bias parameter is set to 0.4 which is standard in open economy models. Also, Calvo probability parameter equals 2/3, and the elasticity of substitution between home and foreign produced goods is set to 1.5. Nevertheless, in the following section I will introduce asymmetries in the home's country parameters to characterise their effects on capital flows dynamics.
Various empirical studies provide values for output volatility that are on average twice as large in emerging markets compared to developed countries.[16] Therefore,in the following section, the standard deviation of home(emerging) productivity shocks are set at 1%, and the standard deviation of foreign(advanced) productivity is set at 0.5%.For simplicity reasons, we assume, that productivity shocks are uncorrelated across countries.

Table 1: Parameter Values

Parameter	Concept	Value Home (Foreign)
β	4% steady state real interest rate	0.99 (0.99)
σ	Consumption elasticity	1 (1)
ϕ	Labour supply elasticity	2(2)
α	**Share of domestic consumption to imported goods**	0.2-**0.4**-0.6 (0.4)
ϵ	Elasticity b/varieties within the same country	6 (6)
θ	**E b/varieties produced at H and F**	1-**1.5**-2 (1.5)
η	**Calvo probability of price stickiness**	0.01-**2/3**-0.8 (0.6)
μ_π	Inflation weight	1.5 (1.5)
μ_{nr}	Nominal interest rate MPR weight	0.8 (0.8)
ρ^A	Productivity shock persistance	0.9 (0.9)
ρ^G	Government shock persistence	0.9 (0.9)
ϵ^r	Monetary shock volatility	0.1% (0.1%)
ϵ^A	Productivity shock volatility	0.5%-**1%** (0.5%)
ϵ^G	Government shock volatility	0.5%- **1%** (0.5%)

[15] Mostly Devereux and Sutherland (2009), Aguiar and Gopinath (2007) and Gali and Monacelli (2005).
[16] Schmitt-Grohe and Uribe, Aguiar and Gopinath (2007).

4.2 Net flows model vs Gross flows model

In this section, I show the distinction between gross and net capital flows matters when evaluating their impact and dynamics in a general equilibrium model. Table 2 reports theoretical business cycle moments for the autarky and the portfolio cases.In the Autarky model agent is allowed to trade internationally in domestic and foreign goods at no cost, but the financial markets are closed at the international level, so the domestic representative agent is the only owner of domestic firms and can only borrow home real bonds. Same logic applies to foreign agent. However, under financial integration, domestic agent is allowed to trade in bonds issued by domestic and foreign government and home and foreign firm's ownership through equities.

First, I compare second moments statistics of the different cases with HP filtered business cycle moments presented for advanced and emerging markets (taken mostly from Uribe and S.Schmitt-Grohe Open Economy textbook(Chapter 1) and Coeurdacier et al. (2010)). I present moments for both the autarky and the portfolio models, under the symmetric and the asymmetric cases (in terms of Calvo probability and volatility of shocks). There is no full risk sharing in any case. While in the autarky model cases this correlation is fairly high, close to 0.95, in the portfolio model cases, the correlation is lower and around 0.6. Also, the positive correlation of domestic and foreign output shown in the data is better replicated in the portfolio cases, but is it very low (close to 0.02), since the autarky model shows negative and small correlation.

The asymmetric cases deliver higher volatility for the emerging market variables since they exogenous shocks are set to have a higher volatility. The autarky model produces higher volatilities for output, consumption and net exports. It is shown that the portfolio case is closer to empirical data regarding the correlation between home and foreign output and consumption, especially in the asymmetric case, where home country is riskier.

Table 2: Business Cycle Moments

	St. Deviation			Correlation		
Case	Y	C/Y	NX	(Y,C)	(Y, Y^*)	(C, C^*)
Data Developing	2.6%	1.32%	1.58%	0.78	0.138	0.87
Data Advanced	1.38%	0.85%	0.5%	0.78	0.138	0.87
Autarky Case	1.09%	0.86%	3.3%	0.77	-0.01	0.96
Portfolio Case	1.05%	0.98%	2.8%	0.83	0.03	0.64
A. Home	2.14%	0.74%	5.5%	0.91	-0.03	0.97
A. Foreign	1.11%	1.21%	5.5%	0.53	-0.03	0.97
P. Home	2.08%	0.89%	4.4%	0.91	0.023	0.66
P. Foreign	1.07%	1.24%	4.4%	0.65	0.023	0.66

Second, I discuss the impulse response functions for the two versions of the model. Figure 5 shows in each row the impact of a shock in output, consumption and net exports in both the autarky and the portfolio model. The graph shows relatively different responses for output,consumption and trade balance variables among the two models analysed here, which reinforces our motivation to study gross flows instead of net flows in a general equilibrium model. Overall, the direction of the responses is similar, but the quantitative results differ among the two models, basically due to the capital gains and losses obtained from portfolio positions in the financial integrated model, which are missing in the autarky model.

The impact in home consumption is slightly higher, and that on foreign consumption is less, than that of the autarky model. Domestic output responds fairly similar under both models. The impact of the shock on the trade account is now less relative to that on the autarky model, since domestic exports increase by less and imports show a very small increase.
The responses of foreign variables also show different quantitative results, as shown in Figure 6. Again, output behaves fairly similar in both models, but consumption is relatively different since under autarky reflects higher consumption responses for both productivity and government shocks. The main difference between the two models can be shown with the consumption differential, which strongly responds under financial integration than in the autarky case.In this section, it has been shown that introducing endogenous portfolio choice in an otherwise standard open economy model is important when analysing its dynamics, since capital gains and losses from portfolio positions have effects on consumption.

5 Gross flows between two asymmetric countries

In this section, the focus is on characterising which asymmetries between home and foreign countries can explain portfolio equilibrium and dynamics. First, I focus in the portfolio equilibrium for different parameterisations. Then, I analyse capital flows dynamics and break them down into price and volume effects.

5.1 Zero order holdings analysis

Table 3 reports international portfolios positions solved endogenously using Devereux and Sutherland procedure from Section 3. It shows the near non stochastic steady state positions for different parameter values relative to domestic output. (i.e $\frac{\bar{\alpha}}{\beta \bar{Y}}$). Starting from the benchmark calibration in which both countries are calibrated symmetrically with standard values; Calvo probability (i.e. $\eta = 2/3$), home bias (i.e. $\alpha = 0.4$), elasticity of substitution between home and foreign goods (i.e. $\theta = 1.5$), and standard deviation of volatility of shocks (i.e. $\sigma_A^2 = 0.5\%$). Then, I departure from benchmark calibration by introducing asymmetries in the home parameter values. I also present the case in which both, Calvo Parameter and volatility of shocks, is calibrated asymmetrically.

For the benchmark model, symmetrically calibrated, the domestic agent goes short in home bonds, while long in foreign bonds. Also, she goes long in domestic equity and short in foreign equity. Actually, she owns 24% of the foreign firm and 76% of the domestic firm. I first describe zero order asset holdings for a higher and lower degree on Calvo probability of adjusting prices. Results show that having flexible price setting mechanism at home, while foreign country suffers from nominal rigidities causes the domestic agent to increase her negative position in foreign equity at the same time increasing her bond holdings positions. When home country prices are stickier than foreign country ones, then home agent reduces her foreign equity position, while maintaining fairly similar bond holdings. When both countries are calibrated to have flexible price mechanism, then home

Table 3: Near-Non-stochastic portfolioposition: Zero order asset holdings

Parameter Values		Portfolio Positions		
Home	Foreign	$\bar{\alpha}_{E,F}(S_F)$	$\bar{\alpha}_{B,H}$	$\bar{\alpha}_{B,F}$
Symmetry	Symmetry	-11.4 (0.24)	-3.07	3.07
$\eta = 0.001$	$\eta^* = 2/3$	-26.4 (0.56)	-3.55	3.23
$\eta = 0.8$	$\eta^* = 2/3$	-0.32 (0.007)	-3.16	3.13
$\eta = 0.001$	η^* =0.001	-49.5 (0.99)	-4.9	4.9
$\theta = 5$	$\theta^* = 1.5$	-5.3 (0.11)	-1.9	1.8
$\theta = 3$	$\theta^* = 1.5$	-7.05 (0.15)	-2.38	2.37
$\theta = 1$	$\theta^* = 1.5$	-10.76 (0.23)	-3.41	3.42
$\alpha = 0.2$	$\alpha^* = 0.4$	-19.37 (0.41)	-3.98	3.95
$\alpha = 0.55$	$\alpha^* = 0.4$	-38.04 (0.81)	+1.36	-1.44
$\sigma_A^2 1\%$	$\sigma_A^2 * 0.5\%$	-8.37 (0.17)	-3.41	3.33
Asymmetry	Asymmetry	-9.56 (0.2)	-3.45	3.42

agent portfolio positions are increased, since consumption prices uncertainty is reduced via nominal adjustment.

Then, I describe zero order asset holdings for a higher and lower degree in the θ parameter. Results show that portfolio positions are also sensitive to the elasticity of substitution between home produced goods and foreign produced goods. The more elastic the less portfolio diversification. The opposite holds for lower elasticity of substitution.

Finally, I describe the results for higher and lower degree on home bias in consumption. It should be noticed than for values of $\alpha = 0.5$, real exchange rate = 1. The higher the consumption bias ($\alpha \approx 0$) the higher is the portfolio position both in bonds and equity, taking the domestic agent almost half of the foreign firm ownership. When domestic agents have a foreign goods consumption bias (i.e $\alpha \approx 1$)they also increase their portfolio positions. These results point out that when consumption preferences are more restricted, agent bear uncertainty through portfolio choice. To conclude, I also analyse the asymmetric case, which results in home bias in equity, short position in domestic bonds and long position in foreign bonds.

Existing literature focused in the Equity Bias Puzzle shows large domestic asset position for most advanced countries,[17] The focus of this paper is not to obtain financial positions that match their empirical findings, but to analyse the effects of capital flows after domestic shocks instead. Note however, that positions remain fairly stable for the standard parameter values. It shows how domestic agent takes short positions on domestic bonds while she goes long in foreign bonds. We argue that this represents an efficient portfolio allocation since domestic (foreign) bond returns are negatively (positively) correlated with home GDP. Also, domestic equity returns are higher correlated with home GDP than foreign equity returns).

[17] Heathcote and Perri (2013) and others.

5.2 First order portfolio analysis

To evaluate first order portfolio dynamics, I first need to solve for the portfolio positions of real bonds and equity held by each country as it is shown in previous section. It has been argued how these positions impact the responses of the macroeconomic variables, portfolio dynamics and valuation effects. These dynamics will be related to the movements in all underlying shocks in the model and the purely-predetermined endogenous state variables, as it has been discuss in Section 3. I follow Devereux and Sutherland (2009) to describe the 1^{st} order movements in the home country holdings as

$$\hat{\alpha}_{a,t} = \alpha_{a,t} - \bar{\alpha}_a \approx \gamma_1 \hat{A}_{h,t} + \gamma_2 \hat{A}_{f,t} + \gamma_3 \hat{G}_{h,t} + \gamma_4 \hat{G}_{f,t} + \gamma_5 N\hat{F}A_t + \gamma_6 \hat{V}_{h,t} + \gamma_7 \hat{V}_{f,t} + \gamma_8 N\hat{R}_{h,t} + \gamma_9 N\hat{R}_{f,t} \tag{5.1}$$

where a refers to any asset, being home and foreign equities and bonds.

To better understand these dynamics, Table 4 reports the gamma vector(i.e effects of shocks and purely-predetermined variables on portfolio dynamics). The interpretation of the γ coefficients is as follows. A rise in either A or A* will lead the home country to increase its position in domestic bonds, as well as reducing its position in foreign bonds. It will lead to a decrease in foreign equity position and a increase in domestic equity position for the reasons that have been already explained. The effect of a rise in either G or G* is the opposite. In addition, an increase in NFA tends to be allocated towards domestic equity, domestic bonds and foreign bonds respectively. Increases in equity prices lead to decrease in their corresponding equity positions.

Table 4: Portfolio Dynamics. The Gamma Vector

$\hat{\alpha}_{i,j}$	$\hat{A}1$	$\hat{A}2$	$\hat{G}1$	$\hat{G}2$	$N\hat{F}A$	$\hat{V}1$	$\hat{V}2$	$N\hat{R}$	$N\hat{R}2$
$\hat{\alpha}_{E,H} =$	+	-	-	+	+	-	+	-	+
$\hat{\alpha}_{E,F} =$	-	+	+	-	-	+	-	+	-
$\hat{\alpha}_{B,H} =$	+	+	-	-	+	-	+	+	+
$\hat{\alpha}_{B,F} =$	-	-	+	+	+	-	+	-	-

Moreover, net foreign dynamics can be broken down into moments in financial asset holdings (i.e. domestic bonds, foreign bonds, foreign equity and domestic equity). Taking Devereux and Sutherland approach, it is possible to break down gross asset and liability movements (i.e changes in $\hat{\alpha}_{a,t}$) into price and volume movements. Up to a 1^{st}-order approximation the following relationships hold

$$\widehat{\alpha}_{FE,t} = \overline{q^*_{FE,t} S_f} \times \hat{q^*_{FE,t}} + \hat{S_{F,t}} \tag{5.2}$$

$$\widehat{\alpha}_{DB,t} = \overline{q^*_{DB,t} b_h} \times \hat{q^*_{DB,t}} + \hat{b_{H,t}} \tag{5.3}$$

$$\widehat{\alpha}_{FB,t} = \overline{q^*_{FB,t} b_f} \times \hat{q^*_{FB,t}} + \hat{b_{F,t}} \tag{5.4}$$

where $q^*_{FE,t}$ is the value of foreign equity (i.e $\frac{P^*_{Ft}}{P^*_t} Q_t V^*_t$), $q^*_{DB,t}$ that of domestic bonds (i.e $(r_t)^{-1}$) and $q^*_{FB,t}$ that of foreign bonds (i.e $Q_t(r^*_t)^{-1}$)

The focus of the paper is to characterise which asymmetries help to explain portfolio dynamics, to that end, I plot domestic and foreign bond and equity responses to domestic shocks, for different parameter values, (i.e. Calvo probability, home bias in consumption and volatility of the shocks). See Appendix Figures 7, 8 and 9.

Domestic productivity shock

From the discussion above, it follows the rise in home productivity leads to a fall in $\widehat{\alpha}_{FE,t}$ followed by an increase. We know that the price falls, so we can figure out the rise of its volume . The results point out that capital flows may be pro-cyclical or counter-cyclical depending on which asset we focus our attention, but they tend to be pro-cyclical. The impact of a home productivity shock on foreign equity outflows is pro-cyclical after all, even though there is a fall in the first periods. Since ex-post returns of pre-existing portfolio give rise to NFA, domestic agent reallocates the gain by increasing her position in foreign equity, since its returns are also expected to rise. Equity inflows can be derived within the model and are also pro-cyclical, actually their response is higher than foreign equity outflows.

Since marginal cost decreases, optimising firms reset their prices to a lower level, so that there is a real depreciation in the home country. Real return on domestic equity rises relative to that of foreign equity. Since Central Bank reacts to changes in CPI inflation, it will conduct an expansionary monetary policy by lowering nominal interest rates, making home real bond returns lower than those of foreign bonds. Notice that the home productivity shock is persistent, so expected rate of returns on all assets rise and realised returns will be equalised after one period. On both counts, home agent experiences a capital gain due to her portfolio position, which is short in domestic bonds and foreign equity, while long in foreign bonds and domestic equity, leading to an improvement in home country NFA. Hence, home consumption is higher relative to the autarky case. The movement in ΔNFA and the current account differ due to this valuation effect on the pre-existing portfolio. It is shown to have a positive effect.

Domestic government spending shock

Since this is an aggregate demand shock, optimising firms reset their prices to a higher level, so that there is a real appreciation in the home country. Real return on domestic equity decreases and so does foreign equity realised return. Since Central Bank reacts to changes in producer price inflation, it will conduct an contractionary monetary policy by increasing nominal interest rates, making home real bond returns higher than those of foreign bonds. Notice that the home government shock is persistent, making expected rate of returns on all assets rise and realised returns will be equalised after one period. On both counts, home agent experiences a capital loss due to her portfolio position. The movement in ΔNFA and the current account differ due to this valuation effect on the pre-existing portfolio which are shown in plot 5 and they are decreasing.
Figure ? shows equity and bond dynamics following a government shock to the home market economy. In this section I skip the analysis of the gamma vector since it is done before in the paper. As it has been said earlier, the portfolio model shows an decrease in the NFA. Moreover, this decrease can be broken down into an decrease in domestic bonds, a increase in foreign bonds, and a rise in domestic equity holdings. From the discussion the earlier section, it follows the rise in home government shock leads to a small increase

in $\widehat{\alpha}_{FE,t}$. We know that the price falls, so we can figure out also the decline of its volume which shown in plot ?.

The results point out that capital flows may be pro-cyclical or counter-cyclical depending on which asset we focus our attention. The impact of a home government shock on foreign equity inflows is pro-cyclical after all. Since ex-post returns of pre-existing portfolio give a decline to NFA, domestic agent adjusts her portfolio by increasing her position in foreign equity, foreign bonds and domestic equity. Equity inflows can be derived within the model and are also pro-cyclical, actually their response is higher than foreign equity outflows.

Domestic monetary shock

To be written

6 Conclusion

Financial market integration of emerging markets economies is believed to reduce consumption and income implications of their high level of country specific risks. Free capital flows were key after the 1990s but the recent financial behaviour has put them into a question mark since their effects are quite unclear. While some emerging market policy makers are willing to receive capital inflows some others complaint about the economic instability they create.

Most theoretical open economy DSGE models are either missing endogenous portfolio choice or treating it as a driver rather than the response to aggregate shocks. Whether the distinction between net and gross capital flows matters when evaluating its impact and dynamics in a general equilibrium model is shown to be important and depending on the financial market structure . Also, the underlying asymmetries between the two countries are key to understand the behaviour of gross portfolio flows, especially those regarding nominal price rigidities, the degree of home bias in consumption, the elasticity of consumption between home and foreign produced goods and the volatility of exogenous shocks.

This work is the first to address some of this limitations, using a fully structural open economy DSGE model with endogenous portfolio choice, incomplete financial markets and home bias in consumption, and focusing the attention on the dynamics for both macroeconomic and portfolio variables after domestic shocks between two asymmetric countries. However, it is required to continue the analysis with a more general model, which may include capital accumulation, capital adjustment costs, nominal rigidities in wages and other exogenous sources, such as investment specific or mark-up shocks. A further research would also imply whether this countries's stabilising tools actually work in this financial integrated world, and probably other macro prudential tools are worth to study, as for example capital controls.

A

APPENDIX A: The Steady State

The Steady State functions for the system are the following. Note that there are no time subscripts.

- Marginal cost

$$\psi = mc = \frac{\epsilon - 1}{\epsilon} \tag{SSB1}$$

- Domestic interest rate

$$r = R = \rho \tag{SSB2}$$

- Price level CPI

$$h(S) \equiv \frac{P}{P_H} = \left[(1-\alpha) + \alpha S^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{SSB3}$$

- Production function

$$Y = N^{1-\tau}; \tag{SSB4}$$

- Labour
-

$$C = Y - I - NX - \bar{g}Y \tag{SSB6}$$

- Wage

$$W = MC(1-\tau)N^{-}\tau \tag{SSB6}$$

- Parameter home labour supply

$$\chi = \frac{WC^{\sigma}}{N^{\phi}} \tag{SSB6}$$

- Domestic equity

$$V = \frac{\beta}{1-\beta} D \tag{SSB7}$$

- Aggregated dividends domestic firms

$$D = \left(\frac{1}{\epsilon}\right) \frac{Y}{h(S)} \tag{SSB8}$$

- Asset market condition,

$$S_F = 1 - S_F^*; S_H = S_H^* \tag{SSB9}$$

If symmetric countries , then $S_H^* = S_F$

Figure 1. Financial global integration. Gourichas and Rey (2013)

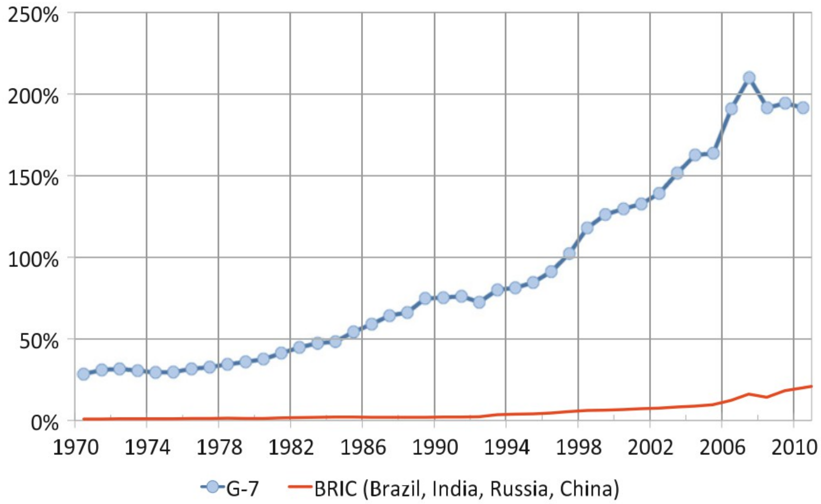
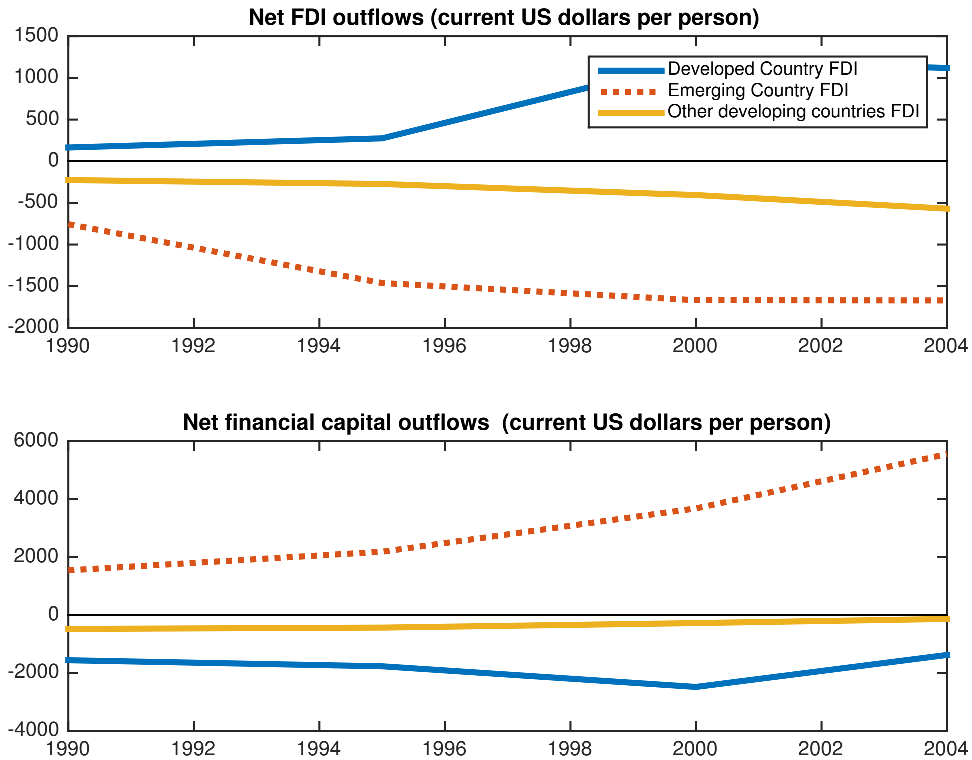


Figure 10.4 G-7 and BRIC Cross-Border Assets and Liabilities (Percent of World GDP). Cross-Border Assets and Liabilities Defined as the Sum of Gross External Assets and Liabilities. *Source:* Lane and Milesi-Ferretti (2007a) updated to 2010

B
APPENDIX B: Graphs and Tables

Figure 2. Patterns of Capital Flows by Country Groups, 1990-2004, Ju and Wei (AEJ 2010)



Note: ***21 Developed Countries*** : Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. ***22 Emerging Markets*** : Argentina, Brazil, Chile, China, Colombia, Egypt, Hong Kong SAR, India, Indonesia, Israel, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Singapore, South Africa, Thailand, Turkey, and Venezuela. ***33 Other Developing Countries***: Algeria, Bangladesh, Benin, Bolivia, Botswana, Burkina Faso, Burundi, Cameroon, Costa Rica, Cote dIIvoire, the Dominican Republic, Ecuador, El Salvador, Gabon, Ghana, Guatemala, Haiti, Honduras, Jamaica, Kenya, Mauritius, Nicaragua, Niger, Nigeria, Panama, Papua New Guinea, Paraguay, Senegal, Sri Lanka, the Syrian Arab Republic, Togo, Tunisia, and Uruguay. Source: Lane Milesi Ferreti: The External Wealth of Nations

Figure 3.
Increasing importance of valuation effects : Advanced Countries (Gourichas and Rey 2013)

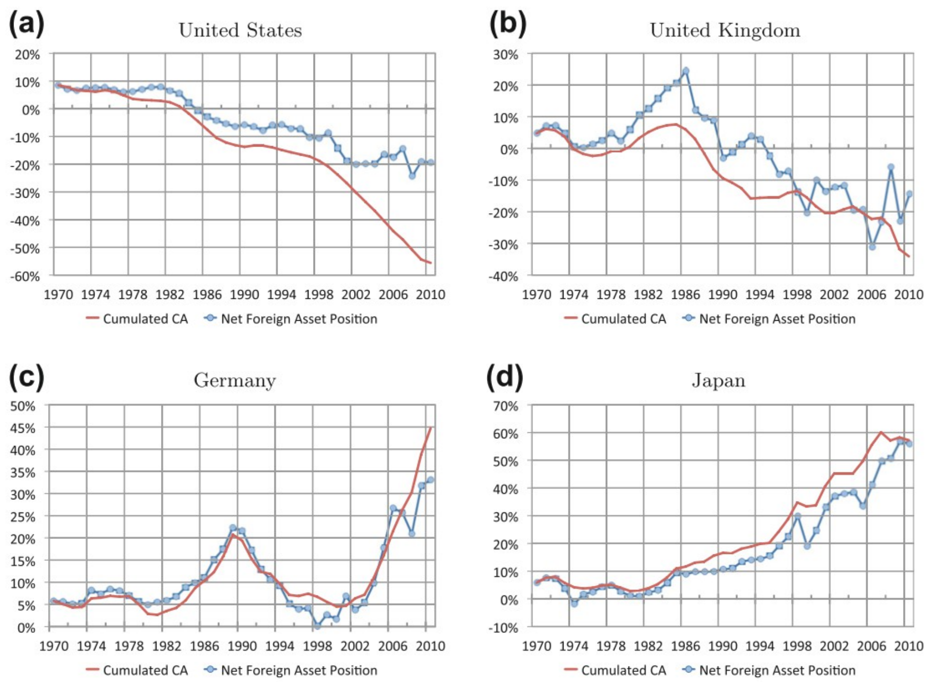


Figure 10.6 Cumulated Current Account and Net Foreign Asset Position: U.S., U.K., Germany, and Japan, 1970–2010. Percent of GDP. *Source:* Lane and Milesi-Ferretti (2007a) updated to 2010.

Figure 4. Increasing importance of valuation effects: BRIC (Gourichas and Rey 2013)

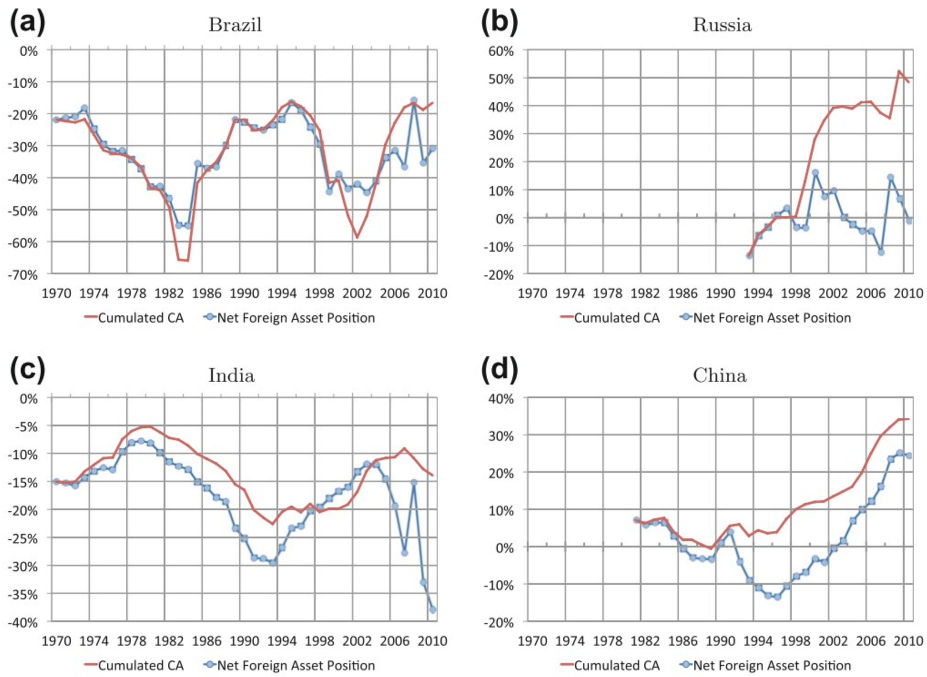


Figure 10.7 Cumulated Current Account and Net Foreign Asset Position: Brazil, Russia, India, and China, 1970–2010. Percent of GDP. *Source:* Lane and Milesi-Ferretti (2007a) updated to 2010.

Figure 5. Comparison of Portfolio Model and Autarky Model

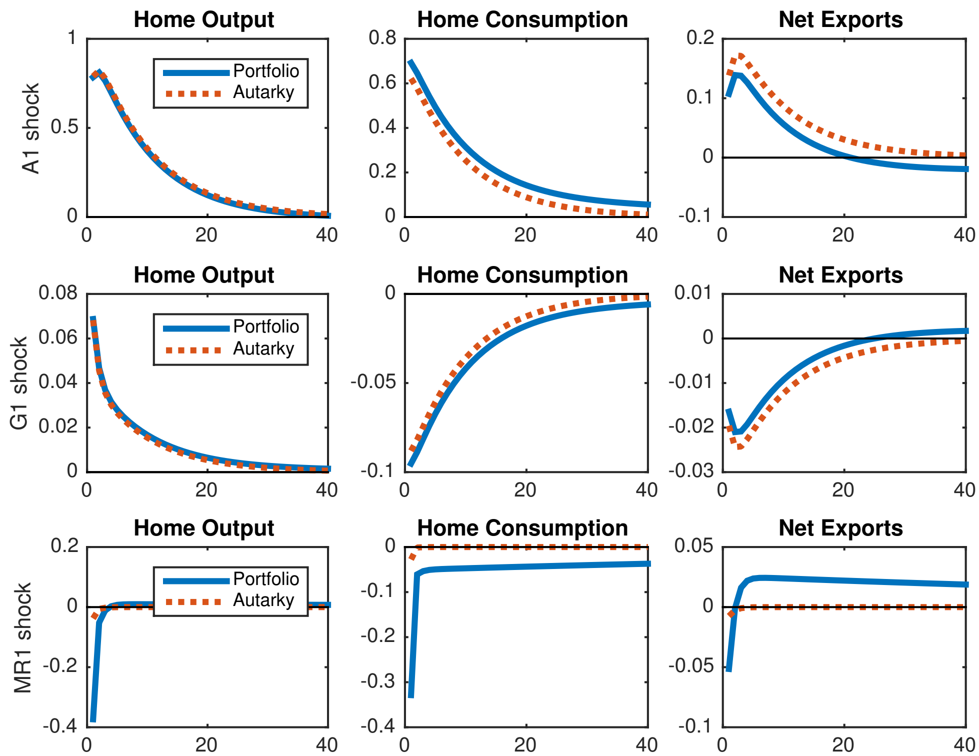


Figure 6. Comparison of Portfolio Model and Autarky Model

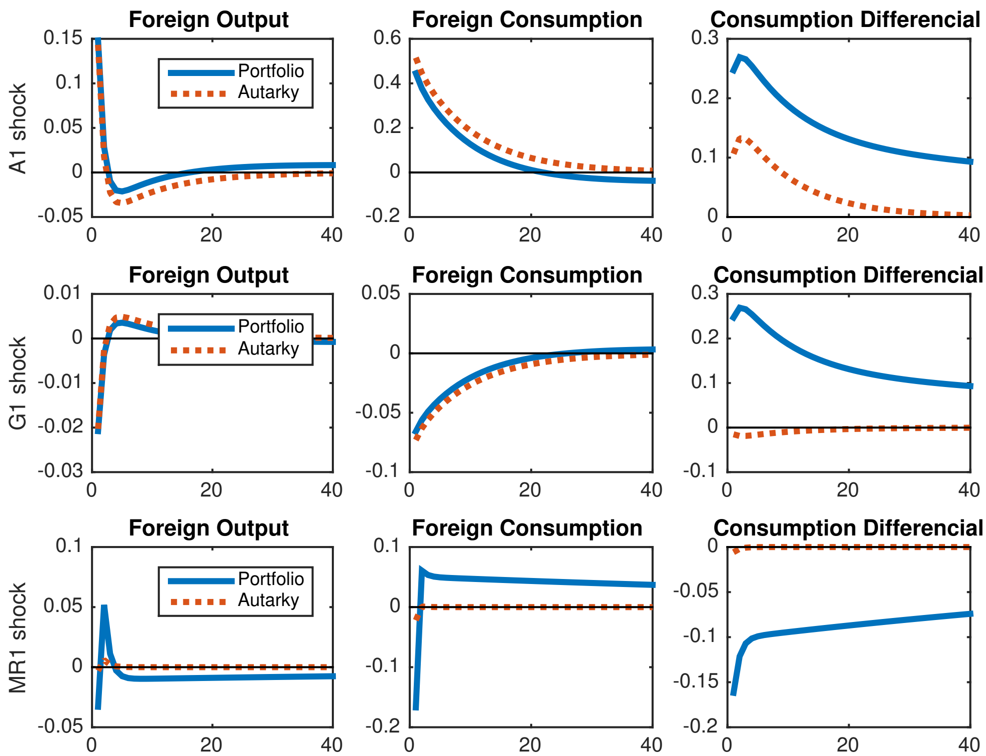


Figure 7. Gross assets and liabilities dynamics: Calvo probabilities

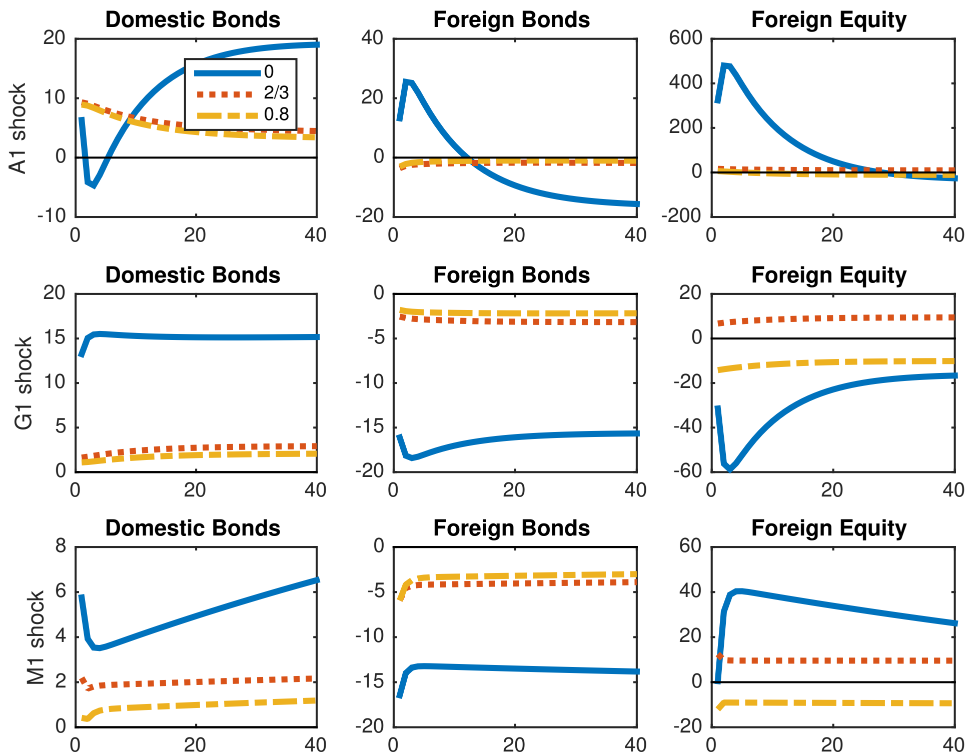


Figure 8. Gross assets and liabilities dynamics: Home Bias Consumption

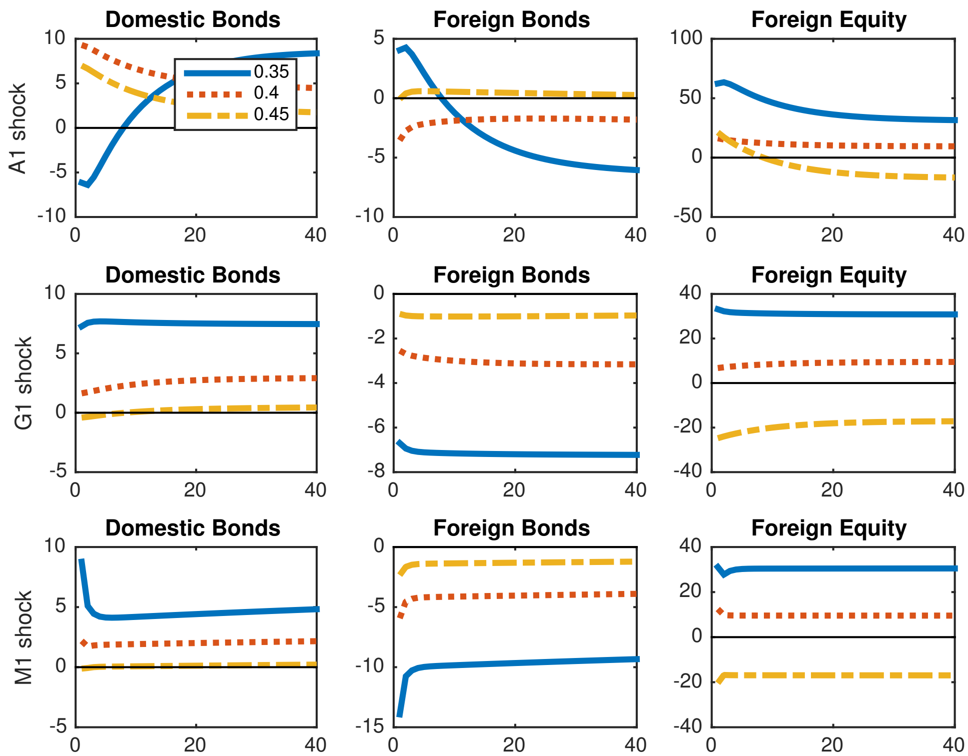
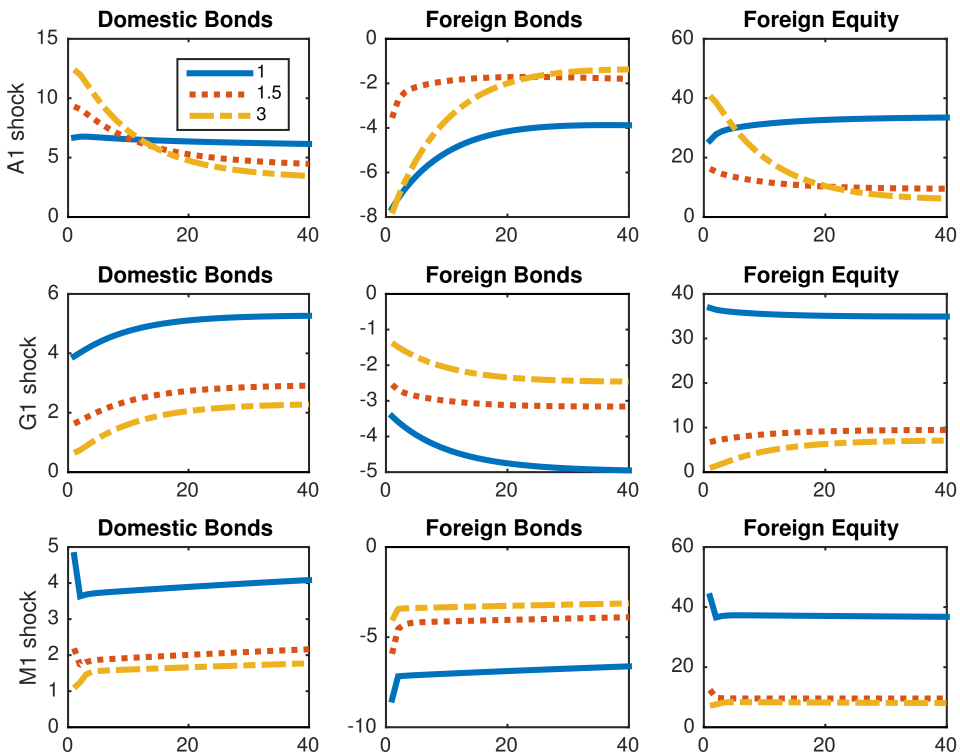


Figure 9. Gross assets and liabilities dynamics: Elasticity



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