Financial Openness and Macroeconomic Instability in Emerging Market Economies

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Abstract

This paper shows how the macroeconomic instability that affects more financially open emerging economies can be explained in terms of imperfect international financial integration. The analytic tool used is a stochastic dynamic equilibrium model. The model, based on a small open economy, is calibrated on the Malaysia economy. International financial relations are characterized by the presence of a borrowing constraint, that amplifies the volatility of exogenous shocks. Impulse response and simulation analyses are conducted. Main result is that, in presence of international financial frictions and given a positive economic shock to the considered developing country, greater access to international liquidity can cause high short-run macroeconomic instability.

1 Introduction

One of the major puzzles in international economics is that the increased international economic integration (a process that has started around the mid 1980s) has not reduced macroeconomic volatility in emerging market economies in the same measure as in industrialized countries. In particular, emerging market economies output volatility has essentially remained unchanged in the 1990s period relatively to the previous ones, while volatility of consumption and investment has increased. As a result, both consumption and investment volatilities have been always higher than output volatility, before and after the mid 1980.[1]

A possible explanation of the macroeconomic instability in emerging market economies relies on imperfect international financial integration. In fact, the period starting from the mid-eighties is not only characterized by higher macroeconomic volatility but it is also the one in which, after decades of financial repression, many emerging economies have chosen to pursue a financial liberalization strategy, in the sense of increasing domestic competition among financial operators and integrating domestic financial markets with the rest of the world. Public sector-oriented financial practices - based on interest caps, centrally allocated lending and/or an over-regulated banking industry - have been substituted by more market-oriented procedures.

This empirical regularity has been investigated, with the result that in the emerging markets case financial openness- usually measured by gross capital flows as ratio to gross domestic product - can systematically be associated to an increase in macroeconomic volatility.[2]

According to the theory, this piece of evidence sounds puzzling: standard theoretical models of international finance suggest that, under general conditions, financial integration should be expected to lead to a decline in the relative volatility of consumption and other main macroeconomic variables:

[1]According to Kose et al. (2003a), during the 1990s, the median percentage standard deviation of annual growth rate of output, consumption have been equal to 3.59 (4.05 during the 1980s), 4.66 (4.09), respectively. Instead, figures for industrialized countries are as follows: for output 1.61 (2.03); for consumption 1.72 (1.98). In a similar way, Kim et al. (2003) find that for Asian countries consumption and investment relative volatilities (standard deviations of expenditure components relative to output) are higher during the 1985-1996 period than in the 1960-84 period, with investment being the most volatile component.

[2]See for example Kose et al. (2003b).

with raising financial integration, agents in the emerging economies should have an improved opportunity of performing intertertemporal consumption smoothing, in such a way to reduce consumption volatility relative to income volatility.[3]

Recently, many theoretical papers have tried to rationalized the link between international financial integration and increase in the macroeconomic volatility in emerging market economies. The basic idea is that emerging economies, differently from industrialized countries, have only a *limited* and *conditional* access to international liquidity. This aspect is usually introduced in otherwise standard models by allowing private firms (a) to use foreign-currency-denominated debt as main financial tool, subject to (b) international risk premia - dependent on the level of the firm leverage - and/or (c) borrowing constraints. Main implication of the friction is the domestic amplification of foreign shocks: changes in net wealth or in the value of the assets used as collateral in the borrowing constraint amplify the effects of the shocks, producing a macroeconomic over-reaction. This is the mechanism that creates excess volatility.

While in this way the existing literature takes into account the macroeconomic implications of the imperfect nature of the financial integration, it does not properly consider the consequences of the financial openness process. This paper tries to fill the gap, by analyzing the relation between financial openness process and macroeconomic instability.

To illustrate the point, a dynamic stochastic general equilibrium model is calibrated on the economy of Malaysia, a country that during the mid '80s implemented a process of financial liberalization. The model is based on a small open economy. Main aspect of the setup is the presence of a borrowing constraint: entrepreneurs' borrowing from the rest of the world is a proportion m of the value of the collateral. Following the literature, real estate is used as collateral.[4] The borrowing constraint acts as an amplifica-

[3]The same seems to be not true for industrialized countries: financial openness in their case is associated with a reduction in macroeconomic volatility. See for example Blanchard and Simon (2001) and McConnell and Perez-Quiros (2002). As a result, macroeconomic volatility is higher in emerging market economies than in in industrialized countries. Kim et al. (2003), instead, find that Asian economies are roughly 35% more volatile than G-7 countries for the period 1960-1996.

[4]Many authors have emphasized, from one side, the role of real estate as collateral in both domestic and international financial transactions; from the other, the growth of

tion tool: given a positive economic shock, such as a terms of trade shock and/or real exchange rate shock, the higher level of domestic activity induces a higher price of the properties; given the role of the real estate as collateral, its higher value allows higher borrowing, and hence higher consumption and investment.

Allowing a higher level of borrowing for a given value of the collateral, more financially open economies experience - as a consequence of a given shock - greater instability. The previously described mechanism is stronger when the economy is more financially open. This is shown through several exercises.

Firstly, to quantitatively validate the model, I try to replicate the volatility of malaysian private consumption.

Secondly, to highlight the relevance of the financial openness process for the macroeconomic instability, several degrees of financial openness are considered, by opportunely changing the financial parameter in the borrowing constraint.

Thirdly, alternative monetary policy regimes are considered. All the previously described exercises are performed under the assumption, consistent with empirical evidence on emerging markets, of a fixed exchange rate policy. As alternative, an inflation targeting regime is considered, under which the domestic monetary authority targets a fixes level of the domestic consumption price inflation. Allowing the exchange rate to fluctuate can induce a reduction in the instability level.

The paper is structured in the following way. Next section relates the present work to the existing literature, emphasizing similarities and differences. Section three describes the setup: the microfoundations of the model, the optimization problems and the equilibrium relations are illustrated. Section four reports the results of the analysis, based on impulse response functions and simulations. Finally, section five contains the conclusions.

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real estate prices during the lending booms financed with international liquidity. See, among the others, Bank of International Settlements (20..) Collyns et al. (2002), Corsetti (1998), Corsetti et al. (1998), Jansen (2003), Krugman (1999), Mera and Renaud (1999), Radelet and Sachs (1998). For a study about the so called “real estate credit channel” in industrialized countries, see Iacoviello (2004).

2 Related Literature

Many papers consider the implications of international financial frictions for macroeconomic performance of emerging markets. To summarize, models can be split in two categories: the first is formed by models where the financial friction is introduced in the form of Bernanke, Gertler and Gilchrist financial accelerator;[5] the second is composed by setups characterized by an international borrowing constraint à la Kyiotaki -Moore (1997)[6].

The first set is comprehensive of models such as Gertler, Gilchrist and Natalucci (2001), Cespedes, Chang and Velasco (2002a, 2002b), Bacchetta (2000), Devereux and Lane (2001), Aghion et al. (2003). They study how alternative exchange rate regimes affects macroeconomic performance in presence of international financial frictions. In all those models, because firms face limits on their leverage, the level of investment is strongly affected by the net worth of their owners. A common result is the emphasis on the vulnerability of the countries to external shocks, such as a deterioration in the terms of trade or an exogenous increase in the risk premium: the exogenous external shocks are magnified by the balance-sheet effect due to the financial accelerator, and affect the country performance over the business cycle.[7]

The second set of models apply the Kiyotaky-Moore accelerator to open emerging economies. Paasche (2001) develops an international real business cycle model where each emerging economy is subject to an international borrowing constraint, with domestic real estate used as collateral.[8]

Devereux and Poon (2004) study the optimality of monetary policy in emerging market economies in the presence of financial constraints: key element of their one-period model is that firms in the small open emerging economy are subject to an international borrowing constraint, with fixed domestic-currency denominated asset used as collateral. Schneider and Tor-

[5] See Bernanke, Gertler and Gilchrist (1999). See also Bernanke and Gertler (1999).

[6] See also Kiyotaki (1998).

[7] The Bernanke-Gertler framework has been widely exploited also in the industrialized countries context. Faia (2002), among the others, inserts the Bernanke-Gertler-Gilchrist framework into a two country monetary model, to study how domestic financial frictions amplify international shocks.

[8] Iacoviello and Minetti (2003a) and (2003b) analyze the effects of the same type of constraint on the business cycle of open industrialized countries. Iacoviello (2004) uses a closed economy version of the constraint to study how financial frictions affect monetary transmission to the business cycle.

nell (2000), Tornell and Westermann (2001, 2002, 2003), Caballero and Krishnamurthy (2001) analyze the relevance of sectorial and national credit market imperfections - such as asymmetric sectorial financing constraint, currency mismatching and guarantees - in amplifying macroeconomic shocks in middle income countries. Mendoza (2000), using a small open economy model, shows how dollarization entails potentially large benefits for emerging economies by weak informational or institutional frictions driving credit constraint.

More recently, always using theoretical frameworks based on some form of imperfect access to financial markets, some authors have focused on the implications of financial liberalizations for the macroeconomic performance.

Tornell et al. (2004), for example, show the existence of a positive link between financial liberalization, growth, and crises, using a disaggregate model based on the real and financial asymmetries between tradables and nontradables sectors. Also in this case, the existence of financial frictions is key for the final results. Similarly, Aghion and Bacchetta (2003) analyze the role of financial factors as a source of instability in small open economies; in particular, they focus on the relation between financial liberalization and macroeconomic instability: domestic entrepreneurs are borrowing constrained, with current cash flow used as collateral.

The model developed here is closed in the spirit to Aghion and Bacchetta (2003): the effects of different degrees of financial openness on the macroeconomic stability of the open economy are considered. However, there are some differences. Firstly, consistently with the evidence on emerging markets, central role is given to the real estate, because of its role as collateral. Secondly, the model is characterized by nominal rigidities: sticky prices are introduced, so that implications of alternative exchange rate regimes and of the degree of price flexibility for the macroeconomic performance can be analyzed.

3 The Setup

The framework is based on a small-open economy stochastic dynamic general equilibrium model. The small open economy represents the emerging economy. The incomplete asset market assumption characterizes the international financial relations: the only asset in the model is a nominal riskless bond that is internationally traded. There are three types of agents in the small economy: entrepreneurs, consumers, retailers.

Entrepreneurs are the key agents in the model. They consume and invest, borrow from the rest of the world, produce a wholesale good using capital, real estate and labor as productive inputs. The wholesale good is sold to the domestic retailers. Most importantly, entrepreneurs are subject to an international borrowing constraint: in each period, the amount of foreign debt cannot exceed a fraction of expected value of the real estate, which is used as collateral. The borrowing constraint is the tool that amplifies volatility, as it will be shown later.

Consumers consume, supply labor to the entrepreneurs, trade the riskless bond with the rest of the world, own the firms in the retail sector.

Retailers differentiate the wholesale good, sell the resulting brands to the consumers, to the entrepreneurs and to the rest of the world agents; finally, they transfer the resulting profits to the consumers.

Rest of the world agents are taken as exogenous. They trade both goods and bonds with the agents of the small open economy.

Consumption, investment and price indices are initially described. For simplicity, it is assumed that Home agents have symmetric preferences.[9] All goods, except real estate and the wholesale good (see below) are internationally traded.

3.1 Good Indices

The consumption bundle C in the small economy is a composite good: it is characterized by two internationally traded goods. One, denominated Home good, is produced by the domestic retailers; the other, denominated Foreign good, is produced in rest of the world. So C is defined as:

$$C_t \equiv \left[a_H^{\frac{1}{\rho}} \left(C_{H,t}\right)^{\frac{\rho-1}{\rho}} + \left(1-a_H\right)^{\frac{1}{\rho}} \left(C_{F,t}\right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{1}$$

C_H and C_F are respectively consumption of Home and Foreign goods. a_H is the share of home produced goods in the consumption bundle, with $0 < a_H < 1$. Home and Foreign goods are imperfect substitute, with constant elasticity of substitution ρ.

[9] In what follows, the terms 'Home' and 'small economy' will be used as sinonymous. The same rule holds for the terms 'Foreign' and 'rest of the world'.

Home good is produced in a number of brands defined over a continuum of unit mass. Brands are indexed by $h \in [0,1]$. One brand is an imperfect substitute for all other brands, with constant elasticity $\theta > 1$. The same is true for the foreign good. Consumption of Home and Foreign goods are defined as:

$$C_{H,t} \equiv \left(\int_0^1 C_t(h)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}}, \quad C_{F,t} \equiv \left(\int_0^1 C_t(f)^{\frac{\theta-1}{\theta}} df \right)^{\frac{\theta}{\theta-1}} \tag{2}$$

It is further assumed that the same composition of the consumption bundle C applies to the investment basket I:

$$I_t \equiv \left[a_H^{\frac{1}{\rho}} (I_{H,t})^{\frac{\rho-1}{\rho}} + (1-a_H)^{\frac{1}{\rho}} (I_{F,t})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{3}$$

where I_H and I_F are respectively investment of Home and Foreign goods:

$$I_{H,t} \equiv \left(\int_0^1 I_t(h)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}}, \quad I_{F,t} \equiv \left(\int_0^1 I_t(f)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}} \tag{4}$$

The rest of the world bundle of Home produced goods is assumed to have the same structure as the Home consumption ones:

$$AD^*_{H,t} \equiv \left(\int_0^1 AD^*_t(h)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}} \tag{5}$$

The above index enters with a weight a^*_H in a bundle consumed by the rest of the world:[10]

$$AD^*_t \equiv \left[a_H^{*\frac{1}{\rho}} \left(AD^*_{H,t}\right)^{\frac{\rho-1}{\rho}} + (1-a^*_H)^{\frac{1}{\rho}} \left(AD^*_{F,t}\right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{6}$$

where $AD^*_{F,t}$ is defined as:

$$AD^*_{F,t} \equiv \left(\int_0^1 AD^*_t(f)^{\frac{\theta-1}{\theta}} df \right)^{\frac{\theta}{\theta-1}} \tag{7}$$

[10]Note that AD^*_t does not represent the basket of all goods consumed into the rest of the world. For simplicity, and without loss of generality, the full specification of rest of the world preferences is left unmodelled.

3.2 Price Indices

Let $p_t(h)$ denote the price of brand h expressed in the Home currency, and $p_t^*(f)$ the price of brand expressed in the Foreign currency.

The utility-based price index of the Home-produced goods is:[11]

$$P_{H,t} = \left(\int_0^1 p_t\,(h)^{1-\theta}\, dh \right)^{\frac{1}{1-\theta}} \tag{8}$$

while that of the Foreign-produced goods is:

$$P_{F,t}^* = \left(\int_0^1 p_t^*\,(f)^{1-\theta}\, dh \right)^{\frac{1}{1-\theta}} \tag{9}$$

For simplicity, it is assumed that the law of one price holds. So the following relationships are verified:

$$p_t(h) = S_t p_t^*(h) \qquad\qquad p_t\,(f) = S_t\ p_t^*\,(f) \tag{10}$$

where S_t, $p_t^*(h)$, and $p_t\,(f)$ are respectively the nominal exchange rate, expressed as Home currency per unit of foreign currency, the price of brand h expressed in terms of the foreign currency and the price of foreign good in home currency.

The Home country utility-based consumption price index is:

$$P_t = \left[a_H\,(P_{H,t})^{1-\rho} + (1-a_H)\,(P_{F,t})^{1-\rho} \right]^{\frac{1}{1-\rho}} \tag{11}$$

P_F is the price of the foreign composite good expressed in domestic currency terms .

The terms of trade are defined as:

$$T_t \equiv \frac{S_t P_{F,t}^*}{P_{H,t}} \tag{12}$$

and the 'real exchange rate' as:

$$RS_t \equiv \frac{S_t P_t^*}{P_t} \tag{13}$$

[11] P is derived as the minimum expenditure needed to buy one unit of the consumption or investment goods.

P_t^* is the utility based price index of the composite bundle (6); it is equal to:

$$P_t^* = \left[a_H^* \left(P_{H,t}^* \right)^{1-\rho} + (1 - a_H^*) \left(P_{F,t}^* \right)^{1-\rho} \right]^{\frac{1}{1-\rho}} \tag{14}$$

3.3 Intratemporal Allocation

Given the specification of consumption baskets, consumer's demand for generic brand h is a function of the relative price of h and the total consumption of Home goods:[12]

$$C_t'(h) = \left(\frac{p_t(h)}{P_{H,t}} \right)^{-\theta} C_{H,t}' \tag{15}$$

Consumers demand for the Home composite good is:

$$C_{H,t}' = a_H \left(\frac{P_{H,t}}{P_t} \right)^{-\rho} C_t' \tag{16}$$

Entrepreneurs solve a similar decision problem not only for consumption, but also for investment. So:

$$C_t(h) = \left(\frac{p_t(h)}{P_{H,t}} \right)^{-\theta} C_{H,t} \quad , \quad I_t(h) = \left(\frac{p_t(h)}{P_{H,t}} \right)^{-\theta} I_{H,t} \tag{17}$$

Entrepreneur's demand for the Home composite good is:

$$C_{H,t} = a_H \left(\frac{P_{H,t}}{P_t} \right)^{-\rho} C_t \quad , \qquad I_{H,t} = a_H \left(\frac{P_{H,t}}{P_t} \right)^{-\rho} I_t \tag{18}$$

The rest of the world demand for each Home brand h is:

$$AD_t^*(h) = \left(\frac{p_t(h)}{P_{H,t}} \right)^{-\theta} AD_{H,t}^* \tag{19}$$

where the law of one price has been used.

[12]The intratemporal problem consists in maximizing, in each period, consumption given a fixed amount of expenditure. Note that, from now on, the '′' indicates variables related to the consumer agent.

The rest of the world demand for the bundle $AD^*_{H,t}$ is equal to:

$$AD^*_{H,t} = a^*_H \left(\frac{P^*_{H,t}}{P^*_t} \right)^{-\rho} AD^*_t \tag{20}$$

Similar demand functions can be derived for the generic brand f produced in the rest of the world economy.

3.4 Entrepreneurs

The optimization problem solved by entrepreneurs is the key element of the setup. The entrepreneurs do not have unlimited access to international financial markets: a borrowing constraint affects the amount of financial resources they can get from the rest of the world. In this way, the fact that emerging markets have imperfect access to international financial markets is introduced into the model.

Preferences. Each entrepreneur maximizes the following lifetime utility:[13]

$$E_t \sum_{s=0}^{\infty} \gamma^{t+s} \left[\ln C_{t+s} \right] \tag{21}$$

where C is the entrepreneur consumption. $\gamma < 1$ is the entrepreneur discount rate. E_t is the expectation operator at time t.

Borrowing Constraint. Main aspect of the allocation problem is the presence of the borrowing constraint. Following Kiyotaki and Moore (1997), it is assumed the existence of a limit on the net foreign debt of the agent. The bond, B, is a riskless one, and is denominated in foreign currency. In each period t, the amount she can borrow, comprehensive of interest payment, cannot exceed a fraction $m \leq 1$ of next period's foreign currency expected value of real estate holdings (lenders are concerned about the foreign currency value of the collateral). Hence, entrepreneur debt is limited by:

[13] It is assumed that: (a) preferences and intial wealth conditions are the same for each entrepreneur; (b) the population of entrepreneurs is defined over the continuum $[0, 1]$. Taking into account that, as it will be clear later in the main text, income revenues are similar across the entrepreneurs, both the above assumptions allow to consider a representative agent for the class of entrepreneurs.

$$-B_t \leq mE_t\left(\frac{Q_{t+1}}{S_{t+1}}ho_t\right) \tag{22}$$

or, if the above constraint were expressed in domestic currency terms, by:

$$-S_tB_t \leq mE_t\left(\frac{S_tQ_{t+1}}{S_{t+1}}ho_t\right) \tag{23}$$

where Q is the domestic currency price, determined in the domestic competitive real estate market, of the domestic real estate stock and ho is the Home stock of real estate owned by the entrepreneur. One way to rationalize this constraint is by thinking to the existence of liquidation costs: in case of default, costs amount to a fraction $1-m$ of the real estate value.

Different values of m correspond to different levels of financial openness. Financial openness can be interpreted as a change in the technical condition of producing financial services. It corresponds to a permanent change in the parameter m. In the simulation exercises, illustrated later in the paper, the greater degree of financial openness is introduced in the form of higher value of m: entrepreneurs are allowed to increase the amount of borrowing, given the expected value of the collateral.

Other entrepreneur's constraints are standard: the budget constraint, the technology constraint, the capital accumulation law.

Budget Constraint. The entrepreneur consumes and invests, is the owner of the real estate and capital stocks she uses in the production process, hires labor services supplied by the consumer, produces the wholesale home good under a perfect competition regime and sells it to the domestic retail sector;[14] so she is subject to the following budget constraint:

$$\begin{aligned}\frac{S_tB_t}{1+i_t^*} - S_tB_{t-1} &= P_t^WY_t - P_tC_t - Q_t\left(ho_t - ho_{t-1}\right) - W_tL_t \\ &-P_tI_t - \frac{\psi}{2}P_t\left(\frac{I_t}{K_t}-\delta\right)^2K_t \end{aligned} \tag{24}$$

where P_t^W is the nominal price of the wholesale good, Y_t is the produced output, W_t is the nominal wage paid by the entrepreneurs to rent the labor

[14]Hence the wholesale good is not internationally traded.

services L_t, I_t is the flow of investment in the capital stock K. i_t^* is the nominal yield in foreign currency, paid at the *end of period t but known at the beginning time t*. Real estate h_t is considered as a durable good. Capital installation entails an adjustment cost of $\frac{\psi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2 K_t$, paid in units of the consumption good. ψ dictates the elasticity of investment to the price of capital, which, in a neighborhood of the steady state, is equal to $1/\psi\delta$.

Technology Constraint. Entrepreneurs produce the wholesale good according to the following 'Cobb-Douglas' production function:

$$\begin{aligned} Y_t &= (ho_{t-1})^{\mu}\,(K_{t-1})^{\alpha}\,(L_t)^{1-\alpha-\mu} \\ 0 &< \alpha < 1 \\ 0 &< \mu < 1 \end{aligned} \tag{25}$$

Accumulation Law. The capital stock evolves accordingly to the following capital accumulation law:

$$K_t = (1-\delta)\,K_{t-1} + I_t \tag{26}$$

where δ is the depreciation rate.

First Order Conditions. In each period t, the agent maximizes her utility function (21) with respect to C_t B_t, ho_t, I_t, K_t, L_t, subject to the borrowing constraint (23), the budget constraint (24), the technology constraint (25) and the accumulation law for capital (26). Let's define λ_t and Ψ_t as the time t shadow value of the borrowing constraint and of the capital accumulation law, respectively. The resulting first order conditions are:

$$E_t\left(-\frac{S_t}{P_tC_t\,(1+i_t^*)}+\gamma\frac{S_{t+1}}{P_{t+1}C_{t+1}}+\frac{S_t}{P_t}\lambda_t\right)=0 \tag{27}$$

$$\frac{Q_t}{P_tC_t} = E_t\left\{\gamma\frac{\mu P_{t+1}^W Y_{t+1}}{P_{t+1}C_{t+1}h_t}+\gamma\frac{Q_{t+1}}{P_{t+1}C_{t+1}}+mE_t\left(\lambda_t\frac{S_tQ_{t+1}}{S_{t+1}P_t}\right)\right\} \tag{28}$$

$$\Psi_t = \frac{\psi}{C_t}\left[\left(\frac{I_t}{K_t}\right)-\delta\right]+\frac{1}{C_t} \tag{29}$$

$$\Psi_t = \gamma E_t \left\{ \frac{\alpha P^W_{t+1} Y_{H,t+1}}{P_{t+1} C_{t+1} K_t} \right\} + (1-\delta)\gamma E_t \Psi_{t+1} + \\ -\frac{1}{C_t}\left[\frac{\psi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2 - \psi \frac{I_t}{K_t}\left(\frac{I_t}{K_t}-\delta\right)\right] \tag{30}$$

$$\frac{P^W_t}{P_t}\frac{Y_t(1-\alpha-\mu)}{L_t} = \frac{W_t}{P_t} \tag{31}$$

The first equation is the consumption euler equation; the second one is the real estate demand equation. They both contain λ_t, the lagrange multiplier of the borrowing constraint. This constraint causes a distortion in both the intertemporal and intratemporal allocation of resources: from one side, its presence affects the intertemporal consumption smoothing decisions; from the other, in each period resources must be allocated among the non durable consumption good C_t and the durable real estate ho_t.

Equations (29) and (30) are standard in models of investment with adjustment costs. Equation (29) defines the shadow value of one unit of investment today, which equals the marginal cost of investment. Equation (30) states that this value must be equated across time periods. At the optimum, the shadow price of capital must equal the capital's marginal product next period plus the shadow value of capital in the next period plus the capital contribution to lower installation costs. Equation (31) is the first order condition for labor demand: at the margin, labor product equals its cost.

3.5 Consumers

Consumers are not subject to a borrowing constraint. They are the owners of the retailers and supply labor to the entrepreneurs.

Preferences. Consumers maximize the following utility function:[15]

$$E_t \sum_{s=0}^{\infty} \beta^{t+s}\left[\ln C'_{t+s} + \chi \ln \frac{M'_{t+s}}{P_{t+s}} - \frac{\kappa}{\eta} L'^{\eta}_{t+s}\right] \tag{32}$$

[15]It is assumed that consumers (a) have symmetric preferences; (b) have equal initial wealth conditions; (c) equally share retailers revenues; (d) supply labor in a competitive labor market. Direct implication of the above assumptions is the possibility of adopting the representative agent feature for the consumers.

where β is the consumer discount rate; it is assumed to be equal to the rest of the world discount rate, and strictly greater than entrepreneur discount rate: $\gamma < \beta$.[16] In the generic period $t+s$, L'_{t+s} is the amount of labor rented to the entrepreneur, M'_{t+s}/P_{t+s} is the real balance holdings, where M'_{t+s} is the nominal quantity of money.

Budget Constraint. In each period, the consumer is subject to the following budget constraint:

$$\frac{S_t B'_t}{1+i^*_t} - S_t B'_{t-1} + M'_t - M'_{t-1} = W_t L'_t + D'_t - P_t C'_t + T'_t \tag{33}$$

D'_t are the profits from ownership of the retailers (see next section), while T'_t is nominal lump-sum transfer from the government.

First Order Conditions. The first order conditions are the standard ones:

$$E_t \left(-\frac{S_t}{P_t C'_t \left(1+i^*_t\right)} + \beta \frac{S_{t+1}}{P_{t+1} C'_{t+1}} \right) = 0 \tag{34}$$

$$\frac{W_t L'_t}{P_t C'_t} = \kappa L'^{\eta}_t \tag{35}$$

The first equation is the consumption euler equation. The second is the labor supply first order condition.

Since it is assumed that the Home monetary authority follows an exchange rate targeting rule (as illustrated later in the text), money supply will always respond to meet money demand at the desired equilibrium exchange rate. As utility is separable in money balances, the actual quantity of money has no implications for the rest of the model, and the money first order condition can therefore be ignored.

[16] This assumption will be used to show that the entrepreneur's borrowing constraint is binding.

3.6 Retailers

Retailers buy the domestic homogeneous good from the entrepreneurs, differentiate and sell it both domestically and internationally. Each retailer is the only producer of a single differentiated good. Profits are transferred in a lump-sum fashion to the consumers. The retail sector is subject to a monopolistic competition regime. In this way it is possible to rationalize the introduction of price stickiness through 'Calvo' price adjustment.[17] In agreement with the preferences of consumers, entrepreneurs and rest of the world agents, the final goods are defined as the CES composite of individual retail goods:

$$Y_t \equiv \left(\int_0^1 Y_t(h)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}} \tag{36}$$

where h indexes each retailer and $\theta > 1$.

Demand Constraints. Demand good for each type of final good h is:

$$Y_t(h) = \left(\frac{p_t(h)}{P_{H,t}} \right)^{-\theta} Y_t \tag{37}$$

Consumers, entrepreneurs and the rest of the world agents buy final goods from retailers. So:

$$Y_t = C_{H,t} + I_{H,t} + C'_{H,t} + AD^*_{H,t} \tag{38}$$

where $C_{H,t}$, $I_{H,t}$, $C'_{H,t}$ and $AD^*_{H,t}$ are defined in the 'Intratemporal Allocation' section.

Profit function. Each retailer chooses price $p^o_t(h)$ in such a way to maximize expected profits given the wholesale price and the above demand equations. Prices can be changed in every period only with probability $1-\vartheta$. So the retailer maximization problem is :

$$\max_{p^o_t(h)} \sum_{k=0}^{\infty} \vartheta^k E_t \left(\Lambda_{t,t+k} \frac{p^o_t(h) - P^W_{t+k}}{P_{t+k}} Y_{t+k}(h) \right) \tag{39}$$

[17] See Calvo (1983).

$$
Y_{t+k}(h) \overset{sub}{=} \left(\frac{p_t^o(h)}{P_{H,t+k}}\right)^{-\theta} \left[\begin{array}{c} a_H \left(\frac{P_{H,t+k}}{P_{t+k}}\right)^{-\rho} \left(C_{t+k} + I_{t+k} + C'_{t+k}\right) \\ +a_H^* \left(\frac{P_{H,t+k}}{P_{t+k}^*}\right)^{-\rho} AD_{t+k}^* \end{array} \right] \quad (40)
$$

where $\Lambda_{t,t+k} = \beta(C'_t/C'_{t+k})$ is the household discount rate (retailers are agents for the household). Since retailers simply repackage wholesale goods, $P_t^W/p_t^o(h)$ is the marginal cost of producing a unit of output ($p_t^o(h)/P_t^W$) is instead the gross markup of final over wholesale goods).

First order condition. The resulting first order condition is the following one:

$$
\sum_{k=0}^{\infty} \vartheta^k E_t \left(\Lambda_{t,t+k} \frac{(1-\theta)\, p_t^o(h) + \theta P_{t+k}^W}{P_{t+k}} Y_{t+k}(h) \right) = 0 \quad (41)
$$

At the optimum, expected discounted marginal revenues are equated to expected discounted marginal costs. Profits, as written before, are rebated lump-sum to consumers.

Since there are no firm-specific state variables, all retailers setting price at t will choose the same optimal price $p_t^o(h)$. It can be shown that, in the neighborhood of the steady state, the domestic price index evolves according to

$$
P_{H,t} = \left(\vartheta P_{H,t-1}^{1-\theta} + (1-\vartheta)\left(p_t^o(h)\right)^{1-\theta}\right)^{1/(1-\theta)} \quad (42)
$$

Equations (41) and (42), once log-linearized around the steady state, yield a Phillips curve, that relates current inflation positively to the marginal cost and to the expected inflation.

3.7 Rest of the World Agents

Behavior of the agents in the rest of the world is taken as exogenous. It assumed that rest of the world agents are able to supply the amount of bonds agents in the small economy need. In the section illustrating the dynamics of the system, the exogenous law of motion of the foreign currency price of the good F is introduced as driving force of the economy.

3.8 Monetary Policy Targets

Consistently with the empirical evidence on emerging market economies, the assumption holds that the small open economy targets a certain level of the nominal exchange rate. So:[18]

$$\frac{S_t}{S_{t-1}} - 1 = 0 \tag{43}$$

3.9 Market Clearing Conditions

The model is closed by the market clearing conditions and the government budget constraints.

It is assumed that total amount of real estate in the economy is fixed. Hence the house market clearing condition is:

$$ho_t = H \tag{44}$$

The labor market clearing condition is:

$$L'_t = L_t \tag{45}$$

Home final good market clearing is, for each brand h:

$$Y_t(h) = C_t(h) + I_t(h) + C'_t(h) + AD^*_t(h) \tag{46}$$

The Home government budget constraints at date t is:

$$G_t + (M_t - M_{t-1}) = T_t \tag{47}$$

where G is the public expenditure for consumption. It is introduced just for calibration issues: in all the computed exercises it will be set equal to its steady state value. To avoid distributional issues, I assume that entrepreneurs and patient agents equally contribute, through a similar amount of lum-sum taxes, to finance the public expenditure.

The money market clearing is:

$$M_t = M'_t \tag{48}$$

[18]Other authors use targeting rules instead of the more popular policy rule. See, for example, Svensson(2000, 2002, 2003), Benigno and Benigno (2003), De Paoli (2003).

3.10 The Equilibrium

It is possible to define a rational expectations equilibrium as:

1. a sequence of allocations

$$\left\{ \begin{array}{c} B_t, B'_t, K_t, C_t, C'_t, C_{H,t}, C'_{H,t}, C_t\left(h\right), C'_t\left(h\right), C_{F,t}, C'_{F,t}, C'_t\left(f\right), \\ AD^*_t, AD^*_{H,t}, AD^*_t\left(h\right), AD^*_t(f), K_t, I_t, I_{H,t}, I_t(h), I_{F,t}, I_t\left(f\right), M_t, M'_t, L_t, ho_t, Y_t, Y_t\left(h\right) \end{array} \right\}_{t=0}^{\infty}$$

and

2. a sequence of prices $\left\{P_t,\ P_{H,t},\ p_t(h),\ P_{F,t},\ p^*_t(f),\ P^*_t,\ S_t,\ Q_t,\ i^*_t,\ P^W_t, T_t,\ RS_t\right\}_{t=0}^{\infty}$

such that, given the initial conditions $B'_{-1}, K_{-1}, ho_{-1}, B_{-1}, M_{-1}, T_{-1}$, and the shocks that will be introduced later, in every period t:

- entrepreneurs maximize the utility function(21) subject to the borrowing constraint (23), the budget constraint (24), the technology constraint (25), the capital accumulation law (26);
- consumers maximize the utility function (32) subject to the budget constraint(33);
- intratemporal first order conditions (15), (16), (17), (18), (19) and (20) are verified;
- retailers maximize the expected discounted flow of profits (39) subject to the sequence of demand constraints (40);
- the law of Home price evolution (42) holds;
- the clearing conditions for real estate (44), labor (45), home final good (46) and money (48) markets hold;
- the government budget constraint (47) holds;
- the monetary policy target (43) (or(**??**)) is satisfied.

3.11 Parameter Settings

The model, which is loglinearized around a deterministic steady state (see Appendix for details), is calibrated to match the yearly 'great' ratios of Malaysia over the period 1960-1996 using parameter values which are consistent with those commonly used in the literature. In the mid '80s, in fact, Malaysia and other countries in the south-east part of Asia implemented a program of fixed exchange rate and trade and financial liberalization. As a result, there were strong inflows of foreign capitals, mostly in the form of foreign currency borrowing, and huge increase in the stock and property price indexes. [19]

The parameters are the following ones:

Preferences	β, γ, a_H, ρ, τ, a_H^*
Production	α, μ, θ, ϑ, δ, ψ
Finance	m
Shock autocorrelation	ρ_{π_F}, ρ_{RS}

The model is calibrated on yearly frequency.

β, consumer's discount rate, is set equal to 0.96; a_H, the share of home good in home consumption and investment indices, is equal to 0.4; ρ, intratemporal elasticity of substitution, is equal to 1; α, the capital share, is 0.5; μ, the real estate share, is set equal to 0.03; the probability of the price not adjusting, ϑ, is assumed to be 0.32; θ is set to 6, in such a way to have a steady state markup equal to 1.2; δ, the depreciation rate, is set to 0.025; τ is set equal to 1.01. γ, the entrepreneur's discount rate is set equal to 0.92. ψ is set equal to 2. The loan to value ratio, m, is set equal to 0.5. In the dynamics' exercises, I'll perform a sensitivity analysis by varying the value of m, so to show the effect, in terms of (higher) volatility, of financial liberalizations. The patient agent financial position, B/Y, is chosen so to match the net export to ouput ratio.

The actual ratios of Malaysia and the steady-state ones are reported in table 1, where X/Y, M/Y are the respectively the export and import to output ratios, C is the sum of entrepreneurs and patient agents consumption levels. As it can be seen from the table, the steady-state ratios and the actual ones have very close values (G/Y is exogenously set).

After the steady-state, I now calibrate the dynamics of the model. I study the effects of two shocks that literature widely recognizes as relevant

[19] For more details, see Kim, S.H., A. Kose, and M. Plummer (2003)

for emerging market economies: shocks to the real exchange rate and to the import prices. I model the exogenous process of the two variables as a VAR(1), which is estimated roughly over the same period (1962-1996 instead of 1960-1996, due to lack of data for 1960 and 1961) used to compute the steady state ratios. Data used to estimate the VAR have a yearly frequency and are logged and HP-filtered. The deterministic part of the VAR is formed by a constant. The estimated regressive coefficients and the residual variance-covariance matrix are reported in Table 2.

4 Results

Main goal of the paper is to construct a model that is able to explain the high macroeconomic volatility, in particular the relative volatility of consumption (with respect to that of output) that characterize emerging market countries that implement a process of financial liberalization. As a first step, to quantitatively validate the calibrated model, I compare the actual volatilities of malaysian consumption and investment to the simulated counterparts. After, I'll show how volatility increases when the degree of financial openness is higher (in the model, it corresponds to a greater value of the parameter m). Finally, to gain some intuition of the simulation results, I'll perform impulse response analysis.

4.1 Simulations

Statistics reported in table 3 are averages of statistics computed from 100 simulations. Each simulation consists of 100 periods; the first 64 observations have been discarded, so to work with a number of years (36) equal to those used to construct the actual statistics. The simulated model has volatilities lower than the actual ones; in particular, the investment simulated volatility is much lower than the actual one, probably because the calibrated value of investment adjustment cost parameter is too high. However, the actual and simulated relative volatilities of consumption have close values.

How does the degree of financial openness affect the volatility results? To answer to this question, I simulate the model when the parameter m has a value equal to 0 (entrepreneurs are in a condition of 'financial autarchy'), 0.3 ('relatively low degree of financial openness') and 0.8 ('relatively high degree of financial openness'). The values of other parameters are not changed. Results in terms of relative volatility of consumption are reported in table 4. As it can be seen, there is a positive relationship between the value of m and the consumption instability.

Impulse Responses

To better understand the amplification mechanism due to the borrowing constraint, I present some impulse response functions (see Figure number 1) to a +1% shock to foreign price of imported good, under a fixed exchange rate regime, in the case of $m = 0.3$ and in the case of $m = 0.7$.

Note that in both cases, in the first period, the levels of output, consumption, investment but for $m = 0.7$, when the economy is more financially open, the value of the main variables in the impact period is higher: output, investment, consumption increase more. The intuition for the results can be based on the following factors.

Firstly, the terms of trade change has a positive effect on domestic output: home agents increase their demand for home produced goods, substituting away demand for imported good. Given the sticky price and fixed exchange rate regime assumptions, the result is a positive effect on output and domestic inflation.

Secondly, the higher value of m implies that the borrowing constraint produces stronger amplification mechanism. In fact, the initial positive demand shock induces the increase in demand of real estate for production purposes, and hence the increase in the real estate price. The increase in value of collateral has two effects: a wealth effect, which is stronger for higher values of m, that induce entrepreneurs to consume and invest more; a substitution effect, that induces entrepreneurs to substitute consumption goods with the real estate -because a higher m implies the real estate has a higher value as collateral - and hence produces a further increase in the value of the collateral, reinforcing and amplifying the positive effect of the initial shock.

Hence, in the impact period, higher values of foreign borrowing, investment, output, consumption and real estate prices are related to the more financially open economy.

4.2 Inflation Targeting Regime

One of the assumptions of all the previous exercises is the fixed exchange rate regime. Here, instead, it is assumed that the monetary authority targets a zero level of final good price inflation. Hence, the exchange rate is allowed to fluctuate. m is set equal to 0.7. Given the considered exogenous increase in the foreign price of imported good, exchange rate appreciates so that total inflation is zero. As shown in Figure 2, output, consumption, investment, also under this monetary regime, but by less (however, the magnitude of the difference is not high) than when the nominal exchange rate is fixed; in fact, fluctuations of the nominal exchange rate offset the foreign price variation of the imported good, and hence tend to compensate the destabilizing macroeconomic effect of the shock: the increase in the relative price of foreign good is less pronounced, implying a lower stimulating effect on domestic production, and hence, through the lower demand for the real estate input, on the price of real estate. As a consequence, the borrowing constraint amplifies to a less extent the initial positive shock. Simulations (see Table 5) confirm this interpretation: demand changes for domestically produced tradable goods will be moderate, and consequently real estate demand and Home good inflation price variability is lower. The economy is relatively more stable. Exchange rate flexibility seems to introduce a degree of freedom in stabilizing the economy. Note that this exercise has only a positive relevance. In fact, from a normative point of view, to conclude that inflation targeting regime is better than the fixed exchange rate regime is not so straightforward: from one side, the model lacks a proper (possibly microfounded) welfare analysis, necessary to rigorously evaluate both regimes; secondly, the 'credibility' aspect of alternative regimes, that here it's not considered, can assume particular relevance in the emerging market economies context.

5 Conclusions

This paper has addressed the relation between macroeconomic performance and financial openness in developing economies. In particular, it has argued that greater but at the same time imperfect access to international liquidity can cause macroeconomic instability. To highlight that point, analysis has been conducted using a small open economy. Impulse response functions and simulation exercises have shown how in more financially open regimes the volatility amplifying effect of financial frictions, introduced in form of an international borrowing constraint, is stronger.

The obtained results introduce further stimulating questions for future research.

First, a two country version of the model could be realized and calibrated, so to study how the imperfect financial markets affects the business cycle correlation between emerging markets and developed countries; in particular, how spillovers from industrialized countries are propagated to developing economies.

Second, implications for macroeconomic stability of a wider financial structure should become object of analysis; a possible question is if and how the introduction of equities, when traded across countries, would affect the way financial friction interact with the business cycle. Clearly, the focus would indirectly be on why developing economies use mainly borrowing to get international resources. *That* is one of the basic questions business cycle analysis should contribute to answer to.

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Table 1: Malaysia components of National Expenditure

Ratio	Actual Value 1960-1996	Steady-state Value
C/Y	55.7	56.7
I/Y	25.69	24.16
G/Y	15.33	15.33
X/Y	57.80	57.7
M/Y	55.82	49.1
$(X-M)/Y$	1.98	1.8

Notes: % values. Actual values are taken from Kose et al. (2003).

Table 2: Real exchange rate and import price inflation shocks

AR(1) Matrix	$\begin{bmatrix} 0.68 & 0.03 \\ -0.20 & 0.08 \end{bmatrix}$
Residual variance-covariance matrix	$\begin{bmatrix} 0.0013 & 0.021 \\ 0.021 & 0.0032 \end{bmatrix}$

Notes: the order of the variables is as follows: real exchange rate, import prices.

Table 3: Malaysia volatility

	Volatility		Relative volatility	
Variable	Actual	Simulated	Actual	Simulated
Y	3.39	2.55	1	1
C	4.68	3.11	1.38	1.22
I	14.09	6.95	4.16	2.73

Notes: volatility is measured by the the standard deviation of logged and filtered (HP filter, with $\lambda = 100$) variables; the relative volatility is equal to the standard deviation of the considered variable in terms of the output standard deviation.

Table 4: Malaysia volatility

	Relative volatility of consumption
$m = 0.5$	1.22
$m = 0$	0.92
$m = 0.3$	1.08
$m = 0.7$	1.32

Notes: the relative volatility is equal to the standard deviation of the considered variable in terms of the output standard deviation. To solve the model without having numerical problems, $m = 0$ is approximated by $m = 0.01$.

Table 5: Malaysia volatility

	Relative volatility of consumption	
	Nominal Exchange Rate Target	Inflation Target
$m = 0.5$	1.22	0.97
$m = 0$	0.92	0.54
$m = 0.3$	1.08	0.75
$m = 0.7$	1.32	1.24

Notes: the relative volatility is equal to the standard deviation of the considered variable in terms of the output standard deviation. To solve the model without having numerical problems, $m = 0$ is approximated by $m = 0.01$.

Appendix: solution of the model

The equilibrium dynamics is characterized by solving a first-order log-linear approximation to the equilibrium conditions around the non-stochastic steady state. In the following, firstly the deterministic steady state and then the log linearized equations are shown.

The steady state

A steady-state equilibrium is considered in which all the shocks are zero, there is no capital accumulation ($K_t = K_{t-1} = K$), no debt change ($B_t = B_{t-1} = B$, $B'_t = B'_{t-1} = B'$) and in which all price inflation rates as well as exchange rate depreciation are zero: $P_t/P_{t-1} = 1$, $Q_t/Q_{t-1} = 1$, $S_t/S_{t-1} = 1$. The following price normalization is used: $p(h) = P_H = P_F = P = 1$. The steady state relative prices (steady state terms of trade) are: $T = 1$, $RS = 1$.

From the first order conditions of the intratemporal maximization problem - equations (16), (17) and the correspondent "foreign good" versions - the following steady state allocations are obtained:

$$C'_H = a_H C' \quad , \quad C'_F = (1 - a_H) C' \tag{SS.1}$$

$$C_H = a_H C \quad , \quad C_F = (1 - a_H) C \tag{SS.2}$$

$$I_H = a_H I \quad , \quad I_F = (1 - a_H) I \tag{SS.3}$$

Rest of the world demand for home goods (20) in steady state is:

$$AD^*_H = a^*_H AD^* \tag{SS.4}$$

From the consumer euler equation (34), using $C_t = C_{t-1} = C$ and $S_t/S_{t-1} = 1$, the steady state value of i^* satisfies:

$$\beta = \frac{1}{1 + i^*} \tag{SS.5}$$

Combining the steady state versions of the consumer and entrepreneur euler equations the following value for λ, the lagrange multiplier, can be obtained:

$$\lambda = \left(\frac{\beta - \gamma}{C} \right) \tag{SS.6}$$

By assumption, $0 < \gamma < \beta < 1$; so the lagrange multiplier is strictly greater than zero in the steady state (and in a small neighborhood of it). As a consequence, the borrowing constraint is binding.

From the retailer first order condition (41), the steady state marginal cost results equal to:

$$MC = \frac{P^W}{P_H} = \frac{\theta - 1}{\theta} \tag{SS.7}$$

From equation (28), the steady state "real estate value to output" ratio is:

$$\frac{Qho}{Y} = \frac{\mu\gamma MC}{(1-\gamma) + m(\gamma - \beta)} \tag{SS.8}$$

The borrowing constraint equation (22) becomes:

$$-\frac{B}{Y} = m\frac{\mu\gamma MC}{(1-\gamma) + m(\gamma - \beta)} \tag{SS.9}$$

From the capital accumulation law (26), the "investment to capital " ratio is:

$$\frac{I}{K} = \delta \tag{SS.10}$$

From equations (29) and (30), the "capital to output" ratio is:

$$\frac{K}{Y} = \frac{\gamma\alpha MC}{1 - \gamma(1-\delta)} \tag{SS.11}$$

Combining the above two equations, the "investment to output" ratio can be derived:

$$\frac{I}{Y} = \delta\frac{\gamma\alpha MC}{1 - \gamma(1-\delta)} \tag{SS.12}$$

From the entrepreneur budget constraint (24), after having derived the steady state version of the labor first order condition (31), the "entrepreneur consumption to output" ratio can be written as:

$$\begin{aligned}\frac{C}{Y} &= MC + (\beta - 1)\, m\frac{\gamma\mu MC}{(1-\gamma) + m(\gamma - \beta)} \\ &\quad -\delta\frac{\gamma\alpha MC}{1-\gamma(1-\delta)} - (1 - \alpha - \mu)\, MC\end{aligned} \tag{SS.13}$$

From the consumer budget constraint (33), the "consumer consumption to output " ratio is:[20]

[20] To derive the steady state budget constraint, the monetary authority constraint is used, and it is assumed money supply is constant in steady state.

$$\frac{C'}{Y} = (1 - MC) + (1 - \beta)\frac{B'}{Y} + (1 - \alpha - \mu) MC \tag{SS.14}$$

The system does have one degree of freedom: B' and hence B'/Y can be set arbitrarily.

The Loglinearized equilibrium equations

Local dynamics is studied by linearizing the equilibrium conditions around the above described steady state.

Let variables with a time subscript t, $t+1$ or $t-1$ denote deviations (they are more precisely defined in the following), and let those without a time subscript denote steady state values. The model can be reduced to a log-linearized system given by the following blocks of equations in the variables: y, c , c', b, b', k, i, π, π_H, π_F^*, ΔS, q, tot, ad^*, mc, rs.

π, π_H, π_F^*, ΔS are percentage changes of, respectively, the small economy inflation rate, of the home good inflation, of the foreign good inflation, of the nominal exchange rate. y, c, c', b, b', k, i, q, tot, ad^*, mc, rs are log-deviations from steady state of, respectively, output, entrepreneur's consumption, consumer's consumption, entrepreneur's debt in real terms, consumer's debt in real terms, stock of capital, investment, real estate price index in real terms, terms of trade, rest of the world demand, retailer's marginal cost, real exchange rate.

For simplicity, consistently with the small open economy case, the following assumptions hold: (a) the riskless bond interest rate and foreign demand are constant over time; (b) the weight of home goods in foreign total demand bundle, is close to zero; (c) the weight of Home component in the total demand for foreign produced good is small. In this way, equilibrium changes in the small open economy affect the rest of the world equilibrium in a negligible way.

To save on notation, the expectation operator between variables dated $t+1$ is dropped. However the variables must be intended as in expected value conditional on the information available at time t.

The equations are the following ones:

1. aggregate demand

$$\hat{Y}_t = \rho (1 - a_H) \widehat{TOT}_t + a_H \rho \frac{AD^*}{Y} \widehat{rs}_t + \frac{C_H}{Y}\hat{C}_t + \frac{C'_H}{Y}\hat{C}'_t + \frac{I_H}{Y}\hat{I}_t \tag{AD1}$$

$$\hat{q}_t = \left(\frac{qh}{Y}\right)^{-1} \mu\gamma MC \left[\widehat{mc_{t+1}} - (1 - a_H) \widehat{TOT}_{t+1} + \hat{Y}_{t+1} - \hat{C}_{t+1}\right]$$

$$
\begin{aligned}
&+\hat{C}_t + \gamma\left(\hat{q}_{t+1} - \hat{C}_{t+1}\right) \\
&+m\beta\left(\hat{q}_{t+1} - \Delta S_{t+1} + \pi_{t+1} - \hat{C}_{t+1}\right) \\
&-m\gamma\left(\hat{q}_{t+1} - \hat{C}_{t+1}\right) \qquad \text{(AD2)}
\end{aligned}
$$

$$
\begin{aligned}
\hat{C}_t \;=\;& \psi\delta\left(\hat{I}_t - \hat{K}_t\right) \\
&+\beta(1-\delta)\hat{C}_t - \beta\psi\delta(1-\delta)\left(\hat{I}_{t+1} - \hat{K}_{t+1}\right) \\
&-\alpha\beta MC\frac{Y}{K}\left[\widehat{mc_{t+1}} - (1-a_H)\widehat{TOT}_{t+1} + \hat{Y}_{t+1} - \hat{K}_t\right] \qquad \text{(AD3)}
\end{aligned}
$$

$$
\hat{C}_{t+1} = \hat{C}_t + \widehat{\Delta S}_t - \pi_{t+1} \qquad \text{(AD4)}
$$

2. borrowing constraint

$$
\hat{B}_t = \hat{q}_{t+1} + \pi_{t+1} - \Delta S_{t+1} \qquad \text{(BC1)}
$$

3. aggregate supply

$$
\hat{Y}_t = \alpha\hat{K}_{t-1} + (1-\mu-\alpha)\hat{L}_t \qquad \text{(AS1)}
$$

$$
Y_t = (1-a_H)\widehat{TOT}_t - \widehat{mc}_t + \hat{C}_t + \tau\hat{L}_t \qquad \text{(AS2)}
$$

$$
\pi_{H,t} = \beta\pi_{H,t+1} + \frac{(1-\vartheta)(1-\beta\vartheta)}{\vartheta}\widehat{mc}_t \qquad \text{(AS3)}
$$

4. Flows of funds/ Other variables

$$
\widehat{TOT}_t = \widehat{TOT}_{t-1} + \Delta S_t + \pi^*_{F,t} - \pi_{H,t} \qquad \text{(FF1)}
$$

$$
\pi_t = a_H\pi_{H,t} + (1-a_H)\Delta S_t + (1-a_H)\pi^*_{F,t} \qquad \text{(FF2)}
$$

$$
\Delta S_t = 0 \qquad \text{(FF3)}
$$

$$
\hat{K}_t = (1-\delta)\hat{K}_{t-1} + \delta\hat{I}_t \qquad \text{(FF4)}
$$

$$\beta\frac{B'}{Y}\hat{B}'_t = +\frac{B'}{Y}\left(\hat{B}'_{t-1}-\pi_t+\Delta S_t\right) + \left\{\hat{Y}_t-(1-a_H)\widehat{TOT}_t - MC\left[\widehat{mc}_t-(1-a_H)\widehat{TOT}_t+\hat{Y}_t\right]\right\} + MC\,(1-\alpha-\mu)\left[\widehat{mc}_t-(1-a_H)\widehat{TOT}_t+\hat{Y}_t\right]-\frac{C}{Y}\hat{C}'_t \quad \text{(FF5)}$$

$$\beta\frac{B}{Y}\hat{B}_t = \frac{B}{Y}\left(\hat{B}_{t-1}-\pi_t+\Delta S_t\right)+MC\left[\widehat{mc}_t-(1-a_H)\widehat{TOT}_t+\hat{Y}_t\right] - MC\,(1-\alpha-\mu)\left\{mc_t-(1-a_H)\widehat{TOT}_t+\hat{Y}_t\right\} - \frac{C}{Y}\hat{C}_t-\frac{I}{Y}\hat{I}_t \quad \text{(FF6)}$$

5. Shock process

$$\begin{bmatrix} rs_{t+1} \\ \pi^*_{F,t+1} \end{bmatrix} = \begin{bmatrix} \rho_{RS} & \rho_{RS,\pi_F} \\ \rho_{\pi_F,RS} & \rho_{\pi_F} \end{bmatrix} \begin{bmatrix} rs_t \\ \pi^*_{F,t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{RS,t+1} \\ \varepsilon_{\pi^*_F,t+1} \end{bmatrix} \quad \text{(SH1)}$$

$$\begin{matrix} \varepsilon_{RS,t+1} \\ \varepsilon_{\pi^*_F,t+1} \end{matrix} \sim N\begin{bmatrix} \sigma_{RS} & \sigma_{RS,\pi_F} \\ \sigma_{\pi_F,RS} & \sigma_{\pi_F} \end{bmatrix} \quad \text{(SH2)}$$

The equations are divided in 5 blocks. The first block contains the demand side of the economy.

The first equation is the aggregate demand for the home produced good.

The second equation derives from the entrepreneur euler consumption equation (27) and real estate demand equation (28), taking into account the real estate market clearing condition (44).

The third equation derives from investment and capital first order conditions, respectively equation (29) and equation (30).

The fourth equation derives from consumer euler condition (34).

The second block is the borrowing constraint. It derives from equation (23).

The third block is the supply side of the economy.

The first equation derives from the technology constraint (25).

The second equation represents the equilibrium on the labor market; it derives from the firm labor demand (31), from the consumer labor first order condition (35) and from the labor market clearing condition (45).

The third equation derives from the solution of the retailer maximization problem; it relates the today inflation rate to the expected inflation and to the retailer marginal cost.

The fourth block contains equations describing flows of funds and remaining variables.

The first equation describes the evolution of the terms of trade. It derives from the definition of the terms of trade (12) .

The second equation derives from the price index (11) and from the law of one price (10).

The third equation is the exchange rate regime: consistently with the empirical evidence on emerging markets, a fixed exchange rate regime is assumed to hold. However, also an inflation targeting regime will be considered.[21]

The fifth equation is the log-linearized version of the capital accumulation law (26).

The sixth equation derives from the consumer budget constraint (33).

The seventh equation derives from the entrepreneur budget constraint (24).

Finally, block number five contains the exogenous process: it represents the law of motion of real exchange rate and foreign good price inflation rate.[22]

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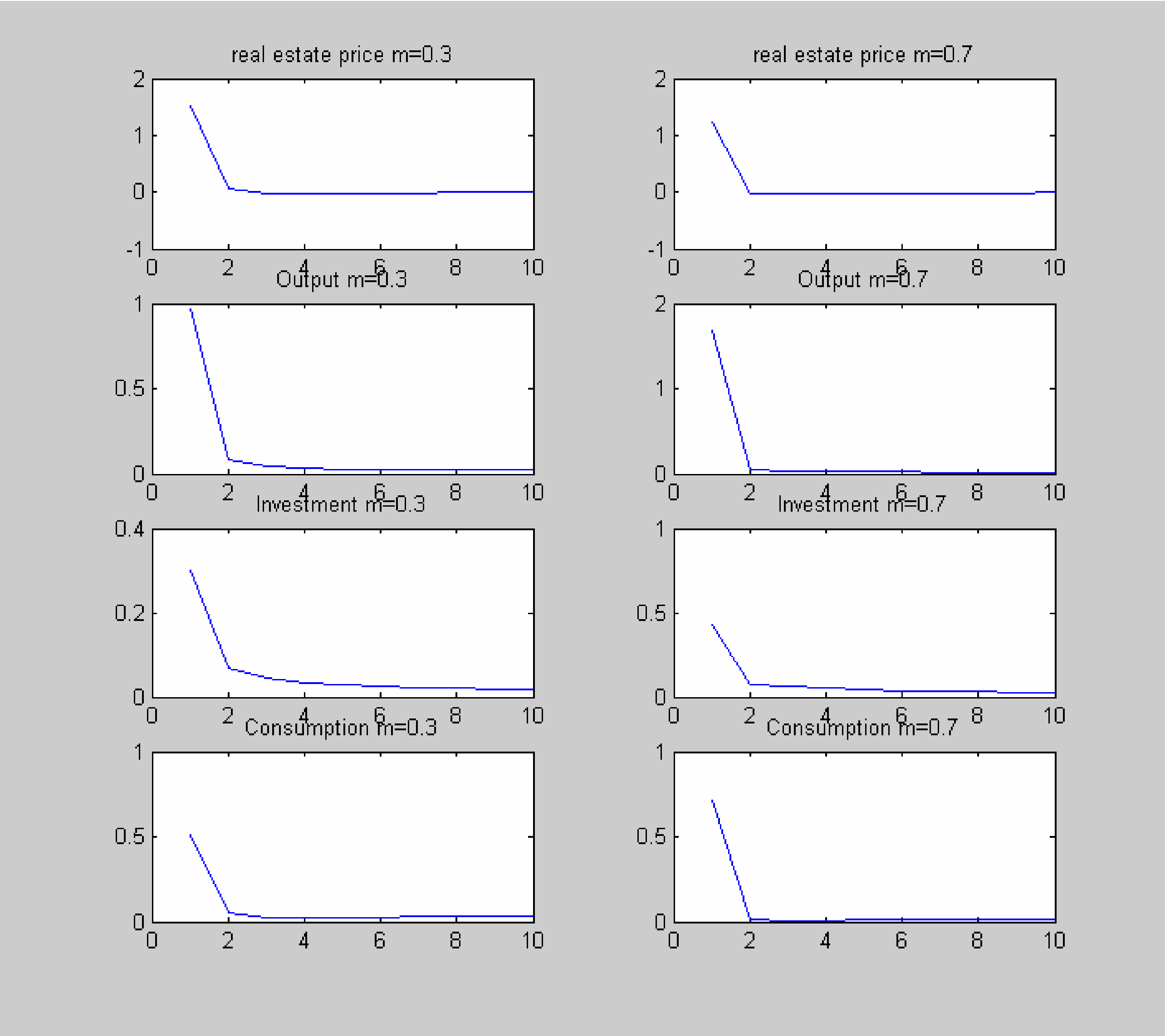
[21]In that case the equation $\Delta S_t = 0$ is substituted by $\pi_t = 0$. As a cosequence, the nominal exchange rate is allowed to fluctuate.

[22]A well known technical problem in models characterized by incomplete markets is the non-stationarity. Following Benigno (2001) and Schmitt-Groé and Uribe (2001), a small friction, $\phi(b_t)$, is included into the euler euquation and into the budget constraints of the consumer agents: in the nonlinear versions of the equations, it multiplies the gross interest rate $(1 + i_t^*)$; so it's enters additively into the linearized equations.

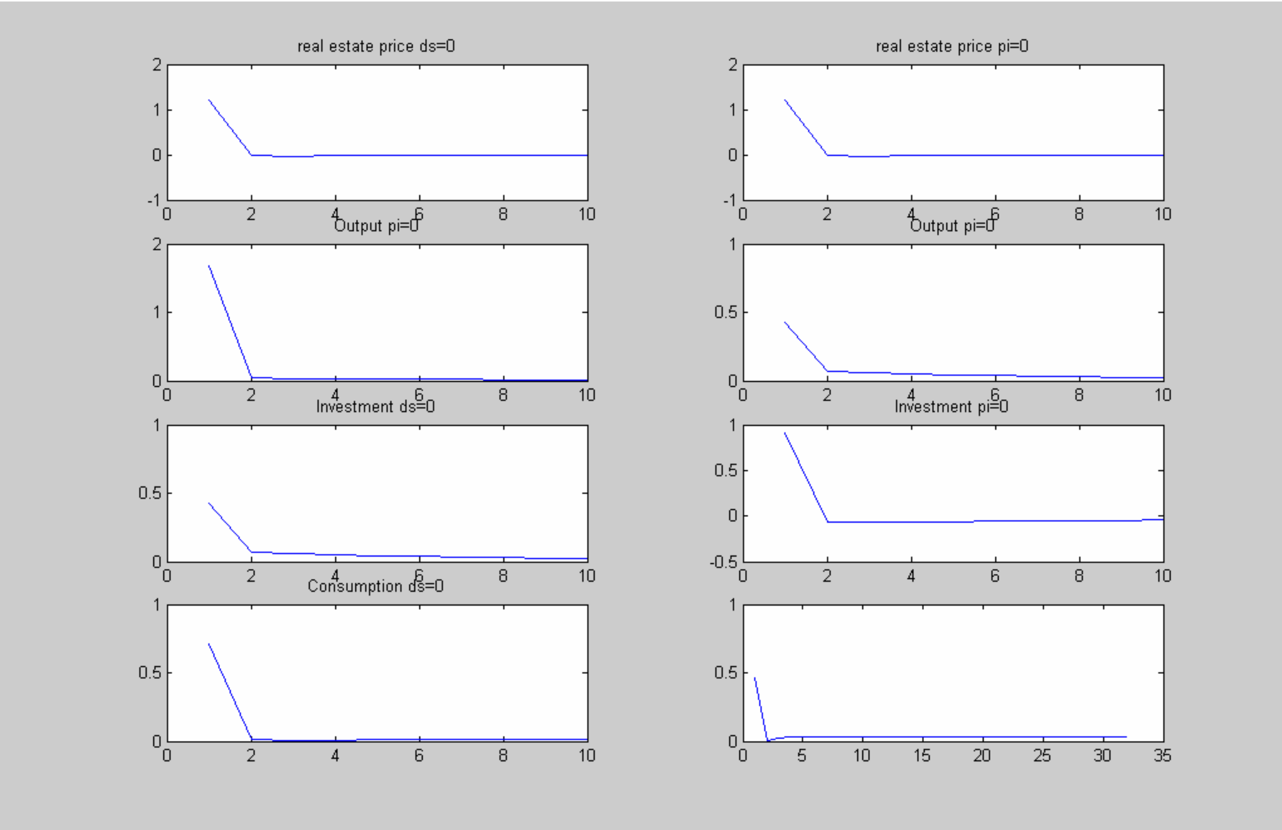
$\phi(b_t)$ is a function which depends on the real holdings of the foreign assets across the entire category of consumers. This means that each consumer take it as given when deciding the optimal holding of the foreign bond. $\phi(b_t)$ satisfies the following restrictions: $\phi(B/Y) = 1$ and it is equal to 1 only if $(B/Y)_t = B/Y$; $\phi(.)$ is a differentiable, (at least) decreasing function in the neighborhood of zero. In the calibration, it's set equal to a value very close to 0, to make it as innocuos as possible in terms of affecting the dynamics of the system.

Figure 1: Responses to a 1% import price shock



Horizontal Axis: years.
Vertical Axis: % values.

Figure 2: Responses to a 1% import price shock



Horizontal Axis: years.
Vertical Axis: % values.