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CAPITAL CONTROLS SPILLOVERS

by Valerio Nispi Landi*

Abstract

I built a three-country business cycle model with one AE and two EMEs to analyze the spillover effects arising from capital controls. I find that, following a push-factor shock from the AE, if one EME tightens capital controls, the other EME experiences an additional wave of foreign investments. In addition, the spillover effects are economically meaningful and can be sizable under specific conditions. Moreover, my findings point out that, in the presence of international financial frictions, moderate capital controls may be useful to EMEs to affect the interest rate at which they trade international bonds. Finally, based on my results, coordination among EMEs in setting capital controls seems to deliver relatively small welfare gains compared with the Nash equilibrium.

JEL Classification: F38, F41, F44.
Keywords: capital controls, open economy macroeconomics, international business cycles.

Contents

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1 Introduction[1]

Since the global financial crisis, many emerging countries have been restricting their financial account. The "Ka" indicator, developed by Fernández et al. (2016) is a measure of capital controls, defined as restrictions on cross-border financial flows that discriminate between residents and non-residents: since 2006, in emerging markets this indicator is on an increasing trend, reflecting a retrenchment of financial liberalization (figure 1). The economic theory provides at least four rationales which can justify capital controls: i) they reduce the probability of a financial crisis (Korinek, 2011); ii) they allow to manage the exchange rate (Costinot et al., 2014; and Heathcote and Perri, 2016); iii) they mitigate the impact of foreign financial shocks and usefully complement monetary policy (Aoki et al., 2016 and Nispi Landi, 2017) and iv) they restore monetary independence in countries with a fixed exchange rate (according to the Mundellian impossible trinity). Nowadays the use of capital controls under specific circumstances is accepted by the IMF, which also emphasizes that they should not substitute for warranted macroeconomic adjustment (see IMF, 2012). Nevertheless, not all countries have tightened capital controls in the last years. For instance, while Brazil introduced several restrictions on capital flows in 2008 and 2009, Russia made its financial account more open in this period. On the other hand, G7 economies do not seem to use these policy instruments extensively (figure 1).

Capital controls may entail some spillover effects to other countries, exactly as trade or monetary policies. Indeed, if capital controls are not set in a coordinated fashion (as figure 1 seems to suggest), a capital controls tightening in some countries is likely to deflect capital flows to other countries with no controls in place, especially if cross-border flows are driven by global drivers. For instance, if Brazil raises capital controls in response to a capital inflow surge coming from the US, another emerging country, say Mexico, may experience a larger wave of capital inflows (figure 2). On the one hand, the latter can be welcome, whenever they finance productive investments. On the other hand, capital flows may increase macroeconomic volatility and appreciate the exchange rate: should these developments lead to macrofinancial instability, the Mexican government might consider to restrict financial account in turn, thus triggering a capital controls escalation. In addition, if capital controls are used by some large emerging markets, there could be consequences also for advanced economies. The aim of this paper is specifically to assess these spillover effects. Notably, I focus on the following questions: How does one country's capital controls affect the business cycle of other countries? Do emerging economies need

[1]I thank for their useful feedback Antonio Bassanetti, Pietro Catte, Flavia Corneli, Riccardo Cristadoro, Claudia Maurini, Francesco Paternò, Riccardo Settimo, Alessandro Schiavone, Stefania Villa and seminar participants of Bank of Italy REI internal workshop. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of Italy.

to coordinate when they set capital controls?

To these ends, I set up an international real business cycle model consisting of one advanced economy (AE, henceforth) and two emerging economies (EME1 and EME2, henceforth). Capital inflows in the emerging economies are driven by preference and risk-premium shocks in AE. These shocks aim to capture exogenous changes in the international interest rate, which is considered one of the main drivers of capital flows.[2] For instance, in the model, a negative preference shock reduces the marginal utility of consumption of AE households, who therefore increase their lending to emerging markets. By simulating a capital controls tightening in EME1, simultaneously with the preference (or the risk-premium) shock, I can assess how much of the effects of such a policy spill over to EME2 and AE. Notably, I calibrate the model in order to replicate the relative size of population and GDP of advanced and emerging economies in the world. Accordingly, EME1 and EME2 (calibrated to be identical) are not (too) small compared to AE.[3]

The type of capital controls instrument is a crucial choice for the analysis. I assume that investors in emerging economies pay a tax on cross-border financial flows. This policy tool resembles the "Imposto sobre operações financeiras" (IOF) applied in Brazil on some categories of capital inflows. Following part of the literature (e.g. Unsal, 2013 and Heathcote and Perri, 2016), the tax rate is assumed to react to variations in the country's net foreign asset position (NFA) relative to GDP: when NFA is low (high), the government raises (lowers) controls to dampen the capital inflow increase (reduction). This assumption is consistent, for instance, with the Brazilian capital controls policy: Brazil's controls were tightened in periods of large portfolio inflows (in Brazil and other EMEs) and were loosened in periods of lower inflows.[4] The tax can take negative values, in that case it can be interpreted as a subsidy on capital inflows.

In the context of my model, I find that a capital controls rule that aggressively reacts to NFA variations allows EME1 to shield the economy from "push-factor shocks", curbing the capital inflow and mitigating the macroeconomic boom. If EME2 does not use capital controls, it receives an additional inflow of capital, which amplifies the initial shock and further boosts economic activity. Given that EME1 is not too small compared to AE, its policy affects the AE business cycle too: AE households invest more in their economy, accordingly AE consumption and investment rise. Moreover, capital controls

[2]Since the seminal works of Calvo et al. (1993) and Fernandez-Arias (1996), push factors such as US interest rates were found to be the main determinant of capital flows in emerging countries. More recently, Rey (2015) shows that US monetary policy strongly affects financial conditions in the rest of the world. For an exhaustive survey of the literature, refer to Koepke (2015).

[3]The focus of this paper is on capital controls spillovers, hence the model does not include other policy instruments (such as fiscal, monetary and macroprudential policies) typically used by emerging countries before resorting to capital controls. For an analysis of the interactions between different policy tools in an emerging economy, the reader can refer to Nispi Landi (2017).

[4]As shown for instance by Forbes et al. (2016).

are welfare improving for the two EMEs: indeed, these policy tools affect the interest rate at which EMEs borrow and lend. Nevertheless, welfare gains arising from policy coordination between EMEs are negligible compared to a Nash equilibrium in which each EME independently sets capital controls.

There is a growing empirical literature finding spillover effects from capital controls. Forbes et al. (2016) show that when Brazil increases its capital controls, portfolio flows move to those countries that are more closely linked to China through their exports.[5] Moreover, they show that investors reduce their exposure to countries that are considered likely to mimic Brazilian policy and to raise capital controls. Lambert et al. (2013) find that the Brazilian IOF may have contributed to divert capital flows to other Latin American economies. The estimates provided by Giordani et al. (2016) suggest that when some countries restrict their financial account, capital flows are deflected to other countries with a similar risk profile. Pasricha et al. (2015) report evidence that capital controls in one of the BRICS economies entail relevant consequences for other BRICS economies, via net capital inflows and exchange rates. Ghosh et al. (2014) show that a country's bank flows are significantly higher when its neighbors are relatively closed to capital flows.

The theoretical literature has also focused on the normative side of capital controls spillovers, analyzing whether international coordination would end up in a welfare improvement. In a stylized model, Jeanne (2014) and Korinek (2017) derive some conditions under which there is no room for international cooperation, as long as capital controls externalities are mediated through a competitive price (i.e. the international interest rate). However, if these conditions are violated (notably, when policy instruments are imperfect or during liquidity traps), then a coordinated use of capital controls is Pareto improving. In a two-country model with incomplete financial markets, De Paoli and Lipinska (2013) and Heathcote and Perri (2016) find that capital controls coordination yields sizable welfare gains compared to the Nash equilibrium, because it allows to improve risk sharing. My model shares many features with these two papers, since it is a DSGE with incomplete financial markets. Nevertheless, it crucially departs from these works in one characteristic: it is a three-country model, where the third country is an advanced economy which does not use capital controls, as the empirical evidence suggests. This entails several important implications. First, I can analyze the effects of capital inflow shocks that originate from an advanced economy: this is important, given that push factors are a relevant source of capital inflows in emerging markets. Second, I can study the desirability of capital controls (Nash vs coordination equilibrium) focusing only on

[5]The authors argue that many investors viewed their allocations to Brazil as a way to benefit from strong growth in China.

those countries that actually use capital controls: indeed, in a model with two symmetric countries, the latter should be interpreted as two big advanced economies. Third, in a world where capital flows are driven by push factors, I can assess the spillover effects of capital controls in those emerging economies that do not use these policy tools: despite the relevance of this issue, I am not aware of any international business cycle model which addresses this last point.

The remainder of the paper is organized as follows. Section 2 presents the three-country model and the calibration strategy. Section 3 analyzes the macroeconomic response to two push-factor shocks and verifies the existence of capital controls spillovers. In Section 4 a normative analysis is conducted. Section 5 shows sensitivity analysis on three key parameters. Section 6 concludes.

Capital Controls

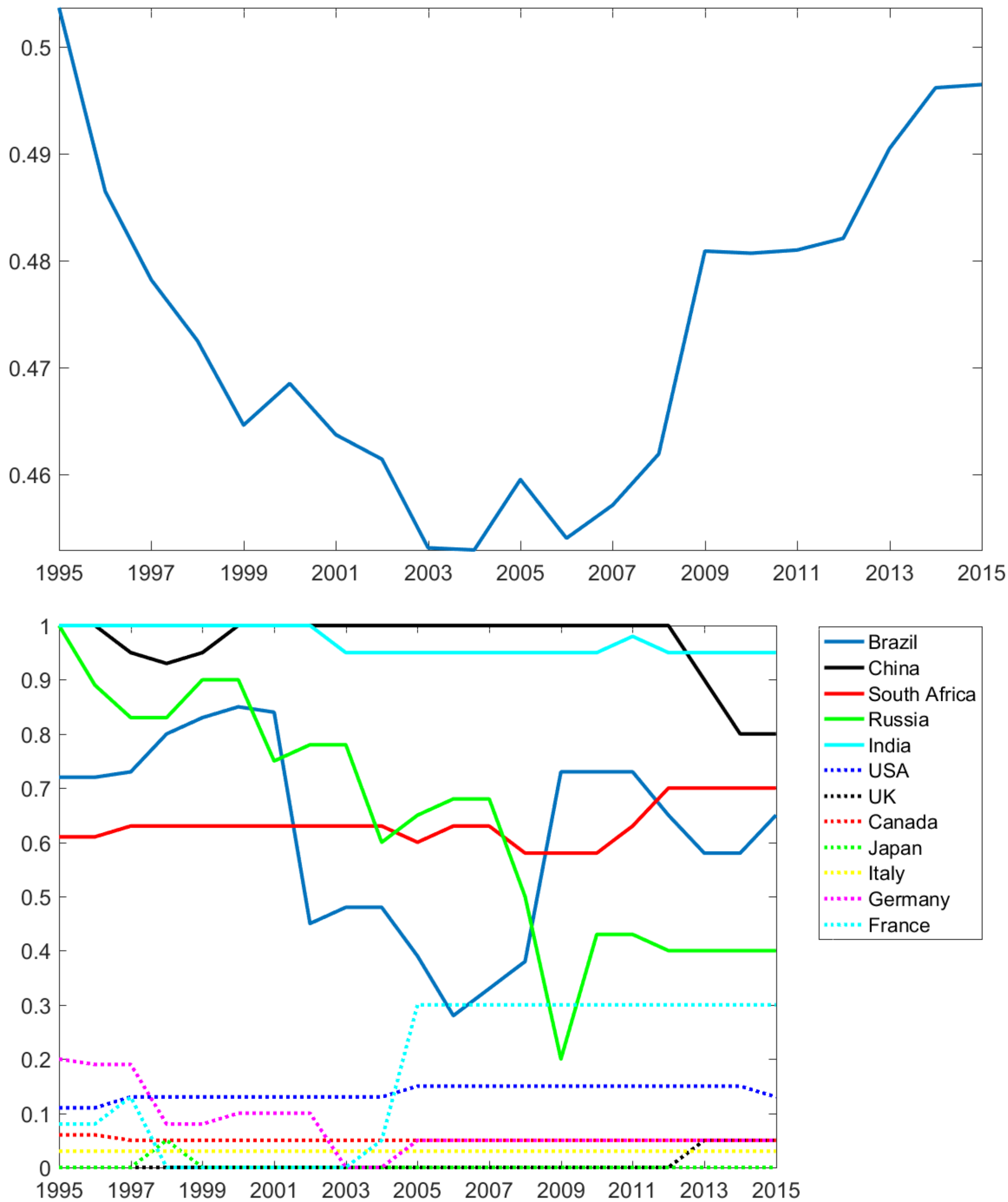

Figure 1: Top panel: Ka index in emerging economies, unweighted average across countries. The definition of emerging economies follows the IMF criterion. Bottom panel: Ka index in BRICS and G7 economies. The Ka index lies between zero (the country has no restriction on any category of flows) and one (the country has restrictions on all categories of flows). Source: Fernández et al. (2016).

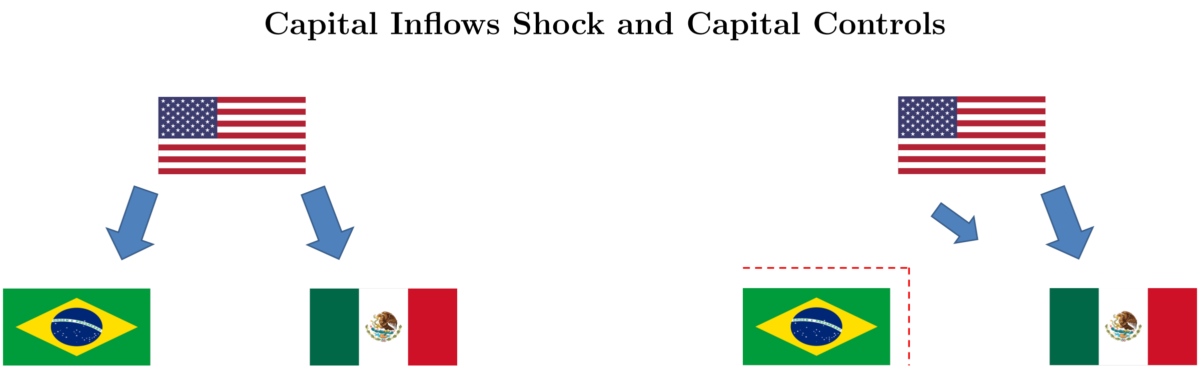

Figure 2: In the left panel capital moves from US to Brazil and Mexico. In the right panel, Brazil's imposition of capital controls deflects a share of the flows to Mexico.

2 The Model

The world economy consists of three countries: one advanced economy (AE) with relative population size of n_3 and two emerging economies (EME1 and EME2) with relative size n_1 and n_2 respectively.[6] Variables in EME2 are indexed with a star, variables in AE are indexed with "A". Each economy features a representative firm, producing a domestic good, and a representative household, consuming domestic and imported goods. Households rent physical capital and supply labor to firms: both production inputs are not mobile across countries. The three countries trade a one-period risk-free bond, denominated in the AE consumption bundle: given that there are no state-contingent securities and this is the only bond that is internationally traded, international financial markets are incomplete. Moreover, I assume that this bond is intermediated by banks, owned by AE households. Accordingly, if AE is a net issuer (buyer) of the bond, the two EMEs record a financial surplus (deficit); I assume that in steady state the financial account is in equilibrium, it turns out that the amount of bonds traded in steady state is zero. Moreover, I assume a financial friction such that the interest rate paid (earned) by EMEs on the international bond is a decreasing function of their net financial asset position. AE and the two EMEs differ in the size of the economy, in the composition of consumption and investment bundles and in total factor productivity. On top of that, I assume that AE does not use capital controls and EME1 and EME2 are identical (so $n_1 = n_2$). In what follows, I describe the model, providing the complete list of the equations in the Appendix. Figure 3 shows the structure of EME1 (an equivalent structure applies to EME2 and AE).

[6] By normalizing to 1 total population, it turns out $n_1 + n_2 + n_3 = 1$.

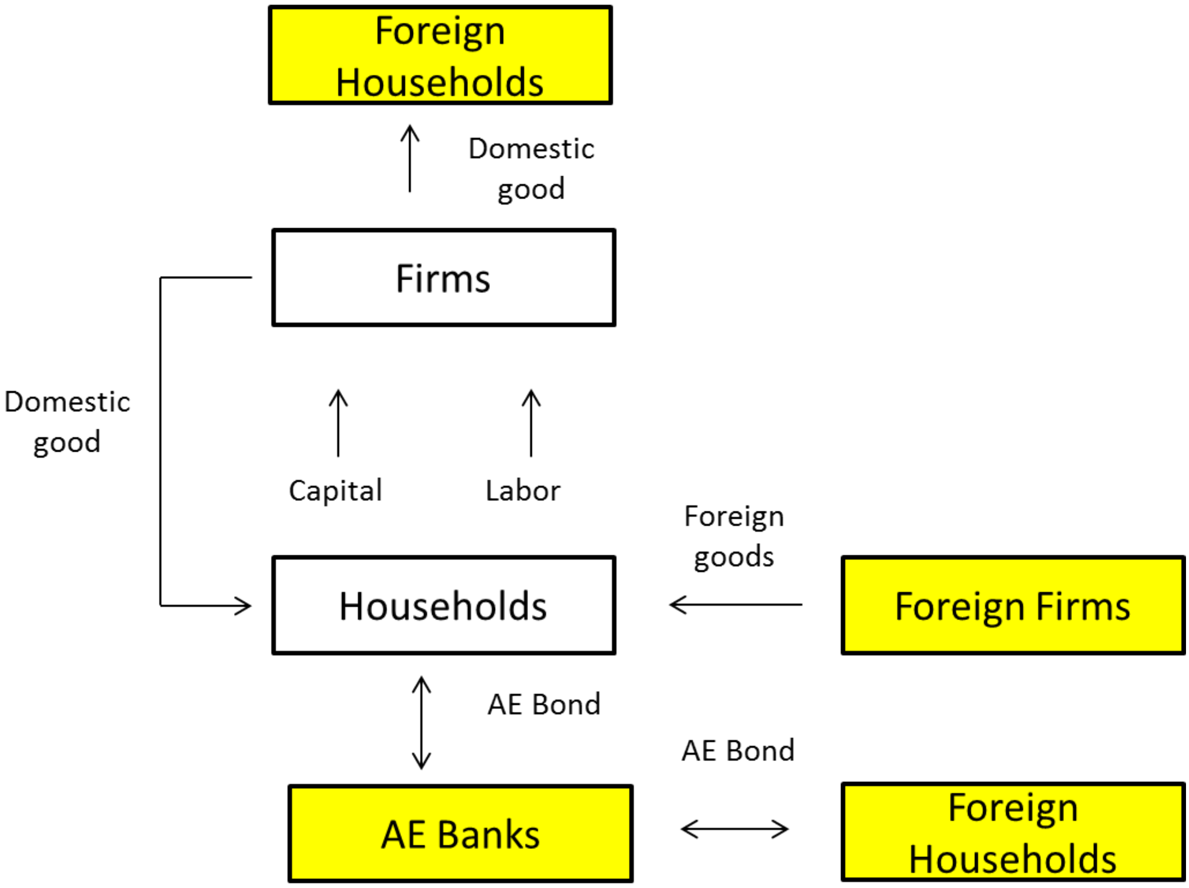

Figure 3: The structure of the economy.

2.1 Bundles of Goods and Prices

The consumption good c_t in EME1 is a CES bundle of goods produced in the three countries:

$$c_t = \left[\nu_1^{\frac{1}{\mu}} c_{1t}^{\frac{\mu-1}{\mu}} + \nu_2^{\frac{1}{\mu}} c_{2t}^{\frac{\mu-1}{\mu}} + \nu_3^{\frac{1}{\mu}} c_{3t}^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}, \tag{1}$$

where c_{1t}, c_{2t} and c_{3t} are EME1 consumption of EME1, EME2 and AE goods respectively, ν_1, ν_2 and ν_3 are positive constants and $\mu > 0$ is the elasticity of substitution between different goods. The investment good i_t features an identical composition:

$$i_t = \left[\nu_1^{\frac{1}{\mu}} i_{1t}^{\frac{\mu-1}{\mu}} + \nu_2^{\frac{1}{\mu}} i_{2t}^{\frac{\mu-1}{\mu}} + \nu_3^{\frac{1}{\mu}} i_{3t}^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}. \tag{2}$$

The price of the consumption and investment bundle in EME1 p_t reads:

$$p_t = \left[\nu_1 p_{1t}^{1-\mu} + \nu_2 p_{2t}^{1-\mu} + \nu_3 p_{3t}^{1-\mu} \right]^{\frac{1}{1-\mu}}, \tag{3}$$

where p_{1t}, p_{2t} and p_{3t} are the price of EME1, EME2 and AE goods respectively. These prices are all expressed in terms of the AE consumption good which is the numéraire (so that $p_t^A = 1$). In the other two countries similar definitions apply. Accordingly, consumption and investment bundles are defined as follow:

$$c_t^* = \left[(\nu_1^*)^{\frac{1}{\mu}} c_{1t}^{*\frac{\mu-1}{\mu}} + (\nu_2^*)^{\frac{1}{\mu}} c_{2t}^{*\frac{\mu-1}{\mu}} + (\nu_3^*)^{\frac{1}{\mu}} c_{3t}^{*\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}} \tag{4}$$

$$c_t^A = \left[\left(\nu_1^A\right)^{\frac{1}{\mu}} c_{1t}^{A\frac{\mu-1}{\mu}} + \left(\nu_2^A\right)^{\frac{1}{\mu}} c_{2t}^{A\frac{\mu-1}{\mu}} + \left(\nu_3^A\right)^{\frac{1}{\mu}} c_{3t}^{A\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}} \tag{5}$$

$$i_t^* = \left[(\nu_1^*)^{\frac{1}{\mu}} i_{1t}^{*\frac{\mu-1}{\mu}} + (\nu_2^*)^{\frac{1}{\mu}} i_{21t}^{*\frac{\mu-1}{\mu}} + (\nu_3^*)^{\frac{1}{\mu}} i_{3t}^{*\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}} \tag{6}$$

$$i_t^A = \left[\left(\nu_1^A\right)^{\frac{1}{\mu}} i_{1t}^{A\frac{\mu-1}{\mu}} + \left(\nu_2^A\right)^{\frac{1}{\mu}} i_{2t}^{A\frac{\mu-1}{\mu}} + \left(\nu_3^A\right)^{\frac{1}{\mu}} i_{3t}^{A\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}} \tag{7}$$

and the following holds:

$$p_t^* = \left[\nu_1^* p_{1t}^{1-\mu} + \nu_2^* p_{2t}^{1-\mu} + \nu_3^* p_{3t}^{1-\mu} \right]^{\frac{1}{1-\mu}} \tag{8}$$

$$1 = \nu_1^A p_{1t}^{1-\mu} + \nu_2^A p_{2t}^{1-\mu} + \nu_3^A p_{3t}^{1-\mu}. \tag{9}$$

Notice that p_t (p_t^*) can be interpreted as the EME1 (EME2) real exchange rate vis-à-vis the AE good (so that if p_t is higher, EME1 faces a real appreciation). The EME1 household's demand for the three consumption goods is given by:

$$c_{1t} = \nu_1 \left(\frac{p_{1t}}{p_t} \right)^{-\mu} c_t \tag{10}$$

$$c_{2t} = \nu_2 \left(\frac{p_{2t}}{p_t} \right)^{-\mu} c_t \tag{11}$$

$$c_{3t} = \nu_3 \left(\frac{p_{3t}}{p_t} \right)^{-\mu} c_t. \tag{12}$$

Analogous demand functions can be derived for investment goods. Similar expressions hold in the other two countries.

2.2 Households

In EME1 the representative household solves the following maximization problem:[7]

$$\max_{\{c_t,h_t,b_{3t},b_{1t},k_t\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\log \left(c_t - \frac{h_t^{1+\varphi}}{1+\varphi} \right) \right] \right\} \tag{13}$$

$$s.t.\ c_t + (1-\tau_t)\frac{b_{3t}}{p_t} + b_{1t} + k_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1} = \tag{14}$$

$$w_t h_t + \left[u_t + (1-\delta)\right] k_{t-1} + r_{t-1}^{B1}\frac{b_{3t-1}}{p_t} + r_{t-1}b_{1t-1} + \Pi_t + t_t.$$

where h_t denotes hours of work remunerated at wage w_t, $\varphi > 0$ is the inverse of the Frisch elasticity of labor supply, k_t is physical capital rented at rate u_t and depreciating at rate δ, Π_t denotes profits from domestic firms and t_t are lump-sum transfers from the government. As standard in the real business cycle literature, investment in new capital requires the payment of quadratic adjustment costs, which are captured by the positive parameter κ_I. b_{3t} denotes EME1 holdings of a one-period bond denominated in AE's consumption bundle, yielding a gross interest rate of r_t^{B1};[8] notably, a capital controls tax τ_t applies to holdings of this bond. Furthermore, households can also trade a one-period risk-free bond b_{1t} denominated in EME1 consumption bundle, yielding an interest rate of r_t: I assume that this bond is not traded abroad, given that emerging economies struggle to issue debt instruments in their own currency. Physical capital follows the standard law of motion:

$$k_t = (1-\delta)k_{t-1} + i_t. \tag{15}$$

First order conditions yield two bond Euler equations, an investment Euler equation and a labor supply expression:

[7] These preferences have been introduced by Greenwood et al. (1988) and are able to reproduce some key business cycle facts in open economies (the reader can refer to Chapter 4 of the textbook by Uribe and Schmitt-Grohé, 2017).

[8] The index "B1" means that the transaction occurs between AE banks and EME1 households.

$$
\begin{aligned}
1 &= \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \frac{r_t^{B1}}{1-\tau_t} \frac{p_t}{p_{t+1}} \right) && (16) \\
1 &= \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} r_t \right) && (17) \\
1 + \kappa_I \left(\frac{k_t}{k_{t-1}} - 1 \right) &= \beta \mathbb{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[\kappa_I \frac{k_{t+1}}{k_t} \left(\frac{k_{t+1}}{k_t} - 1 \right) - \frac{\kappa_I}{2} \left(\frac{k_{t+1}}{k_t} - 1 \right)^2 + u_{t+1} + (1-\delta) \right] \right\} && (18) \\
h_t^{\varphi} &= w_t && (19)
\end{aligned}
$$

where λ_t is the marginal utility of consumption:

$$
\lambda_t = \left(c_t - \frac{h_t^{1+\varphi}}{1+\varphi} \right)^{-1}. \qquad (20)
$$

The household's maximization problem in EME2 is symmetric to EME1's problem. On the other hand, AE households are not subject to capital controls and their maximization problem is the following:

$$
\max_{\left\{ c_t^A, h_t^A, k_t^A, b_{3t}^A \right\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \psi_t^A \left[\log \left(c_t^A - \frac{{h_t^A}^{1+\varphi}}{1+\varphi} \right) \right] \right\} \qquad (21)
$$

$$
\begin{aligned}
s.t.\ c_t^A + k_t^A + b_{3t}^A + \frac{\kappa_I}{2} \left(\frac{k_t^A}{k_{t-1}^A} - 1 \right)^2 k_{t-1}^A = \\
w_t^A h_t^A + \left[u_t^A + (1-\delta) \right] k_{t-1}^A + r_{t-1}^A b_{3t-1}^A + \Pi_t^A + t_t^A, \qquad (22)
\end{aligned}
$$

where b_{3t}^A is the amount of the one-period AE risk-free bond traded with banks, yielding a gross interest rate of r_t^A. The rest of notation is standard. Notice the role of the preference shock ψ_t^A: when it is lower, AE households are willing to enjoy more consumption and leisure in the future rather than in the current period. It results that they invest more in physical capital and bonds: capital moves from advanced to emerging economies. First order conditions yield two Euler equations, one for physical capital and one for the international bond, plus the labor supply expression:

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^A}{\lambda_t^A} r_t^A \right) \tag{23}$$

$$1+\kappa_I \left(\frac{k_t^A}{k_{t-1}^A} - 1 \right) = \beta \mathbb{E}_t \left\{ \frac{\lambda_{t+1}^A}{\lambda_t^A} \left[\kappa_I \frac{k_{t+1}^A}{k_t^A} \left(\frac{k_{t+1}^A}{k_t^A} - 1 \right) - \frac{\kappa_I}{2} \left(\frac{k_{t+1}^A}{k_t^A} - 1 \right)^2 + u_{t+1}^A + (1-\delta) \right] \right\} \tag{24}$$

$$h_t^{A\varphi} = w_t^A \tag{25}$$

where λ_t^A is AE's marginal utility of consumption:

$$\lambda_t^A = \psi_t^A \left(c_t^A - \frac{h_t^{A1+\varphi}}{1+\varphi} \right)^{-1}. \tag{26}$$

Finally, it is assumed that the preference shifter follows an autoregressive process:

$$\log \left(\frac{\psi_t^A}{\psi^A} \right) = \rho_\psi \log \left(\frac{\psi_{t-1}^A}{\psi^A} \right) + v_t^\psi, \tag{27}$$

where ψ^A is the steady state of ψ_t and $v_t^\psi \sim N(0, s_\psi)$ is an exogenous shock.

2.3 Firms

In each country there is a representative firm producing the country-specific good. The EME1 firm uses the following production function:

$$y_t = Z k_{t-1}^\alpha h_t^{1-\alpha}, \tag{28}$$

where y_t is EME1 output and Z is total factor productivity. The profit maximization problem reads:

$$\max_{k_{t-1}, h_t} p_{1t} Z k_{t-1}^\alpha h_t^{1-\alpha} - p_t u_t k_{t-1} - p_t w_t h_t. \tag{29}$$

First order conditions yield the demand of input goods:

$$k_{t-1} = \alpha \frac{p_{1t} y_t}{p_t u_t} \tag{30}$$

$$h_t = (1-\alpha) \frac{p_{1t} y_t}{p_t w_t}. \tag{31}$$

Analogous expressions hold in the other two countries.

2.4 Banks

There are two representative AE banks that act as financial intermediaries between AE households and EMEs: one bank operates with EME1, the other one with EME2. Banks do not have own funds and their profits are all distributed to AE households. AE banks pay a quadratic adjustment cost (where κ_D is a positive parameter) when they change the size of their operations. This financial friction has a twofold goal: i) it makes the model stationary, with a well-defined steady-state;[9] ii) it is a reduced form strategy to introduce an endogenous risk premium in EMEs interest rate, dependent on the EMEs external debt stock, as it will be clear below. Moreover, banks' profits are hit by a shock θ_t proportional to the size of their operations: this non-fundamental shock captures the fact that irrational exuberance of AE investors may affect the interest rates applied to EMEs. The maximization problem of the representative bank which operates with EME1 is the following:

$$\max_{\{f_{1t}\}_{t=0}^{\infty}} \Pi_{t+1}^{B1} = \max_{\{f_{1t}\}_{t=0}^{\infty}} \left(r_t^{B1} - r_t^A\right) f_{1t} - \frac{\kappa_D}{2}\left(f_{1t} - f_1\right)^2 - \theta_t f_{1t}, \tag{32}$$

where f_{1t} is the amount of bonds traded with EME1. The first order condition reads:

$$r_t^{B1} = r_t^A + \kappa_D\left(f_{1t} - f\right) + \theta_t. \tag{33}$$

Notice that θ_t acts as an exogenous non-fundamental risk-premium factor: when θ_t is low, the interest rate applied to EME1 debt decreases without any change in economic fundamentals. The stochastic process for the risk-premium factor is the following:

$$\theta_t = \rho_\theta \theta_{t-1} + v_t^\theta, \tag{34}$$

where $v_t^\theta \sim N\left(0, s_\theta\right)$ is an exogenous shock.

Notice that in equilibrium the following holds:

$$n_1 b_{3t} + n_3 f_{1t} = 0. \tag{35}$$

Accordingly, the bank arbitrage condition becomes:

$$r_t^{B1} = r_t^A - \frac{n_1}{n_3}\kappa_D\left(b_{3t} - b_3\right) + \theta_t. \tag{36}$$

The latter condition implies that whenever EME1 borrows more from abroad (so b_{3t} is lower), it pays a higher interest rate on its debt. A symmetric condition holds in EME2.

[9] See the discussion in Schmitt-Grohé and Uribe (2003) on how to close open economy models with incomplete financial markets.

2.5 Policy Instruments

In the two EMEs, a tax is applied on international bond holdings. This instrument has been analyzed in depth by other theoretical works on capital controls (see Unsal, 2013 and Heathcote and Perri, 2016). Furthermore, some emerging countries have been resorting to similar policy tools. Indeed, since the early 90's Brazil has been charging a tax on the foreign exchange transactions when capital first enters the country.[10] Instead, other emerging economies have resorted to unremunerated reserve requirements on capital inflows: this tool is also a de facto tax on foreign investment.[11] Following Heathcote and Perri (2016), I assume that this instrument responds endogenously to variations in the country's net foreign asset position (as a fraction of the GDP):

$$\tau_t = -\phi \left(\frac{b_{3t}/p_t}{p_{1t}y_t/p_t} - \bar{b} \right), \tag{37}$$

where $\bar{b}$ is the steady state of $\frac{b_{3t}}{p_{1t}y_t}$ and $\phi \geq 0$. When the net foreign asset position is lower (capital flows to EME1), the government raises the tax to discourage capital inflows (it does the opposite when the net foreign asset position is higher). Accordingly, this tool is consistent with the common practice of EMEs' policy makers, who tend to restrict capital controls when the economy experiences large capital inflows. Given that τ_t and b_{3t} are both zero in steady state,[12] a positive ϕ implies that the tax rate takes negative values when the country invests abroad: in this case, the tax should be interpreted as a subsidy on capital inflows.[13] In EME2, an analogous instrument is implemented. Revenues from capital controls are rebated to households through lump-sum transfers t_t.

2.6 Equilibrium

Market clearing in the international bond market requires:

$$n_1 b_{3t} + n_2 b_{3t}^* + n_3 b_{3t}^A = 0. \tag{38}$$

[10] See Chamon and Garcia (2016) for an evaluation of the Brazilian recent experience with capital controls.

[11] Chile, Colombia and Thailand have used unremunerated reserve requirements in the past. These country-cases have been analyzed by Cowan and De Gregorio (2007), Cárdenas and Barrera (1997) and Vithessonthi and Tongurai (2013) respectively.

[12] The results of the paper do not change if τ and/or b_{3t} are not zero in steady state.

[13] Given that the policy rule is linear in the net foreign asset position, when the latter improves, capital controls decrease and can take negative values. Nevertheless, emerging economies are usually more concerned about net capital inflows rather than net outflows: the policy rule specified in this model does not capture this asymmetry. I leave the analysis of non-linear policy rules to future research.

Notice that if the latter condition is combined with (35) (and its EME2 counterpart), one can obtain:

$$n_3 b^A_{3t} = n_3 f_{1t} + n_3 f_{2t}, \tag{39}$$

which implies that the amount of bonds issued (or bought) by AE households should be equal to the total amount of bonds intermediated by the two AE banks.
EME1 and EME2 domestic bonds are not traded abroad. It results in equilibrium:

$$n_1 b_{1t} = 0 \tag{40}$$

$$n_2 b^*_{2t} = 0. \tag{41}$$

Market clearing conditions for the three consumption goods read:

$$n_1 (c_{1t} + i_{1t} + Adj_{1t}) + n_2 (c^*_{1t} + i^*_{1t} + Adj^*_{1t}) + n_3 \left(c^A_{1t} + i^A_{1t} + Adj^A_{1t}\right) = n_1 y_t \tag{42}$$

$$n_1 (c_{2t} + i_{2t} + Adj_{2t}) + n_2 (c^*_{2t} + i^*_{2t} + Adj^*_{2t}) + n_3 \left(c^A_{2t} + i^A_{2t} + Adj^A_{2t}\right) = n_2 y^*_t \tag{43}$$

$$n_1 (c_{3t} + i_{3t} + Adj_{3t}) + n_2 (c^*_{3t} + i^*_{3t} + Adj^*_{3t}) + n_3 \left(c^A_{3t} + i^A_{3t} + Adj^A_{3t}\right) = n_3 y^A_t, \tag{44}$$

where Adj denotes capital adjustment costs.[14] Notice that by Walras Law one of the previous conditions is redundant. Finally, it is useful to define GDP in the three countries:

$$gdp_t \equiv \frac{p_{1t}}{p_t} y_t = c_t + i_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1} + tb_{3t} \tag{45}$$

$$gdp^*_t \equiv \frac{p_{2t}}{p^*_t} y^*_t = c^*_t + i^*_t + \frac{\kappa_I}{2}\left(\frac{k^*_t}{k^*_{t-1}} - 1\right)^2 k^*_{t-1} + tb^*_{3t} \tag{46}$$

$$gdp^A_t \equiv p_{3t} y^A_t = c^A_t + i^A_t + \frac{\kappa_I}{2}\left(\frac{k^A_t}{k^A_{t-1}} - 1\right)^2 k^A_{t-1} + tb^A_{3t}, \tag{47}$$

where tb_t denotes the trade balance.

2.7 Calibration

There are three groups of parameters that must be calibrated. The first group includes those parameters that are specific to AE and EMEs. These parameters govern the population size, the steady-state GDP and net financial asset position, the coefficients in consumption and investment bundles and the steady-state preference shifter. I proceed as follows. I interpret EME1 as a homogeneous group of emerging countries with an

[14] I assume that banks' operating cost (i.e. the quadratic adjustment costs and the exogenous risk premium factor) are distributed through lump-sum transfers by the AE government.

identical capital controls policy and EME2 (AE) as a homogeneous group of emerging (advanced) countries with no capital controls in place.[15] I take a sample of advanced and emerging economies (those reporting the net financial asset position in 2016): there are 74 countries (34 advanced, 40 emerging) representing 91% of world GDP.[16] The population size of AE (parameter n_3) corresponds to the share of population in advanced economies in the sample: it results $n_3 = 0.19$; since I assume that the two EMEs are symmetric, $n_1 = n_2 = \frac{1-n_3}{2} = 0.405$. In the sample, GDP per capita in the advanced economies is 3.81 times the EMEs' one: therefore I set $\{Z, Z^*, Z^A\}$ such that in steady state $gdp^A = 3.81gdp = 3.81gdp^*$.[17] By normalizing $Z = Z^* = 1$, I get $Z^A = 1.46$.[18] By aggregating the net financial asset positions of all countries in each of the two samples, advanced and emerging economies feature a similar small deficit (about 3% of GDP): hence, I set $\bar{b} = \bar{b}^* = 0$ (which implies that the AE net financial position is zero too). The steady-state preference shifter is calibrated so that the steady-state replicates the complete-market efficient allocation:

$$n_1\lambda = n_3\lambda^A \cdot p, \tag{48}$$

which implies $\psi^A = 8.12$.[19] In order to calibrate the weight coefficients in (1)-(7), I use the following strategy: the coefficient in the bundle of country i on the good produced by country j (with $i, j = EME1, EME2, AE$ and $i \neq j$) is the product of a parameter η capturing the openness of country i and the GDP share of country j; the weight on the good produced by the same country (when $i = j$), is the complement to one of the other two coefficients.[20] For instance, by calibrating the openness parameter η to 0.15, for EME1 this procedure yields:[21]

[15]When I conduct the normative analysis in Section 4, I assume that also EME2 can manage capital controls.

[16]More details on this dataset can be found in the Appendix.

[17]The resulting GDP share of AE is 50%.

[18]Notice that according to this calibration EME1 and EME2 are not too small relative to AE.

[19]A social planner maximizing the weighted average of countries' utilities would allocate resources in order to equalize marginal utilities of consumption of all countries, weighted by the population size and the exchange rate. This assumption ensures that the steady state is efficient from the point of view of the global social planner, thus it represents a good benchmark to start simulations. However, it does not imply that the steady state is efficient also from the point of view of the single economies.

[20]This method is typically used in the calibration of bundle coefficients in two-country models, where the two countries are asymmetric in population.

[21]It turns out that 88.75% of EME1 bundle is composed by the EME1 good, 7.5% by the AE good and the remaining 3.75% by the EME2 good.

$$
\begin{aligned}
\nu_2 &= \eta \frac{n_2 gdp^*}{n_1 gdp + n_2 gdp^* + n_3 gdp^A} = 0.0375 && (49)\\
\nu_3 &= \eta \frac{n_3 gdp^A}{n_1 gdp + n_2 gdp^* + n_3 gdp^A} = 0.0750 && (50)\\
\nu_1 &= 1 - \nu_2 - \nu_3 = 0.8875. && (51)
\end{aligned}
$$

The second group of parameters includes coefficients of utility and production functions, which are equal for the three countries in the model. I set these parameters following the quarterly calibration in Heathcote and Perri (2016), which study the desirability of capital controls in a standard two-country model. The inverse of the Frisch elasticity of labor supply ϕ is calibrated to 1; the discount factor β assumes the standard value of 0.99; the capital share in the production function α is 0.36; physical capital depreciates at a rate of $\delta = 1.5\%$ quarterly; the elasticity of substitution μ between the domestic and the foreign good is set to 1.5. Heathcote and Perri (2016) calibrate the openness parameter η in order to have a steady-state imports/GDP ratio of 30%, approximately the average trade share for advanced economies in 2015. However, the economies modeled in this paper aim to capture three groups of countries: thus, ideally, for the AE η should be set in order to match the advanced economies' imports only from emerging economies (and the same for EME1 and EME2). Hence, I set η to an arbitrary low value ($\eta = 0.15$, small compared to values typically used in the literature), and I perform a robustness check with a more standard number (see section 5.3).

The third group of coefficients includes those parameters that do not affect the steady state (I assume that these parameters are the same in the three countries). The capital adjustment cost κ_I is calibrated to 75, to match an EMEs' investment volatility equal to three times output volatility; the debt adjustment coefficient is calibrated to a small value ($\kappa_D = 0.001$), as standard in the literature; I assume rather persistent stochastic processes, as standard in the international business cycle literature ($\rho_\psi = \rho_\theta = 0.9$); the standard deviation of the shocks are $s_\psi = 0.05$ and $s_\theta = 0.01$. The following table summarizes the calibration.

Parameters	Description	Value
n_1, n_2, n_3	Population size	$0.405, 0.405, 0.19$
Z, Z^*, Z^A	Total factor productivity	$1, 1, 1.46$
$\overline{b}, \overline{b}^*$	Steady state NFA	$0, 0$
η	Openness degree	0.15
ν_1, ν_2, ν_3	Weight coefficients in EME1	$0.8875, 0.0375, 0.0750$
$\nu_1^*, \nu_2^*, \nu_3^*$	Weight coefficients in EME2	$0.0375, 0.8875, 0.075$
$\nu_1^A, \nu_2^A, \nu_3^A$	Weight coefficients in AE	$0.0375, 0.0375, 0.9250$
α	Share of capital in production	0.36
β	Discount rate	0.99
δ	Depreciation rate	0.015
φ	Inverse of Frisch elasticity of labor supply	1
μ	ES between domestic and foreign goods	1.5
κ_I	Capital adjustment cost coefficient	75
κ_D	Debt adjustment coefficient	0.001
ψ^A	Steady-state preference shifter	8.12
ρ_ψ	Autoregressive parameter (preference)	0.9
s_ψ	Standard deviation (preference)	0.05
ρ_θ	Autoregressive parameter (risk premium)	0.9
s_θ	Standard deviation (risk premium)	0.01

Table 1: Calibration.

3 Impulse Response Analysis

In this section, two capital inflows shock are simulated to analyze capital controls spillover effects: a preference shock in AE and a risk-premium shock. While the first one is a fundamental shock, since it affects the discount factor of AE households, the second one is a non-fundamental shock, since it introduces a friction in the economy. The model is solved through a first-order approximation around the non-stochastic steady state.[22]

3.1 Preference Shock in AE

A negative one standard-deviation preference shock in AE aims to capture the effects of a capital inflows surge in emerging economies driven by push factors. This fundamental shock is a standard demand impulse for the advanced economy, given that it reduces consumption and prices, while increasing saving and, in equilibrium, investment. First, I consider a baseline scenario in which policy rule coefficients are $\phi = \phi^* = 0$, so capital controls are out of the picture. The shock induces AE households to shift resources from consumption to investment: they increase physical capital and buy foreign bonds (figure 4, blue solid line). Accordingly, AE runs a trade balance surplus, which mirrors an improvement in the net financial asset position with the rest of the world. AE production decreases on impact by more than 0.1%, driven by a smaller consumption demand and it recovers quickly due to a higher stock of capital (after a few periods GDP is higher than the steady-state level). The AE desire to save ends up causing an international interest rate reduction which is transmitted to EMEs bonds. In the baseline scenario, the impulse responses of EME1 and EME2 are identical, given the symmetry of these economies (blue solid line in figures 5 and 6). The interest rate decline allows emerging economies to borrow more from AE: borrowed resources are used to increase consumption and investment in physical capital. As a result, GDP rises considerably (by about 0.15% on impact), also driven by an increase in labor which is more productive given the higher stock of physical capital. Finally, the exchange rate appreciates in emerging economies, reflecting the demand reduction in AE. All in all, the preference shock fosters a persistent capital inflow surge in EME1 and EME2 (around 1.2% of steady-state GDP after 10 quarters), a financial account deficit (more than 0.2% of steady-state GDP on impact) and a real appreciation of EMEs goods: this dynamics replicates reasonably well the standard narrative of a capital inflow shock driven by push factors.

What happens if EME1 tightens capital controls? I assume that the EME1 capital controls rule responds aggressively to changes in the net financial asset position. Notably,

[22]A complete list of the model's equation as well as details on computation of the steady state can be found in the Appendix.

I set $\phi = 1$, while $\phi^* = 0$. Notice that this policy rule implies a strong commitment for EME1: whenever the net financial asset position deteriorates by 1% of GDP, the government commits to increase capital controls by 100 basis points and such a commitment is assumed to be fully credible.

This calibration of the policy rule shields EME1 from the shock. On impact, capital inflows are almost offset (black dotted line, figure 5), given that borrowing abroad is now more costly for EME1 households. The capital controls tightening affects the interest rate parity condition, since a smaller fall in the EME1 interest rate is required to clear the bond market. Not surprisingly, the EME1 macroeconomic boom is dampened: domestic demand grows by less and the exchange rate experiences a smaller appreciation. This capital controls policy spills over into EME2 through an additional and persistent capital inflow surge (black dotted line, figure 6): on impact, the foreign debt/gdp ratio[23] is 0.05 percentage points higher with respect to the baseline scenario; the maximum gap between the two scenarios is around 0.26 percentage points, reached after some years. This implies that, on impact, about 26% of the capital that were warded off by EME1 are deflected to EME2, while total AE capital outflows are reduced by one third. On top of that, in EME2, the by-product of EME1 capital controls policy is not limited to capital inflows. Indeed, the EME2 macroeconomy is further stimulated: the consumption and investment impact response is 20% higher than the impact response under the baseline scenario. It turns out that spillovers are economically meaningful, although they are not very big.

It is worth highlighting that EME1 is not calibrated as a small economy: we can think of EME1 as homogeneous group of emerging countries with a similar (tight) capital controls policy. Hence, EME1 policy may affect AE as well. A significant share of capital flows warded off by EME1 reduces AE external position, so the AE financial account surplus is much lower compared to the baseline scenario. These smaller imbalances translate into a lower GDP decline on impact. The intuition is the following: in the AE, the higher desire to consume more in the future (driven by the preference shock) can be fulfilled by investing more either in physical capital or in foreign bonds; however, EME1 capital controls policy makes the latter option less profitable: thus, the AE capital stock rises, boosting AE production. In addition, the AE interest rate decreases by slightly more to equalize the marginal return of capital, since EME1 households reduce their borrowing demand.

[23]Since the financial instrument is a one-period bond, debt corresponds to capital inflows.

3.2 Risk-Premium Shock

An exogenous reduction in risk premium, as the preference shock, behaves like a capital-inflows push factor for emerging economies: the response of EME1 and EME2 is qualitatively and quantitatively comparable to that obtained under the preference shock (figures 7-9). However, the macroeconomic implications for AE change considerably. As before, I first consider a baseline scenario in which capital controls are absent. A reduction in the risk premium reduces the EMEs' domestic interest rate: EMEs households borrow more from AE banks, foreign capital flows to EMEs and their exchange rate appreciates. The increased resources allow EMEs to consume and invest more, boosting GDP (around 0.4% on impact). Given that AE banks lend more abroad, they increase borrowing from AE households, who require a higher interest rate. The rise in AE interest rate decreases consumption and investment (while the latter responds positively to a preference shock). Therefore, compared to the other shock, the responses of AE investment and its interest rate have the opposite sign, while AE GDP remains persistently below the steady state.

Also under this scenario, capital controls allow EME1 to smooth out the shock. However, now spillover effects are slightly larger: on impact, the foreign debt/GDP ratio is about 0.1 percentage points higher with respect to the baseline scenario; the maximum gap between the two scenarios is around 0.7 percentage points, reached after some years. Notably, the advanced economy is considerably affected, given that the higher desire to invest abroad is compensated by a tightening in EMEs capital controls. Under the preference-shock case, the spillover effect on the AE is much smaller, since AE households are willing to postpone consumption in any case, due to the negative shock to their marginal utility. On the other hand, under the risk-premium case, the only reason why AE is willing to invest abroad is a lower risk premium: if the latter is offset with financial restrictions in EME1, AE banks reduce their exposure to EME1 and borrow less from AE households.

By summarizing the findings of this section, I find that capital controls in one emerging economy amplify the business cycle of the other emerging country, these spillovers effects are economically meaningful, yet not very big. Moreover, the advanced economy is remarkably affected by capital controls only when they are set in response to a higher desire of AE agents to invest more abroad and less in their own country (i.e. under risk-premium shocks).

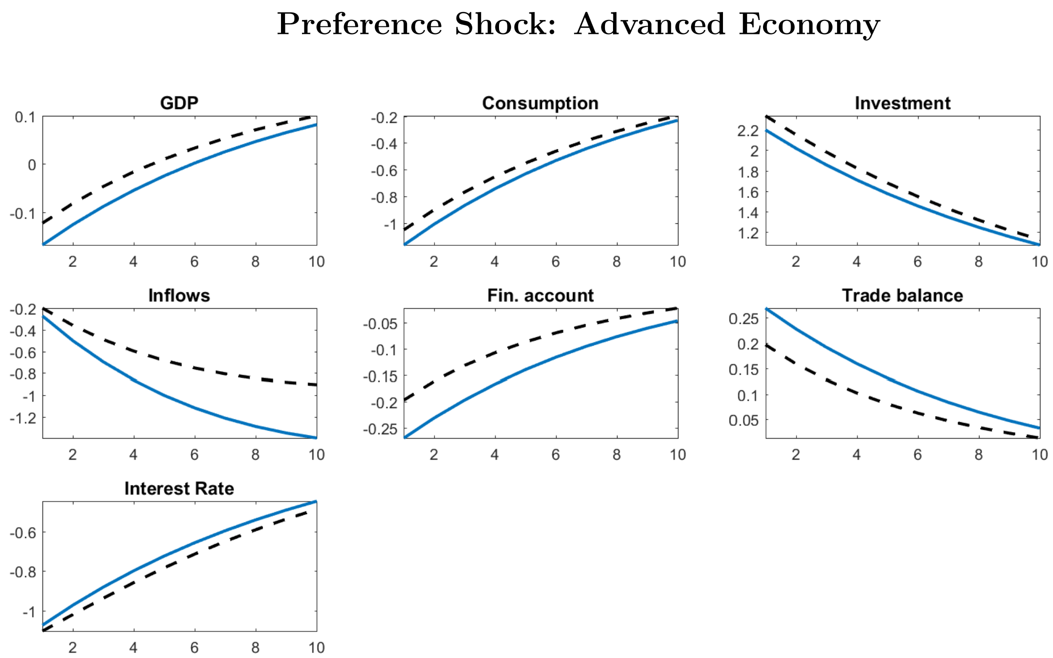

Figure 4: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

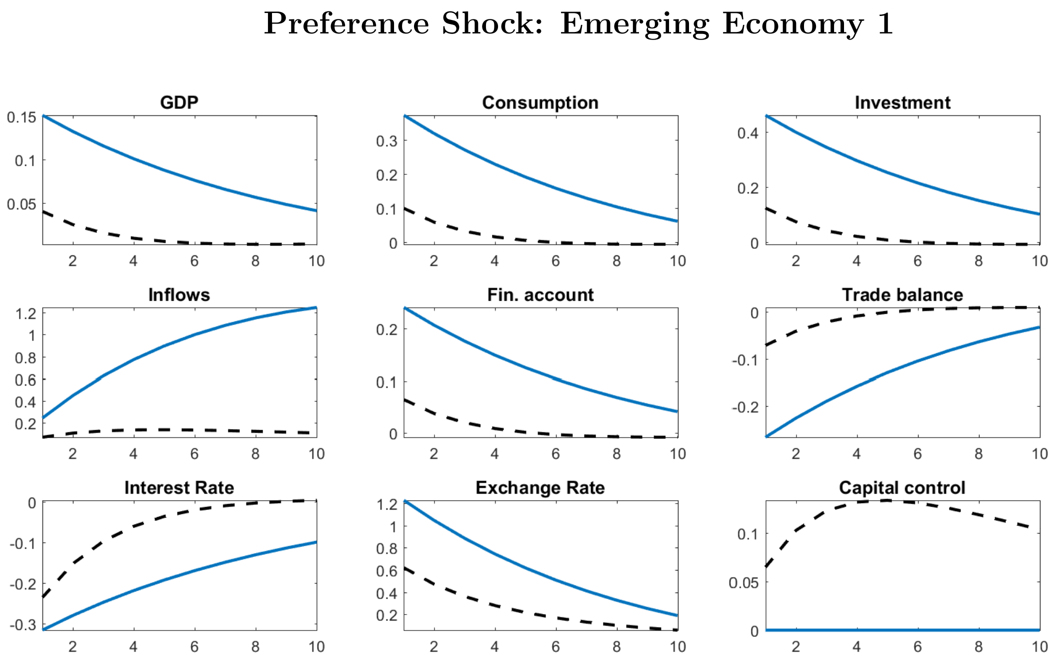

Figure 5: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Preference Shock: Emerging Economy 2

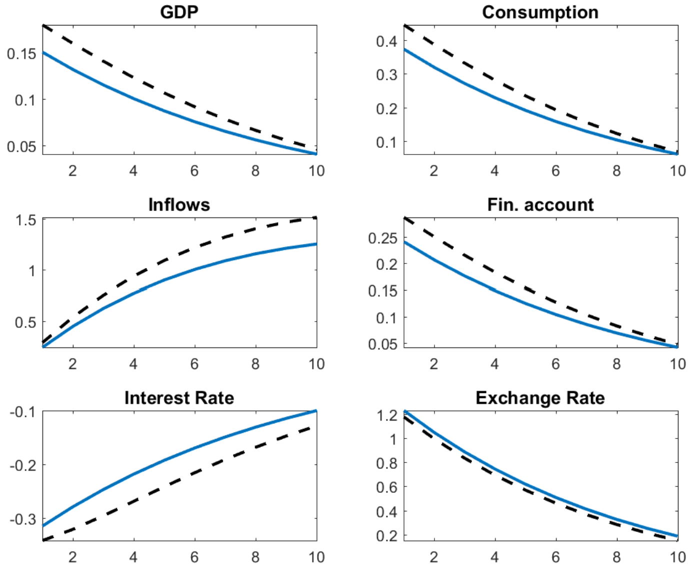

Figure 6: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period correspond to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Advanced Economy

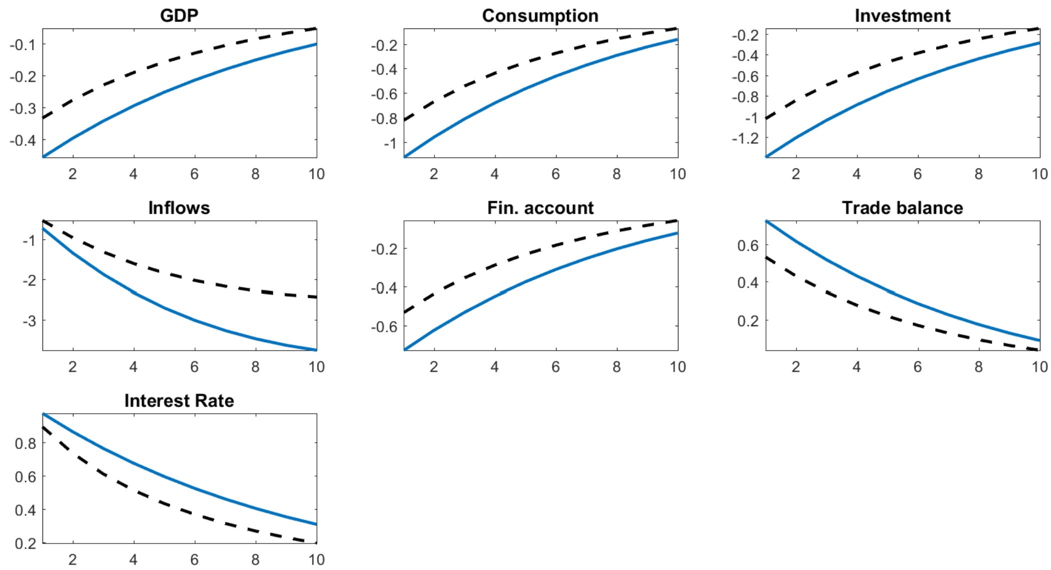

Figure 7: Impulse response functions to a risk premium shock ($v_t^{\theta} = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Emerging Economy 1

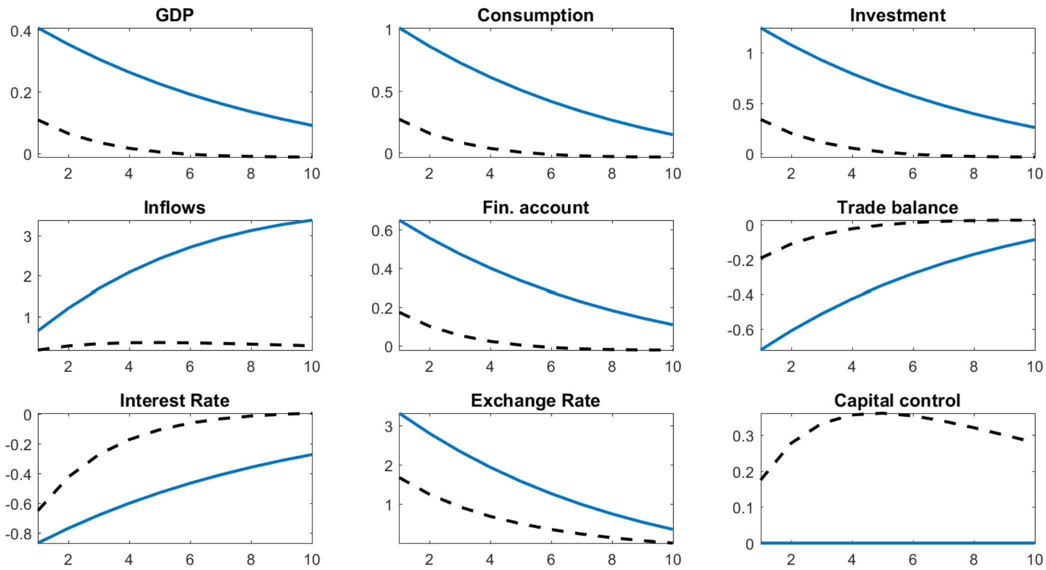

Figure 8: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Emerging Economy 2

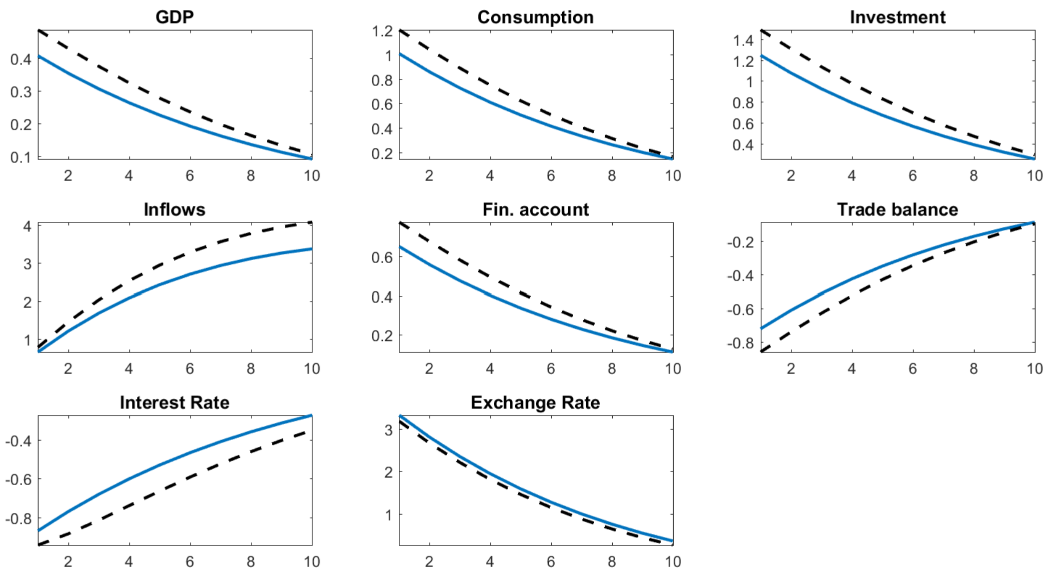

Figure 9: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

4 Are Capital Controls Desirable?

I study the desirability of capital controls along several dimensions. First, I consider the scenario in which an EME1 social planner maximizes EME1 households' welfare ($\mathcal{W}_t$) by choosing the policy parameter ϕ, taking as given that EME2 does not use capital controls (so $\phi^* = 0$). Second, I study the Nash equilibrium in which both EME1 and EME2 maximize their welfare, assuming that the other emerging country is also choosing capital controls optimally. Third, I analyze the coordination equilibrium between EME1 and EME2, which maximize the sum ($\mathcal{W}_t^{eme}$) of their welfare functions.[24]

These three maximization problems are numerically solved for each of the two shocks. Notably, I follow the approach of Schmitt-Grohé and Uribe (2004). Hence I take a second-order approximation of the model around the non-stochastic steady state and I "numerically" maximize households' expected welfare conditional on being in steady state in the initial period. Welfare functions are defined as follows:

$$\mathcal{W}_t = \log\left(c_t - \frac{h_t^{1+\varphi}}{1+\varphi}\right) + \beta \mathbb{E}_t \mathcal{W}_{t+1} \tag{52}$$

$$\mathcal{W}_t^* = \log\left(c_t^* - \frac{h_t^{*1+\varphi}}{1+\varphi}\right) + \beta \mathbb{E}_t \mathcal{W}_{t+1}^* \tag{53}$$

$$\mathcal{W}_t^{eme} = n_1 \mathcal{W}_t + n_2 \mathcal{W}_t^*. \tag{54}$$

For each optimal policy, I provide a measure of the consumption gain relative to the benchmark case of free international trade ($\phi = \phi^* = 0$). The consumption gain is defined as the fraction of households' consumption that would be needed to equate welfare under the baseline scenario with the level of welfare implied by the optimal rule.

First, I start the normative analysis with the risk-premium shock. If the EME1 social planner maximizes $\mathcal{W}_t$, assuming the EME2 does not use capital controls, optimal ϕ is equal to 0.04 (first row in Table 2), with a consumption gain of about 0.04%. Why are capital controls optimal for EME1? The intuition resembles the point made by Farhi and Werning (2014) and Heathcote and Perri (2016): capital controls allow countries to affect the international interest rate, lowering it when they borrow and raising it when the invest. To better understand this argument, it is useful to derive the linearized UIP condition between EME1 and AE interest rates:

[24] I do not focus on the problem of the global social planner, who takes into account AE welfare too. The reason is that in this model, AE does not use capital controls (consistently with the empirical evidence), accordingly it has no instruments to face potential welfare losses.

$$\hat{r}_t = \hat{r}_t^A - \mathbb{E}_t \Delta \hat{p}_{t+1} + \beta\theta_t - \beta\kappa_D \frac{n_1}{n_3}\hat{b}_{3t} + \tau_t, \tag{55}$$

where "hat" variables denote deviations from the steady state. This equation is an arbitrage condition between investing in EME1 bonds (yielding $\hat{r}_t$) and in bonds issued by AE banks. The latter consists of five components: the AE interest rate $\hat{r}_t^A$; the expected depreciation of EME1 good ($-\mathbb{E}_t \Delta \hat{p}_{t+1}$); the exogenous risk-premium shock (θ_t); the endogenous risk-premium component, which is a decreasing function of EME1 external investment ($-\beta\kappa_D \frac{n_1}{n_3}\hat{b}_{3t}$); the capital controls tax (τ_t). Let

$$r_t^{eff} \equiv \hat{r}_t^A - \mathbb{E}_t \Delta \hat{p}_{t+1} + \beta\theta_t - \beta\kappa_D \frac{n_1}{n_3}\hat{b}_{3t} \tag{56}$$

be the effective interest rate, that is, the rate at which EME1 is *de facto* borrowing from abroad. Notice that capital controls have no direct impact on r_t^{eff}, given that fiscal revenues arising from capital controls are distributed to EME1 households. However, capital controls do have an impact on at least three components of r_t^{eff}. Indeed, capital controls can affect the expected exchange rate depreciation, the risk-premium endogenous component and the AE interest rate. In particular, as far as the risk-premium component is concerned, the EME1 social planner internalizes the financial friction which affects country's international financial transactions: indeed, the social planner takes into account that, when the economy borrows, higher capital controls reduce capital flows, thus improving the net financial asset position and, accordingly, mitigating the endogenous risk premium (figure 10). Nevertheless, notice that the optimal value for ϕ and the associated welfare gain are quite low.[25] Indeed, a stronger elasticity of capital controls to debt increases would further reduce the effective interest rate, with the cost of excessively compressing capital inflows: in other words, the welfare benefit of borrowing at a lower interest rate decreases, when the amount borrowed is not sufficiently high.

In the previous section, I found that there exist spillover effects in EME2 when $\phi = 1$, but they are not very large. It turns out that, when $\phi = 0.04$, spillover effects are quite negligible. This implies that EME1 optimal policy is virtually independent from EME2 capital controls: accordingly, the EME1 social planner finds it optimal to set $\phi = 0.04$ even if EME2 optimally sets capital controls. The resulting Nash equilibrium is therefore $\phi = \phi^* = 0.04$. My result differs from Heathcote and Perri (2016), who find that the more aggressive capital controls policy in one country, the more aggressive the policy of the other country. The difference lies in the model setup: while Heathcote and Perri (2016) consider a model with two symmetric big countries (which should interpreted as

[25] The small welfare gains that I find throughout this section are in line with the low welfare costs of business cycle in this class of model.

two advanced economies), in the model of this paper with three countries, the two emerging economies are not sufficiently large to mutually affect their policies in a significant way. Therefore, at this point it is not surprising that, if the two EMEs coordinate their strategies, they would choose a policy only slightly tighter than the Nash equilibrium. Indeed, a tighter policy implemented by both countries can affect AE interest rate in a way that is more favorable to EMEs. However, welfare gains with respect to the Nash equilibrium are not remarkable. The reason is, again, the low spillover effects arising under the optimal policy.

The findings highlighted in this section are obtained assuming that the economy is hit only by risk premium shocks. However, notice that the same results emerge under discount factor shocks, given that, for the two EMEs, the macroeconomic consequences of these two shocks are qualitatively similar (Table 3).

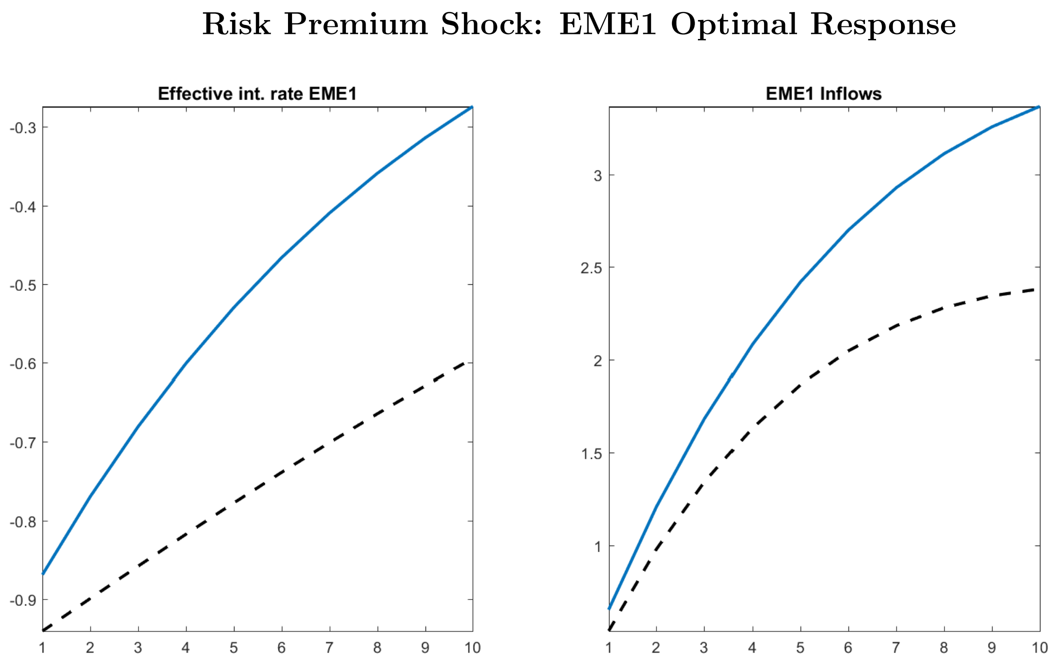

Figure 10: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 0.04$ and $\phi^* = 0$. Responses are in in level deviations from the steady state. One period correspond to a quarter. Interest rate response is annualized.

Risk-premium shocks		
Planner	**Optimality**	**Consumption gain**
EME1	$\phi = 0.04$	0.0365%
Nash	$\phi = 0.04$, $\phi^* = 0.04$	0.0442%
EME	$\phi = 0.05$, $\phi^* = 0.05$	0.0449%

Table 2: Optimal policy under risk-premium shocks.

Discount factor shocks		
Planner	**Optimality**	**Consumption gain**
EME1	$\phi = 0.04$	0.0057%
Nash	$\phi = 0.04$, $\phi^* = 0.04$	0.0070%
EME	$\phi = 0.06$, $\phi^* = 0.06$	0.0072%

Table 3: Optimal policy under discount factor shocks.

5 Sensitivity Analysis

In this section I verify the robustness of my results on the values assigned to three crucial parameters: EME1 size (n_1), the elasticity of the endogenous risk premium to external debt (κ_D) and the openness parameter η.

5.1 EME1 Size

The relevance of capital controls spillover crucially depends on the size of the countries tightening cross-border restrictions. If a single small country raises its capital controls, this policy hardly affects other economies. But if a large group of countries changes their capital controls stance, then spillover effects may be sizable. In the previous section I have assumed that half of emerging economies in the world tight the capital controls tax: now I calibrate this share to 80%, without changing the size of AE.[26] Impulse responses are reported in the Appendix. Under preference shocks, EME2 experiences a higher capital inflow surge, if EME1 uses capital controls (figure A.3): on impact, capital inflows are 0.09 percentage higher respect to a scenario with no changes in EME1 policy; the maximum gap between the two scenarios (reached after some years) is around 0.5 percentage points. The impact response of consumption and investment is now 29% larger than the impact response with no changes in EME1 policy. Clearly, if a large set of emerging economies restricts their financial account, the business cycle in advanced economies cannot remained unaffected: on impact, the GDP reduction is half of the response with no controls in place. As in the previous section, the positive impact of EME1 policy on the AE hinges on the amplified response of investment in physical capital. Therefore, when the size of EME1 is big, spillover effects arising from capital controls are larger.

Spillovers effects under risk-premium shocks are even larger. On impact, EME receives higher capital flows by 0.24 percentage points, compared to the scenario with EME1 controls. The maximum gap between the two scenarios is above one percentage point (figure A.6).

The normative analysis barely changes when EME1 is larger. Under risk-premium shocks, EME1 sets $\phi = 0.07$, both when $\phi^* = 0$ and when ϕ^* is optimally set ($\phi^* = 0.02$). EME1 optimal parameter is higher compared the baseline scenario, given that now EME1 is able to play a larger role in affecting AE interest rate. Moreover, when EMEs coordinate, the resulting optimal policy coincides with the Nash equilibrium. Indeed, given EME2 small size, its policy is almost irrelevant in shaping EME1's policy stance.

[26] It turns out $n_1 = 0.65$ and $n_2 = 0.16$.

5.2 Endogenous Risk Premium

In this model, EMEs find it optimal to use capital controls in order to affect the interest rate at which they borrow and lend. In particular, they can have an impact on the endogenous risk premium, which depends on the country's external debt. Therefore, the elasticity of the endogenous risk premium to debt is a key parameter in the analysis. Following the literature, under the baseline calibration I set this parameter to a small value. If such elasticity was bigger, EMEs would have a more powerful channel to affect the interest rate. In this section I choose a value ten times bigger than the baseline calibration (so I set $\kappa_D = 0.01$) and I repeat the normative analysis (tables 4 and 5). As expected, countries set a tighter policy stance to exploit their increased power to affect the risk premium. However, each country's policy is still barely affected by the other country: EME1 does not change its policy stance, if also EME2 optimizes; in addition, the Nash and the coordination equilibrium are very close here too. Indeed, even if capital controls are now tighter, a relatively high κ_D reduces the volatility of capital flows, thus dampening spillover effects.[27] It turns out that welfare gains are even smaller than the baseline scenario: the benefit of an increased power on the interest rate is more than compensated by the reduced possibility to trade financial resources, given the smaller volatility of capital flows.

Risk-premium shocks		
Planner	**Optimality**	**Consumption gain**
EME1	$\phi = 0.29$	0.0224%
Nash	$\phi = 0.29$, $\phi^* = 0.29$	0.0243%
EME	$\phi = 0.33$, $\phi^* = 0.33$	0.0244%

Table 4: Optimal policy under risk-premium shocks (higher κ_D).

Discount factor shocks		
Planner	**Optimality**	**Consumption gain**
EME1	$\phi = 0.30$	0.0032%
Nash	$\phi = 0.31$, $\phi^* = 0.31$	0.0036%
EME	$\phi = 0.35$, $\phi^* = 0.35$	0.0036%

Table 5: Optimal policy under discount factor shocks (higher κ_D).

[27] κ_D is the elasticity of the interest rate to the banks' credit supply: hence, when it is high, small variations in credit supply are necessary to meet changes in the interest rate.

5.3 Trade Openness

Given that the three economies in this paper should be interpreted as three homogeneous groups of countries, their trade openness is calibrated to be relatively small: indeed, the trade openness of a group of countries vis-à-vis the rest of the world is smaller than the openness of an individual small economy vis-à-a vis the rest of the world. In this subsection I verify how trade openness (as captured by parameter η) is affecting the results: thus I repeat the simulations by setting $\eta = 0.3$ (the baseline value is 0.15). It turns out that the weights in the consumption and investment bundles change under the new calibration are the following:

Parameter	**Country**	**Value**
ν_1, ν_2, ν_3	EME1	$0.7750, 0.075, 0.15$
$\nu_1^*, \nu_2^*, \nu_3^*$	EME2	$0.075, 0.775, 0.15$
$\nu_1^A, \nu_2^A, \nu_3^A$	AE	$0.075, 0.075, 0.85$

Table 6: Weights coefficients when $\eta = 0.3$

Impulse response functions are reported in Appendix. Not surprisingly, under the new calibration the impact of both shocks is amplified, given that the three countries are now linked by tighter trade relationships, though the shape of impulse responses are qualitatively identical. Accordingly, also spillovers effects are slightly larger. The bottom line of the normative analysis does not change compared to the baseline calibration: the more relevant difference lies in the consumption gain, which is higher if trade openness is larger.

6 Conclusions

This paper analyzes the spillover effects produced by emerging economies when they impose capital controls in response to capital inflow shocks coming from advanced economies. Simulations performed with a three-country (AE, EME1 and EME2) business cycle model show that relatively tight capital controls implemented in EME1 deflect capital flows to EME2, if the latter does not resort to similar restrictions: the inflows deflection affects EME2's business cycle, bringing about an expansion of its economic activity. These spillover effects are economically meaningful and can be sizable if there are many countries using capital controls (i.e. when EME1 size is calibrated to be big). Moreover, since in the model EME1 is not small relatively to AE, the imposition of capital controls affects also AE's macroeconomy: AE households invest more in their economy, accordingly AE consumption and investment rise.

The normative analysis points out that, within the model employed in this paper, countries find it optimal to use capital controls in order to affect the interest rate at which they borrow and lend. However, the optimal policy stance of an individual emerging economy requires only a moderate use of capital restrictions: I find that the elasticity of capital controls to external debt should be set at small values. Furthermore, welfare gains arising from a coordination strategy are quite small compared to the Nash equilibrium, given that spillover effects are not large when capital controls are set to small values. Therefore, the policy implication is immediate: moderate capital controls do not necessarily require coordination among emerging countries. Nevertheless, in the model of this paper, affecting the interest rate is the sole rationale for the imposition of capital controls. It turns out that augmenting the model with frictions in the domestic financial markets may lead to higher optimal capital controls, which in turn could generate larger spillover effects. I reserve the study of this promising issue to future research on capital controls spillovers.

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Appendix

A Model Equations

The equilibrium can be characterized by equations (57)-(97) listed below, that describe the dynamics of 41 endogenous variables.

A.1 EME1

Marginal utility of consumption:

$$\lambda_t = \left(c_t - \frac{h_t^{1+\varphi}}{1+\varphi}\right)^{-\sigma}. \tag{57}$$

Euler equation for bonds and capital:

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \frac{r_t^{B1}}{1-\tau_t} \frac{p_t}{p_{t+1}}\right) \tag{58}$$

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} r_t\right) \tag{59}$$

$$\begin{aligned} 1 = {} & \beta \mathbb{E}_t \left\{\frac{\lambda_{t+1}}{\lambda_t}\left[\kappa_I \frac{k_{t+1}}{k_t}\left(\frac{k_{t+1}}{k_t}-1\right) - \frac{\kappa_I}{2}\left(\frac{k_{t+1}}{k_t}-1\right)^2 + u_{t+1} + (1-\delta)\right]\right\} - \\ & -\kappa_I\left(\frac{k_t}{k_{t-1}}-1\right) \end{aligned} \tag{60}$$

Law of motion of capital:

$$k_t = (1-\delta) k_{t-1} + i_t. \tag{61}$$

Labor supply:

$$h_t^{\varphi} = w_t. \tag{62}$$

Input demands:

$$k_{t-1} = \alpha \frac{p_{1t} y_t}{u_t} \tag{63}$$

$$h_t = (1-\alpha) \frac{p_{1t} y_t}{w_t}. \tag{64}$$

Production function:

$$y_t = Z k_{t-1}^{\alpha} h_t^{1-\alpha}. \tag{65}$$

Resource constraint:

$$p_t c_t + p_t i_t + p_t \frac{\kappa_I}{2} \left(\frac{k_t}{k_{t-1}} - 1 \right)^2 k_{t-1} + b_{3t} = p_{1t} y_t + r_{t-1}^{B1} b_{3t-1}. \tag{66}$$

Price level:

$$p_t^{1-\mu} = \nu_1 p_{1t}^{1-\mu} + \nu_2 p_{2t}^{1-\mu} + \nu_3 p_{3t}^{1-\mu}. \tag{67}$$

Capital controls rule:

$$\tau_t = -\phi \left(\frac{b_{3t}}{p_{1t} y_t} - \bar{b} \right). \tag{68}$$

Bank interest rate:

$$r_t^{B1} = r_t^A - \frac{n_1}{n_3} \kappa_D \left(b_{3t} - b_3 \right) + \theta_t. \tag{69}$$

A.2 EME2

Marginal utility of consumption:

$$\lambda_t^* = \left(c_t^* - \frac{h_t^{*1+\varphi}}{1+\varphi} \right)^{-\sigma}. \tag{70}$$

Euler equation for bonds and capital:

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^*}{\lambda_t^*} \frac{r_t^{B2}}{1-\tau_t^*} \frac{p_t^*}{p_{t+1}^*} \right) \tag{71}$$

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^*}{\lambda_t^*} r_t^* \right) \tag{72}$$

$$\begin{aligned} 1 = {} & \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}^*}{\lambda_t^*} \left(\kappa_I \frac{k_{t+1}^*}{k_t^*} \left(\frac{k_{t+1}^*}{k_t^*} - 1 \right) - \frac{\kappa_I}{2} \left(\frac{k_{t+1}^*}{k_t^*} - 1 \right)^2 + u_{t+1}^* + (1-\delta) \right) \right] - \\ & -\kappa_I \left(\frac{k_t^*}{k_{t-1}^*} - 1 \right). \end{aligned} \tag{73}$$

Law of motion of capital:

$$k_t^* = (1-\delta) k_{t-1}^* + i_t^*. \tag{74}$$

Labor supply:

$$h_t^{*\varphi} = w_t^*. \tag{75}$$

Input demands:

$$k_{t-1}^{*} = \alpha \frac{p_{2t} y_{t}^{*}}{u_{t}^{*}} \tag{76}$$

$$h_{t}^{*} = (1-\alpha) \frac{p_{2t} y_{t}^{*}}{w_{t}^{*}}. \tag{77}$$

Production function:

$$y_{t}^{*} = Z^{*} k_{t-1}^{*\alpha} h_{t}^{*1-\alpha}. \tag{78}$$

Resource constraint:

$$p_{t}^{*} c_{t}^{*} + p_{t}^{*} i_{t}^{*} + p_{t}^{*} \frac{\kappa_I}{2} \left(\frac{k_{t}^{*}}{k_{t-1}^{*}} - 1 \right)^{2} k_{t-1}^{*} + b_{3t}^{*} = p_{2t} y_{t}^{*} + r_{t-1}^{B2} b_{3t-1}^{*}. \tag{79}$$

$$p_{t}^{*1-\mu} = \nu_{1}^{*} p_{1t}^{1-\mu} + \nu_{2}^{*} p_{2t}^{1-\mu} + \nu_{3}^{*} p_{3t}^{1-\mu}. \tag{80}$$

Capital controls rule:

$$\tau_{t}^{*} = -\phi^{*} \left(\frac{b_{3t}^{*}}{p_{2t} y_{t}^{*}} - \overline{b}^{*} \right). \tag{81}$$

Bank interest rate:

$$r_{t}^{B2} = r_{t}^{A} - \frac{n_2}{n_3} \kappa_D \left(b_{3t}^{*} - b_{3}^{*} \right) + \theta_t. \tag{82}$$

A.3 AE

Marginal utility of consumption:

$$\lambda_{t}^{A} = \psi_{t}^{A} \left(c_{t}^{A} - \frac{h_{t}^{A1+\varphi}}{1+\varphi} \right)^{-\sigma}. \tag{83}$$

Euler equation for bonds and capital:

$$1 = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^{A}}{\lambda_{t}^{A}} r_{t}^{A} \right) \tag{84}$$

$$\begin{aligned} 1 = {} & \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}^{A}}{\lambda_{t}^{A}} \left(\kappa_I \frac{k_{t+1}^{A}}{k_{t}^{A}} \left(\frac{k_{t+1}^{A}}{k_{t}^{A}} - 1 \right) - \frac{\kappa_I}{2} \left(\frac{k_{t+1}^{A}}{k_{t}^{A}} - 1 \right)^{2} + u_{t+1}^{A} + (1-\delta) \right) \right] - \\ & -\kappa \left(\frac{k_{t}^{A}}{k_{t-1}^{A}} - 1 \right). \end{aligned} \tag{85}$$

Law of motion of capital:

$$k_{t}^{A} = (1-\delta) k_{t-1}^{A} + i_{t}^{A}. \tag{86}$$

Labor supply:

$$h_t^{A\varphi} = w_t^A. \tag{87}$$

Input demands:

$$\begin{aligned} h_t^{A\varphi} &= w_t^A \quad (88) \\ k_t^A &= (1-\delta)\, k_{t-1}^A. \quad (89) \end{aligned}$$

Production function:

$$y_t^A = Z^A k_{t-1}^{A\alpha} h_t^{A1-\alpha}. \tag{90}$$

Resource constraint:

$$c_t^A + i_t^A + \frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A} - 1\right)^2 k_{t-1}^A + b_{3t}^A = p_{3t} y_t^A + \frac{n_2}{n_3} r_{t-1}^{B1} b_{3t-1} + \frac{n_1}{n_3} r_{t-1}^{B2} b_{3t-1}^*. \tag{91}$$

Price level:

$$1 = \nu_1^A p_{1t}^{1-\mu} + \nu_2^A p_{2t}^{1-\mu} + \nu_3^A p_{3t}^{1-\mu}. \tag{92}$$

Stochastic processes:

$$\begin{aligned} \theta_t &= \rho_\theta \theta_{t-1} + v_t^\theta \quad (93) \\ \log\left(\frac{\psi_t^A}{\psi^A}\right) &= \rho_\psi \log\left(\frac{\psi_{t-1}^A}{\psi^A}\right) + v_t^A \quad (94) \end{aligned}$$

A.4 Equilibrium

Clearing of good markets:

$$\begin{aligned} y_t &= \nu_1 \left(\frac{p_{1t}}{p_t}\right)^{-\mu} \left[c_t + i_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1}\right] + \\ &+ \frac{n_2}{n_1} \nu_1^* \left(\frac{p_{1t}}{p_t^*}\right)^{-\mu} \left[c_t^* + i_t^* + \frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*} - 1\right)^2 k_{t-1}^*\right] + \\ &+ \frac{n_3}{n_1} \nu_1^A (p_{1t})^{-\mu} \left[c_t^A + i_t^A + \frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A} - 1\right)^2 k_{t-1}^A\right]. \quad (95) \end{aligned}$$

$$
\begin{aligned}
y_t^* &= \nu_2^* \left(\frac{p_{2t}}{p_t^*}\right)^{-\mu} \left[c_t^* + i_t^* + \frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*} - 1\right)^2 k_{t-1}^*\right] + \\
&+ \frac{n_1}{n_2}\nu_2 \left(\frac{p_{2t}}{p_t}\right)^{-\mu} \left[c_t + i_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1}\right] + \\
&+ \frac{n_3}{n_2}\nu_2^A \left(p_{2t}\right)^{-\mu} \left[c_t^A + i_t^A + \frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A} - 1\right)^2 k_{t-1}^A\right]. \qquad (96)
\end{aligned}
$$

Clearing of bond markets:

$$
n_1 b_{3t} + n_2 b_{3t}^* + n_3 b_{3t}^A = 0. \qquad (97)
$$

The market clearing condition of the AE good is redundant by Walras law. It reads as follows:

$$
\begin{aligned}
y_t^A &= \nu_3^A \left(p_{3t}\right)^{-\mu} \left[c_t^A + i_t^A + \frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A} - 1\right)^2 k_{t-1}^A\right] + \\
&+ \frac{n_1}{n_3}\nu_3 \left(\frac{p_{3t}}{p_t}\right)^{-\mu} \left[c_t + i_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1}\right] + \\
&+ \frac{n_2}{n_3}\nu_3^* \left(\frac{p_{3t}}{p_t^*}\right)^{-\mu} \left[c_t^* + i_t^* + \frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*} - 1\right)^2 k_{t-1}^*\right].
\end{aligned}
$$

A.5 Useful Definitions

The impulse response functions shown in the paper plot some variables whose precise definition is provided below. Gross domestic product:

$$
\begin{aligned}
gdp_t &= \frac{p_{1t}}{p_t} y_t \\
gdp_t^* &= \frac{p_{2t}}{p_t^*} y_t^* \\
gdp_t^A &= p_{3t} y_t^A.
\end{aligned}
$$

Imports:

$$
\begin{aligned}
m_t &= \frac{1}{p_t}\left[p_{2t}\nu_2\left(\frac{p_{2t}}{p_t}\right)^{-\mu} + p_{3t}\nu_3\left(\frac{p_{3t}}{p_t}\right)^{-\mu}\right]\left[c_t + i_t + \frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 k_{t-1}\right] \\
m_t^* &= \frac{1}{p_t^*}\left[p_{1t}\nu_1^*\left(\frac{p_{1t}}{p_t^*}\right)^{-\mu} + p_{3t}\nu_3^*\left(\frac{p_{3t}}{p_t^*}\right)^{-\mu}\right]\left[c_t^* + i_t^* + \frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*} - 1\right)^2 k_{t-1}^*\right] \\
m_t^A &= \left(p_{1t}^{1-\mu}\nu_1^A + p_{2t}^{1-\mu}\nu_2^A\right)\left[c_t^A + i_t^A + \frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A} - 1\right)^2 k_{t-1}^A\right].
\end{aligned}
$$

Exports:

$$
\begin{aligned}
x_t &= \frac{1}{p_t}\left\{\frac{n_2}{n_1}p_{1t}\nu_1^*\left(\frac{p_{1t}}{p_t^*}\right)^{-\mu}\left[c_t^*+i_t^*+\frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*}-1\right)^2 k_{t-1}^*\right]\right\} \\
&+\frac{1}{p_t}\left\{\frac{n_3}{n_1}p_{1t}^{1-\mu}\nu_1^A\left[c_t^A+i_t^A+\frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A}-1\right)^2 k_{t-1}^A\right]\right\} \\
x_t^* &= \frac{1}{p_t^*}\left\{\frac{n_1}{n_2}p_{2t}\nu_2\left(\frac{p_{2t}}{p_t}\right)^{-\mu}\left[c_t+i_t+\frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}}-1\right)^2 k_{t-1}\right]\right\} \\
&+\frac{1}{p_t^*}\left\{\frac{n_3}{n_2}p_{2t}^{1-\mu}\nu_2^A\left[c_t^A+i_t^A+\frac{\kappa_I}{2}\left(\frac{k_t^A}{k_{t-1}^A}-1\right)^2 k_{t-1}^A\right]\right\} \\
x_t^A &= \frac{n_1}{n_3}p_{3t}\nu_3\left(\frac{p_{3t}}{p_t}\right)^{-\mu}\left[c_t+i_t+\frac{\kappa_I}{2}\left(\frac{k_t}{k_{t-1}}-1\right)^2 k_{t-1}\right]+ \\
&+\frac{n_2}{n_3}\left(\frac{p_{3t}}{p_t^*}\right)^{-\mu}\nu_3^*\left[c_t^*+i_t^*+\frac{\kappa_I}{2}\left(\frac{k_t^*}{k_{t-1}^*}-1\right)^2 k_{t-1}^*\right].
\end{aligned}
$$

Trade balance:

$$
\begin{aligned}
tb_t &= x_t - m_t \\
tb_t &= x_t^* - m_t^* \\
tb_t^A &= x_t^A - m_t^A.
\end{aligned}
$$

Debt:

$$
\begin{aligned}
d_t &= -\frac{b_{3t}}{p_t} \\
d_t^* &= -\frac{b_{3t}}{p_t^*} \\
d_t^A &= -b_{3t}^A.
\end{aligned}
$$

Financial account:

$$
\begin{aligned}
fa_t &= d_t - d_{t-1} \\
fa_t^* &= d_t^* - d_{t-1}^* \\
fa_t^A &= d_t^A - d_{t-1}^A.
\end{aligned}
$$

B Steady State

The computation of the non-stochastic steady state follows three steps. First, I can easily derive from equations (59), (60), (69), (72), (73), (82), (84) and (85):

$$\begin{aligned} r &= \frac{1}{\beta} = r^* = r^A = r^{B1} = r^{B2} \\ u &= \frac{1}{\beta} + 1 - \delta = u^* = u^A, \end{aligned}$$

where variable without a time subscript denote their steady-state level. By (58) and (71) it results:

$$\tau = \tau^* = 0.$$

The three laws of motion of capital imply:

$$\begin{aligned} i &= \delta k \\ i^* &= \delta k^* \\ i^A &= \delta k^A. \end{aligned}$$

By using these findings I can solve numerically a system of 21 equations in 21 variables. The equations are the following:

- Three capital demand equations: (64), (77), and (89).
- Three labor market equations: eliminate the wage in each country and equalize (62) and (64), (75) and (77), (87) and (89).
- Three production functions: (65), (78) and (90).
- Three resource constraints: (66), (79) and (91).
- Three CPI equations: (67), (80) and (92).
- Three market clearing conditions (two for EMEs goods and one for bonds): (95), (96), (97).
- Two equations come from the two capital controls rules which imply:

$$\begin{aligned} \frac{b}{p_1 y} &= \overline{b} \\ \frac{b^*}{p_2 y^*} &= \overline{b}^*. \end{aligned}$$

- One equation comes from the following restriction:

$$\frac{p_3 y^A}{p_1 y} = gdp^{Ratio},$$

where gdp^{Ratio} is a parameter governing the ratio between AE and EME1 GDP in steady state. The 21 variables of this systems are the following:

$$\left\{c, c^*, c^A, h, h^*, h^A, p, p^*, k, k^*, k^A, y, y^*, y^A, p_1, p_2, p_3, b, b^*, b^A, Z^A\right\}.$$

Once the system is solved, one can easily derive the value of the other variables by using the remaining equations. In particular, after finding λ, one can recover ψ^A by imposing $n_1\lambda = n_3\lambda^A \cdot p$:

$$\psi^A = \frac{n_1}{n_3 p}\lambda\left(c_t^A - \frac{h_t^{A1+\varphi}}{1+\varphi}\right).$$

C Data

The data used to calibrate some parameters come from the International Investment Position Database by the IMF. The sample includes all countries that have reported data on the net financial asset position in 2016. There are 34 advanced economies and 40 emerging economies, listed below.

Advanced Economies: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

Emerging Economies: Albania, Armenia Bangladesh, Belarus, Bhutan, Brazil, Cape Verde, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Macedonia, Guatemala, Hungary, India, Indonesia, Jamaica, Latvia, Lesotho, Mexico, Moldova, Morocco, Nicaragua, Pakistan, Panama, Philippines, Poland, Romania, Russia, São Tomé and Principe, Saudi Arabia, South Africa, Suriname, Tajikistan, Thailand, Timor-Leste, Turkey.

The following table summarizes the statistics used in the calibration.

Variable	AE	EME
Population (bil.)	1.0	4.4
GDP PPP (Int. $ bil.)	48922	54740
GDP PPP per capita (Int. $ bil.)	47487	12467
NFA/GDP (%)	−2.9	−3.2

Table 7: Summary statistics (2016). NFA is the sum across countries of the net financial asset position (difference between external assets and external liabilities) of each country in the sample. Source: IIP Database, IMF.

D Additional Figures

D.1 Large EME1

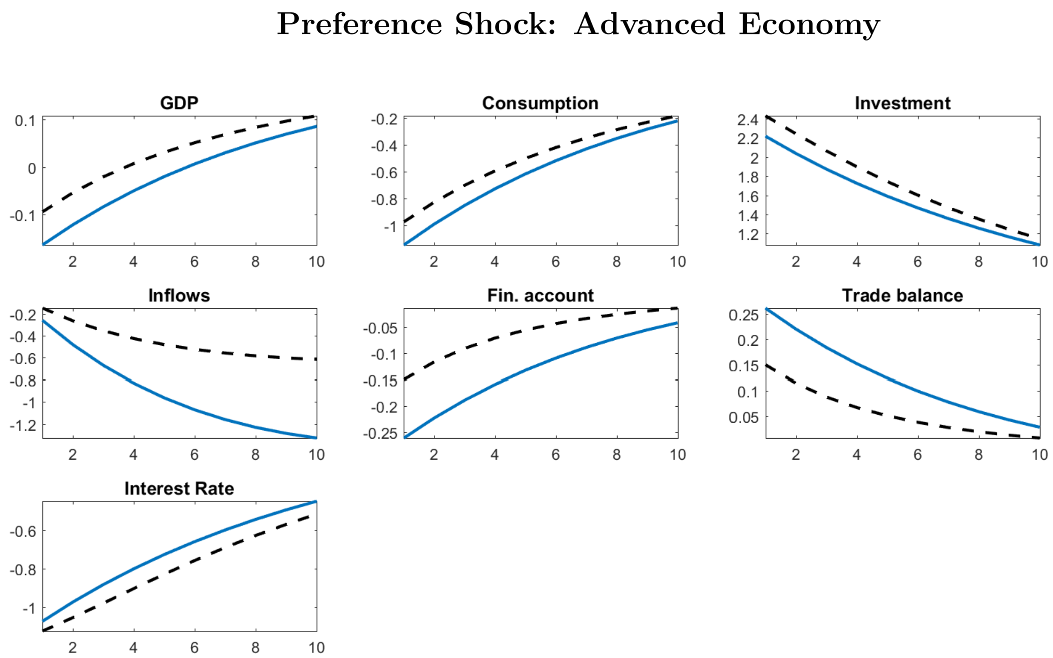

Figure A.1: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Preference Shock: Emerging Economy 1

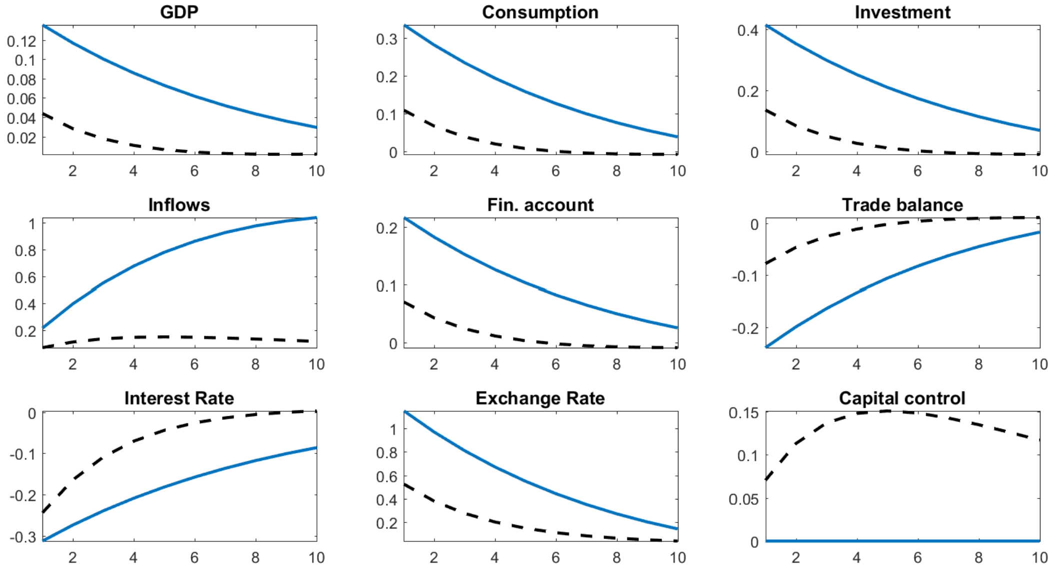

Figure A.2: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Preference Shock: Emerging Economy 2

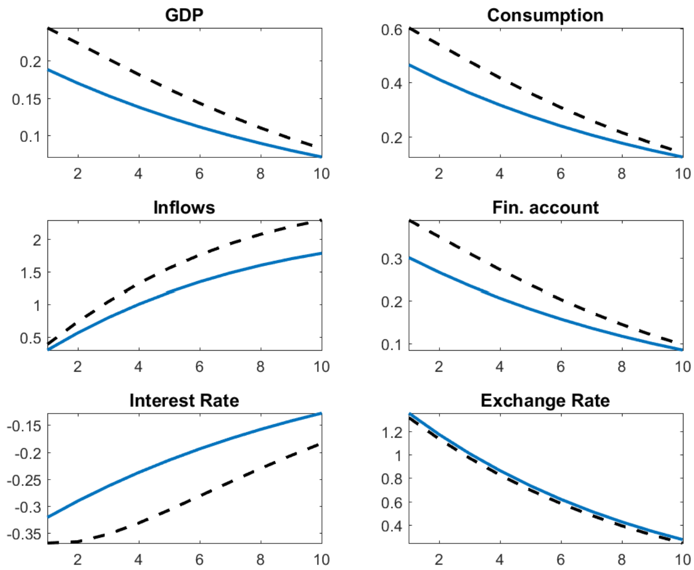

Figure A.3: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period correspond to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Advanced Economy

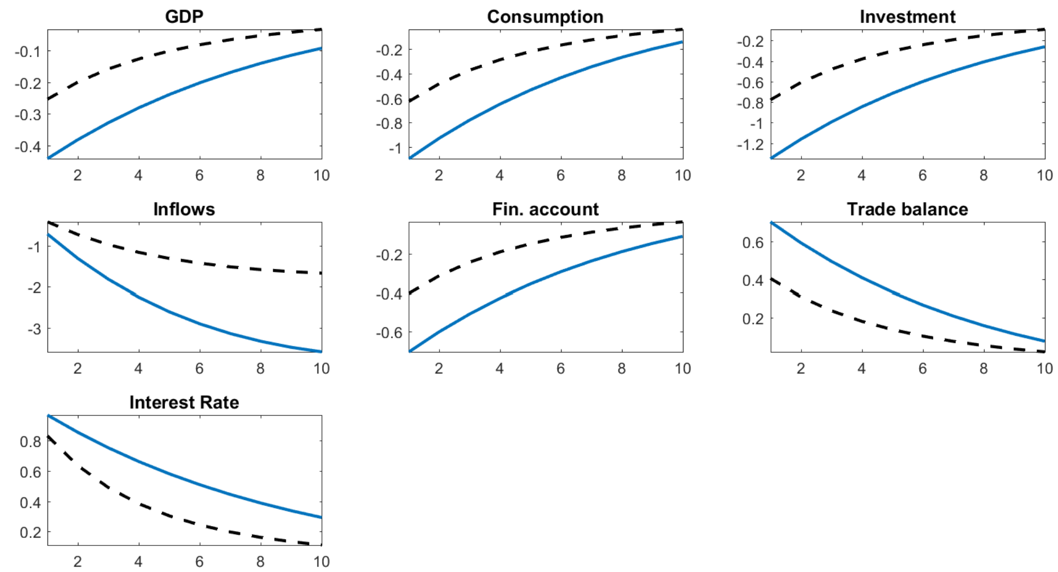

Figure A.4: Impulse response functions to a risk premium shock ($v_t^{\theta} = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Emerging Economy 1

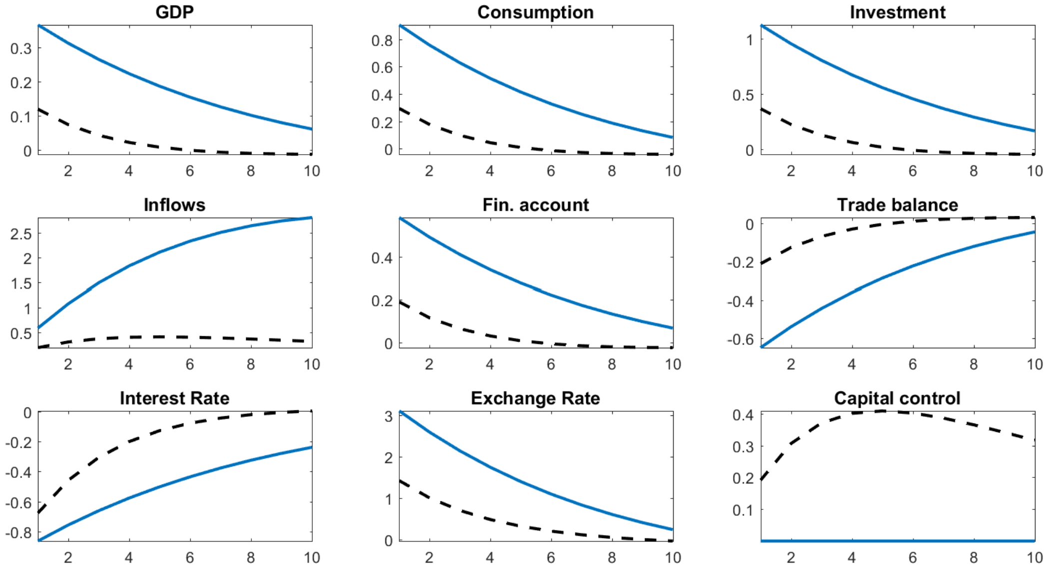

Figure A.5: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Emerging Economy 2

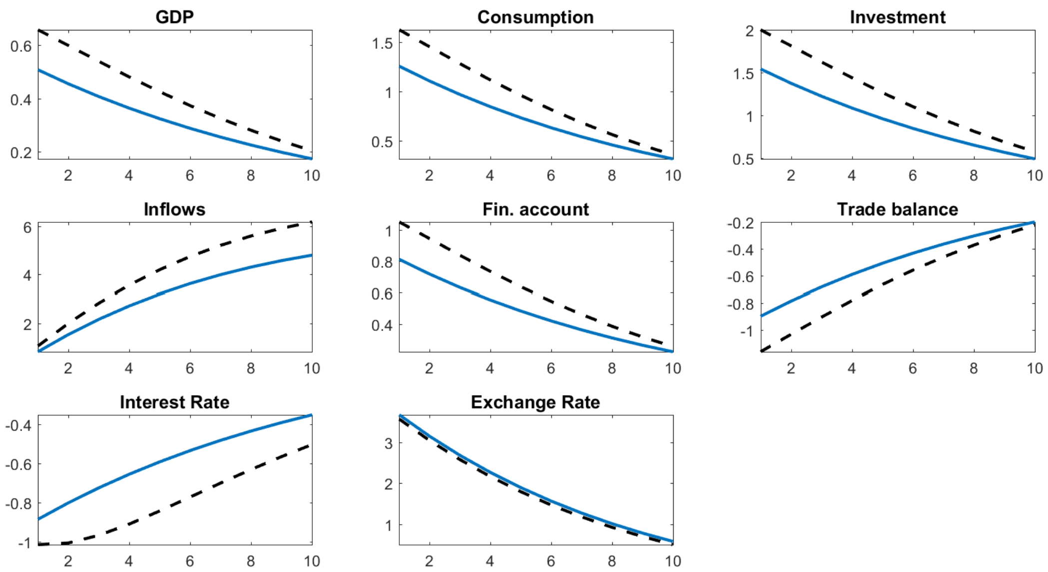

Figure A.6: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

D.2 Large Openness

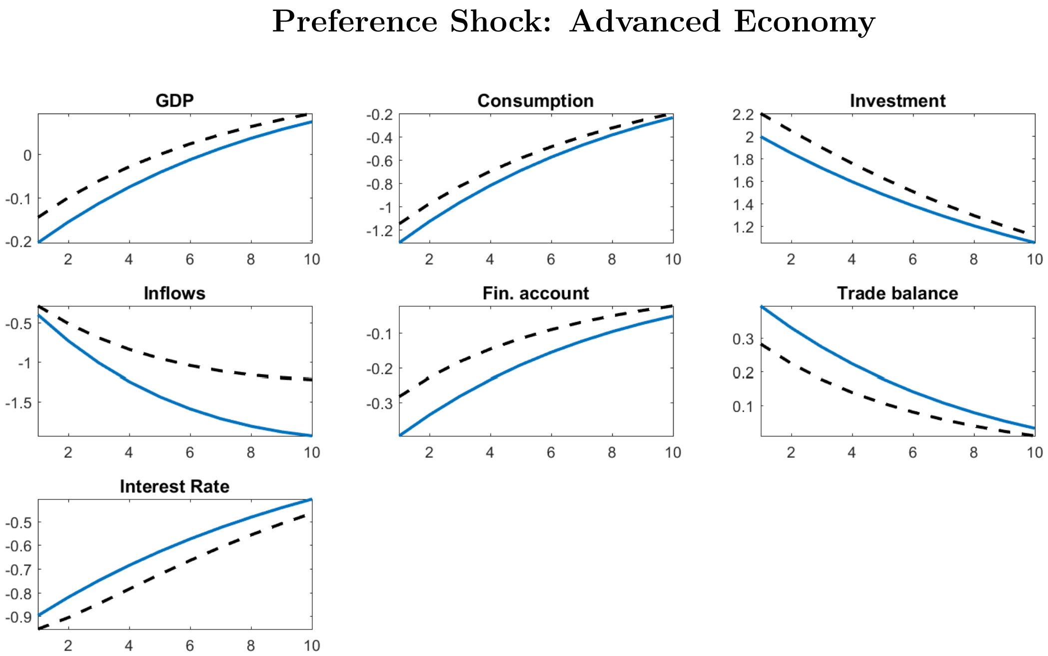

Figure A.7: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

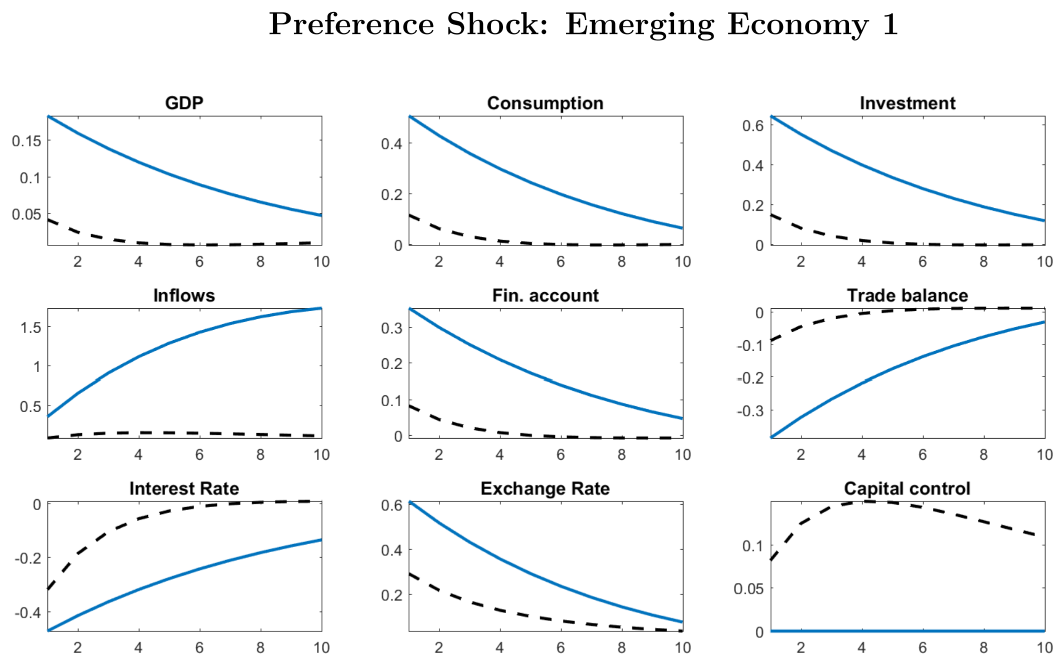

Figure A.8: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

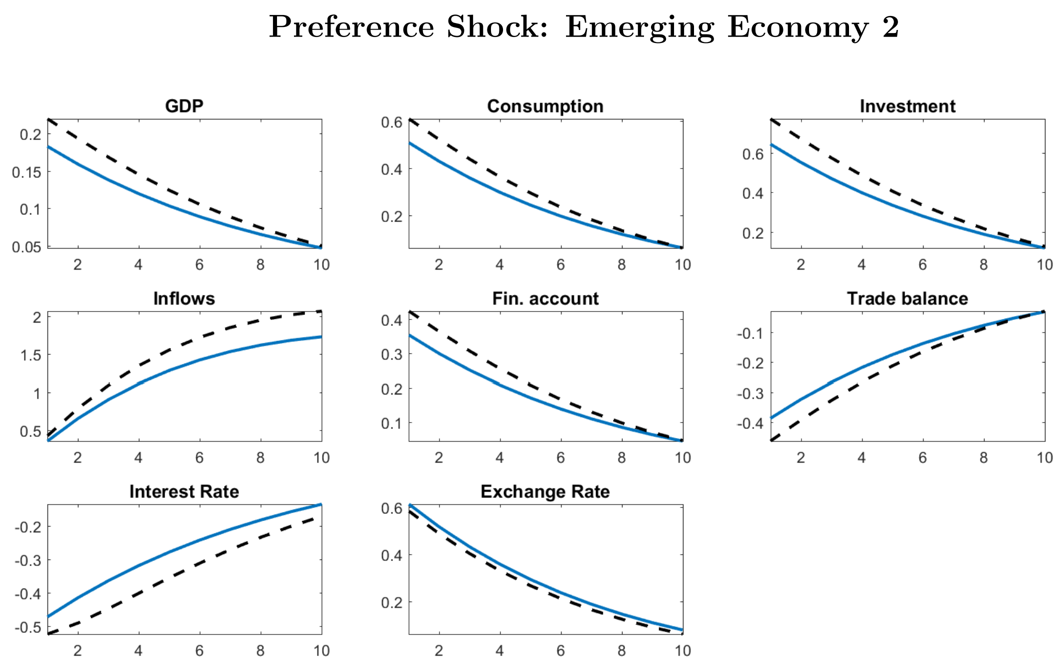

Figure A.9: Impulse response functions to an AE preference shock ($v_t^{\psi} = -0.05$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period correspond to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

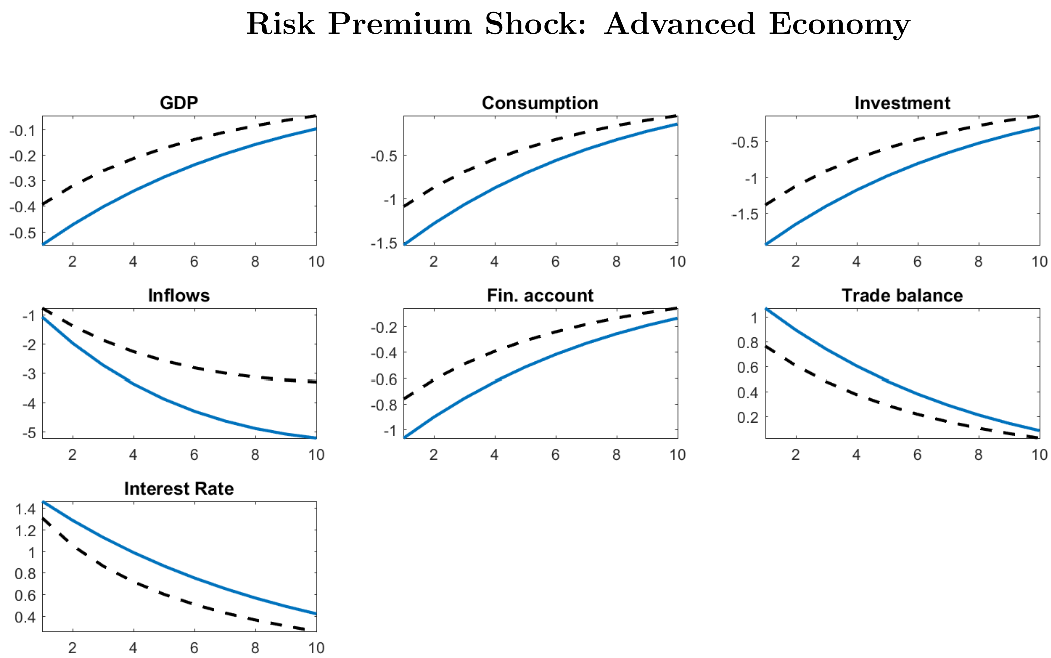

Figure A.10: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

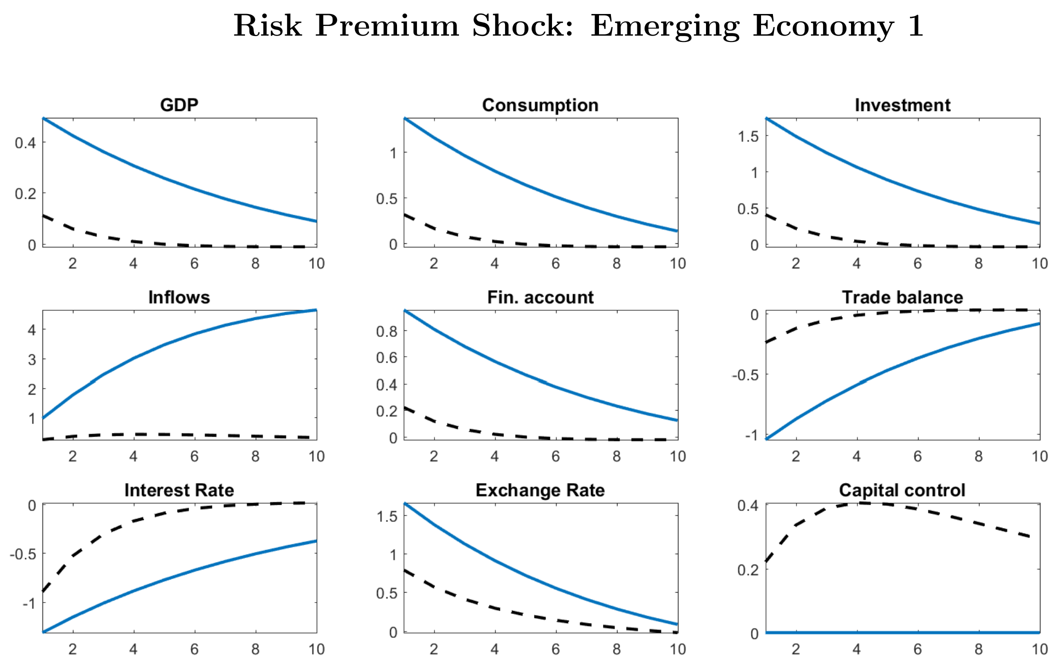

Figure A.11: Impulse response functions to a risk premium shock ($v_t^\theta = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

Risk Premium Shock: Emerging Economy 2

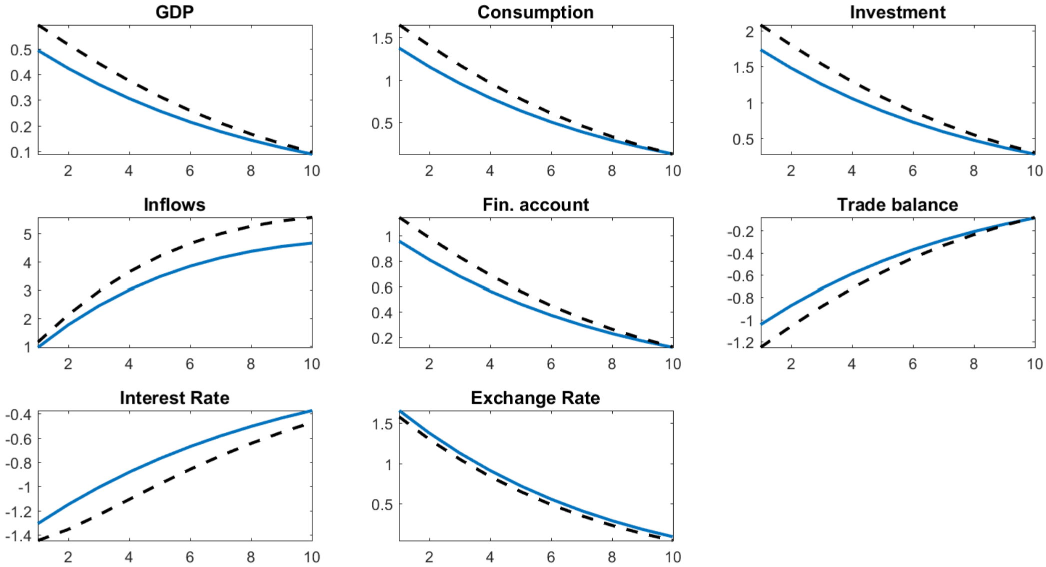

Figure A.12: Impulse response functions to a risk premium shock ($v_t^{\theta} = -0.01$). In the blue solid line $\phi = 0 = \phi^*$, in the black dotted line $\phi = 1$ and $\phi^* = 0$. Responses are in log-deviations from the steady state. One period corresponds to a quarter. Interest rate response is annualized. Interest rate, debt/GDP and financial account/GDP are expressed in level deviations from the steady state.

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