Institutional investors and emerging markets with intermediate exchange rate regimes: A stock-flow consistent model

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15 November 2015

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November 17, 2015

Abstract

This paper develops a two-country stock-flow consistent model to analyse the relationship between advanced and emerging countries. The relationship between the two countries is asymmetric: advanced countries are characterised by an institutional investors' sector which invests in both domestic and emerging markets assets, whereas emerging markets own advanced countries assets as a result of foreign exchange reserves accumulation by their central bank. The paper aims to show how the portfolio choice of institutional investors, which have return requirements to meet, is the key driver of financial stability in emerging markets, particularly by determining the dynamics of the exchange rates of emerging markets economies. Their role, compared to a standard open-economy model may be stabilising or de-stabilising, depending on the nature of the shock that induces changes in portfolio choices. The paper also shows how "intermediate" exchange rate regimes, as commonly found nowadays in the practice of emerging markets central banks, may be succesful at containing such instabilities.

Keywords: Institutional Investors, Emerging Markets, Stock-Flow Consistent Models, Exchange Rates

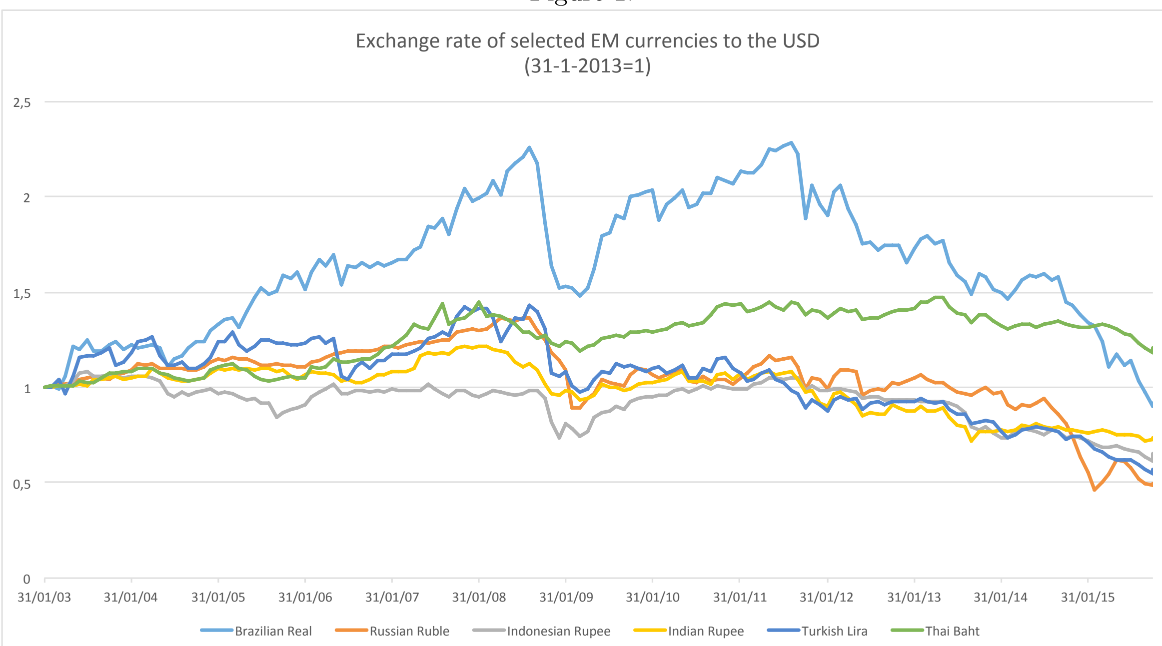
JEL Codes: E12, F30, G11, G23

Introduction and background

Emerging markets (EMs) integration into the global financial system has often faced difficulties. The currency and financial crises in East Asia in the late 90's represent a well-known example in which a situation leading foreign investors to quickly sell their assets resulted in a large systemic crisis, with collapses in asset prices and exchange rates. All these crises were usually preceded by a boom in capital flows to these countries, triggered by some domestic or global event, which abruptly came to an end.

Exchange rates typically follow such cycles, appreciating with capital inflows and depreciating with capital outflows. As 1 clearly shows, many EM currencies appreciated to the US dollar, in the years before the crisis, then collapsed in 2008, when the global "flight to safety" put pressure on all the world's currencies. The subsequent wave of capital inflows to EMs since the 2008 crisis, led to appreciation in 2009-2012 period. However since then, exchange rates in major EMs have started to decline. In 2013, when speculation about the FED "tapering" Quantitative Easing (QE) policies sparked uncertainty about the future of capital flows to EMs, which had been conspicuous since the recovery from the 2008 crisis, and led to a sell-off of EM assets. Continuing rumours about rising interest rates in advanced countries, coupled with the slowdown and financial troubles in China during the summer of 2015, maintain the pressure high on emerging markets, though a drastic sell-off of EM assets as a whole has not (yet?) occurred.

Figure 1:



Source: Bloomberg

Understanding how different factors can contribute to these phenomena is crucial for an understanding of financial (in)stability of EMs. Dynamic-stochasitc general equilibrium (DSGE) have been developed to tackle such issues. These models, collectively fitting in the category "international macro-finance", feature substantial innovations compared to the standard DSGE models, such as multiple assets in open-economy models, incomplete financial markets and informational asymmetries[1]. These

[1]The inclusion of such features required the development of new techniques (Tille and van Wincoop, 2010; Devereux and Sutherland, 2011). See Pavlova and Rigobon (2010) for a survey of the literature

models are able to capture some of the features of international financial conditions EMs, such as the simultaneous expansion of two-ways gross capital flows, which earlier models were not able to capture given their focus on current accounts. Devereux and Sutherland (2009) in particular find that EMs with a long-position in foreign bonds and a negative position in domestic portfolio equities and direct investments from abroad achieve a good degree of international risk-sharing.

DSGE models of this kind however typically have a Real Business Cycle core and therefore largely assume away monetary and financial considerations, with the resulting implications on the money supply and the exchange rate [2]. There is also no explicitly modeled financial sector, as the portfolio choice is made by households seeking to insure their consumption, nor a central bank, which leaves interest rates to be determined by what is effectively a loanable funds mechanism. This is very much at odds with recent developments in the literature on financial intermediaries as actors, and risk-aversion and monetary policy as drivers of capital flows to EMs and global financial stability in general (Bruno and Shin, 2013; Rey, 2013; Shin, 2013). As Kaltenbrunner and Painceira (2015) claim, financial flows volatility is the crucial driver of vulnerabilities in EMs, especially for what concerns exchange rate volatility. Moreover, the explosion of cross-border asset holdings in the world (figure 2), including in EMs, over the past twenty years or so, renders any analysis of international financial phenomena based on 'real' rather than a 'monetary' factors at best incomplete[3].

For these reasons, this paper develops an open-economy two-country stock-flow consistent (SFC) model. These models, unlike real-business cycle models, are monetary from the start and explicitly include a financial sector, evaluating its role within a macroeconomic system. Furthermore in line with the general principles of SFC modeling, these ensure that the accounting of the models is complete and consistent, so that every asset and liability holdings and flows are accounted for.

The standard reference for SFC models with open capital accounts is paper 12 in Godley and Lavoie (2012), while several additional models have been developed to analyse different open-economy issues[4]. While this model draws substantially on the basic formulation, it presents several elements of novelty. Firstly, the relationship between the two countries is explicitly modeled as asymmetrical: aside from choosing different starting values for stocks and flows[5], only the advanced country invests in EM financial assets, whereas the EM foreign investments are confined to the central bank's holdings of foreign exchange reserves (FXR). Indeed, as shown in figure 2 and figure **??**, EM financial integration is mostly driven by the liability side, with EM being first recipients of foreign investments, while their

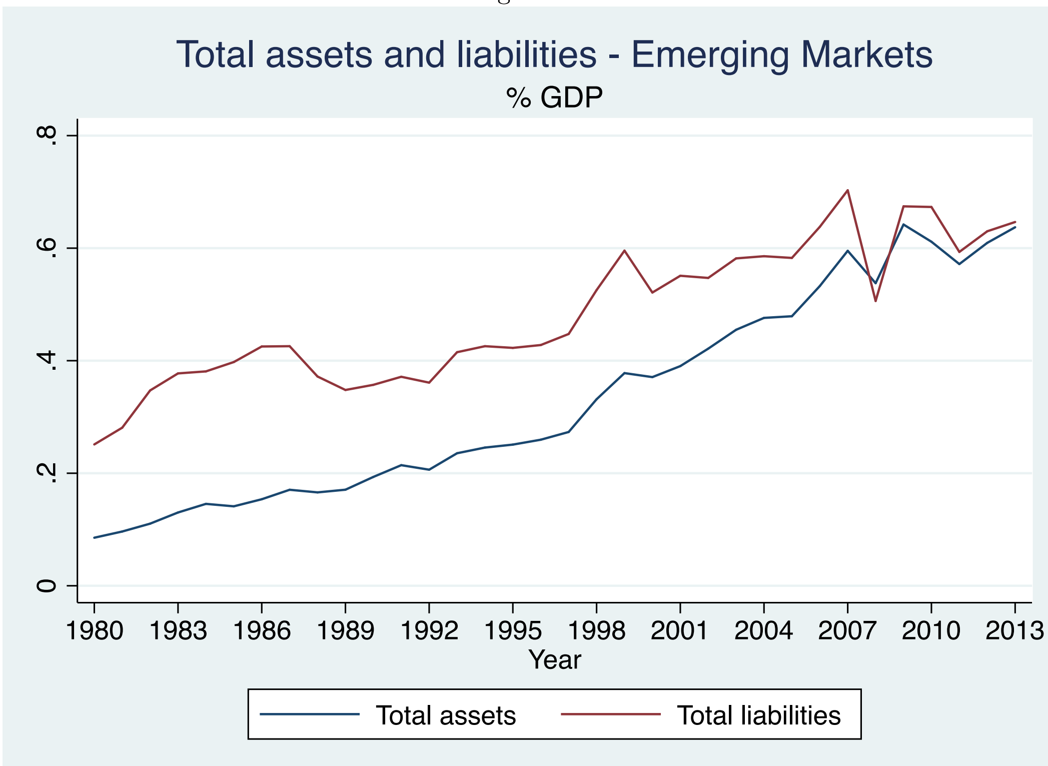
[2] Devereux and Sutherland (2009) for example assume that the money supply of the home country grows at a constant rate and determines the price level through a quantity theory of money relationship, with a stochastic velocity term. There is no independent nominal exchange rate determination, as this price level also represents the ratio of the home country price to the foreign country price.

[3] See for example Borio and Disyatat (2011)

[4] See for exampleLavoie and Zhao (2010); Lavoie and Daigle (2011); Mazier and Tiou-Tagba Aliti (2012); Bortz (2014). See Caverzasi and Godin (2015) for a more comprehensive survey of the SFC models literature, including open economy models.

[5] E.g. National income in the EM at the beginning of the simulation period is half the size of the advanced country.

Figure 2:



Source: Author's calculations based on IMF Balance of Payments data and Lane and Milesi-Ferretti (2007)

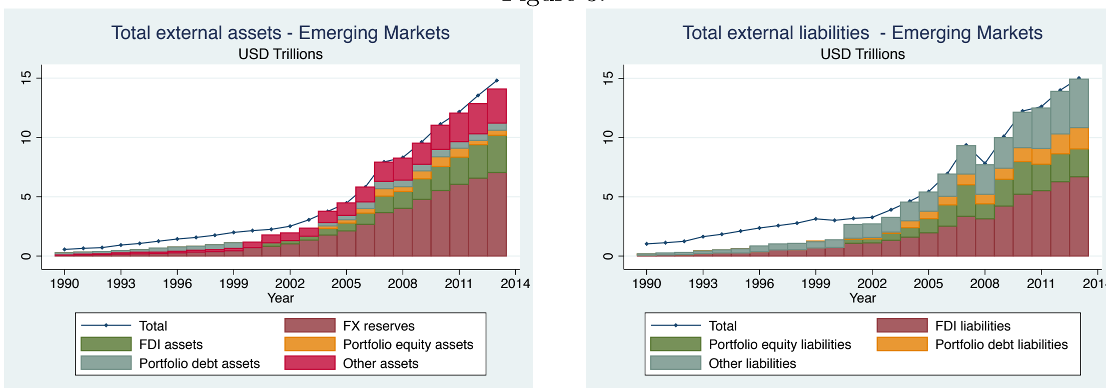
foreign holdings always lag behind, and are mostly held as FXR.

Secondly, the advanced country features an institutional investors sector. To the best knowledge of the author this is the first time this is included in a SFC model. As it will be shown the sector works as a financial intermediary for the household sector, promising a fixed return on the claims households hold on them, and investing in financial assets to face those obligations. Their financial behaviour is characterised, amongst standard portfolio choice considerations, by the search for returns as high as to ensure their assets are enough to fulfill their long-term obligations. In other words, institutional investors seek to achieve and maintain a fully-funded status. Their portfolio choice is therefore a crucial variable determining the international financial dynamics of the model.

This kind of investors have become really important in driving the cross-border capital flows to EM. As shown in figure 4, holdings have grown substantially[6] over the past decade, and in particular

[6]These allocations are based on the EPFR database, which only captures a part of the total holdings to EM by

Figure 3:



Source: Author's calculations based on IMF Balance of Payments data and Lane and Milesi-Ferretti (2007)

to EM equities before the crisis and to EM bonds in the post-crisis environment. It is a known stylised fact that most pension funds from advanced countries are currently underfunded (figure 5), which may induce them to search for returns in riskier assets, such as EM assets. This behaviour is therefore crucial to determine the dynamics of international financial investment, which are the central focus of this model.

Finally, EMs' central banks invest in FXR, but in a way that does not result in either completely pegged nor flexible, exchange rate regime, but rather a managed float. This is similar to what is done in Mazier and Tiou-Tagba Aliti (2012), and is very much in line with the empirical reality of EMs, which in most cases have a managed/dirty floating exchange rate regime with the accumulation of vast FXR as a buffer of safety [7].

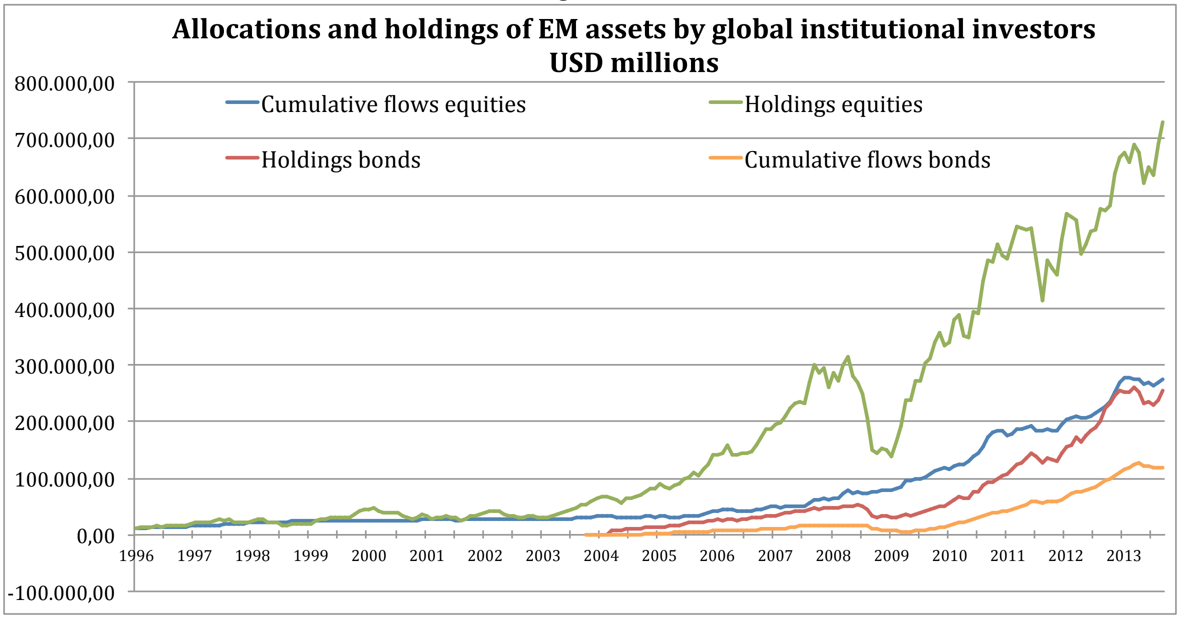
It will be shown that the combination of these elements can result in large swings in exchange rates and capital flows. As institutional investors responds to shocks that have an effect on both their financial assets and liabilities, their allocation EMs assets vis-à-vis advanced countries change which, considering their relative sizes, can result in notable changes in exchange rates. The macroeconomic implications on income and current accounts are also stressed. Moreover the simulation will highlight the stabilising impact of CB's in a floating exchange rate regime.

The paper is divided into 5 sections. Section 1 describes the accounting matrices, and some of the general features of the model. Section 2 goes through the equations of the model. Section 3 discusses the issue of paramters and variable value choices. Section 5 presents the simulations for two scenarios.

institutional investors. Actual holdings are therefore likely to be higher.

[7] See for example Calvo and Reinhart (2002); Aizenman *et al.* (2010)

Figure 4:



Source: Author's calculations based on EPFR

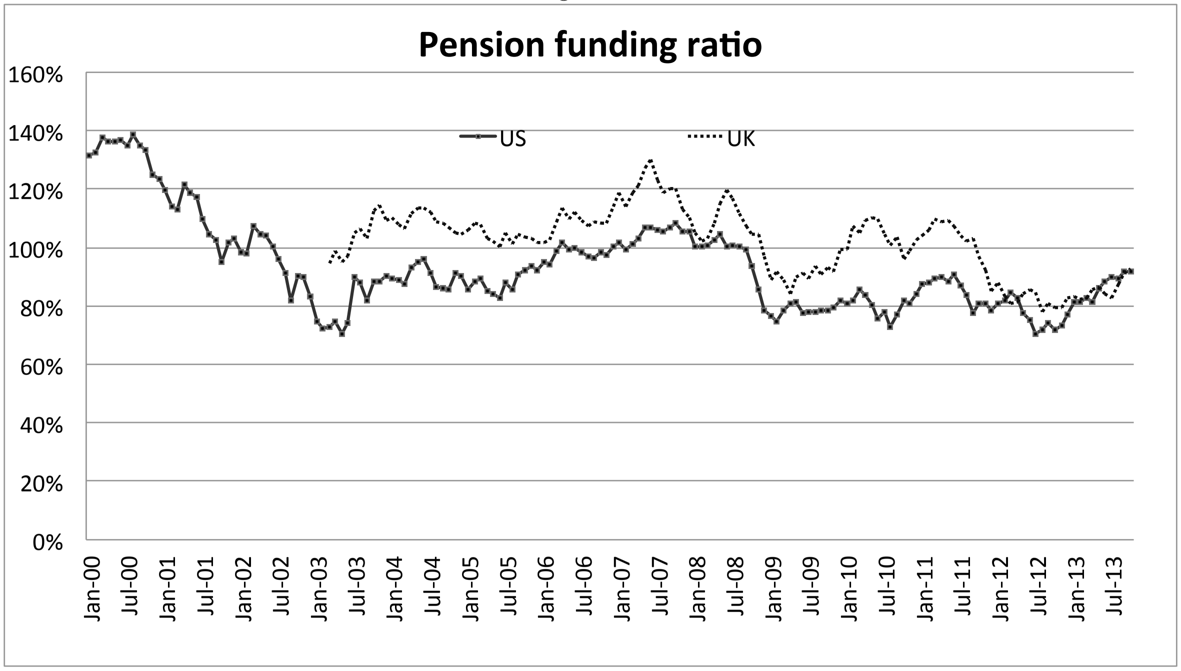
Section 6 concludes.

1 Accounting structure and general model features

table 1 describe the balance sheet of the two countries. As discussed, there are five sectors in the advanced (ADV) country and four in the EM country. The additional sector in the ADV country is the institutional investor (Inst). Households in both countries only hold domestic bills and high powered money, issued respectively by their domestic governments and central banks. Central banks hold domestic bills, and FXR in the EM country as discussed. The production sector is highly simplified, as in the paper 12 model of Godley and Lavoie (2012): it does not represent an explicit firm sector and therefore it does not hold fixed capital goods.

The institutional investor sector allocates its assets between domestic B_{adv_inst}, foreign B_{em_inst} bills and cash - the residual asset - , and they also have the opportunitty to invest in an additional advanced country bills B_{adv2_inst}, which offers a higher interest rate than the regular bills. These bills effectively take the role of of "risky" domestic assets held by institutional investors, the implications of which will be discussed in the next section. Institutional investors' liabilities are in the form of accounts Acc held by households. These accounts yield benefit payments from the institutional investors sector to households.

Figure 5:



Source: Milliman and Pension Protection Fund

Table 1: Balance sheet

	ADV						EM			
	HH	Prod	Gov	CB	Inst	xr	HH	Prod	Gov	CB
Bills Adv	B_{adv_advh}		$-B_{adv}$	B_{adv_advcb}	B_{adv_inst}	xr	B_{em_emh}			$B_{adv\_emcb} \cdot (1/xr)$
Bills Adv2	B_{adv2_advh}			B_{adv2_advcb}	B_{adv2_inst}	xr				
Bills EM					$B_{em\_inst} \cdot xr$	xr			$-B_{em\_emcb}$	B_{em_emcb}
Account Inst	Acc				$-Acc$	xr				
Money	H_{adv_advh}			$-H_{adv}$	H_{adv_inst}	xr	H_{em_emh}			$-H_{em}$
Net worth	$-V_{advh}$		$-NW_{advg}$	0	$-NW_{inst}$	xr	$-V_{emh}$		$-NW_{emg}$	$-NW_{emcb}$

Table 2: Transaction Flows

	ADV					EM			
	HH	Prod	Gov	CB	Inst	HH	Prod	Gov	CB
Cons	$-C_{adv}$	$+C_{adv}$				$-C_{em}$	$+C_{em}$		
Gov exp		$+G_{adv}$	$-G_{adv}$				$+G_{em}$	$-G_{em}$	
Trade		$-IM_{adv}$					$-IM_{em}$		
		$+X_{adv}$					$+X_{em}$		
GDP	$+Y_{adv}$	$-Y_{adv}$				$+Y_{em}$	$-Y_{em}$		
Tax	$-T_{adv}$		$+T_{adv}$			$-T_{em}$		$+T_{em}$	
Cont	$-Cont$				$+Cont$				
Ben	$+Ben$				$-Ben$				
Interest payments	$+r_{adv} \cdot B_{adv\_advh,-1}$		$-r_{adv} \cdot B_{adv,-1}$	$+r_{adv} \cdot B_{adv\_advcb,-1}$	$+ r_{adv} \cdot B_{adv\_inst,-1}$ $+ r_{em} \cdot B_{em\_inst,-1} \cdot xr$	$+r_{em} \cdot B_{em\_emh,-1}$		$-r_{em} \cdot B_{em,-1}$	$+ r_{adv} \cdot B_{adv\_emcb,-1} \cdot 1/xr$ $+ r_{em} \cdot B_{em\_emcb,-1}$
CB prof			$+F_{advcb}$	$-F_{advcb}$				$+F_{emcb}$	$-F_{emcb}$
ΔMoney	$-\triangle H_{adv\_advh}$			$+\triangle H_{adv}$	$-\triangle H_{adv\_inst}$	$-\triangle H_{emh}$			$+\triangle H_{emh}$
ΔBills Adv	$-\triangle B_{adv\_advh}$		$+\triangle B_{adv}$	$-\triangle B_{adv\_advcb}$	$-\triangle B_{adv\_inst}$	$-\triangle B_{em\_emh}$			$-\triangle B_{adv\_emcb} \cdot 1/xr$
ΔBills Em					$-\triangle B_{em\_inst} \cdot xr$			$+\triangle B_{em}$	$-\triangle B_{em\_emcb}$
ΔBills2 Adv			$+\triangle B_{adv2}$	$-\triangle B_{adv2\_advcb}$	$-\triangle B_{adv2\_inst}$				
(ΔAcc)	$[-\triangle Acc]$				$[+\triangle Acc]$				
Total	0	0	0	0	0	0	0	0	0

table 2 shows the flows between sectors occurring in one period. Given the simplified production structure households receive the whole national production as income, i.e. the sum of consumption, government expenditure plus the trade balance ($Y = C + G + X - IM$). There is no investment, as there is no fixed capital in the model, which implies that the model is a stationary state rather than growth model. Households also receive interest payments on the bills they hold. In addition to that, households receive benefits Ben from the institutional investor sector and pay contributions $Cont$ to it. The sum of these terms plus national income minus taxes represent households' disposable income, which it is used to finance consumption. The rest is saved and allocated across assets: domestic bills ($-\triangle B_{adv\_advh}$) and cash ($-\triangle H_{adv\_advh}$). Every year they also acquire (or lose) value in their accounts held with institutional investors ($-\triangle Acc$). This acquisition, as it will be shown, is connected to contributions made, and to avoiud double counting the term is therefore added between brackets, meaning that it is not included in the column sum adding up to 0, but it is just a remind of the accounting change associated with it.

The governments of both countries behave in a standard way for SFC models. The receive tax revenue from households and central bank profits', and they use it to finance government expenditure and service their existing debt. They issue new bills to finance any deficits arising. Similarly central banks receive interest payments on the bills they hold, which they give to governments, issue cash and purchase government bills. The EM central bank, as discussed, purchase both ADV bills as FXR and EM bills. The only source of capital gains/losses are exchange rate swings. An appreciation of the EM currency vis-à-vis the ADV currency (i.e. an increase in xr), results in capital gains for ADV institutional investors on the bills they hold, and a capital loss on the EM central bank's FXR. For this reason a full revaluation matrix would be redundant. Institutional investors receive contributions from households, and interest payments on their domestic and foreign bills. They then purchase/sell across those assets. Once again, their liabilities from accounting standpoint increase by an amount that is exactly equal to the net acquisition of accounts by households.

The very simple structure of the real side of the economy of this model means that effectively many issues typical of Post-Keynesian models, which SFC models are broadly part of, are missing. For example, assuming away a well specified firm sector mens that the issue of income distribution between capitalists and workers, and the associated issues of inflation and productivity are effectively assumed away. And similarly, the absence of firms and banks means that credit and "inside-money" issues are also absent. This clearly dimities the realisticness of the set-up. However, as shown in Godley and Lavoie (2012), with open-economy models the number of equations starts to grow very quickly, greatly increasing their complexity at the expense of clarity. Furthermore, there are examples in which making similar assumptions about fixed prices and comparing the results after relaxing such assumptions did not result in substantial changes (Mazier and Tiou-Tagba Aliti, 2012). Insofar as the model has a theoretical-logical purpose and is not used for policy analysis, it is therefore preferable to make a few simplifying assumptions to gain on clarity and tractability.

2 Sectoral equations

2.1 Households

$$Cons_{adv} = \alpha_{0adv} + \alpha_{1adv} \cdot Yd^{exp}_{adv} + \alpha_{2adv} \cdot V_{adv,-1} \tag{1}$$

$$Cons_{em} = \alpha_{0em} + \alpha_{1em} \cdot Yd^{exp}_{em} + \alpha_{2em} \cdot V_{em,-1} \tag{2}$$

$$Yd_{adv} = Y_{adv} + Ben - Cont - T_{adv} + r_{adv} \cdot B_{adv\_advh,-1} \tag{3}$$

$$Yd_{em} = Y_{em} - T_{em} + r_{em} \cdot B_{em\_emh,-1} \tag{4}$$

$$Cont = \beta \cdot Y_{adv} \tag{5}$$

$$\triangle V_{adv} = Yd_{adv} - Cons_{adv} \tag{6}$$

$$\triangle V_{em} = Yd_{em} - Cons_{em} \tag{7}$$

$$B^d_{adv\_advh} = \mu_{adv} \cdot V_{adv} \tag{8}$$

$$H^d_{adv\_advh} = V_{adv} - B_{adv\_advh} \tag{9}$$

$$B^d_{em\_emh} = \mu_{em} \cdot V_{em} \tag{10}$$

$$H^d_{em} = V_{em} - B_{em\_emh} \tag{11}$$

As discussed households consume, and allocate their non consumed income to different assets. Households' consumption depends on expected disposable income (Yd^{exp}) and lagged wealth (V_{-1}), as shown in equation (1) and (2). Disposable income is total national income, minus taxes, plus interest payments, and in the case of advanced countries, contributions minus benefits from institutional investors (equation (3) and (7)).

Households' wealth only changes as a result of net saving, since households in both countries do not hold any variable price assets, and therefore experience no capital gain/losses (equation (6) and

(7)). They allocate wealth in fixed proportion to bills and cash (equations (12)-(15))[8].

Contributions in ADV are determined by the dynamics of the economy. equation (5) states that contributions are equal to a proportion β of current national income. It is easy to conceive such a relation in terms of a funded pension system: the proportion β is the contribution rate out of income that current workers have to pay in to their pension fund in order to accrue benefits. Much like taxes, this is an automatic deduction to current income. For this reason it is best to treat this as a cash-flow concept that is imposed onto households rather than part of their portfolio choice.

2.2 International trade and production

$$log(X_{adv}) = \epsilon_{oadv} + \epsilon_{1adv} \cdot log(xr) + \epsilon_{2adv} \cdot log(Y_{em}) \tag{12}$$

$$log(X_{em}) = \epsilon_{oem} + \epsilon_{1em} \cdot log(1/xr) + \epsilon_{2em} \cdot log(Y_{em}) \tag{13}$$

$$IM_{adv} = X_{em} \cdot xr \tag{14}$$

$$IM_{em} = X_{adv} \cdot 1/xr \tag{15}$$

$$Y_{adv} = Cons_{adv} + G_{adv} + X_{adv} - IM_{adv} \tag{16}$$

$$Y_{em} = Cons_{em} + G_{em} + X_{em} - IM_{em} \tag{17}$$

In line with most SFC models, exports are determined by prices and income in logarithmic terms, so that parameters represent elasticities (equation (12) and (13)). However in this model, as the production process is simplified so that it does not feature flexible prices, the only relevant price is the nominal exchange rate[9]. As it is a two-country model, imports of a country are exactly equal to the exports of the other countries, as represented by the imports equations (14) and (15), which ensure the consistency of the accounting.

By construction the balance of payments of each country is as follows:

$$CA_{adv} = X_{adv} - IM_{adv} + r_{em} \cdot B_{em\_inst,-1} \cdot xr - r_{adv} \cdot B_{adv\_emcb,-1} \tag{18}$$

$$KA_{adv} = \triangle B_{adv\_emcb} - \triangle B_{em\_inst} \cdot xr \tag{19}$$

[8]Superscript s and d indicate demanded, and supplied.

[9]The same is done in Mazier and Tiou-Tagba Aliti (2012, p. 364)

$$CA_{em} = X_{em} - IM_{em} + r_{adv} \cdot B_{adv\_emcb,-1} \cdot \frac{1}{xr} - r_{em} \cdot B_{em\_inst,-1} \tag{20}$$

$$KA_{em} = \triangle B_{em\_inst} - \triangle B_{adv\_emcb} \cdot \frac{1}{xr} \tag{21}$$

$$CA_{adv} = KA_{adv} \qquad CA_{em} = KA_{em}$$

The current account is the sum of the trade balance plus the net balance of interest payments on foreign assets and liabilities, while the capital account is the difference between the net purchase of assets minus the net incurrence of liabilities. Foreign holdings are only in the form of EM bills held by institutional investors, and FXR held by EM central banks.

2.3 Government and central bank

$$\triangle B^s_{adv} = G_{adv} + r_{adv} \cdot B^s_{adv,-1} + r_{adv2} \cdot B^s_{adv2} - T_{adv} - F_{advcb} \tag{22}$$

$$\triangle B^s_{em} = G_{em} + r_{em} \cdot B^s_{em,-1} - T_{em} - F_{emcb} \tag{23}$$

$$G_{adv} = \overline{G}_{adv} \tag{24}$$

$$G_{em} = \overline{G}_{em} \tag{25}$$

$$T_{adv} = \theta_{adv} \cdot Y_{adv} \tag{26}$$

$$T_{em} = \theta_{em} \cdot Y_{em} \tag{27}$$

$$F_{advcb} = r_{adv} \cdot B^s_{adv\_advcb} \tag{28}$$

$$F_{emcb} = r_{em} \cdot B^s_{em\_emcb} + r_{adv} \cdot B^s_{adv\_advcb} \cdot 1/xr \tag{29}$$

$$B^d_{adv\_advcb} = H^s_{adv} - B^d_{adv2\_advcb} \tag{30}$$

$$B^d_{adv2\_advcb} = B^s_{adv2} - B^s_{adv2\_inst} \tag{31}$$

$$\triangle B^d_{em\_emcb} = \triangle H^s_{em} - \triangle B^s_{adv\_emcb} \cdot 1/xr1 \tag{32}$$

$$B^s_{adv2} = \overline{B}^s_{adv2} \tag{33}$$

Equations (22) and (23) represent the government budget constraint: government expenditures plus interest payments, minus tax revenues and central bank profits, is equal to the net issuance of government bills, which are assumed to be the only financing mechanism for governments[10]. Government expenditures are fixed (equations (24) and (25)), and taxes are a fixed proportion on current national income (equations (26) and (27)). Central banks receive interest payments on government bills they hold, and these profits are then transferred to governments (equations (28) and (29)).

Central banks balance sheets identies are expressed in equation (30) and (32). From equation 33, it can be seen that the high-yield the asset's existing stock is constant, with the central bank acting as a dealer of last resort, depending on institutional investors' demand31. Realistically, these securities should represent private sectors' liabilities, such as equities or corporate bonds. But under the simplified framework of this model, where the production sector has no fixed capital holdings, liabilities can only be issued by the government. The high-yield government bills could represent securities with a long-term maturity[11], or issued by other public sector bodies - e.g. agencies or local authorities-, which, given the higher default and/or holding risk, could justify the higher the higher returns.

2.4 Institutional investors

$$Acc = Acc_{-1} + Cont - \chi \cdot Acc_{-1} \tag{34}$$

$$Ben = Acc_{-1} \cdot \hat{r}_{inst} + \chi \cdot Acc_{-1} \tag{35}$$

$$V_{inst} = V_{inst,-1} + CF_{inst} + CG_{inst} \tag{36}$$

$$CF_{inst} = Cont - Ben + r_{em} \cdot B^s_{em\_inst,-1} \cdot xr + r_{adv} \cdot B^s_{adv\_inst,-1} + r_{adv2} \cdot B^s_{adv2,-1} \tag{37}$$

[10] This choice is made to avoid the complication of bond prices, which in the open economy would have considerably complicated the determination of exchange rates and asset prices.

[11] Indeed the addition of this bill has the same impact of long-term bonds in Godley and Lavoie (2012) chapter 4's model, at least for the case where central banks act to keep the price of such bonds fixed.

$$CG_{inst} = \triangle xr \cdot B^s_{em\_inst,-1} \tag{38}$$

$$r_{inst} = (r_{em} \cdot B^s_{em\_inst,-1} \cdot xr + r_{adv} \cdot B^s_{adv\_inst,-1} + r_{adv2} \cdot B^s_{adv2,-1} + CG_{inst})/V_{inst,-1} \tag{39}$$

Institutional investors are the key innovation of the model. As previously discussed, they receive contributions from the household sector and give them in return an account balance. Such accounts therefore accumulate with new contributions from households minus a proportion χ that is returned to households ((34)). Similarly, benefits are equal to the previous period outstanding balance in the accounts times a guaranteed return $\hat{r}_{inst}$, plus the same proportion χ ((35)).

The logic behind these equations is the following. Current workers pay contributions to build up their accounts with institutional investors. Institutional investors pay benefits to households, both by delivering the guaranteed returns, and by returning part of the account balance that workers have hitherto accumulated[12]. This latter element is again easily exemplified by a funded pension scheme: workers accumulate benefits entitlements, but these are drawn down as benefits are paid. Therefore, as a whole the household sector accumulates claims on institutional investors whenever their current contributions exceed the level of repayments, formally when $Cont = \beta \cdot Y_{adv} > \chi \cdot Acc_{-1}$. It is easy to see that this effectively occurs when the economy whenever national income increases from one period to another, i.e. in conditions of economic expansion: as contributions are directly proportional to current income, in a stationary setting they will increase above drawdown of past accounts, only if income increases above the previous period's level. Equivalently, if the economy falls and the level of contributions keep falling, as a whole the households sector will be losing their claims on institutional investors, as benefits are paid out. In the limit case where contributions are zero, it will take $1/\chi$ years to empty the accounts[13].

Institutional investors assets are the sum of the previous period's assets, plus the net cash flows balance, plus/minus capital gains/losses (equation (36)). The cash flow of institutional investors is the balance between benefits and contributions, plus investment income, i.e. interest payments on their domestic and foreign bills holdings (equation(37)). Capital gains only occur as a result of exchange rate swings (equation (38)). The actual rate of return of institutional investors is equal to investment income and capital gains over previous period wealth (equation (39)). It is intuitive to see that institutional investors assets and liabilities can differ, insofar as their rate of return r_{inst} differs from the one they guaranteed $\hat{r}_{inst}$ [14].

[12] Logically this is very similar to a loan with repayments on the principal, with households being the lender and institutional investors the borrower.

[13] This suggests an interpretation of χ as a measure of longevity of the population: the higher it is the longer it takes for claims of households to be completed cancelled, meaning that the population is living longer.

[14] This can also be shown formally. By merging (34) and (35) the following is obtained:

$$PBO = Acc \cdot \frac{(1+\hat{r}_{inst})^{t_{pbo}}}{(1+r_{pbo})^{t_{pbo}}} \tag{40}$$

$$r_{pbo} = r_{adv} + \tau \tag{41}$$

$$fg = 1 - \frac{V_{inst}}{PBO} \tag{42}$$

Equations (40), (41) and (42) define the accounting valuations of institutional investors' liabilities. Institutional investors such as pension funds and insurers, typically estimate their liabilities by discounting the future value of benefits. Aside from making assumptions about the future value of benefits/premia to be paid, a key variable to be chosen is the discount rate. This is very often closely related to a highly-rated bond yield. In this model the benefits calculation is simplified, and only depends recursively on the previous year accounts' balance. Projected benefits obligations (PBO) therefore are approximated with a 10-year forward looking rule-of-thumb, calculated as end of period's accounts, carried forward by maturing t_{pbo} years at the rate $\hat{r}_{inst}$ and discounted back with the r_{pbo} discount rate (equation (40)). The discount rate is a simple markup over interest rates on bills (equation (41)). The funding gap (fg) measures the magnitude of the deviation from full funding, i.e. when current assets are equal to PBO (equation (42)).

$$\frac{B^d_{adv\_inst}}{V^{exp}_{inst}} = \lambda_0 - \lambda_1 fg + \lambda_2 \cdot r_{adv} \tag{43}$$

$$\frac{B^d_{em\_inst}}{V^{exp}_{inst}} = [(1-\lambda_0) + \lambda_1 fg - \lambda_2 \cdot r_{adv}] \cdot \left[(1-\lambda_{01}) + \lambda_{02} \cdot r_{em} - \lambda_{03} \cdot r_{adv2} + \lambda_{04} \cdot \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}} \right) \right] \tag{44}$$

$$\frac{B^d_{adv2\_inst}}{V^{exp}_{inst}} = [(1-\lambda_0) + \lambda_1 fg - \lambda_2 \cdot r_{adv}] \cdot \left[\lambda_{01} - \lambda_{02} \cdot r_{em} + \lambda_{03} \cdot r_{adv2} - \lambda_{04} \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}} \right) \right] \tag{45}$$

$$Acc = Acc_{-1} \cdot (1 + \hat{r}_{inst}) + Cont - Ben$$

and likewise by replacing (37) and (38) into (36), and making use of the relationship expressed by (39), the following is obtained:

$$V_{inst} = V_{inst,-1} \cdot (1 + r_{inst}) + Cont - Ben$$

$$H^d_{adv\_inst} = V_{inst} - B^s_{em\_inst} \cdot xr - B^s_{adv\_inst} - B^s_{adv2\_inst} \tag{46}$$

Equations (44), (43) and (46) define the asset allocation of institutional investors. The general structure is the standard Tobinesque portfolio choice mechanism typical of all SFC models, with a decomposition of EM returns into a interest rate plus expected exchange rate appreciation (dxr^{exp}). However, the portfolio choice follows a liabilty-driven investment mechanism[15], whereby the institutional investors sector operates a distinction between "safe" assets and "return-seeking" assets according to their funding levels and the base interest rates.

Portfolio choice is in this sense a two-step procedure. In the first stage institutional investors decide how much to allocate to domestic bills and how much to the return-seeking portfolio, which depends on two factors. The first is the impact of their funding gap fg, which has a positive impact on the allocation to return-seeking assets. The higher the gap, the higher the need for returns to fill such a gap and therefore the higher the allocation to higher-yielding assets. The second is the levels base interest rates - what is measured by the impact of λ_2 -, which can be interpreted as both a return factor, which makes domestic bills more attractive by definition, but also as a risk-appetite factor: as the literature mentioned in the introduction discusses, monetary policy is the crucial determinant of the overall level of investors risk-appetite, generating an in inverse relationship between the policy rates and risk-taking.

In the second stage they decide the composition of the return-seeking portfolio, i.e. they allocate assets between EM and high yield ADV bills, depending on their relative characteristics. Such characteristics are the usual linear combination of returns, plus the component is the element in brackets after λ_4, which represents the impact of FXR. FXR are seen as an element that decreases the perceived systemic risk of EM, and therefore accumulating them makes EM bills more attractive vis-a-vis high-yield advanced countries' bills. The positive parameter λ_4 is supposed to capture this relationship: whenever FXR are higher than a set level - equal to the value in the steady state of the model - allocation to EM increases.

Realised cash holdings, as in all SFC models, are the residual element from asset allocation.

2.5 Asset supplies and exchange rate regime closure

$$H^s_{adv} = H^d_{adv\_inst} + H^d_{adv\_adh} \tag{47}$$

$$H^s_{em} = H^d_{em\_emh} \tag{48}$$

$$B^s_{adv\_advh} = B^d_{adv\_advh} \tag{49}$$

[15] See Appendix for futher details.

$$B^s_{adv\_inst} = B^d_{adv\_inst} \tag{50}$$

$$B^s_{adv2\_inst} = B^d_{adv2\_inst} \tag{51}$$

$$B^s_{em\_emh} = B^d_{em\_emh} \tag{52}$$

$$B^s_{adv\_advcb} = B^d_{adv\_advcb} \tag{53}$$

$$B^s_{em\_emcb} = B^d_{em\_emcb} \tag{54}$$

Equations 47 to (53) describe asset supplies. Households and institutional investors achieve their desired levels of domestic bills holdings, and cash is supplied on demand. Central banks also purchase as much bills as they need.

$$xr = \frac{B^d_{em\_inst}}{B^s_{em\_inst}} \tag{55}$$

$$B^s_{em\_inst} = B^s_{em} - B^s_{em\_emcb} - B^s_{em\_emh} \tag{56}$$

$$\triangle B^s_{adv\_emcb} = \gamma_1 \cdot \triangle B^d_{em\_inst} \tag{53a}$$

$$\triangle B^s_{adv\_emcb} = \gamma_2 \cdot \triangle Y_{em} \cdot xr \tag{53b}$$

$$B^s_{adv\_emcb} = \bar{B}^s_{adv\_emcb} \tag{53c}$$

The above equations define the exchange rate, and FXR accumulation by the EM central bank, and together determine the closure of the system. The exchange rate is determined in the EM bills market, depending on the relative excess demand or supply by foreign institutional investors (equation (55)). The supply of EM bills to institutional investors $B^s_{em\_inst}$ depends on the toal supply minus domestic demand, and therefore crucially depends on the holdings of the central bank, and its FXR level. Therefore the three different closures of the system are determined by equation (53), which represent different behaviour by the EM central bank with respect to its accumulation of FXR. Equations (53a) and (53b) show two different versions of a managed floating regime: in the first one, which represent the baseline scenario, the central bank simply tries to counterbalance part of the private capital inflows coming from abroad, effectively trying to avoid excessive volatility of the exchange rate and create a buffer against the new liabilities of the country; in the second one the central bank FXR increase with GDP expressed in foreign currency[16]. Equation (53c) represent a pure floating exchange rate regime, where the level of FXR is constant.

A fixed exchange rate regime has been deliberately discarded as it is a non-realistic description of current exchange rate arrangements for the great majority of EM economies[17]. A pure float is also quite uncommon in EM countries, but it is used as a control case to see the effect of foreign exchange intervention.

2.6 Expectations

$$V_{inst}^{exp} = V_{inst,-1} + CF_{inst,-1} \tag{57}$$

$$Yd_{adv}^{exp} = Yd_{adv,-1}^{exp} + \phi(Yd_{adv,-1} - Yd_{adv,-1}^{exp}) \tag{58}$$

$$Yd_{em}^{exp} = Yd_{em,-1}^{exp} + \phi(Yd_{em,-1} - Yd_{em,-1}^{exp}) \tag{59}$$

$$dxr^{exp} = d\bar{x}r^{exp} \tag{60}$$

Expectations are treated in a rather simplified way. Institutional investors' wealth expectations are equal to the previous period's value plus the previous period's cash flow (equation (57)). Households' disposable income expectations follow a standard adaptive process (equation (58) and (59)). Following paper 12 model in Godley and Lavoie (2012), there are no specified expectations about the exchange rate value, but only expectations about appreciation/deprecation, which is zero on average.

3 Initial values and stationary steady state

The structure of the model is now complete. With 60 equations (excluding a number of "control" equations which have no causal role but only serve to track the evolution of other variables) and 104 variables, the model is relatively compact, considering it features two economy and the addition of new sector [18]. This is mostly due to the simplifications on trade and production, with no separate equations for 'real' values, which would effectively almost double the amount of existing equations.

As with all SFC models, values for parameters, exogenous variables and the initial values for the endogenous variables had to be chosen. What follows is a brief overview of some of these choices, also

[16] This is chosen for convenience, different values such as a fixed ratio to imports, showed no substantial differences.
[17] See Ghosh *et al.* (2015)
[18] The model in paper 12 of Godley and Lavoie (2012) has over 90 equations.

presented schematically in table 3. As a general choice method, most parameters were chosen with values in line with those of the SFC literature, or using stylised facts from the empirical evidence. Moreover, these values have to comply with the stationary steady state of the model, which forms the baseline scenario.

Table 3: Parameters and variables values

Parameter	Value	Exogenous variables	Value
α_{1adv}	0.8	$\bar{G}_{adv}$	300
α_{2adv}	0.15	G_{em}	150
α_{1em}	0.8	r_{adv}	0.05
α_{2em}	0.14	r_{em}	0.025
β	0.05	$\hat{r}_{inst}$	0.033
μ_{adv}	1/6	Initial values endogenous variables	
μ_{em}	0.2	Y_{adv}	1000
θ_{adv}	0.3245	Y_{em}	500
θ_{em}	0.31	B^s_{adv}	1200
χ	0.075	B^s_{em}	400
τ	0.005	B^s_{adv2}	166.667
λ_0	0.6	H^s_{adv}	500
λ_2	5	H^s_{em}	300
λ_{01}	0.625	xr	1
λ_{02}	4.2	Acc	666.667
λ_{03}	5	V_{inst}	666.667
λ_{04}	0	$\bar{dxr}^{exp}$	0
γ_1	0.5		
γ_2	0.4		
ϕ	0.3		
$\epsilon_{1adv} = \epsilon_{1em}$	0.7		
$\epsilon_{2adv} = \epsilon_{2em}$	1		

In a stationary state there should be not changes in balance sheets, and therefore no net saving. As a result, the α parameters determining consumption are chosen with values very close to Godley and Lavoie (2012), but slightly higher to ensure that $Yd = Cons$ in both countries. Asset allocation of households was chosen to consist mostly in cash holdings, since ADV households hold much of their financial assets indirectly through institutional investors, and EM households being from a non-advanced country do not invest much in financial markets.

The portfolio allocation of institutional investors has been chosen to be heavily skewed towards advanced countries bills - 60% to B_{adv}, 25% to B_{adv2} and 15% B_{em}. These paramters result in a 60-40 allocation to liability-matching vs return seeking assets, and also reflect the well known phenomenon of home-bias. The behavioural parameters λ determining such allocation were chosen to values close to

5, as in Godley and Lavoie (2012). The funding gap parameter λ_1, was chosen to be smaller than the returns parameter. λ_4 was chosen to be zero in the baseline case, but will be activated in alternative scenarios to assess its impact.

Parameters β and χ were chosen to be 0.05 and 0.0875. This was a rather arbitrary choice, but reasonable considering it implies a stationary pension fund balance sheet - i.e. a funding gap equal to zero - with a 5% contribution rate in the baseline steady state. Tax to GDP parameters θ are higher than those chosen by Godley and Lavoie (2012), but are actually much closer to the OECD average level of 33.7% as of 2012[19]. Chosen values for elasticity parameters to trade ϵ are the same as in Godley and Lavoie (2012).

Interest rates were chosen to be 2.5% in ADV, 4.2% for the high-yield ADV bill, and 5% in EM. Again this is to reflect the existing reality of bonds issued in emerging markets promising a higher yield. The guaranteed rate of return $\hat{r}_{inst}$ on institutional investors' account is 3.3%, chosen to ensure a higher rate than domestic government bills. The parameter τ is 0.05, a spread over the ADV' interest rate. This implies that in the baseline steady state $\hat{r}_{inst} = r_{inst} = r_{pbo}$ and likewise $V_{inst} = Acc = PB$.

Values chosen for γ_1 is again rather arbitrarily chosen expressing that the EM central bank will purchase FXR by exactly half the amount by which EM's foreign liabilities increase in foreign currency terms in the baseline scenario. The value chosen for γ_2 on the other hand are very much in line with the data, e.g. the average of developing Asia FXR to GDP was 40% in 2008 (Park and Estrada, 2009).

The supply of financial assets was also chosen to respect existing stylised facts. Public debt to GDP levels are higher in ADV than in EM, although government expenditures are more or less the same. ADV's GDP is twice as big as EM's. The size of the institutional investors sector is slightly smaller than in the real world, e.g. the OECD average for pension funds' assets to GDP is 86%[20] compared to 66.67% of the model. Without changing the structure of the model, increasing the size of the institutional investors' sector would however generate different problems, as it would require the increase in the supply of either cash, or bills, which would make model asset to GDP levels implausibly high, or reduce institutional investors return below the base interest rate.

In the simulation exercises, the value of some of these parameters will be changed, as means of a robustness check. Especially those parameters expressing the most crucial and/or novel relationships, such as λ_1 and γ_1 will be subject to changes, as to ensure the model's result are not only a reflection of the initial choice of the parameters' values.

4 Simulation

Three different scenarios are generated, where the baseline model - the stationary case - is shocked by modifying the value of exogenous variables or parameters. All the scenarios are simulated for 500

[19] Source: OECDstat
[20] Source: OECDstats

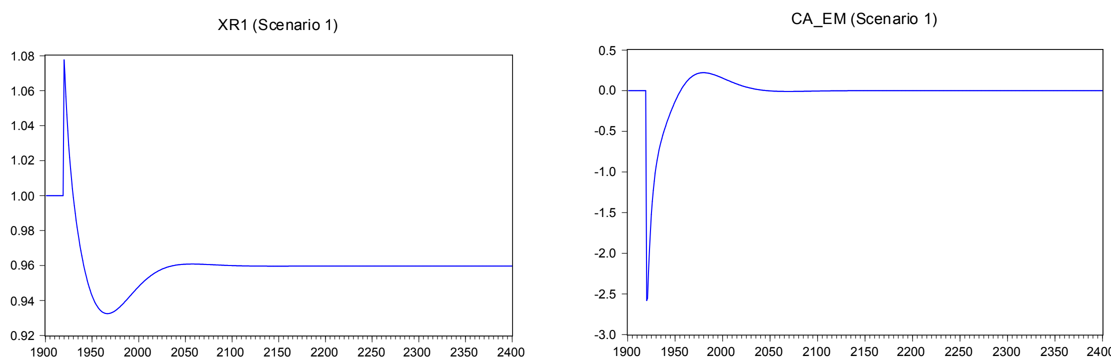
periods. The main variable of interest will be the exchange rate, as it effectively summarises how most of the other variables will change.

4.1 Scenario 1: EM growth story

In the first scenario, the λ_{01} parameter is shocked downwards, thus increasing the allocation to EM bills within the return-seeking portfolio. The interpretation of such a change is that institutional investors see potential in the EM assets, following for example a new positive outlook for the future of the country, or simply because they find information about it more accessible, and therefore are induced to increase their allocation to EM bills.

The initial effect on the exchange rate is straightforward: as shown in figure 6, there is an initial spike in the exchange rate, since the higher allocation to EM bills generate excess demand and, through equation (55), an appreciation of the EM currency. The appreciation generates a trade deficit (figure 7), which in turn generates a government deficit, increasing the supply of government bills. The excess supply of government bills generates a depreciation of the exchange rate, and over time improves the trade balance and eventually the current account balance, which registers a surplus. As a result the excess supply of government bills reverses, the exchange rate appreciates until it stabilises at a new lower equibrium level.

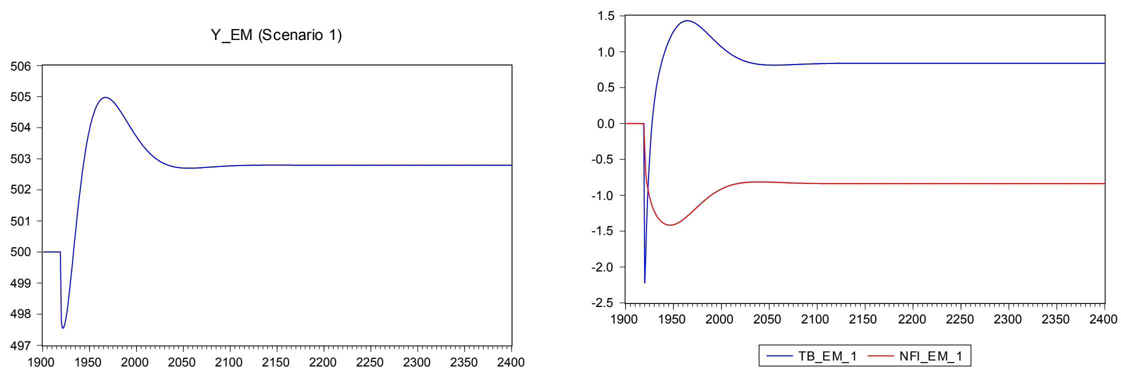
Figure 6: Exchange rate and funding gap



Response of the exchange rate and EM current account after an increase in desire to hold EM bills

At the new lower level for the exchange rate, the trade balance is in a surplus, and as a result GDP is also at a higher equilibrium level (figure 7). As the current account is in balance, the trade surplus is offset by a net factor income deficit. Despite the higher level of reserves held by the central bank, the increased allocations to EM by foreign institutional investors generate a higher foreign debt level, therefore worseing the net factor income surplus.

Figure 7: GDP and current account components

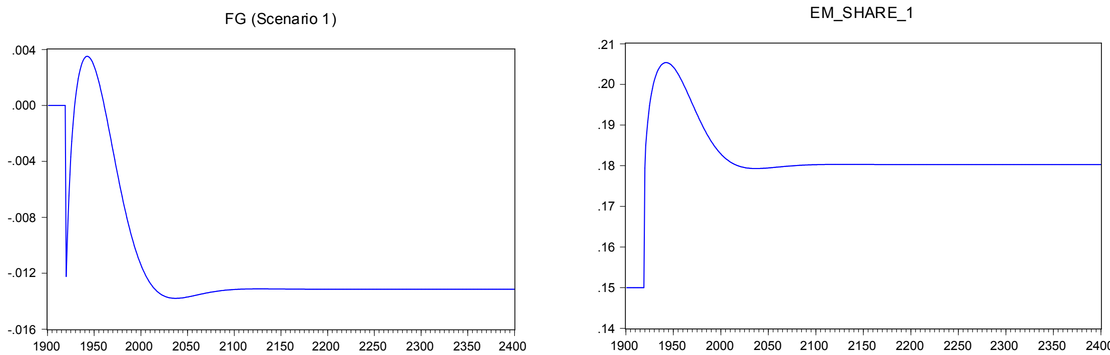


Response of GDP, trade balance and net factor income after an increase in the desire to hold EM bills

A key force shaping the dynamics of the system is the funding gap on portfolio choice (figure 8). The initial increase is allocation to EM bills is mitigated by the effect of the funding gap: the higher returns initially earned by institutional investors, due to exchange rate appreciation and higher income returns as a result of the portfolio shift, improve the funding levels of the sector. The result of this process is that the exchange rate initially appreciates by less than in it would have been with households investors, therefore generating a smaller current account deficit. After the initial shock however, due to the lower funding gap levels institutional investors starts selling their EM positions, thus putting downward pressure on the exchange rate. This improves the trade balance, which, despite being smaller than it would have been in a situation without institutional investors is able to push the EM current account into a surplus. This is due to the lower debt levels originated at the beginning of the shock period, which generated a much smaller debt servicing burden, thereby lowering the borrowing requirements of the government, and lowering the increase in foreign debt payments. The resulting current account surplus effectively induces a shortage of EM assets, which increases the exchange rate through equation (55). Notably, the new equilibrium level has a negative funding gap, i.e. a funding surplus.

Given the importance of the funding gap, it is important to study the sensitiveness of the system the value of the parameter λ_1. This is shown in figure 9. The result is pretty clear: the higher the value of λ_1 the smaller the magnitude of the swings in the short-run and the lower equilibrium level of the exchange rate. A higher λ_1 represents a higher willingness of institutional investors to closely stick to a full funding level ($fg = 0$), as a result any action resulting in a deviation from it will induce counterbalancing moves, hence dampening their impact. Therefore with a very high λ_1 the asset

Figure 8: Funding gap and share of EM bills



Effect on the funding gap and the share of EM government bills in the portfolio of institutional investors, after an increase in the desire to hold EM bills

allocation will change little in both the short and the long-run, and the funding gap will remain closer to zero. It is not surprising therefore that, conversely, with $\lambda_1 = 1.5$ the magnitude of the swings is bigger, therefore amplifying the chain of events describe in the previous paragraph, and ultimately inducing a higher equilibrium exchange rate level.

Finally note the comparison with the $\lambda_1 = 0$, the case where institutional investors act as simle intermediaries distributing all returns are they achieve them[21]. The case shown with the $\lambda_1 = 0$ in figure 9, shows effectively the same chain of events that can be obtained as a result of a similar shock in Godley and Lavoie (2012): after a liquidity preference shock, the initial response of the system is the same, with a sudden spike in the exchange rate and then a depreciation following a current account deficit. However the exchange rate falls to a stabilise at a lower level, compared to all the other cases. This is due to the higher initial appreciation, giving rise to higher external debt, which in turn requires a lower exchange rate and a higher trade surplus to face the higher net factor income deficit. The counterbalancing force given by the funding levels, which contains the initial increase in allocation to EM bills, results in less sharp movements ofr the exchange rate, both in the short-run (the initial appreciation) and the long-run (the higher new steady state exchange rate).

So far the simulations have been made under the exchange rate regime described by equation (53a), with the baseline parameter values. . figure 10 shows what would happen under different values for γ_1, under a FXR accumulation regime targeting GDP growth as in equation (53b), and under a flexible exchange rate regime.

Qualitatively the results are very similar under the three regimes. However the EM central bank

[21] This is obtained by simply replacing $r_{inst} = \hat{r}_{inst} = r_{pbo}$in all equations, and $\lambda_1 = 0$.

seems to be more successful at realising its intents when accumulating FXR according to equation (53a), i.e. targeting capital inflows. Under this regime, the exchange rate movements are subsantially dampened compared to the flexible exchange rate regime, and the adjustment quicker. Unsurprisingly, this stabilizing impact is higher the higher parameter γ_1 is. The GDP target seems to be on the other hand less successful as a stabilising working rule for central banks: in the short-run it fails to substantially contain the inital appreciation, and even amplifies the subsequent fall, although it does stabilise the exchange rate at a less depreciated level than in the pure floating case.

The advantage of having a managed floating exchange rate regime seem apparent by these dynamics. It gives the central bank the opportunity to accumulate FXR, without having to resort to a pegged exchange rate, which may present issues for EM that are facing balance of payments deficits. Following a simple rule of thumb, like purchasing and selling FXR in accordance to capital inflows and outflows may well be useful policy strategy: as the simulations suggest a "path-dependence" for the system as a whole, and in particular for exchange rate movements - the smaller the initial appreciation, the smaller the subsequent depreciation - containing the short-run volatility of exchange rates results a good strategy to contain the volatility of exchange rates in the long-run.

Intermediate exchange rate regimes also are perfectly consistent with an interest-rate targeting monetary policy. Although no equation directly relates H^d_{em} and H^s_{em}, the supply and demand for cash balances in EM, the two are equal in all the simulations, while at the same time, the central bank's balance sheet identities remain true. Just like Godley and Lavoie (2012) find for the fixed-exchange rate case, in a managed floating exchange rate reime the EM central bank is still able to keep its interest rate fixed, without losing control on the high-powered money supply. This is perfectly consistent not only with a flexible exchange rate, but also with a managed float.

It is interesting to note, that under such a regime, the accumulation of FXR does not seem to be particularly correlated with current account movements. As shown in figure 11, when the EM central bank choose to target capital inflows, FXR accumulation is entirely driven by them, with current accounts leaning in the same direction as reserves to offset capital inflows. When the EM central bank targets GDP, FXR are much more stable - which explains why under this regime the exchange rate is much more volatile -. But even in this case, FXR seem to mostly respond to capital flows rathern than current account changes.

These figures show the important point made by Borio and Disyatat (2011) that in a monetary economy, such as that depicted by SFC models, there is no necessary link between current accounts and FXR accumulation. Two-way gross capital flows very often dwarf net flows, represented by current accounts, and it is therefore wrong to attach any particular flow to current accounts. "In fact, causality between the current account and the accumulation of reserves is more likely to run the other way: the accumulation may reflect the wish to resist the appreciation of the currency, when the authorities face strong foreign demand for domestic currency assets, manifested in gross capital inflows" (Borio and

Disyatat, 2011, p. 12). This is exactly what is happening in this model, even with a highly simplified two way gross flows system, with only one asset traded internationally by private agents.

As a last simulation exercise for this scenario, the parameter λ_4 representing the positive impact of FXR on allocation to EM assets is activated. The result, shown in figure 12, show two clear results. Firstly, the higher the value of the parameter the higher the volatility and the longer the adjustment to the equilibrium level. A positive λ_4 gives a procyclical twist to allocations and the exchange rate, as allocations to EM bills increase as new capital inflows generate accumulation of FXR, and decrease as FXR falls fall as a result of capital outflows, which amplifies the exchange rate swings. Secondly, the equilibrium level is lower the higher the value of the parameter. Effectively at the new equilibrium level, allocations and FXR are higher, but the net factor income has worsened due to the higher external debt, which results in an exchange rate depreciation.

4.2 Scenario 2: "post-2008"

The second scenario presents multiple shocks to r_{adv}, the interest rate on ADV bills. The interest rate is first decreased from 2.5% to 1% for fourty periods and then is is brought back up. This is supposed to simulate a scenario similar to what investors have been facing since 2008, with bond yields dramatically falling as a result of ultra-expansionary monetary policy by advanced countries' central banks. The increase of interest rates represents the ongoing "tapering" process, and forthcoming interest rate reversal.

The results of this experiment are shown in 13. The overall chain of events is similar to that described in the previous section. As a result of the interest rate shock, institutional investors allocate more to EM bills, which appreciates the exchange rate. This generates a current account deficit, which sparks higher supply of EM bills, due to higher borrowing needs from the government. This pushes the exchange rate downwards, therefore improving the trade balance, but the higher interest payments plunge the economy further into deficit. When interest rates are increased back, the exchange rate drops a little more, and this time the trade balance starts to improve substantially as to bring back to current account closer to balance. Indeed, with the rates back to their initial level, the correction is such that economy experiences a current account surplus, such that it cancels the net additional debt previously accumulated. As a result the economy is back to initial equilibrium levels.

It is useful once again to compare this to what would happen in the absence of institutional investors[22]. In such a situation, shown in figure 14, the dynamics are similar than for the previous case. The economy experiences an initial appreciation of the currency due to the lower returns on ADV

[22] Again this is done by putting $\hat{r}_{inst} = r_{inst} = r_{pbo}$ so that effectively institutional investors are pure intermediaries for households.

bills and the subsequent change in asset allocation. This generates a deficit in the current account, due to the same higher financing needs of the EM government. However, unlike the other case, the current account starts improving due to a rapidly depreciating currency, and a rapidly improving trade balance. In other words the system simply adjusts back to equilibrium. Indeed for the case without an explicit behavioural mechanism for institutional investors, this scenario produces exactly the same results as the previous one: a change in interest rates has the same effect as a change in liquidity preference, just like in the model of Godley and Lavoie (2012).

Once again the key role in affecting the dynamics of the system is played by the funding gap (figure 15). Since a lower value of r_{adv} generates a positive funding gap - both through assets reductions and liability increases -, it amplifies the initial shock on the exchange rate, contains its subsequent fall, and slightly amplifies the second interest rate shock. This effectively results in a higher buildup of a current account deficit and foreign debt. As a result the exchange rate needs to depreciate even further in order for the system to be brought back to balance.

Importantly, the process is enhanced for higher values of λ_1, as figure 13 shows. The higher the value the higher the initial appreciation and the sharper the subsequent depreciation. This can be explained by the fact that with higher values for λ_1 investors care more about their initial higher underfunding, and therefore invest more aggressively in EM bills and retain the higher allocation for longer, so long as they remain underfunded. When interest rate rise, the rapid improvement of funding levels generates a bigger selloff of EM assets, which combined with the higher buildup of imbalances generates a much sharper depreciation and adjustment process. Unlike the previous scenarios therefore, the impact of the funding levels on institutional investors portfolio choice, has a destabilising rather than stabilising role on exchange rates.

Overall the process shows how lower interest rates, when increased back to “normal” levels, generates a process akin to an EM cycle. As rates are lowered, capital inflows appreciate the currency, generating a current account deficit (figure 17). The high foreign indebdteness generates a net factor income deficit, and foces the currency to depreciate, despite the fact that capital keeps flowing in. The longer and larger the debt buildup the longer and larger the subsequent fall in the exchange rate will be to bring back the system to equilibrium.

Indeed the increase in exchange rates and their subsequent deterioration since the 2008 crisis, as shown in figure **??**, is similar to the initial phases of the simulation of this scenario. It is indeed well known that a number of EM, known as the “fragile five”(Johnson, 2015), have faced sharper depreciations since the “tapering” announcements, coupled with higher foreign indebtedness and current account deficit pressures.

Finally, in this scenario as in the previous one, the intermediate exchange rate regime, which sees FXR accumulated as a share of capital inflows, is able to contain the exchange rate swings. As clearly shown in figure 18, the higher the parameter γ_1 the higher the reduction in exchange rate volatility, and the quicker the adjstument to the long-run equilibrium. Once again, a GDP target does not seem to be as succseful.

5 Conclusion

The SFC model developed in this paper presents some features that are similar to those that this thesis has put forward. The model features an advanced country with an institutional investor sector, allocating its assets between ADV and EM bills. The sector promises a certain guaranteed return, thus generating the possibility of gaps between asset and liabilities. When the gap is positive, in line with the rest of the arguments presented in this thesis, the sector is assumed to allocate a higher proportion to EM assets, as these give higher interest rates and therefore a possibility to fill that gap by earning higher returns.

The two scenarios presented in the paper show the importance of the funding gap mechanism in determining the dynamics of the model. The funding gap acts as a crucial determinant of portfolio choice, and therefore of the exchange rate, which is the key macroeconomic variable of this simplified model. The effect of the funding gap on financial stability of EM is mixed, depending on how it interacts with the shocks and the other variables. In the case of a shock positively affecting the allocation of EM - or equivalently a rise in the EM interest rate - it acts as a countercyclical variable, dampening the effects of capital inflows that such shocks generate and containing the exchange rate movements. However, when a negative shock to interest rates in advanced countries, it plays a destabilising role, amplifying the cycles. To use the standard macroeconomic terminology, institutional investors that have funding targets act procyclically with respect to "push" factors, and countercyclically with respect to "pull" factors.

The model also shows the importance and consistency of managed floating exchange rate regimes. A central bank accumulating reserves as a fixed proportion of capital inflows is successful at containing exchange rate movements, achieving a quicker stabilisation, and also containing the changes in the long-run equilibrium exchange rates, when these are produced by the model. This may explain why so many EM resort to these exchange rate regimes. However it is important to say that while effective, these measures only contain the instability and do not manage to change what ultimately drives the mechanisms of the model: the portfolio choice of institutional investors. Furthermore, to the extent that reserves accumulation itself acts as an attractor, being interpreted as a sign of financial strength by foreign investors, the dynamics of FXR may still generate instabilities.

The overall message of the model confirms the riskiness of the current situation in EMs. The boom in EM allocation by institutional investors following the 2008 crisis has been nurtured by the low yields in advanced countries. Such a situation is however conducive of a buildup of imbalances and vulnerabilities in EMs, and as a matter of fact a few EMs have been facing current account deficits and deteriorating external balance sheets in very recent times. An interest rate rise in advanced countries could trigger further depreciation, which may ultimately correct these imbalances, but may create substantial harm in the meanwhile. Emerging markets therefore remain under the threat of interest rate rises in advanced economies, a situation which unfortunately long-term institutional investors do not seem to improve in the current circumstances.

Appendix

This appendix discusses liability-driven investment, a portfolio choice mechanism adopted by pension funds and similar investors in recent years. As the name suggests, investors conforming to this paradigm, make the fullfilment of their liabilities the primary objective of their portfolio choice. The primary consequence of this framework is to split the portfolio into two parts, a liability-matching portfolio, whose goal is to protect the current value of the fund's assets from risks - e.g. changes in interest rates -, and a return-seeking portfolio, with the purpose of generating returns sufficient to fulfill those obligations. While government-bonds are typically the only asset included in the liability-matching portfolio, any risky asset can potentially be included in the return-seeking portfolio. The extent to which liabilities are covered determines the proportion between the two portfolios.

In this model, low-yield bills represent the liability-matching portfolio, whereas high-yield and emerging markets bills constitute the return-seeking portfolio. The key variable representing allocation between the two is the funding gap. Equations 43 44 and 45, which represent the portfolio choice mechanism of institutional invesetors, are the result of such a paradigm. This can shown in a few mathematical passages. Institutional investors split their portfolio into a liability matching and a return-seeking portfolio, with weights w_{LM} and w_{RS}, so that $w_{RS} + w_{LM} = 1$. In case of full funding $(fg = 0)$, then:

$$w_{LM} = \lambda_0 + \lambda_2 \cdot r_{adv} \qquad w_{RS} = 1 - \lambda_0 - \lambda_2 \cdot r_{adv}$$

with λ_0 being the parameter which makes institutional investors' return equal to their promised one - and thus maintains the fully funded status:

$$\hat{r}_{inst} = r_{inst} = r_{LM} \cdot (\lambda_0 + \lambda_2 \cdot r_{adv}) + r_{RS} \cdot (1 - \lambda_0 - \lambda_2 \cdot r_{adv})$$

$$\lambda_0 = \frac{\hat{r}_{inst} + \lambda_2 \cdot r_{adv}(r_{RS} - r_{LM}) - r_{RS}}{r_{LM} - r_{RS}}$$

where r_{RS} and r_{LM} are the returns of the returns-seeking and liability-matching portfolios[23].

If there are deviations from the fully-funded status the portfolio is supposed to respond linearly on the funding gap term:

$$w_{LM} = \lambda_0 - \lambda_1 fg + \lambda_2 \cdot r_{adv}$$

$$w_{RS} = (1 - \lambda_0) + \lambda_1 fg - \lambda_2 \cdot r_{adv}$$

The allocations to each individual asset class in the total portfolio, are determined by the relative size of the two portfolios (w_{LM}, w_{RS}) as well as their weights within each one of the portfolios:

$$w_i = w_{i,LM} \cdot w_{LM} + w_{i,RS} \cdot w_{RS} \tag{61}$$

where $w_{i,LM}$ and $w_{i,RS}$ are the portfolio weights to asset i within the liability-matching portfolio and the return-seeking portfolio.

Be $w_{adv,LM}$ the allocation to low-yield advanced country's bills within the liability-matching portfolio. Since the liability-matching portfolio only contains this type of assets $w_{LM,adv} = 1$, and therefore:

$$w_{adv} = \lambda_0 - \lambda_1 fg + \lambda_2 \cdot r_{adv}$$

Assuming that, within the return-seeking portfolio, assets are allocated according to the tobinesque principles, plus the FXR impact discussed in the paper:

$$w_{adv2,RS} = \lambda_{01} - \lambda_2 \cdot r_{em} + \lambda_3 \cdot r_{adv2} + \lambda_4 \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}} \right)$$

$$w_{em,RS} = (1 - \lambda_{01}) + \lambda_2 \cdot r_{em} + -\lambda_3 \cdot r_{adv2} + \lambda_4 \cdot \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}} \right)$$

with $w_{adv2,RS}$ and $w_{em,RS}$ being the allocation to the high-yield and emerging market bill within the return-seeking portfolio. Replacing into 61:

[23] λ_0 in the model is kept exogenous, for the paramters that solve the relationship in the baseline steady state. Endogenising it according the expression above does not change subtantially any of the results, especially if in a dynamic context returns are taken as long-term averages rather than only previous period returns.

$$w_{adv2} = (\lambda_0 + \lambda_1 fg - \lambda_2 \cdot r_{adv}) \cdot \left[\lambda_{01} - \lambda_2 \cdot r_{em} + \lambda_3 \cdot r_{adv2} + \lambda_4 \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}}\right)\right]$$

$$w_{em} = [(1 - \lambda_0) + \lambda_1 fg - \lambda_2 \cdot r_{adv}] \cdot \left[(1 - \lambda_{01}) + \lambda_2 \cdot r_{em} - \lambda_3 \cdot r_{adv2} + \lambda_4 \cdot \left(\frac{B^s_{adv\_emcb} - \bar{B}^s_{adv\_emcb}}{\bar{B}^s_{adv\_emcb}}\right)\right]$$

References

Aizenman, J., Chinn, M.D. and Ito, H. (2010). 'The emerging global financial architecture: Tracing and evaluating new patterns of the trilemma configuration.' *Journal of International Money and Finance*, **29** (4): pp. 615–641.

Borio, C. and Disyatat, P. (2011). 'Global imbalances and the financial crisis: Link or no link?' BIS Working Paper 346, Bank for International Settlements.

Bortz, P.G. (2014). 'Foreign debt, distribution, inflation, and growth in an SFC model.' *European Journal of Economics and Economic Policies: Intervention*, **11** (3): pp. 269–299.

Bruno, V. and Shin, H.S. (2013). 'Capital Flows and the Risk-Taking Channel of Monetary Policy.' Working Paper 18942, National Bureau of Economic Research.

Calvo, G.A. and Reinhart, C.M. (2002). 'Fear of Floating.' *The Quarterly Journal of Economics*, **117** (2): pp. 379–408.

Caverzasi, E. and Godin, A. (2015). 'Post-Keynesian stock-flow-consistent modelling: a survey.' *Cambridge Journal of Economics*, **39** (1): pp. 157–187.

Devereux, M.B. and Sutherland, A. (2009). 'A portfolio model of capital flows to emerging markets.' *Journal of Development Economics*, **89** (2): pp. 181–193.

—— (2011). 'Country Portfolios in Open Economy Macro-Models.' *Journal of the European Economic Association*, **9** (2): pp. 337–369.

Ghosh, A.R., Ostry, J.D. and Qureshi, M.S. (2015). 'Exchange Rate Management and Crisis Susceptibility: A Reassessment.' *IMF Economic Review*, **63** (1): pp. 238–276.

Godley, W. and Lavoie, M. (2012). *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*. Palgrave Macmillan, second edition,revised edition,2nd edition edn.

Johnson, S. (2015). 'Mexico and Colombia join 'fragile five' emerging markets.' *Financial Times*.

Kaltenbrunner, A. and Painceira, J.P. (2015). 'Developing countries' changing nature of financial integration and new forms of external vulnerability: the Brazilian experience.' *Cambridge Journal of Economics*, **39** (5): pp. 1281–1306.

Lane, P.R. and Milesi-Ferretti, G.M. (2007). 'The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004.' *Journal of International Economics*, **73** (2): pp. 223–250.

Lavoie, M. and Daigle, G. (2011). 'A Behavioural Finance Model of Exchange Rate Expectations Within a Stock-Flow Consistent Framework.' *Metroeconomica*, **62** (3): pp. 434–458.

Lavoie, M. and Zhao, J. (2010). 'A Study of the Diversification of China's Foreign Reserves Within a Three-Country Stock-Flow Consistent Model.' *Metroeconomica*, **61** (3): pp. 558–592.

Mazier, J. and Tiou-Tagba Aliti, G. (2012). 'World Imbalances and Macroeconomic Adjustments: A Three-Country Stock-Flow Consistent Model with Fixed or Flexible Prices.' *Metroeconomica*, **63** (2): pp. 358–388.

Park, D. and Estrada, G. (2009). 'Are Developing Asia's Foreign Exchange Reserves Excessive? An Empirical Examination.' ADB Economics Working Paper Series 170, Asian Development Bank.

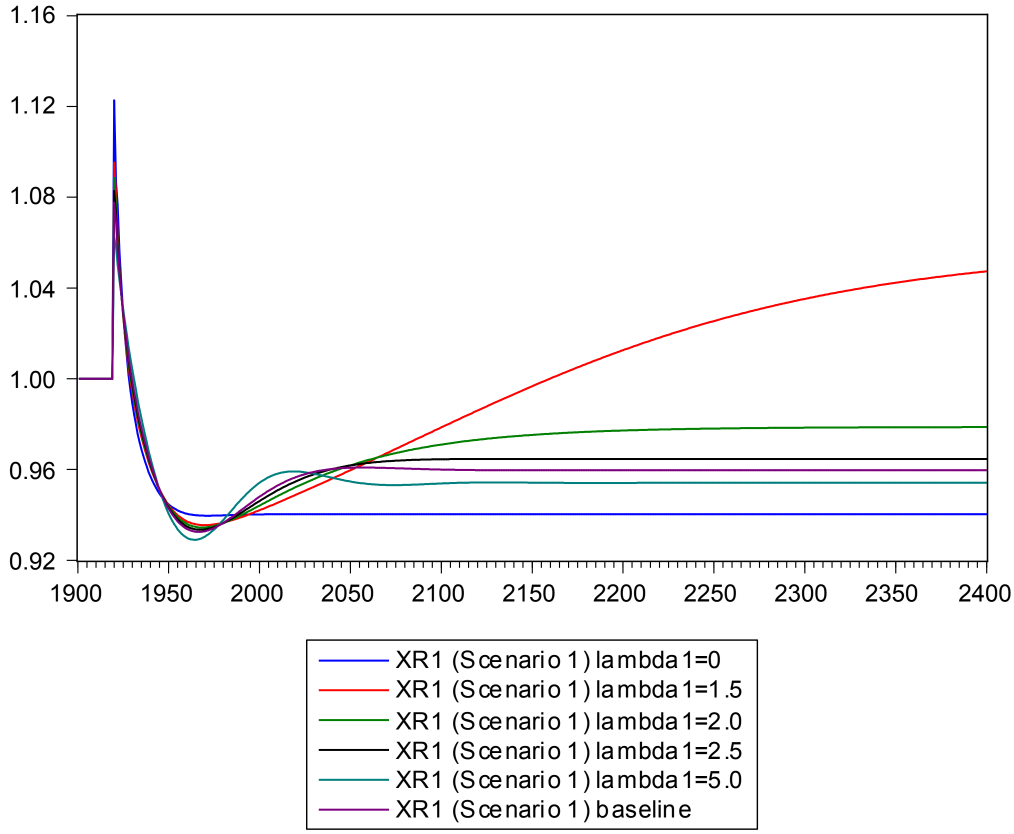
Pavlova, A. and Rigobon, R. (2010). 'International Macro-Finance.' NBER Working Paper 16630, National Bureau of Economic Research.

Rey, H. (2013). 'Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence.' Tech. Rep. Presented at 2013 Economic Policy Symposium, Federal Reserve Bank of Kansas City, Jackson Hole.

Shin, H.S. (2013). 'The second phase of global liquidity and its impact on emerging economies.' Keynote Address, Asia Economic Policy Conference, Federal Reserve Bank of San Francisco.

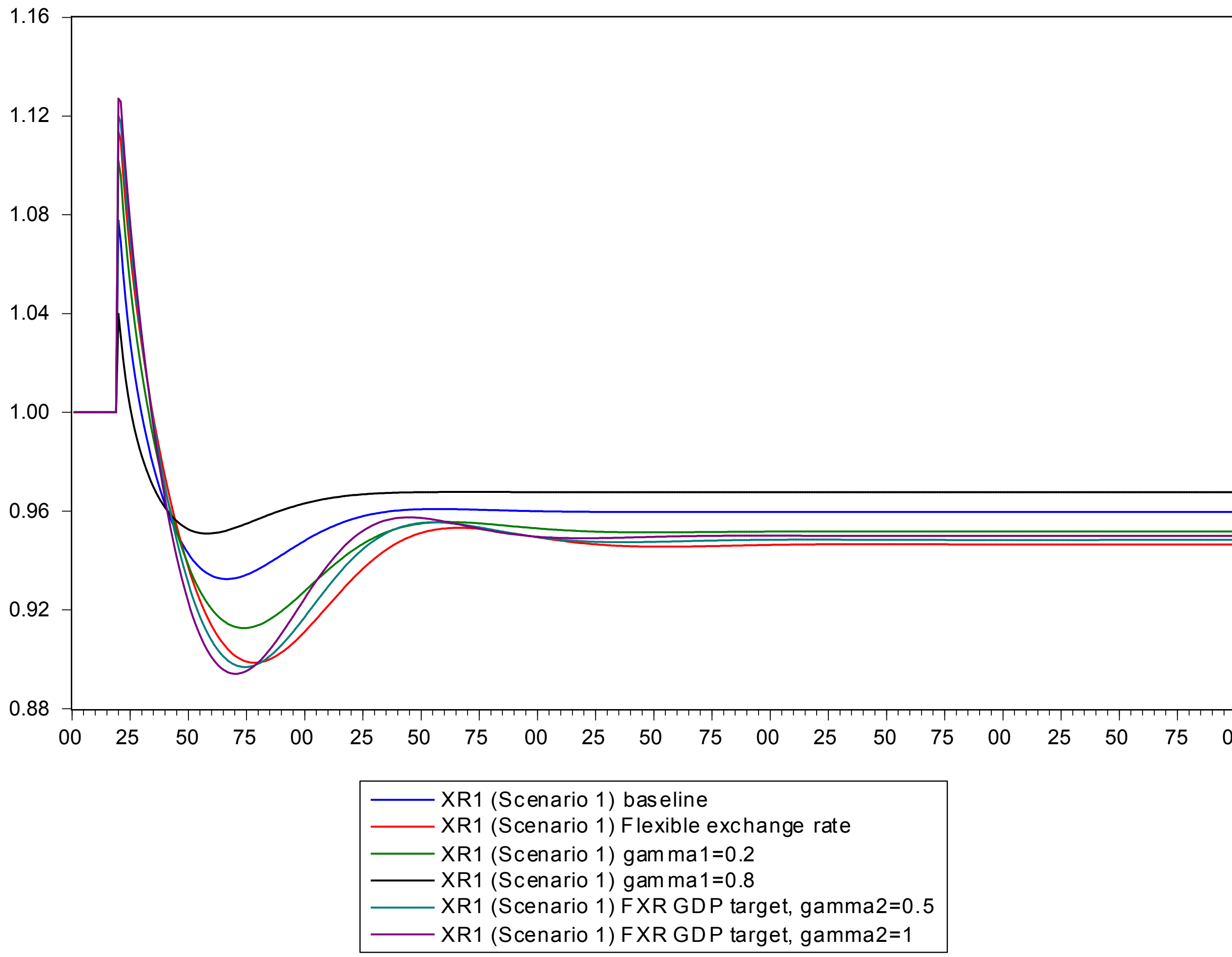
Tille, C. and van Wincoop, E. (2010). 'International capital flows.' *Journal of International Economics*, **80** (2): pp. 157–175.

Figure 9: Exchange rate



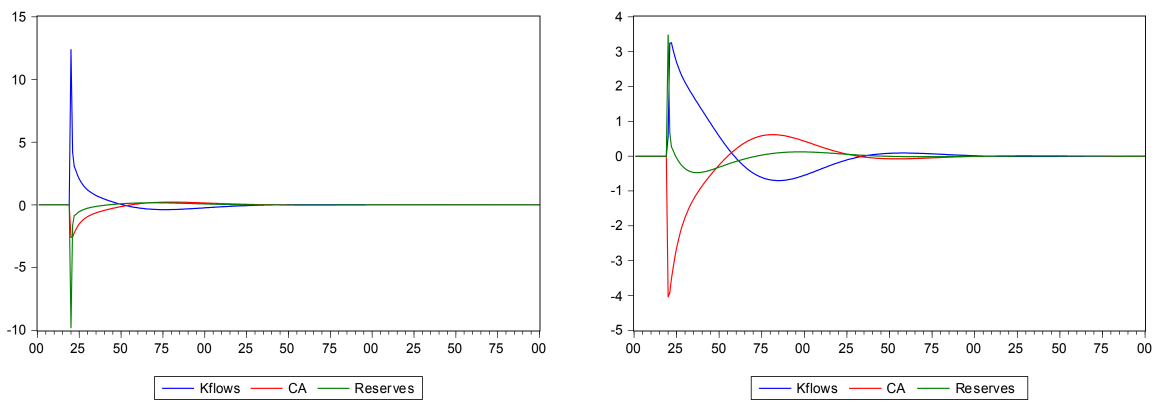
Response of the exchange rate under different assumptions for λ_1, the portoflio choice sensitivity to funding levels, after an increase in desire to hold EM bills

Figure 10: Exchange rate under different regimes



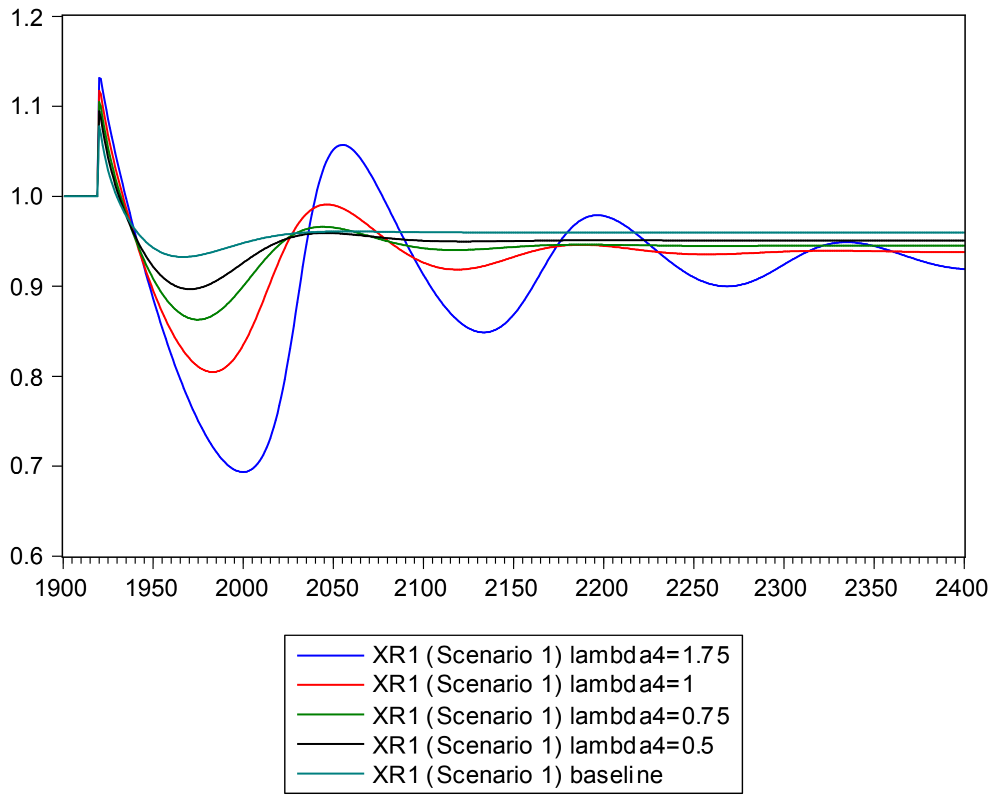
Response of the exchange rate, under different exchange rate regimes after an increase in desire to hold EM bills

Figure 11: Balance of payments components



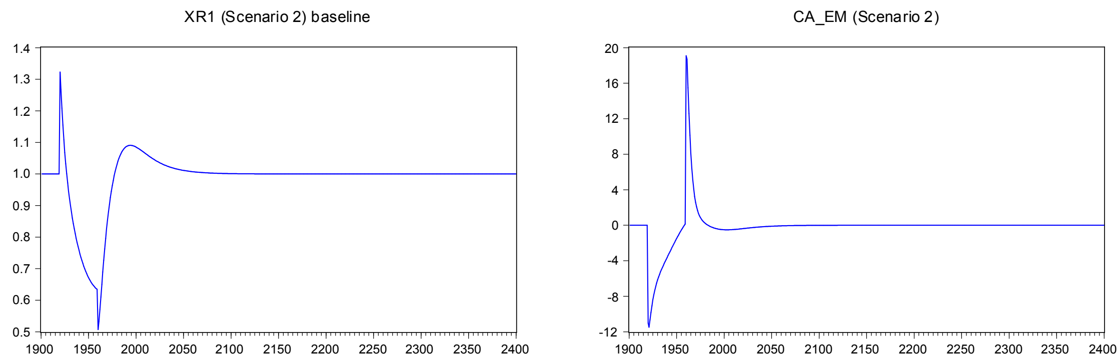
Response of the balance of payment components, under different exchange rate regimes, after an increase in desire to hold EM bills. The figure on the left shows the cases of FXR accumulating according to equation (53a) respectively. The figure on the right shows the cases of FXR accumulating according to equation (53b). Kflows shows private capital inflows, that is net purchases of institutional investors of EM bills.

Figure 12: Exchange rate with active λ_4



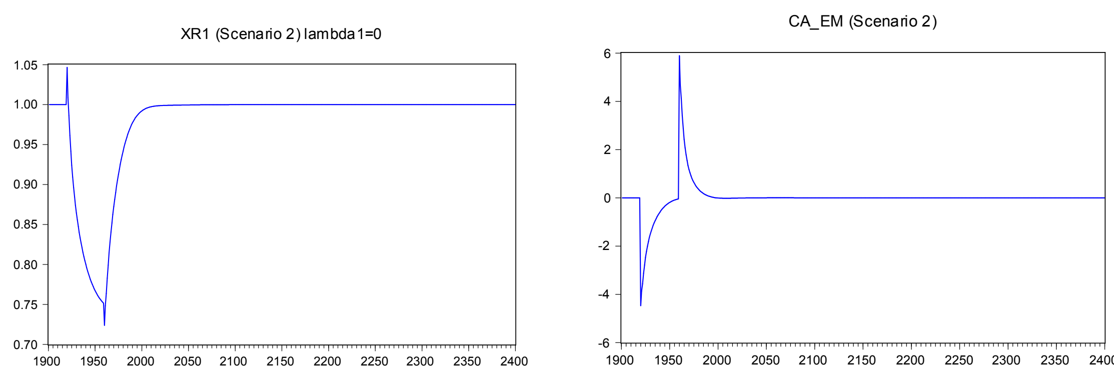
Response of the exchange rate, under different values of λ_4 after an increase in desire to hold EM bills

Figure 13: Exchange rate and current account



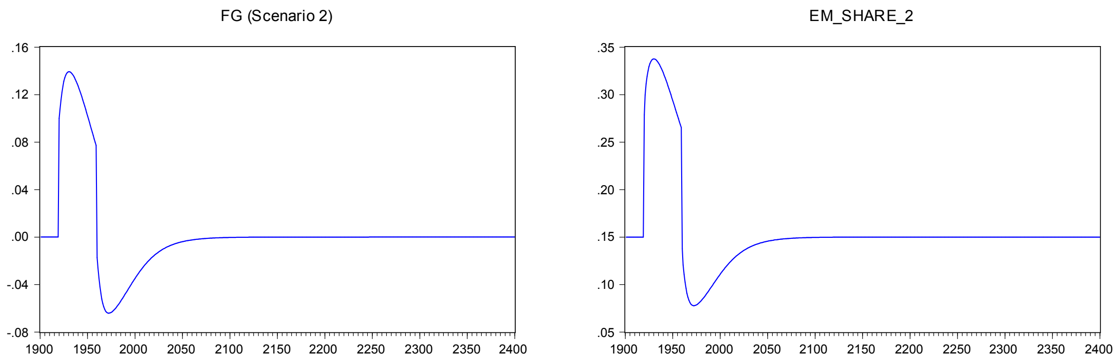
Response of the exchange rate and EM current account, with a double interest rate shock

Figure 14: Exchange rate and current account - no institutional investors



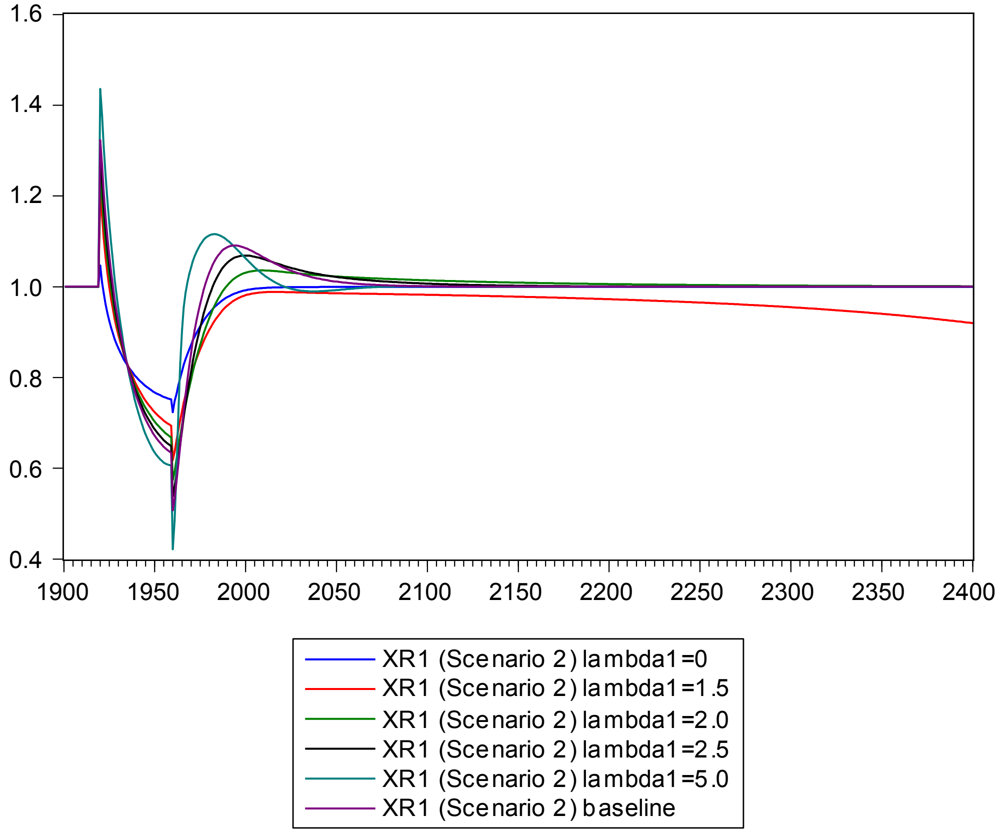
Response of exchange rate and EM current account, with a double interest rate shock, under $\hat{r}_{inst} = r_{inst} = r_{pbo}$

Figure 15: Funding gap and share of EM bills



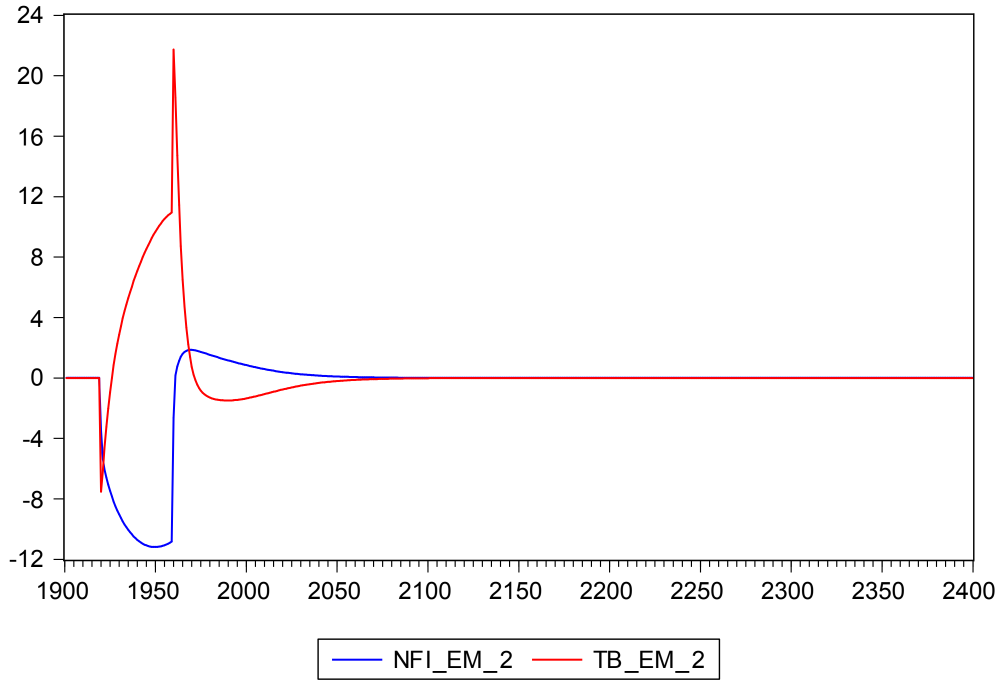
Effect on the funding gap and the share of EM government bills in the portfolio of institutional investors, with a double interest rate shock

Figure 16: Exchange rates under different parameter assumptions



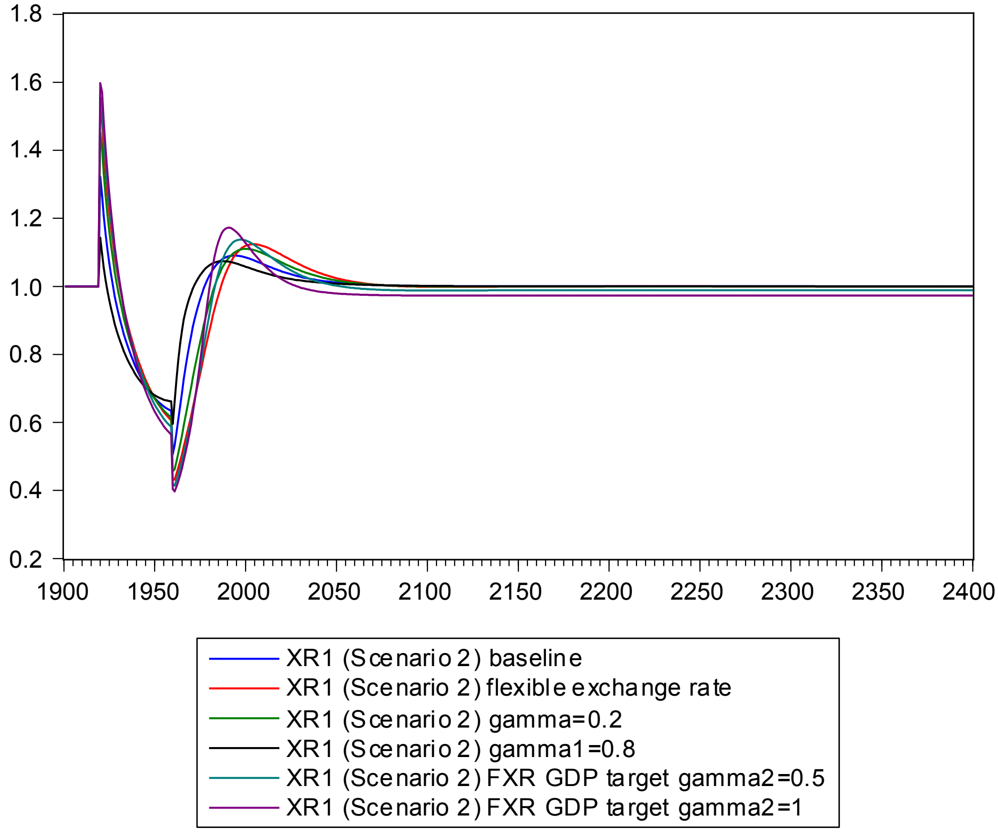
Response of the exchange rate under different assumptions for λ_1, with a double interest rate shock. The black line shows the case above, with $\hat{r}_{inst} = r_{inst} = r_{pbo}$

Figure 17: Balance of payments components



Response of the balance of payments components, with a double interest rate shock

Figure 18: Exchange rate under different regimes



Response of the exchange rate, under different exchange rate regimes with a multiple interest rate shock