Towards a Framework for Macroeconomic Analysis in an Emerging Market Economy

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First version: December 6, 2004
Current version: September 30, 2005

Abstract

Fear of floating, a policy taht usually intends to stabilize foreign debt, can destabilize it. The conclusion is drawn with a small open economy model thtis based on the financial accelerator and that is perturbed to analyze a sudden stop to captial flows. The model introduces exchange rate exposed sectorial balance sheets and sectorial stock and flow consistency. The policy implication is that during a sudden stop the exchange rate should be allowed to float. A case can be made for fear of floating if there are plans to reduce inflation.

JEL classification: E42; E58; F30; F41; G15; H62; H63

Keywords: Sectorial balance sheets; Debt sustainability; Inflation targeting; Sudden stops; New open economy models; Counter-cyclical policies; Country risk; Liability dollarization; Fear of floating

1 Introduction

In an emerging market economy, the government's balance sheet can make the difference between solvency and bankruptcy and the exchange rate is the key asset price in determining the government's net worth. Althoght the exchange rate is a key asset price in an emerging market, the literature on the financial accelerator has not yet included the effect of the exchange rate on the balance sheet of the government.

In this paper, the balance sheet of the government, along with the other sector's balance sheets, is incorporated into a New Open Economy Model (NOEM). The NOEM has sectoral stock and flow consistency and is based on the financial accelerator.

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The literature on the financial accelerator, which originated in Bernanke, Gertler and Gilchrist (1999), was extended to the case of the small open economy by Gertler, Gilchrist and Natalucci (2000), and Céspedes, Chang and Velasco (2000). There is a two country version in Gilchrist (2003), and a multicounty version in Gilchrist, Hairault and Kempf (2004).

While these papers dealt with the effect of the exchange rate on the balance sheet of entrepreneurs, other papers extend the financial accelerator to other sectors. Aoki, Proudman and Vlieghe (2002), for instance, explain financial crises as a consequence of the cycles in residential investment and dealt with the balance sheet of the household. Choi and Cook (2004) foxus on exchange rate balance sheet effects in the banking sector. This paper deals with exchange rate balance sheet effects in all sectors.

The effect of the exchange rate on financial wealth played an important role during the emerging market crisis at the end of the century. The price of capital, central to the theory of the financial accelerator, may have played a role in explaining the drop in output and demand. But in the narrative descriptions of crises the asset price that most abruptly changed net worth was the exchange rate. In this paper, less emphasis will be given to one of the more relevant features of financial crises in mature markets and in the financial accelerator literature −the role of physical capital and its price−, and instead one of the features widely believed to have an important effect on financial wealth during crises in emerging markets −the effect of the exchange rate on financial wealth− will be studied.

The paper is also related to the literature on crises, in particular to the third generation of crisis models which originated in Krugman (1999). Krugman (1999) considers a type of perturbation and a policy experiment like those studied here: a change in market sentiment and the difference that it makes to "let the exchange rate go or stabilize it". He also considers balance sheet effects in banks and in the corporate sector. In this paper, these issues are dealt with within the framework of a NOEM, and with an explicit treatment of the balance sheets of the government and the central bank.

The NOEM literature, launched by Obstfeld and Rogoff (1995), has been surveyed by Lane (2001) and Sarno (2001). New open economy models, like the one developed by Clarida, Galí and Gertler (2001), are characterized by price rigidities, monopolistic competition, and market frictions. Goodfriend and King (1997) call closed economy models with these features, like Woodford (2003), the new neoclassical synthesis.

Besides sectorial balance sheets, other features that will be incorporated into the NOEM of this paper are emerging market issues such as sudden stops, pro-cyclical policies, and the nature of the effect of monetary policy on fiscal policy.

Consider, first, sudden stops. When they occur, they become "*the* central issue" −in words of Krugman (1999)− of macroeconomic policy. A sudden stop is characterized by a large, sudden reversal in the inflow of capital, a sharp increase in the trade balance, a large drop in output, an even larger drop in absorption and an increase in poverty. Sudden stops spread through out emerging markets during 1997-2002. The stylized facts of sudden stops have been dealt with by Edwards (2004), Calvo, Izquierdo and Mejía (2003) and Calvo and Reinhart (2000a).

Based on asset pricing theory, Mendoza and Smith (2002, 2004) propose a model where sudden stops are *endogenous* and *anticipated*. Although in our model sudden stops are *exogenous* and *unanticipated*, our paper, like theirs, reproduces a collapse in output, absorption and in the value of the currency. Our characterization of sudden stops belongs to the family of models with monitoring costs and financial accelerator effects surveyed by Arellano and Mendoza (2002).

In our model, sudden stops are endogenous to market sentiment. Market sentiment, in turn, is a short cut for two elements. First, the apetite for risk on the part of investors and, second, the investor's perception of risk in the particular emerging market. A change in the perception of risk in the assets denominated in domestic currency increases the country risk premium. Whether the crisis occurs under a floating exchange rate, −as in Brazil in 2002− or under a hard peg as in Hong Kong in 1997−, or under a speculative attack on a crawling band −as in the emerging market crises of 1997-1999−, it is characterized by capital outflow, increased trade balance, drop in output, and an even larger drop in absorption.[1]

Consider now the second emerging market issue, pro-cyclical policies. In the case of interest rate policy, pro-cyclical policcy is fear of floating. As shown by Calvo and Reinhart (2000b), fear of floating is pervasive. Countries move interest rates (and also international reserves) to such extent that exchange rate regimes that are, de jure, floating are, de facto, rigid. In this paper we call the increase in the policy interest rate necesary to maintain the exchange rate pro-cyclical because it emphasizes the drop in output.

Pro-cyclical interest rate policy during a sudden stops have a cost that is not small. The cost is what Krugman (1999) calls the "decapitation of the entrepreneurial class". Absorption and output drop, the recession, in turn, also decapitates tax revenue. In addition, debt sustainability calls for pro-cyclical fiscal policy.

Pro-cyclical monetary and fiscal policies were at the core of the International Monetary Fund's strategy during crises. Williamson (2004) points out that "the issue of whether the IMF erred in urging higher interest rates on the crisis countries has never been definitively resolved in the way the fiscal issue was, where the IMF itself admitted it had made a mistake in initially pushing for a tightening." We hope to shade some light on the issue of the higher interest rates in this paper. We show that tight interest rates at a time of sudden stops exacerbate the increase in the government debt to GDP ratio. It is also shown that floating the exchange rate stabilizes government debt and does not seem to constitute a risk to inflation beyond one that is transitory.

Consider, finally, the effect of monetary policy on fiscal policy. As Woodford (2003) argues, in the context of advanced economies, the most important effect of monetary policy on fiscal policy is the role of the interest rate on debt

[1] For a treatment of the transfer problem see Krugman (1999) and Eichengreen (1994).

dynamics. In this paper, we show that in emerging markets as well, one of the most important issues about the effect of monetary policy on fiscal policy during crises in emerging markets is the effect of the monetary policy mix −interest rates and the exchange rate− on debt dynamics. It is sometimes believed that in less developed economies seignorage revenue is still the most important issue in the conduct of monetary policy. However, during the current period of price stability, and after a decade of financial innovation, seignorage can hardly be the exclusive or most important concern of monetary policy. In this study we seek to argue, as Woodford (2003) does for the case of advanced economies, that in emerging markets also a relevant fiscal dimension of monetary policy is the effect of the monetary policy mix on debt dynamics.

Also in relation to the issue of monetary and fiscal policies, it bears emphasis that in our framework, inflation is determined by marginal cost, the gap of the law of one price and inflation expectations; not by money. The advantage of a theory of inflation based on the Phillips curve and not on money is that it is a theory that is relevant for the conduct of monetary policy in the short run, and to explain not large changes in inflation but the evolution of inflation within a range of stability, which is the emphasis in the practice of inflation targeting. Even though the theory of inflation in our model is not monetary, the monetary base is included in the model in order to capture the effect of changes in the quantity of money *on the portfolio* of the central bank and of the household.[2]

The model in the paper takes the analytical tools that are commonly used today in isolation in policy making institutions −flow models of inflation targeting, stock and flow fiscal sustainability analysis, and macroeconomic programing− and makes them work in a single framework. A framework of the type presented here may help coordinate inflation targeting and fiscal responsibility policies. Under the current practice of inflation targeting, for instance, macroeconomic models often provide a common language that helps policy makers communicate. Models of this type may also help flesh out what has been called the "story", which is a coherent dynamic argument about where the economy is, what the impact of the foregoing shocks is, and what the role of policy can be. The story is usually the main thrust of the inflation targeting report. It also helps in accountability since past actions can be evaluated in light of the information available at the moment the decisions were made. A model of the type presented in this paper may, we hope, help build consistent projections for variables relevant to the monetary and fiscal authorities.

One important issue that is beyond the scope of the paper is a separate treatment of the balance sheet of the banking sector. In incorporating the banking sector into a general equilibrium model, we follow the approach of Bernanke, Gertler and Gilchrist (1999): there is no explicit treatment of the balance sheet of banks, but, instead, there is a pair of equations that represent the role of banks in the model. One equation is for the strength of the firm's balance sheet; the other one, for the premium on borrowing.[3] In our model,

[2] Nonetheless, as argued by King (2002), in the long run a superneutral model and the quantitative theory are not incompatible.

[3] Although banks are not explicitly modeled, the projections for price, flow and stock

the banking sector is part of the private sector −which is represented by the household.

There are five sections in the paper including this introduction. Sectorial balance sheets and sectorial stock and flow consistency are developed in section two. The remainder of the model is presented in section three. The fear of floating and free market approaches to the exchange rate under a sudden stop are studied in section four. The conclusions are given in section five.

2 The exchange rate and financial net worth

A lot of mileage can be gained by studying budget constraints and balance sheets alone without regard to optimizing behavior. In this section, the balance sheet and budget constraints of the economy and the sectors are combined to derive expressions for the law of evolution of overall and sectorial financial net worth. A simple equation is proposed for the valuation effect of the exchange rate on net foreign assets.

At this point some definitions are in order. The domestic nominal risk free rate, i_t^f, or policy rate, is determined by the monetary authority independently. The foreign risk free rate, i_t^{f*}, is determined by the foreign monetary authority, and in the model it is also the return received by those domestic residents that invest in the foreign country.

The country risk, ϕ_t, is the premium paid by a domestic issuer of debt, or the premium received by the holder of that debt, whether a domestic or foreign resident.

The domestic and foreign risky rates are defined as

$$\begin{aligned} i_t &= i_t^f + \phi_t \\ i_t^* &= i_t^{f*} + \phi_t \end{aligned} \tag{1}$$

These are the rates paid by an issuer of domestic and foreign debt respectively, or the interest received by the holder of these claims.

The expected return on assets in the two currencies is equalized by the uncovered interest parity condition. In other words, the exchange rate floats so that the expected return on the assets denominated in both currencies is the same.[4]

The average maturity of assets and liabilities in the domestic economy is T. In order to deal with the maturity of debt and assets in the model, it is assumed

variables that can be produced by a model of this type, can be used, in line with Hoggart (2003), to build stress tests for the banking sector. For a survey of stress tets that have been designed for the financial sector see also Sorge (2004).

[4] Were the exchange rate fixed, the risk free rates, domestic and foreign, would be equal to each other $r_t^f = r_t^{f*}$. In that case, instead of the uncovered interest parity condition, the arbitrage condition $r_t^f = r_t^{f*} + \phi_t$ would hold every period.

that every quarter each agent pays (receives) the interest rate of maturity T on the entire debt (asset) stock. The maturity T real risky rate is defined as:

$$\rho_t = \frac{1}{T}\sum_{j=0}^{T-1} r_t + \varrho \tag{2}$$

where $r_t = i_t - E_t \pi_{t+1}$, and ϱ is a term premium. Similar expressions for ρ_t^{f*} and ρ_t^* define maturity T risk free and risky rates in real terms in the foreign economy.

2.1 The valuation effect in the aggregate balance sheet

Assuming there is only one agent in the economy,[5] and assuming, for the moment, that debt matures in one period, the flow budget constraint may be written

$$P_t C_t^T = P_t Y_t + P_t S_t^T + (1 + i_{t-1}^*) A_{t-1}^* E_t - A_t^* E_t \tag{3}$$

where C_t^T is absorption, Y_t is gross *domestic* product, S_t^T is net transfers in the balance of payments, i_t^* is the one period foreign risky interest rate, A_t is net foreign assets, and E_t is the exchange rate.

Let $Q_t = E_t P_t^* / P_t$ be the real exchange rate and let $1 + r_t^* \equiv (1 + i_t^*)/(1 + \pi_{t+1|t}^*)$ be the real interest rate. It is useful to express the second term on the right hand side of the equation as a function of $1 + \chi_t = (Q_t / Q_{t-1})^4$, which is the rate of depreciation of the real exchange rate in annual terms. Dividing by P_t,

$$C_t^T = Y_t + S_t^T + (1 + r_{t-1}^*)(1 + \chi_t)\frac{A_{t-1}^* E_{t-1}}{P_{t-1}} - \frac{A_t^* E_t}{P_t}$$

For debt sustainability analysis, we will deal with the balanced growth path[6]. The equation is, hence, divided by steady state GDP, $\bar{Y}_t$:

$$s_t = -\frac{(1 + r_{t-1}^*)(1 + \chi_t)}{1 + \bar{\gamma}} a_{t-1} + a_t \simeq -(1 + r_{t-1}^* + \chi_t - \bar{\gamma}) a_{t-1} + a_t - s_t^T \tag{4}$$

where flow and stock variables denoted with small case letters indicate percent of steady state output, $y_t \equiv Y_t / \bar{Y}_t$ is output expressed in percent of steady state output, $s_t = y_t - c_t^T$ is the trade balance, and $\bar{\gamma}$ is the rate of growth of steady state output.

[5] Although the model has three agents, to facilitate the exposition, in this section we deal with an economy with a single agent.

[6] In the balanced growth path, the long run growth of flow and stock variables is equal to the rate of growth of trend output and the shares in trend output are constant. Let $\hat{x}_t$ be the percentage deviation of variable x from the steady state and let $\bar{x}$ be the steady state share of variable x in output. It can be shown that the deviation of flow and stock variables measured in percent of steady state output is $x_t = \bar{x}\hat{x}_t$. One of the advantages of the measure x_t is that all variables are in the same numerare. This simplifies some algebraic expressions and also facilitates the reading of the impulse response functions.

As there is no capital stock in the economy, agents hold only financial assets and the aggregate balance sheet can be written,

$$a_t = n_t \tag{5}$$

where a_t is net foreign assets and n_t is financial net worth.

Now, we combine the budget constraint (4) and the aggregate balance sheet (5) to obtain the law of evolution of net worth

$$n_t = (1 + \chi_t)n_{t-1} + s_t^s \tag{6}$$

where, the current account is

$$s_t^s = s_t + s_t^i + s_t^T \tag{7}$$

the cost of interest is

$$s_t^i = (r_{t-1}^* - \bar{\gamma})a_{t-1} \tag{8}$$

and s_t^T is net transfers in the balance of payments. All of these terms are expressed in units of steady state output.

Equation (6) shows that financial net worth or net foreign assets will change along with changes in the current account and also along with changes in the exchange rate. The effect of the exchange rate on the valuation of net foreign assets, the valuation effect, hardly been explored in the literature, two exceptions are Lane and Milesi-Ferretti (2005) and Gourinchas and Rey (2005).

If net foreign assets are negative, an exchange rate depreciation causes the country's net worth to deteriorate. The larger the country's un-hedged debt, the greater will be the impact of exchange rate depreciation on net worth.

The effect of the exchange rate on net worth is often called a "valuation effect." Althought this name suggest the effect is pure accounting, it actually is not. An exchange rate depreciation does change the value of debt (or wealth) in terms of the domestic good.

In our framework, the valuation effect does not belong to flow accounting but to "stock valuation." That is why the choice has been made to include the valuation effect, not in the equation of the current account (7), but in the law of evolution of net worth (6).

2.2 The valuation effect in sectorial balance sheets

Three agents are taken into account: the government, the central bank and the household. Let them be denoted by the superscripts G, CB, and H. Aggregate and sectorial balance sheets are shown in Table 1[7].

The government holds debt denominated in foreign and domestic currencies, D_t^G and B_t^G. For simplicity, the government does not hold money.

The central bank holds international reserves, A_t^{CB}, and government paper, B_t^{CB}. It also owes money, H_t, to its holder, the household.

The household has foreign assets, A_t^H, government paper, B_t^H, and money, H_t.

[7] The set up in Table 1 may be modified for other specifications of sectorial balance sheets.

Economy		Government		Central bank		Household	
A_t	N_t		D_t^G	A_t^{CB}	H_t	A_t^H	N_t^H
			B_t^G	B_t^{CB}	N_t^{CB}	B_t^H	
			N_t^G			H_t	

Table 1: Sectoral balance sheets

Normalizing by steady state output, sectorial balance sheets may be written:

$$\begin{aligned} 0 &= -d_t^G - b_t^G + n_t^G \\ a_t^{CB} + b_t^{CB} &= h_t + n_t^{CB} \\ a_t^H + b_t^H + h_t^H &= n_t^H \end{aligned} \tag{9}$$

Consistency across sectors imposes three conditions. First, that net foreign assets are the sum of foreign debts and claims, $a_t = -d_t^G + a_t^{CB} + a_t^H$; second, that domestic government bonds are in zero net supply, $b_t^G = b_t^{CB} + b_t^H$; and third, that total net worth is the sum of sectorial net worth, $n_t = n_t^G + n_t^{CB} + n_t^H$.

Now consider the sectorial budget constraints:

$$\begin{aligned} G_t &= T_t^H + T_t^{CB} + S_t^{T,G} - (1+\rho_{t-1}+\chi_t)\frac{D_{t-1}^G}{P_{t-1}} + \frac{D_t^{G*}E_t}{P_t} \\ &\quad -(1+\rho_{t-1})\frac{B_{t-1}^G}{P_{t-1}} + \frac{B_t^G}{P_t} \\ \Pi_t^{CB} &= -T_t^{CB} + (1+\rho_{t-1}^{f*}+\chi_t)\frac{A_{t-1}^{CB}}{P_{t-1}} - \frac{A_t E_t}{P_t^*} + (1+\rho_{t-1})\frac{B_{t-1}^{CB}}{P_{t-1}} \\ &\quad -\frac{B_t^{CB}}{P_t} - \frac{1}{1+\pi_t}\frac{H_{t-1}}{P_{t-1}} + \frac{H_t}{P_t} \\ C_t &= \frac{W_t}{P_t}L_t + S_t^{T,H} - T_t^H + \Pi_t^F + (1+\rho_{t-1}^{f*}+\chi_t)\frac{A_{t-1}^{H*}E_{t-1}}{P_{t-1}} - \frac{A_t^{H*}E_t}{P_t} \\ &\quad +(1+\rho_{t-1})\frac{B_{t-1}^H}{P_{t-1}} - \frac{B_t^H}{P_t} + \frac{1}{1+\pi_t}\frac{H_{t-1}}{P_{t-1}} - \frac{H_t}{P_t} \end{aligned} \tag{10}$$

According to these constraints, government expenditure must be financed by taxes T_t^H, a transfer from the central bank, T_t^{CB}, net public transfers in the balance of payments, $S_t^{T,G}$, and the roll over of foreign and domestic debt adjusted for the cost of interest.

The uses of funds in the central bank are: a transfer to the government, T_t^{CB}, and the change in the different assets and liabilities (which may be proved to be equal to the change in financial wealth[8]. The source of funds in the central bank

[8] The change in financial wealth, in percent of steady state output, is $n_t^{CB} - n_{t-1}^{CB}$.

is the interest on foreign reserves and on government paper. Letting $\Pi_t^{CB} = 0$, the central bank budget constraint is an expression either for the transfer from the central bank to the government or for the central bank's net worth; the higher the net worth, the lower the transfer and vice versa[9].

The budget constraint of the household states that consumption is financed by disposable income, interest on the household assets, and the rollover of the household assets. Disposable income is $Y_t + S_t^{T,H} - T_t^H$, where $Y_t = \frac{W_t}{P_t} L_t$ is gross *domestic* product, $S_t^{T,H}$ is net private transfers or workers remittances in the balance of payments, and T_t^H is lump sum non-distortionary taxes. The profits of the two types of firms, Π_t^F,[10] also accrue to the household.

Since, as noted above, our interest is in an economy that moves along a balanced growth path, let us divide the budget constraints by steady state output, $\bar{Y}_t$:

$$\begin{aligned} g_t &= \tau_t^H + \tau_t^{CB} + s_t^{T,G} - (1 + \rho_{t-1} + \chi_t - \bar{\gamma}) d_{t-1}^G + d_t^G \\ &\quad -(1 + \rho_{t-1} - \bar{\gamma}) b_t^G + b_t^G \\ \tau_t^{CB} &= (1 + \rho_{t-1}^{f*} + \chi_t - \bar{\gamma}) a_{t-1}^{CB} - a_t^{CB} + (1 + \rho_{t-1} - \bar{\gamma}) b_{t-1}^{CB} - b_t^{CB} \\ &\quad -(1 - \pi_t - \bar{\gamma}) h_{t-1} + h_t \\ c_t &= y_t + s_t^{T,H} - \tau_t^H + (1 + \rho_{t-1}^f + \chi_t - \bar{\gamma}) a_{t-1}^H - a_t^H \\ &\quad +(1 + \rho_{t-1} - \bar{\gamma}) b_{t-1}^H - b_t^H + (1 - \pi_t - \bar{\gamma}) h_{t-1} - h_t \end{aligned} \tag{11}$$

The budget constraints (11) are combined with the balance sheets (9) to obtain the law of evolution of sectorial net worth:

$$\begin{aligned} n_t^G &= n_{t-1}^G + s_t^G + s_t^{i,G} + s_t^{T,G} - \chi_t d_{t-1}^G \\ n_t^{CB} &= n_{t-1}^{CB} + s_t^{CB} + s_t^{i,CB} + \chi_t a_{t-1}^{CB} \\ n_t^H &= n_{t-1}^H + s_t^H + s_t^{i,H} + s_t^{T,H} + \chi_t a_{t-1}^H \end{aligned} \tag{12}$$

where the sectorial primary structural[11] balance is

$$\begin{aligned} s_t^G &= \tau_t^H + \tau_t^{CB} - g_t \\ s_t^{CB} &= -\tau_t^{CB} \\ s_t^H &= y_t - \tau_t^H - c_t \end{aligned} \tag{13}$$

and the cost of interest (also in percent of steady state output) is:

$$\begin{aligned} s_t^{i,G} &= -(\rho_{t-1}^* - \bar{\gamma}) d_{t-1}^G - (\rho_{t-1} - \bar{\gamma}) b_{t-1}^G \\ s_t^{i,CB} &= (\rho_{t-1}^{f*} - \bar{\gamma}) a_{t-1}^{CB} + (\rho_{t-1} - \bar{\gamma}) b_{t-1}^{CB} + (\pi_t + \bar{\gamma}) h_{t-1} \\ s_t^{i,H} &= (\rho_{t-1}^{f*} - \bar{\gamma}) a_{t-1}^H + (\rho_{t-1} - \bar{\gamma}) b_{t-1}^H - (\pi_t + \bar{\gamma}) h_{t-1} \end{aligned} \tag{14}$$

[9] Jeanne and Svensson (2004) also obtain an equation of this sort.

[10] As firms do not hold assets or liabilities, they are not studied in this section.

[11] It is structural since the numerare is steady state output.

Expressions (12) for sectorial net worth show that not only the exchange rate but also primary savings and the cost of interest have an effect on the evolution of net worth. As will be shown in the section on policy analysis, the primary balance and the interest service on the debt can have larger and more lasting effects on the evolution of financial wealth than the exchange rate.

On impact, an exchange rate depreciation has different effects throughout sectors. If, as in our simulation exercise, the government is a net debtor in foreign currency, and the central bank, the household, and the economy as a whole, net creditors, then, based on expressions (12), an exchange rate depreciation causes net worth to deteriorate in the government sector and to improve in the central bank, in the household and in the economy as a whole.

By adding up the equations in (14), a version of equation (8) in the multiple agent economy obtains:

$$s_t^i = (r_{t-1}^{f*} - \bar{\gamma})(a_{t-1}^{CB} + a_{t-1}^{H}) - (r_{t-1}^{*} - \bar{\gamma})d_{t-1}^{G} \tag{15}$$

2.3 The portfolio

Expressions for sectorial net worth have been obtained and a demand for money will also be derived. In order to complete the derivation of each of the components of the sectorial portfolios, we are left to determine the composition of sectorial claims between those denominated in domestic and foreign currencies. Define total domestic and foreign financial assets by sector, f_t^G, f_t^{CB} and f_t^H as

$$\begin{aligned} f_t^G &\equiv -n_t^G \\ f_t^{CB} &\equiv n_t^{CB} + h_t^{CB} \\ f_t^H &\equiv n_t^H - h_t \end{aligned} \tag{16}$$

Also, let the share of financial assets in foreign currency, by sector, be $\bar{\alpha}_t^G$, $\bar{\alpha}_t^{CB}$, and $\bar{\alpha}_t^H$. Foreign and domestic assets may be obtained as

$$\begin{aligned} d_t^G = \bar{\alpha}^G f_t^G, &\quad b_t^G = (1-\bar{\alpha}^G) f_t^G \\ a_t^{CB} = \bar{\alpha}^{CB} f_t^{CB}, &\quad b_t^{CB} = (1-\bar{\alpha}^{CB}) f_t^{CB} \\ a_t^H = \bar{\alpha}^H f_t^H, &\quad b_t^H = (1-\alpha^H) f_t^H \end{aligned} \tag{17}$$

In the model, the shares of foreign and domestic assets in the portfolio are constant.[12]

2.4 Effect of risk on the exchange rate

Let the premium on risky domestic debt be determined as

$$\phi_t = -c_{\phi n}\hat{n}_t + \varepsilon_t^{\phi}, \tag{18}$$

[12] The choice of portfolio, as well as its effects, the effects of foreign exchange intervention) is beyond the scope of the paper.

and let, in turn, the country risk premium be the residual of the uncovered interest parity condition:

$$Q_t = Q_{t+1|t} \left[\frac{(1 + r_t^{f*})}{(1 + r_t^f)} (1 + \phi_t) \right]^{0.25} \tag{19}$$

Here, Q_t is the real exchange rate, and r_t^f and r_t^{f*} are the real risk free rates at home and abroad in annual terms[13].

As domestic bonds are in zero net supply, a decrease in net foreign assets changes the country's portfolio towards the risky domestic asset. As a result, country risk increases, and the foreign banks will increase the degree of monitoring. The country risk premium will increase. The increase in the risk of holding domestic securities makes the exchange rate jump on impact so that the expected appreciation is negative. The expected appreciation equalizes the return on foreign and domestic assets.

3 The New Open Economy Model

In this section, the remainder of the framework is presented, a NOEM with inflation rigidity, sluggish pass-through, a hypothetical flexible price equilibrium and market frictions.

Following the "minimalistic" approach of Rotemberg and Woodford (1998) and McCallum and Nelson (2001) there is no investment or capital in the model. The inclusion of capital would not make any difference to the issues of interest and policy experiments performed. Household consumption, then, accounts for consumption and investment in a real economy, and the household represents the private sector.

Besides the three agents already considered in the preceding section, there are two representative firms. One produces the home good; the other, distributes the imported good. In the model, the role of firms is to generate price and inflation stickiness. They do not invest or hold financial assets, so, there are no balance sheet effects associated with them.

Firms that distribute the imported good are monopolistic competitors. Firms that produce the domestic good are monopolistic competitors and also hire labor in a competitive market. Unlike prices, wages are free to move every period.

The "minimalistic" approach led us to synthesize all public and private exchange rate balance sheet effects within the balance sheet of the household. With the reaction of the household to financial wealth in the overall economy, the reaction of all agents in the real world is represented.

Foreign banks are financial intermediaries for the financing of domestic expenditure. As in the financial accelerator literature, there is asymmetric information between foreign lenders and domestic borrowers that generates a spread between the risky and the risk free interest rates (the extra cost of funds in

[13] Throughout the paper, the notation $X_{t+1|t} = E_t X_{t+1}$ will be used to denote the expected value of variable X_t given information up to time t.

the emerging market). As explained above, when the balance sheet of the whole economy deteriorates, country risk increases, foreign banks increase the degree of monitoring and the country spread increases. In Bernanke, Gertler and Gilchrist (1999), the external finance premium depends inversely on the ratio of net worth to the firm's capital. In our model without a capital stock, the spread depends negatively on net worth alone[14].

Since the model was designed for policy analysis, it is intended to be relevant empirically. Nominal and real rigidities are, hence, included. The Calvo (1983) and Yun (1996) type of price rigidity, in the variant of Christiano, Eichembaum and Evans (2001), Eichembaum and Fisher (2004) and Woodford (2003), is introduced into the model. Real rigidities are introduced in the form of habit persistence, a type of "catching up with the Joneses". Following Smets and Wounters (2004) and Christiano, Eichembaum, Evans (2001), the habit is external.

The most important effects of the exchange rate on output seem to be demand-driven. For this reason, the supply side of the model is kept as simple as possible; in particular, the exchange rate does not have any effect on supply[15].

The two frictions of the model are a debt elastic risk premium −equation (18)−, and rule of thumb consumption. The two frictions are important to make flows and stocks well behaved.

There are two goods, one domestic and one foreign; both goods are tradable.

3.1 Households

There are two members in the household a permanent income consumer and a rule of thumb consumer. The permanent income consumer solves a standard maximization problem. The restricted consumer follows a rule of thumb.

3.1.1 The permanent income consumer

The household problem is to maximize utility

$$U_t = E_{t|t-d} \sum_{t=0}^{\infty} \beta^i \left[\frac{(C_{t+i}^{\Delta U})^{1-\sigma}}{1-\sigma} + \frac{(\tilde{H}{}^{\Delta}_{t+i})^{1-k}}{1-\kappa} - \frac{L_{t+i}^{1+\eta}}{1+\eta} \right] \tag{20}$$

subject to the corresponding budget constraint in (10). Restricted consumption is taken by the household as a given.

In (20), the quasi-difference $C_t^{\Delta U}$ is the habit in consumption defined as $C_t^{\Delta U} = C_t^U - \gamma_c \overset{\frown}{C}{}^U_{t-1}$, where $\overset{\frown}{C}{}^U_t$ is aggregate unrestricted consumption. The object $\tilde{H}{}^{\Delta}_t$ is the habit in money holdings, where $\widetilde{H}_t = H_t/P_t$ is real balances of the monetary base, and L_t, is hours worked.

[14] An alternative approach has been followed by Christiano, Ghust and Roldos (2002). They keep the capital stock constant.

[15] For a treatment of the effect of the exchange rate on supply, see also Chistiano, Gust and Roldos (2002).

Consumption is determined d periods in advance. Let $X_{t|t-d} \equiv E_{t-d}X_t$ be the expected value of variable X_t with information given up to time $t-d$. Among the first order conditions for the household problem are:

$$(C_t^{\Delta U})^{-\sigma} = \beta(1 + r_{t|t-d})(C_{t+1|t-d}^{\Delta U})^{-\sigma} \tag{21}$$

$$L_t^{\eta}(C_t^{\Delta U})^{\sigma} = \frac{W_t}{P_t} \tag{22}$$

and the uncovered interest parity condition (19).[16]

Let hats denote log deviation from the steady state. In deviation form, from equation (21), unrestricted consumption is:[17]

$$\hat{c}_t^{\Delta U} = -\sigma^{-1} r_{t|t-d} + \hat{c}_{t+1|t-d}^{\Delta U} + \varepsilon_t^{cu} \tag{23}$$

3.1.2 The rule of thumb consumer

As mentioned above, all balance sheet effects on expenditure are aggregated in the balance sheet of the household. The behavioral equation for the restricted consumer is postulated as:

$$\hat{c}_t^{\Delta R} = \mu^H \hat{n}_{t-1|t-d} \tag{24}$$

where $\mu^H > 0$.

According to (24), if net worth is above the steady state, rule of thumb consumption decreases and vice versa.

3.1.3 Domestic and foreign goods

Household consumption is a composite of home and imported goods. The household chooses between domestic and imported goods by minimizing:

$$P_{H,t}C_{H,t}^{U} + P_{F,t}C_{F,t}^{U} \tag{25}$$

subject to

$$C_t^{\Delta U} = \left[(1-\bar{c}_F)^{\frac{1}{\upsilon}}(C_{H,t}^{\Delta U})^{\frac{\upsilon-1}{\upsilon}} + \bar{c}_F^{\frac{1}{\upsilon}}(C_{F,t}^{\Delta U})^{\frac{\upsilon-1}{\upsilon}}\right]^{\frac{\nu}{\nu-1}} \tag{26}$$

where (26) is the composite, $\bar{c}_F$ is the steady state share of imports in output, and υ is the elasticity of substitution between domestic and foreign goods. The

[16] Note that in the Euler equation consumption depends on the risky interest rate.

[17] Here, the variable r_t also means deviation from the steady state. However, in order to simplify the notation, a hat has been used explicitly only in the cases where it is necessary to differenciate the log deviation $\hat{x}_t = \log X_t - \log \bar{X}_t$ from deviation in units of steady state output: $x_t = \bar{x}\hat{x}_t$.

quasi-differences $C_{H,t}^{\Delta U}$ and $C_{F,t}^{\Delta U}$ are defined in obvious ways. Optimization gives the demand functions for home and imported consumption:

$$C_{H,t}^{\Delta U} = \left(\frac{P_{H,t|t-d}}{P_{t|t-d}}\right)^{-\upsilon} C_{t|t-d}^{\Delta U} \tag{27}$$

$$C_{F,t}^{\Delta U} = \left(\frac{P_{F,t|t-d}}{P_{t|t-d}}\right)^{-\upsilon} C_{t|t-d}^{\Delta U} \tag{28}$$

where

$$P_t \equiv \left[(1-\overline{c}_F)P_{H,t}^{1-\upsilon} + \overline{c}_F P_{F,t}^{1-\upsilon}\right]^{\frac{1}{1-\upsilon}} \tag{29}$$

is the CPI, and home and imported consumption is also predetermined d periods.

The rule of thumb consumer also solves the problem of allocating a consumption budget between imported and domestically produced goods.

3.1.4 The demand for consumption

Approximating (29) around the steady state so that $p_t = (1-\overline{c}_F)p_{H,t} + \overline{c}_F p_{F,t}$, conditions (27) and (28) for the unrestricted and restricted consumers may be written:

$$\hat{c}{}_{H,t}^{\Delta U} = \delta\upsilon\varphi_{t|t-d} + \hat{c}{}_{t|t-d}^{\Delta U} + \varepsilon_t^{UH} \tag{30}$$

$$\hat{c}{}_{F,t}^{\Delta U} = -\upsilon\varphi_{t|t-d} + \hat{c}{}_{t|t-d}^{\Delta U} + \varepsilon_t^{UF} \tag{31}$$

$$\hat{c}{}_{H,t}^{\Delta R} = \delta\upsilon\varphi_{t|t-d} + \hat{c}{}_{t|t-d}^{\Delta R} + \varepsilon_t^{RH} \tag{32}$$

$$\hat{c}{}_{F,t}^{\Delta R} = -\upsilon\varphi_{t|t-d} + \hat{c}{}_{t|t-d}^{\Delta R} + \varepsilon_t^{RF} \tag{33}$$

where $\varphi_t = p_{F,t} - p_t$ is a measure of the real exchange rate and $\delta \equiv \overline{c}_F/(1-\overline{c}_F)$.

Multiplying each type of consumption by its share in output in the steady state, gives the deviation of each of the components of consumption in percent of steady state output:

$$\begin{aligned} c_t &= c_{H,t} + c_{F,t} \\ c_{H,t} &= c_{H,t}^U + c_{H,t}^R \\ c_{F,t} &= c_{F,t}^U + c_{F,t}^R \end{aligned} \tag{34}$$

3.1.5 A variety of goods

Consumption of domestically produced goods is a composite of an infinite number of goods indexed in the interval (0,1) and produced under monopolistic competition. The household allocates the budget for home goods by minimizing

$$\int_0^1 P_{H,j,t} C_{H,j,t} dj \tag{35}$$

subject to the definition of the composite good $C_{H,t}$:

$$C_{H,t} = \left[\int_0^1 C_{H,j,t}^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}} \tag{36}$$

The solution to this problem yields the demand function

$$C_{H,j,t} = \left(\frac{P_{H,j,t}}{P_{H,t}} \right)^{-\theta} C_{H,t} \tag{37}$$

where $P_{H,t} = \left[\int_0^1 P_{H,j,t}^{1-\theta} dj \right]^{\frac{1}{1-\theta}}$ is the price index of domestically produced goods.

Consumption of imported goods is also a composite of an infinite number of goods distributed under monopolistic competition. Following the minimization problem described above for domestically produced goods, the household demands imported good j according to:

$$C_{F,j,t} = \left(\frac{P_{F,j,t}}{P_{F,t}} \right)^{-\theta} C_{F,t} \tag{38}$$

where $P_{F,t} = \left[\int_0^1 P_{F,j,t}^{1-\theta} dj \right]^{\frac{1}{1-\theta}}$.

3.1.6 The demand for money

The role of money in the model was explained in the introduction. The demand function is:

$$\hat{h}{}_t^{\Delta} = \frac{1}{\kappa} \left[\sigma \hat{c}{}_t^{\Delta U} - [(1 - \bar{i})/\bar{i}] i_t^f \right] \tag{39}$$

where $\bar{i}$ is the nominal interest rate in the steady state. The demand for money (39) is derived in Appendix C.

3.2 The government

As Woodford (2003) points out, "a fiscal policy commitment is an essential part of a policy framework to achieve macroeconomic stability, in addition to a suitable monetary policy commitment." In our artificial economy, the government is committed to following the tax rule

$$\tau_t^H = c_{\tau y} y_t - \mu^G n_{t-1}^G + \varepsilon_t^\tau \tag{40}$$

where $\mu^G > 0$.

Within our calibration, by combining first, equation (40); second, the expression for the government balance in (13); and third, the linear version of equation (12),[18] a bounded process for net worth obtains.[19]

Government expenditure, in turn, follows

$$g_t^\Delta = \varepsilon_t^G \tag{41}$$

3.3 The central bank

The central bank dividend rule is:

$$\tau_t^{CB} = s_t^{i,CB} + \mu^{CB} n_{t-1}^{CB} \tag{42}$$

where $\mu^{CB} > 0$.

Besides determining the transfer to the government, the central bank is committed to following the Taylor rule:

$$i_t^f = \pi_{t+1|t} + r_t^o + 0.75(\pi_t - \pi_t^{TAR}) + 0.5(y_t - y_t^o) - c_{i\chi}\chi_{t+1|t} \tag{43}$$

where y_t^o is the deviation of output from the steady state if prices were flexible, r_t^o is the natural real interest rate, that is, the interest rate that would hold if prices were flexible, and the coefficient $c_{i\chi}$ is nonnegative.[20]

The coefficient $c_{i\chi}$ takes values according to the two policies studied in the paper. In the simulations, $c_{i\chi} = 0$ is used for floating, and, $c_{i\chi} > 0$ for fear of floating.

3.4 The foreign country

Exports are given by

$$\begin{aligned} \hat{c}{}_t^{\Delta *} &= -\sigma^{-1} r_{t|t-d}^* + \hat{c}{}_{t+1|t-d}^{\Delta *} + \varepsilon_t^{C*} \\ \hat{c}{}_{F,t}^{\Delta *} &= \frac{\delta \upsilon}{\bar{c}_F} q_{t|t-d} + \hat{c}{}_{t|t-d}^{\Delta *} + \varepsilon_t^{CF*} \end{aligned} \tag{44}$$

These expressions are derived in Appendix B.

[18] The linear version of the model is in Appendix 1.

[19] In the terminology of Woodford (2003), this implies that the government follows a fiscal policy that is locally Ricardian.

[20] The exchange rate is defined as the number of domestic currency units per unit of foreign currency. The expected depreciation enters the policy rule with a negative sign because, given a long run real exchange rate of zero, a negative expected depreciation means that the exchange rate is depreciated. The real exchange rate in the policy rule is also written in terms of expected changes because the exchange rate enters the uncovered interest parity condition in terms of expected changes.

3.5 Price and inflation stickiness

In deviation form, CPI inflation is a convex combination of domestic and imported inflation,

$$\pi_t = (1 - \bar{c}_F)\pi_{H,t} + \bar{c}_F \pi_{F,t} \tag{45}$$

Let us now turn to the study of how each of the components on the right hand side of equation (45) is determined.

3.5.1 Inflation of domestically produced goods

As in the case of the consumption of domestically produced goods, government expenditure and exports are also a composite of an infinite number of goods. The domestic and foreign households as well as the government all solve the problem in equations (35) and (36). Each one of them demands good j according to equation (37), and according to similar expressions for $G_{j,t}$ and $C^*_{F,j,t}$. Aggregate demand for good j is hence $Y_{j,t} = C_{H,j,t} + G_{j,t} + C^*_{F,j,t}$, and may be written

$$Y_{j,t} = \left(\frac{P_{H,j,t}}{P_{H,t}}\right)^{-\theta} Y_t \tag{46}$$

Firms face the demand curve (46) and produce under the constant returns to scale production function $Y_{j,t} = Z_t L_t$, where Z_t is the technology factor. The firm's static problem is to minimize cost:

$$\Pi^F_t = \frac{W_t}{P_{H,t}} L_t + MC_t(Y_{j,t} - Z_t L_t) \tag{47}$$

where MC_t is real marginal cost and W_t is the nominal wage.

The optimality condition for this problem is:

$$MC_t = \frac{W_t/P_{H,t}}{Z_t} \tag{48}$$

Product and consumption wages in real terms are defined as $X_{H,t} = W_t/P_{H,t}$, and $X_t = W_t/P_t$ respectively. It can be shown that, given the steady state condition $P_t = P^{1-\bar{c}_F}_{H,t} P^{\bar{c}_F}_{F,t}$, the real product wage is related to the real consumption wage:

$$X_{H,t} = X_t \Phi^{\delta}_t \tag{49}$$

where, $\Phi_t \equiv P_{F,t}/P_t$, is a measure of the real exchange rate.

According to equations (22) and (49), the real product wage is, in turn, a function of the marginal rate of substitution between consumption and labor, and of the exchange rate Φ_t. In addition, labor is given by

$$L_t = Y_t/Z_t$$

Let us now turn to the firm's dynamic problem. A firm that produces a domestic good reoptimizes its price with probability ω_H. If the firm does not reoptimize, it changes the price by a proportion γ_H^π of lagged inflation of domestic goods:

$$\widetilde{P}_{H,j,t} = \gamma_H^\pi \pi_{H,t-1} \widetilde{P}_{H,j,t-1} \tag{50}$$

Let $\widetilde{P}_{H,j,t}$ be the optimal price chosen by the firm when it reoptimizes. Define $X_{t,l} = (\gamma_H^\pi)^l \pi_t \pi_{t+1} \pi_{t+2} ... \pi_{t+l-1}$ for $l \geq 1$ and $X_{t,l} = 1$ for $l = 0$. Equation (50) may be expressed as $\widetilde{P}_{H,j,t+l} = X_{t,l} \widetilde{P}_{H,j,t}$.

The problem of the firm is to pick an optimal price $\widetilde{P}_{H,t}$ to maximize its expected profits

$$E_t \sum_{i=0}^{\infty} \omega_H^i \Delta_{i,t+i} \left[\left(\frac{P_{H,j,t}}{P_{H,t+i}} \right) y_{j,t+i} - MC_{t+i} y_{j,t+i} \right]$$

subject to (46).

In the symmetric solution, all firms choose the same price. So, subscript j can be omitted. The first order condition with respect to the optimal price $\widetilde{P}_t$ is

$$0 = \sum_{i=0}^{\infty} \omega_H^i \Delta_{i,t+i} \left[(1-\theta) \left(\frac{\widetilde{P}_{H,t}}{P_{H,t+i}} \right) + \theta MC_{t+i} \right] \left(\frac{X_{t,i}}{P_{H,t+i}} \right)^{-\theta} Y_{t+i}$$

After some algebra, and letting $\Delta_{i,t+i} = \beta^i \left(\frac{Y_{t+i}}{Y_t} \right)^{-\sigma}$, this expression may be written,

$$\frac{\widetilde{P}_{H,t}}{P_{H,t}} = \frac{\theta}{\theta - 1} \frac{\sum_{i=0}^{\infty} \omega_H^i \beta^i MC_{t+i} Y_{t+i}^{1-\sigma}}{\sum_{i=0}^{\infty} \omega_H^i \beta^i X_{t,i}^{-1} Y_{t+i}^{1-\sigma}} \tag{51}$$

Using $P_{H,t}^{1-\theta} = (1-\omega_H) \widetilde{P}_{H,t}^{1-\theta} + \omega_H P_{H,t-1}^{1-\theta}$ and linearizing around $\pi_{H,t} = 0$, Christiano, Eichembaum and Evans (2001) propose the Phillips curve that, in terms of the quasi-difference of inflation, may be written:

$$\pi_{H,t}^{\Delta} = \pi_{H,t+1|t-d}^{\Delta} + \frac{(1-\beta\omega_H)(1-\omega_H)}{\omega_H} mc_{t|t-d} \tag{52}$$

where inflation is predetermined d periods, and $\pi_{H,t}^{\Delta} = \pi_{H,t} - \gamma_H^\pi \pi_{H,t-1}$ is the quasi-difference of inflation in the price of goods produced domestically.

3.5.2 Inflation of imported goods

When the pass-through is complete and immediate, the law of one price holds. Under complete and immediate pass-through, the domestic price of foreign goods is $P_t^F = P_t^* + E_t$, in levels, and $\pi_{F,t} = \xi_t + \pi_t^*$, in first differences.

Following Monacelli (2003), if the pass-through is sluggish, the law of one price does not hold, and the gap of the law of one price can be defined in levels as $\psi_t = E_t + P_t^* - P_{F,t}$ and in first differences, as

$$\psi_t = \psi_{t-1} + \xi_t + \pi_t^* - \pi_{F,t} \tag{53}$$

Following the Calvo-Yun set up described above for domestically produced goods, Monacelli (2003) introduces sticky prices into inflation of imported goods. The distributor firm faces the demand curve (38) and gets to reoptimize its price with probability ω_F. If the firm does not reoptimize, it changes its price in a proportion γ_F^π of past inflation of imported goods. The firm purchases the good at the price $E_t P_t^*$ and sells it at the price $P_{F,t}$. If $\psi_t > 0$, the firm bears a cost of ψ_t for each unit it distributes. The problem of the distributor firm is to maximize, by the choice of $\widetilde{P}_{F,t}$

$$E_t \sum_{i=0}^{\infty} \omega_H^i \Delta_{i,t+i} \left[\left(\frac{P_{F,j,t}}{P_{F,t+i}} \right) C_{F,j,t+i} - \Psi_{t+i} C_{F,j,t+i} \right] \tag{54}$$

where the demand for the imported goods is given by (38).

Assume inflation of imported goods is also predetermined d periods. Following the derivation of the Phillips curve for inflation of domestically produced goods, Monacelli (2003) proposes an expression for inflation of imported goods that in terms of the quasi-difference of inflation is:

$$\pi_{F,t}^{\Delta} = \pi_{F,t+1|t-d}^{\Delta} + \frac{(1-\beta\omega_F)(1-\omega_F)}{\omega_F} \ \psi_{t|t-d} \tag{55}$$

A nominal depreciation, or a positive shock to foreign inflation results in an increase in the law of one price gap ψ_t. The higher the law of one price gap, the higher the pressure it imposes on inflation of imported goods and vice versa.

3.6 The flexible price equilibrium

3.6.1 Prices

If prices were flexible, ω_H and ω_F in equations (52) and (55), or the probabilitties that firms keep their prices at the level of the previous period (adjusted for a proportion of lagged inflation), would be zero. In this case, the relative price chosen by the firm would be equal to either a constant markup over marginal cost (in the case of the producing firm) or over the law of one price gap (in the case of the distributor firm).

From equation (51) and a similar expression for inflation of imported goods, flexible prices impose the conditions, $\omega_H = \omega_F = 0$ –which imply $\frac{\widetilde{P}_{H,t}}{P_{H,t}} = \frac{\theta}{\theta-1} MC_t$ and $\frac{\widetilde{P}_{F,t}}{P_{F,t}} = \frac{\theta}{\theta-1}\Psi_t$. As the equilibrium is symmetric across firms, the relative optimal price is one, and both the marginal cost and the gap of the law of one price are constant.

The central bank would maintain the inflation of domestically produced goods on target,

$$\pi_{H,t}^{o} = \pi_t^{TAR} \tag{56}$$

and would do so costliesstly since under flexible prices the effect of monetary policy on prices would be infinite.

Under flexible prices, the pass-through would be complete and immediate implying

$$\pi_{F,t}^{o} = \xi_t^{o} + \pi_t^{*}$$

CPI inflation can be obtained as

$$\pi_t^{o} = (1 - \bar{c}_F)\pi_{H,t}^{o} + \bar{c}_F \pi_{F,t}^{o}$$

3.6.2 Flexible price output and demand

Under flexible prices, output would follow

$$y_t^{o} = z_t + l_t^{o} \tag{57}$$

where, from equations (22), (49) and (48), respectively,

$$\begin{aligned} l_t^{o} &= (1/\eta)(x_t^{o} - \sigma c_t^{\Delta o}) \\ x_t^{o} &= x_{H,t}^{o} - \delta \varphi_t^{o} \\ x_{H,t}^{o} &= z_t \end{aligned} \tag{58}$$

Although there are no nominal rigidities in the flexible price equilibrium, real rigidities are maintained. There is habit persistence in consumption, and consumption is predetermined d periods.

Having obtained flexible price output, unrestricted consumption can be found as

$$c_t^{Uo} = y_{t|t-d}^{o} - (c_{F,t|t-d}^{*} - c_{F,t|t-d}^{o}) - g_{t|t-d} - c_{t|t-d}^{Ro} + \varepsilon_t^{CUo}$$

To get the natural or Wicksellian interest rate, relation $\hat{c}_t^{\Delta Uo} = (1/\bar{c}^{U})c_t^{\Delta Uo}$ is used and equation (23) is solved for r_t :

$$r_t^{o} = 0.25\sigma(\hat{c}_{t+1|t-d}^{\Delta Uo} - \hat{c}_{t|t-d}^{\Delta Uo}) + \varepsilon_t^{ro} \tag{59}$$

If prices were flexible and the real interest rate were equal to the Wicksellian interest rate, output would equal the flexible price output and the output gap would be zero.

The complete flexible price equilibrium as well as the complete model in deviation form appear in Appendix A.

4 A sudden stop

In June-July 2002 emerging market bond spreads increased with the increase in the US high yield.[21] Capital flow to emerging markets subsided. In this section, the effect of an exogenous increase in bond spreads, on variables such as output, inflation, capital flow and debt is simulated and the difference in their response to different monetary policies is studied.

The simulation is intended to be quantitatively relevant. The shock is a one percentage point increase in the country risk premium for four quarters. As the model used for the simulation is linear, the impulse response functions can be multiplied by any constant.[22] [23]

4.1 Fear of floating as the benchmark

The monetary authority can react to the increase in the country risk premium with a policy mix of exchange rate depreciation and higher policy interest rate. As fear of floating is the norm, we use this case as the benchmark. The performance of the economy during a sudden stop and under a policy of fear of floating is reported in Figures 1 to 3.

As shown in Figures 1 and 2, the immediate effect of the increase in the country risk premium is a sharp increase in the risky rate due to increases in both the spread itself and in the policy rate. The increase in the policy rate is about 7/10 of the increase in the spread. Within our calibration of the reaction function of the central bank, $c_{i\chi} = 16$, the real exchange rate depreciates 0.15% per point increase in the country risk premium.[24]

4.2 The transfer problem, overall and by sector

In the model, the unanticipated increase in the country risk premium causes an unanticipated outflow of capital −which in our model is a sudden stop. The capital outflow can be understood in two ways. First, it is the result of a drop in consumption that is greater than the drop in output (Figure 1-C). Second, it is the result of an increase in exports and a larger drop in imports (Figure 1-D). In our parameterization, output decreases by more than 0.9 percentage points per percentage point increase in the country risk premium.[25]

[21] In the three months starting May 2002, the Brazilian EMBI increased 10.5 percentage points and in the three months starting June 2002, the Colombian EMBI increased 4.7 percentage points.

[22] The conclusions are robust to the length of the shock as long as it is transitory.

[23] The analysis starts at the moment confidence in the country is lost and the country risk premium increases. The debt crises at the beginning of the eighties and the financial crises of emerging markets at the end of the nineties were preceded by expansionary expenditure and borrowing. This was not the case during the events of 2002 and has no bearing on the current simulation exercise.

[24] A larger value of $c_{i\chi}$ can be used for a fixed real exchange rate. However, we prefered to make a case for high exchange rate rigidity, although not for a completely fixed exchange rate.

[25] Recall that all flow and stock variables are measured in per cent of steady state output.

While total primary savings increase, the burden of the transfer is not equally shared by all sectors (Figure 2). In the initial quarters of the shock, tax revenue drops and the decrease in tax receipts turns the government primary balance into a deficit (Figure 2-A). On average, in the first two years the primary structural balance is -0.43% per point increase in the country risk premium. While the government primary balance is in deficit, the private sector is in surplus (Figure 2-C). On average, in the first two years private savings are 0.64% of steady state output. This is the result of a drop in consumption that is larger than the drop in disposable income (Figure 2-C).

The trade balance improves at the time that output falls. This pro-cyclical behavior of the trade balance increases the volatility of absorption over and above that of output.[26]

4.3 Under fear of floating the debt grows

Although the exchange rate is controlled, government debt skyrockets (Figure 3-A).[27] The main cause of the increase in government debt is not the depreciation of the exchange rate, which is moderate. It turns out that the most important element that causes the huge increase in public debt is the increase in the policy interest rate. The reason is that the increase in interest rates causes both an increase in the cost of servicing the debt and, through recession and decreased tax receipts, a government deficit[28].

The evolution of total and sectorial financial wealth is explained in Figure 3. As a result of the moderate depreciation, government debt jumps on impact by a relatively small amount, 0.2% of steady state output. During the first year of the experiment, due to the increase in the cost of interest, government debt increases strongly and cumulatively by more than 5 percentage points of output! Eventually, as the increase in government debt leads to increased tax revenues, government debt gradually returns to the steady state.

The evolution of the wealth of the private sector is the mirror image of that of the government. The reason is that the former has net assets in foreign and domestic currencies while the later has, in both currencies, net liabilities (Figures 3-B and 3-D).

Central bank financial wealth does not increase with the higher income received on international reserves and government paper. The reason is that, according to the specification of the transfer from the central bank to the government, this higher central bank income is transferred to the government immediately.

[26] According to the permanent income hypothesis, savings should buffer the effect of transitory changes in income on consumption; capital flow and the trade balance should be countercyclical. This could be the case in mature markets and also under transitory shocks to income, but not in emerging markets during sudden stops.

[27] In the graph, an increase in debt is a negative change because government financial wealth is negativethat is, financial wealth is debt. Also, interest income is negative; it is a cost.

[28] Throughout the experiment, it is assumed that the increase in the interest service of the debt and the decrease in tax revenue do not lead to cuts in expenditure in other items of the budget. To fulfill this assumption, government expenditure is simply kept unchanged.

4.4 Under floating, the debt jumps

We now use the NOEM with sectorial balance sheets and stock and flow consistency to simulate a sudden stop under an exchange rate that floats. The exercise is reported in Figures 4 to 7. The purpose of the exercise is to study the consequences of fear of floating in general, and it is also suggestive of a policy issue that has not received enough attention. During the events in 2002 described above, the reaction of monetary policy in Brazil was to tighten the policy interest rate while the reaction in Colombia was to allow the exchange rate to float.

As shown in Figures 4-A, 4-C and 4-E, as a result of the increase in the country risk premium, under the flexible approach the exchange rate depreciates. More interestingly, there is an additional depreciation due to the countercyclical easing of monetary policy in the model. Within our parameterization, the depreciation is about 1.1% per point increase in the country risk premium.

As revealed by Figures 4-B, 4-D and 4-F, whether the exchange rate is rigid or flexible, there is a transfer problem. Roughly the same transfer is made in the case of a floating exchange rate under macroeconomic stability and in the case of fear of floating in the midst of recession.

As shown in Figure 5-B, in comparison with the benchmark, a floating exchange rate makes the effect of the exchange rate on government debt larger (government debt jumps on impact by about 1.1 percentage points of output instead of 0.1% under fear of floating). However, this effect takes place on impact only. In the subsequent quarters, as the interest service on the debt as well as the primary balance are smaller, public debt remains relatively stable.

In sum, a floating exchange rate stabilizes government debt, a rigid exchange rate increases government debt.

Figure 6 contrasts each of the components on the right hand side of equation (12) (with the exception of net transfers) under both the rigid and the flexible approaches to the exchange rate. A floating exchange rate decreases both the cost of interest for the government and the government primary deficit (Figures 6-A and 6-C). The flexible approach also increases the effect of the exchange rate on government debt, but this is an effect that takes place on impact only. Floating also sizably cuts interest income and the primary surplus in the private sector (Figures 6-B and 6-D) and increases the impact effect of the exchange rate on private financial wealth (Figure 6-F).

4.5 The transfer problem by sector

While the economy as a whole transfers savings abroad −runs a trade surplus− regardless of whether the policy is fear of floating or floating (Figure 4-F), the public and private sectors run a surplus or a deficit according to the policy implemented. Under fear of floating, the burden of the transfer is born by the private sector while the government runs a deficit (Figures 6-C and 6-D). Tax collection plummets along with output, and the decrease in tax revenue leads the government balance into a deficit precisely when the economy as a whole runs a surplus. Under floating, the government may not run a deficit (Figure 6-C).

4.6 The pass-through, not a problem

In the case of a float, quarterly depreciation of the nominal exchange rate reaches an annual rate of 4.6% (Figure 7-A). The effect of exchange rate depreciation on the inflation of imported goods is tamed and somewhat lagged. Imported inflation increases by 1.0% in quarter one (Figure 7-B). At the same time, the recession causes inflation of domestically produced goods to decrease (Figure 7-C). As the combined effect of the increase in inflation of imported goods and the decrease in inflation of domestically produced goods, CPI inflation in the short run does not increase (Figure 7-D). It may be argued that this result relies upon the particular specification and parameterization of the model, in particular, on the degree of openness, $\bar{c}_F^* = 0.195$. The same exercise was repeated with a higher degree of openness and it was found that the effect of imported inflation on the CPI, whatever its size, can be only transitory. The reason is that, after a few quarters, imported inflation drops below CPI inflation thereby pushing CPI inflation *down*.

4.7 Counter-cyclical policy

It is worthwhile to emphasize that the important policy issue in regards to floating the exchange rate is that under a sudden stop, the policy interest rate eases. This stance is counter-cyclical since it offsets the recessive effect of the increase in the country risk premium. Furthermore, as tax revenue does not drop along with output, the government is not in deficit and hence it does not need to implement a pro-cyclical cut in expenditure.

The question of the stance of the monetary policy under an outflow of capital has also been studied by Caballero and Krishnamurthy (2003). Based on a different model, they also concluded that fear of floating is pro-cyclical and floating, counter-cyclical.

4.8 Fear of floating and the reduction of inflation

Under the rigid approach to the exchange rate, the tightening of monetary policy keeps the exchange rate fairly constant, but at the cost of the "decapitation of the entrepreneurial class" (Figure 4-B). The recession, in turn, causes a sharp drop in inflation (Figure 7-D)[29]. In our model, the drop in output and inflation are about one percent per percentage point increase in the spread. The reduction in inflation in Brazil and Colombia at the end of the nineties seems to have been attributed almost exclusively to inflation targeting. We contend that the

[29] In the model, inflation returns to the initial steady state target of zero, but in the recently adopted inflation targeting regimes of Brazil and Colombia the authorities met the recession-led reduction in inflation with opportunistic (and welcomed) decreases in the inflation target.

decrease in inflation in these as well as in other countries at the end of the nineties was also the result of the defense of the crawling bands.

5 Conclusions

In an emerging market, what can make the difference between solvency and bankruptcy is not the exchange rate but the management of the policy interest rate. This conclusion has been reached by developing a framework for macroeconomic stability in emerging market economies with a set of exchange rate exposed sectorial balance sheets and with sectorial stock and flow consistency.

The model was used in the study of a sudden stop that was endogenous to a shock to the country risk premium. The claims that foreign currency liabilities and the pass-through of the exchange rate to inflation prevent the exchange rate from floating were evaluated and were found to be weak.

An exogenous shock to the country risk premium −and endogenous unanticipated capital outflow− was studied under two specifications of monetary policy: fear of floating and floating. Under fear of floating, it was shown that the sudden stop causes a drop in output, and the drop in output causes a reduction in inflation.

Although the drop in output is sizable, the drop in absorption is larger. The reasons for the larger drop in absorption are; first, that during a sudden stop the trade balance rises; and second, that a trade surplus is savings. The drop in output is not cushioned by savings as in a mature market. On the contrary, under a sudden stop the behavior of the trade balance is pro-cyclical.

While studying the transfer problem by sector, it was found that under fear of floating, the transfer is done by the private sector in the midst of a recession, and that under floating, the government balance may not run a deficit.

Finally, and surprisingly, we found that fear of floating, the policy that attempts to prevent foreign debt from increasing, results precisely in an increase in the debt to GDP ratio. Fear of floating prevents a transitory impact increase in the *level* of the debt to GDP ratio. But, since it increases the interest cost on the debt and causes a fiscal deficit, it increases the *change* in the debt ratio.

Under a floating exchange rate, government debt stabilizes. The reason is that, although the depreciation causes a transitory increase in the *level* of the debt to GDP ratio, the smaller increase in the cost of interest and the improved government balance decrease the *change* in the debt to GDP ratio.

The policy implication is that under a sudden stop, countries with high government debt or countries whose inflation is in the low single digits would perform better by floating the exchange rate. Foreign debt will jump on impact, but will grow less. Countries whose inflation is still high, provided the debt to GDP ratio is low, may undertake an opportunistic approach to the reduction of inflation and may respond to the capital outflow with a strong defense of the exchange rate. Although this policy would increase the growth of debt, it will certainly reduce inflation.

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6 Appendix A. The complete model in deviation form

6.1 Prices

$$
\begin{aligned}
\pi_t &= (1-\bar{c}_F)\pi_{H,t} + \bar{c}_F \pi_{F,t} \\
\pi^{\Delta}_{H,t+d|t} &= \pi^{\Delta}_{H,t+d+1|t} + \kappa_H \ mc_{t+d|t} \\
\pi^{\Delta}_{F,t+d|t} &= \pi^{\Delta}_{F,t+d+1|t} + \kappa_F \psi_{t+d|t} \\
\pi^{\Delta}_{H,t} &= \pi^{\Delta}_{H,t|t-d} + \varepsilon^{\pi H}_t \\
\pi^{\Delta}_{F,t} &= \pi^{\Delta}_{F,t|t-d} + \varepsilon^{\pi F}_t \\
\pi_{H,t} &= \pi^{\Delta}_{H,t} + \gamma^{\pi}_H \pi_{H,t-1} \\
\pi_{F,t} &= \pi^{\Delta}_{F,t} + \gamma^{\pi}_F \pi_{F,t-1} \\
\kappa_H &= \frac{(1-\beta\omega_H)(1-\omega_H)}{\omega_H} \\
\kappa_F &= \frac{(1-\beta\omega_F)(1-\omega_F)}{\omega_F}
\end{aligned}
$$

6.2 Supply

$$
\begin{aligned}
mc_t &= x_{H,t} - z_t \\
z_t &= \gamma_z z_{t-1} + \varepsilon^z_t \\
x_{H,t} &= x_t + \delta\psi_t \\
x_t &= \eta l_t + \sigma \hat{c}{}^{\Delta}_t \\
l_t &= y_t - z_t
\end{aligned}
$$

6.3 Exchange rates

$$
\begin{aligned}
q_t &= q_{t+1} - 0.25[(i^f_t - \pi_{t+1|t}) - (i^{f*}_t - \pi^*_{t+1|t}) - \phi_t] \\
\chi_t &= 4(q_t - q_{t-1}) \\
\xi_t &= 4(q_t - q_{t-1}) - \pi^*_t + \pi_t \\
\varphi_t &= q_t - \psi_t \\
\psi_t &= \psi_{t-1} + 0.25(\xi_t + \pi^*_t - \pi_{F,t}) \\
\phi_t &= -c_{\phi n} n_{t-1} + \varepsilon^{\phi}_t
\end{aligned}
$$

6.4 Interest rates

$$
i^f_t = \pi_{t+1|t} + r^o_t + 0.75(\pi_t - \pi^{TAR}_t) + 0.5(y_t - y^o_t) - c_{i\chi}\chi_{t+1|t}
$$

$$
\begin{aligned}
i_t &= i_t^f + \phi_t \\
r_t^f &= i_t^f - \pi_{t+1|t} \\
r_t &= r_t^f + \phi_t \\
r_t^* &= r_t^{f*} + \phi_t
\end{aligned}
$$

$$
\begin{aligned}
\rho_t &= \frac{1}{T}\sum_{j=0}^{T-1} r_t + \varrho \\
\rho_t^* &= \frac{1}{T}\sum_{j=0}^{T-1} r_t^* + \varrho^* \\
\rho_t^{f*} &= \frac{1}{T}\sum_{j=0}^{T-1} r_t^{f*} + \varrho^{f*}
\end{aligned}
$$

6.5 Flows

$\hat{c}^{\Delta U}_{t+d|t} = -0.25\sigma r_{t+d|t} + \hat{c}^{\Delta U}_{t+d+1|t}$

$\hat{c}^{\Delta U}_{H,t+d|t} = \delta\upsilon\varphi_{t+d|t} + \hat{c}^{\Delta U}_{t+d|t}$

$\hat{c}^{\Delta U}_{F,t+d|t} = -\upsilon\varphi_{t+d|t} + \hat{c}^{\Delta U}_{t+d|t}$

$\hat{c}^{\Delta R}_{t+d|t} = \mu^H \hat{n}_{t+d-1|t}$

$\hat{c}^{\Delta R}_{H,t+d|t} = \delta\upsilon\varphi_{t+d|t} + \hat{c}^{\Delta R}_{t+d|t}$

$\hat{c}^{\Delta R}_{F,t+d|t} = -\upsilon\varphi_{t+d|t} + \hat{c}^{\Delta R}_{t+d|t}$

$\hat{c}^{\Delta U}_{t} = \hat{c}^{\Delta U}_{t|t-d} + \varepsilon_t^{CU}$

$\hat{c}^{\Delta U}_{H,t} = \hat{c}^{\Delta U}_{H,t|t-d} + \varepsilon_t^{CUH}$

$\hat{c}^{\Delta U}_{F,t} = \hat{c}^{\Delta U}_{F,t|t-d} + \varepsilon_t^{CUF}$

$\hat{c}^{\Delta R}_{t} = \hat{c}^{\Delta R}_{t|t-d} + \varepsilon_t^{CR}$

$\hat{c}^{\Delta R}_{H,t} = \hat{c}^{\Delta R}_{H,t|t-d} + \varepsilon_t^{CRH}$

$\hat{c}^{\Delta R}_{F,t} = \hat{c}^{\Delta R}_{F,t|t-d} + \varepsilon_t^{CRF}$

$c^{\Delta U}_{H,t} = \bar{c}^U_H \, \hat{c}^{\Delta U}_{H,t}$

$c^{\Delta U}_{F,t} = \bar{c}^U_F \, \hat{c}^{\Delta U}_{F,t}$

$c^U_{H,t} = c^{\Delta U}_{H,t} + \gamma c^U_{H,t-1}$

$c^U_{F,t} = c^{\Delta U}_{H,t} + \gamma c^U_{F,t-1}$

$c^{\Delta R}_{H,t} = \bar{c}^R_H \, \hat{c}^{\Delta R}_{H,t}$

$c^{\Delta R}_{F,t} = \bar{c}^R_F \, \hat{c}^{\Delta R}_{F,t}$

$c^R_{H,t} = c^{\Delta R}_{H,t} + \gamma c^R_{H,t-1}$

$c^R_{F,t} = c^{\Delta R}_{H,t} + \gamma c^R_{F,t-1}$

$\hat{c}^{\Delta *}_{F,t+d|t} = (\delta\upsilon/\bar{c}_F) q_{t+d|t} + \hat{c}^{\Delta *}_{t+d|t}$

$\hat{c}^{\Delta *}_{F,t} = \hat{c}^{\Delta *}_{F,t|t-d} + \varepsilon_t^{CF*}$

$c^*_F = \bar{c}^*_F \hat{c}^{\Delta *}_{F,t} + \gamma c^*_{F,t-1}$

$y_t = c_{H,t} + g_t + c^*_{F,t}$

$\delta = \bar{c}_F/(1-\bar{c}_F)$

$g_t^\Delta = \varepsilon_t^g$

$g_t = g_t^\Delta + \gamma g_{t-1}$

$\tau_t^H = c_{\tau y} y_t + \varepsilon_t^\tau$

$\tau_t^{CB} = s_t^{i,CB} + \mu^{CB} n_{t-1}^{CB}$

$y_t^D = y_t - \tau_t^H$

$c_t^T = c_t + g_t$

6.6 Savings

$$\begin{array}{ll} s_t = c^*_{F,t} - c_{F,t} & s^s_t = s_t + s^i_t \\ s^G_t = \tau^H_t + \tau^{CB}_t - g_t & s^{s,G}_t = s^G_t + s^{i,G}_t \\ s^{CB}_t = -\tau^{CB}_t & s^{s,CB}_t = s^{CB}_t + s^{i,CB}_t \\ s^H_t = y_t - \tau^H_t - c_t & s^{s,H}_t = s^H_t + s^{i,H}_t + s^T_t \end{array}$$

6.7 Interest cost

$$\begin{aligned} s^{i,G}_t &= -0.25(\bar{r} - \bar{\gamma})d^G_{t-1} - 0.25(\bar{r} - \bar{\gamma})b^G_{t-1} - \bar{d}^G r^*_{t-1} - \bar{b}^G r_{t-1} \\ s^{i,CB}_t &= 0.25(\bar{r}^{f*} - \bar{\gamma})a^{CB}_{t-1} + \bar{a}^{CB} r^{f*}_{t-1} + 0.25(\bar{r} - \bar{\gamma})b^{CB}_{t-1} + \bar{b}^{CB} r_{t-1} \\ &\quad +0.25(\bar{\pi} + \bar{\gamma})h_{t-1} + \bar{h}\pi_t \\ s^{i,H}_t &= 0.25(\bar{r}^f - \bar{\gamma})a^H_{t-1} + \bar{a}^H r^{f*}_{t-1} + 0.25(\bar{r} - \bar{\gamma})b^H_{t-1} + \bar{b}^H r_{t-1} \\ &\quad -0.25(\bar{\pi} + \bar{\gamma})h_{t-1} - \bar{h}\pi_t \end{aligned}$$

6.8 Stocks

$$\begin{aligned} n_t &= n^G_t + n^{CB}_t + n^H_t \\ n^G_t &= n^G_{t-1} + s^G_t + s^{i,G}_t - 0.25\bar{d}^G \chi_t \\ n^{CB}_t &= n^{CB}_{t-1} + s^{CB}_t + s^{i,CB}_t + 0.25\bar{a}^{CB} \chi_t \\ n^H_t &= n^H_{t-1} + s^H_t + s^{i,H}_t + 0.25\bar{a}^H \chi_t \\ \hat{n}_t &= (1/\bar{n})n_t \end{aligned}$$

$$\begin{array}{lll} f^G_t = -n^G_t & d^G_t = \bar{\alpha}^G f^G_t & b^G_t = (1 - \bar{\alpha}^G) f^G_t \\ f^{CB}_t = -n^{CB}_t + h_t & a^{CB}_t = \bar{\alpha}^{CB} f^{CB}_t & b^{CB}_t = (1 - \bar{\alpha}^{CB}) f^{CB}_t \\ f^H_t = -n^H_t - h_t & a^H_t = \bar{\alpha}^H f^H_t & b^H_t = (1 - \bar{\alpha}^H) f^H_t \end{array}$$

$$\begin{aligned} \hat{h}^\Delta_t &= \frac{\sigma}{\kappa} c^{\Delta U}_t - \frac{1}{\kappa}[(1 - \bar{i}^f)/\bar{i}^f] i^f_t \\ h^\Delta_t &= \bar{h}\hat{h}^\Delta_t \\ h_t &= h^\Delta_t + \gamma h_{t-1} \end{aligned}$$

6.9 The steady state

$$\begin{aligned}
\bar{\pi}_t &= (1-\bar{c}_H)\bar{\pi}_{H,t} + \bar{c}_F \bar{\pi}_{Ft} \\
\bar{\pi}_F &= \bar{\xi} + \bar{\pi}^* \\
\bar{\xi} &= \bar{\pi} - \bar{\pi}^* \\
\bar{r}^f &= \bar{r}^{f*} \\
\bar{r} &= \bar{r}^f + \bar{\phi} \\
\bar{i} &= \bar{\pi} + \bar{r}
\end{aligned}$$

$$\begin{aligned}
\bar{\rho}^f &= \bar{r}^f + \bar{\varrho} \\
\bar{\rho}^{f*} &= \bar{r}^{f*} + \bar{\varrho}^{f*} \\
\bar{\rho} &= \bar{r} + \bar{\varrho}
\end{aligned}$$

$$\begin{aligned}
\bar{c}_F &= \bar{c}_F^* - \bar{s} \\
\bar{c}_H &= 1 - \bar{g} - \bar{c}_F^* \\
\bar{c} &= 1 - \bar{g} - \bar{s} \\
\bar{t}^H &= \bar{g} + \bar{s}^G
\end{aligned}$$

$$\begin{aligned}
\bar{s} &= \bar{s}^g + \bar{s}^{CB} + \bar{s}^H \\
\bar{s}^G &= 0.25(\bar{r} - \bar{\gamma})(\bar{d}^G + \bar{b}^G) \\
\bar{s}^{CB} &= -\bar{\tau}^{CB} \\
\bar{\tau}^{CB} &= 0.25(\bar{r}^f - \bar{\gamma})\bar{a}^{CB} + 0.25(\bar{r} - \bar{\gamma})\bar{b}^{CB} + 0.25(\bar{\pi} + \bar{\gamma})\bar{h} \\
\bar{s}^H &= -0.25(\bar{r}^f - \bar{\gamma})\bar{a}^H - 0.25(\bar{r} - \bar{\gamma})\bar{b}^H + 0.25(\bar{\pi} + \bar{\gamma})\bar{h}
\end{aligned}$$

$$\bar{c}^U = \zeta \bar{c} \qquad \bar{c}_H^U = \bar{c}_H \ \bar{c}^U \qquad \bar{c}_F^U = \bar{c}_F \ \bar{c}^U$$

$$\bar{c}^R = (1-\zeta)\bar{c} \qquad \bar{c}_H^R = \bar{c}_H \ \bar{c}^R \qquad \bar{c}_F^R = \bar{c}_F \ \bar{c}^R$$

$$\begin{aligned}
\bar{n}^{CB} &= \bar{a}^{CB} + \bar{b}^{CB} - \bar{h}^{CB} \\
\bar{n}^G &= -\bar{d}^G - \bar{b}^G \\
\bar{n}^H &= \bar{a}^H + \bar{b}^H \\
\bar{b}^H &= \bar{b}^G - \bar{b}^{CB}
\end{aligned}$$

$$\begin{aligned}
&\bar{f}^G = \bar{d}^G + \bar{b}^G && \bar{\alpha}^G = \bar{d}^G / \bar{f}^G \\
&\bar{f}^{CB} = \bar{a}^{CB} + \bar{b}^{CB} && \bar{\alpha}^{CB} = \bar{a}^{CB} / \bar{f}^{CB} \\
&\bar{f}^H = \bar{a}^H + \bar{b}^H && \bar{\alpha}^H = \bar{a}^H / \bar{f}^H
\end{aligned}$$

6.10 Parameterization

$\bar{d}_t^G = 1$	$\sigma = 4.5$	$\omega_H = 0.75$
$\bar{b}_t^G = 1$	$\eta = 0.25$	$\omega_F = 0.25$
$\bar{a}_t^{CB} = 0.4$	$\upsilon = 0.5$	$\bar{\pi}_H = 0.03$
$\bar{b}_t^{CB} = 0.4$	$\beta = 0.99$	$\bar{\pi}^* = 0.03$
$\bar{h}_t = 0.16$	$\kappa = 5$	$\bar{\gamma} = 0.03$
$\bar{a}_t^H = 1$	$\rho = 0.9$	$\bar{r}^* = 0.03$
$\mu^{CB} = 0.03$	$\zeta = 1/3$	$\bar{\phi} = 0.02$
$\mu^G = 0.03$	$\gamma_F^\pi = 0.9$	$c_{\tau y} = 0.8$
$\mu^H = 0.03$	$\gamma_H^\pi = 0.9$	$c_{\phi n} = 0.03$
$T = 12$	$\gamma_c = 0.9$	$d = 1$
$\bar{\varrho} = 0$	$\bar{\varrho}^{f*} = 0$	$\bar{\varrho}^* = 0$

6.11 Flexible price equilibrium

The equations of the price, supply, and interest rate blocks are explicitly reported. The equations for the blocks on exchange rates, flows, savings, interest cost and stocks are identical to those presented for the case of the rigid price equilibrium.

6.11.1 Prices

$$\begin{aligned}
\pi_t^o &= (1 - \bar{c}_F)\pi_{H,t}^o + \bar{c}_F \pi_{F,t}^o \\
\pi_{H,t}^o &= \pi_t^{TAR} \\
\pi_{F,t}^o &= \xi_t^o + \pi_t^*
\end{aligned}$$

6.11.2 Supply

$$\begin{aligned}
y_t^o &= z_t + l_t^o \\
l_t^o &= (1/\eta)(x_t^o - \sigma c_t^{\Delta o}) \\
x_t^o &= x_{H,t}^o - \delta q_t^o \\
x_{H,t}^o &= z_t \\
c_{t+d|t}^{Uo} &= y_{t+d|t}^o - (c_{F,t+d|t}^* - c_{F,t+d|t}^o) - g_{t+d|t} - c_{t+d|t}^{Ro} \\
c_t^{Uo} &= c_{t|t-d}^{Uo} + \varepsilon_t^{CUo}
\end{aligned}$$

6.11.3 Interest rates

$$
\begin{aligned}
r^o_{t+d|t} &= 0.25\sigma(\overset{\wedge\Delta Uo}{c}_{t+d+1|t} - \overset{\wedge\Delta Uo}{c}_{t+d|t}) \\
r^o_t &= r^o_{t|t-d} + \varepsilon^{ro}_t \\
r^{f,o}_t &= r^o_t - \phi^o_t \\
i^{f,o}_t &= r^{f,o}_t + \pi^o_{t+1|t} \\
i^o_t &= i^{f,o}_t + \phi^o_t
\end{aligned}
$$

7 Appendix B. The foreign economy

The foreign household maximizes $U^*_t = E_t \sum_{t=0}^{\infty} \beta^i \left[\frac{(C^{\Delta *}_{t+i})^{1-\sigma}}{1-\sigma}\right]$ subject to $C^*_t = Y^*_t + (1+i^*_t)\frac{A^*_{t-1}}{P^*_t} - \frac{A^*_t}{P^*_t}$. In deviation form, the first order condition for this problem is

$$\overset{\wedge\Delta *}{c_t} = -\sigma^{-1} r^*_{t-d|t} + \overset{\wedge\Delta *}{c}_{t+1-d|t} + \varepsilon^{C*}_t$$

which is one of the two equations in (44).

Also in the foreign economy, consumption is a composite of home and imported goods. The foreign household chooses among these goods by minimizing $P^*_{H,t}C^*_{H,t}+P^*_{F,t}C^*_{F,t}$ subject to $C^{\Delta *}_t = \left[(1-\bar{c}^*_F)^{\frac{1}{\upsilon}}(C^{\Delta *}_{H,t})^{\frac{\upsilon-1}{\upsilon}} + \bar{c}^{*\frac{1}{\upsilon}}_F(C^{\Delta *}_{F,t})^{\frac{\upsilon-1}{\upsilon}}\right]^{\frac{\nu}{\nu-1}}$. Let E_t be the exchange rate and use $P_{F,t} = P_{H,t}/E_t$. The problem of the foreign household gives the demand for home exports

$$\overset{\wedge\Delta *}{c}_{F,t} = \frac{\delta\upsilon}{\bar{c}_F} q_{t-d|t} + \overset{\wedge\Delta *}{c}_{t-d|t} + \varepsilon^{CF*}_t$$

which is one of the two equations in (44).

8 Appendix C. The demand for money

Consider the budget constraint of the household, and define the auxiliary variable K_t as

$$
\begin{aligned}
K_t &= \frac{W_t}{P_t}L_t + S^T_t - T^H_t + (1+r^{f*}_{t-1})\frac{A^{H*}_{t-1}Q_t}{P^*_{t-1}} \\
&\quad +(1+r_{t-1})\frac{B^H_{t-1}}{P_{t-1}} + \frac{1}{1+\pi_t}\frac{H_{t-1}}{P_{t-1}} \\
&= C_t + \frac{A^{H*}_t E_t}{P^*_t} + \frac{B^H_t}{P_t} - \frac{H_t}{P_t}
\end{aligned}
$$

The household problem may be written

$$\begin{aligned} V(K_t) &= \max\{\frac{(C_t^{\Delta})^{1-\sigma}}{1-\sigma} + \frac{(\tilde{H}_t^{\Delta})^{1-k}}{1-\kappa} - \frac{L_{t+i}^{1+\eta}}{1+\eta} \\ &+\beta V(\frac{W_{t+1}}{P_{t+1}} L_{t+1} + S_{t+1}^{T} - T_{t+1}^{H} + (1+r_t^{f*})\frac{A_t^{H*} Q_{t+1|t}}{P_t^*} \\ &+(1+r_t)\left[K_t - C_t - \frac{A_t^{H*} Q_t}{P_t^*} - \frac{H_t}{P_t}\right] + \frac{1}{1+\pi_{t+1}}\frac{H_t}{P_t})\} \end{aligned}$$

The first order condition with respect to real consumption and real money balances are

$$(C_t^{\Delta})^{-\sigma} = \beta(1+r_t)V_k(K_{t+1})$$

$$(\tilde{H}_t^{\Delta})^{-\kappa} - \beta\left[(1+r_t) - \frac{1}{1+\pi_t}\right]V_k(K_{t+1}) = 0$$

Manipulating these equations gives $\tilde{H}_t^{-\kappa} + \frac{\beta}{1+\pi_t} V_k(K_{t+1}) = (C_t^{\Delta})^{-\sigma}$. Dividing by $(C_t^{\Delta})^{-\sigma}$ and using (21) gives $\tilde{H}_t = (C_t^{\Delta U})^{\sigma/\kappa}\left(\frac{i_t}{1+i_t}\right)^{-1/\kappa}$. In log deviation from the steady state, the demand for money may be written:

$$\hat{h}_t^{\Delta} = \frac{1}{\kappa}\left[\sigma \hat{c}_t^{\Delta U} - [(1-\bar{i})/\bar{i}]i_t\right]$$

which is equation (39).

Figure 1. A shock to the country risk premium,
Main prices and flows

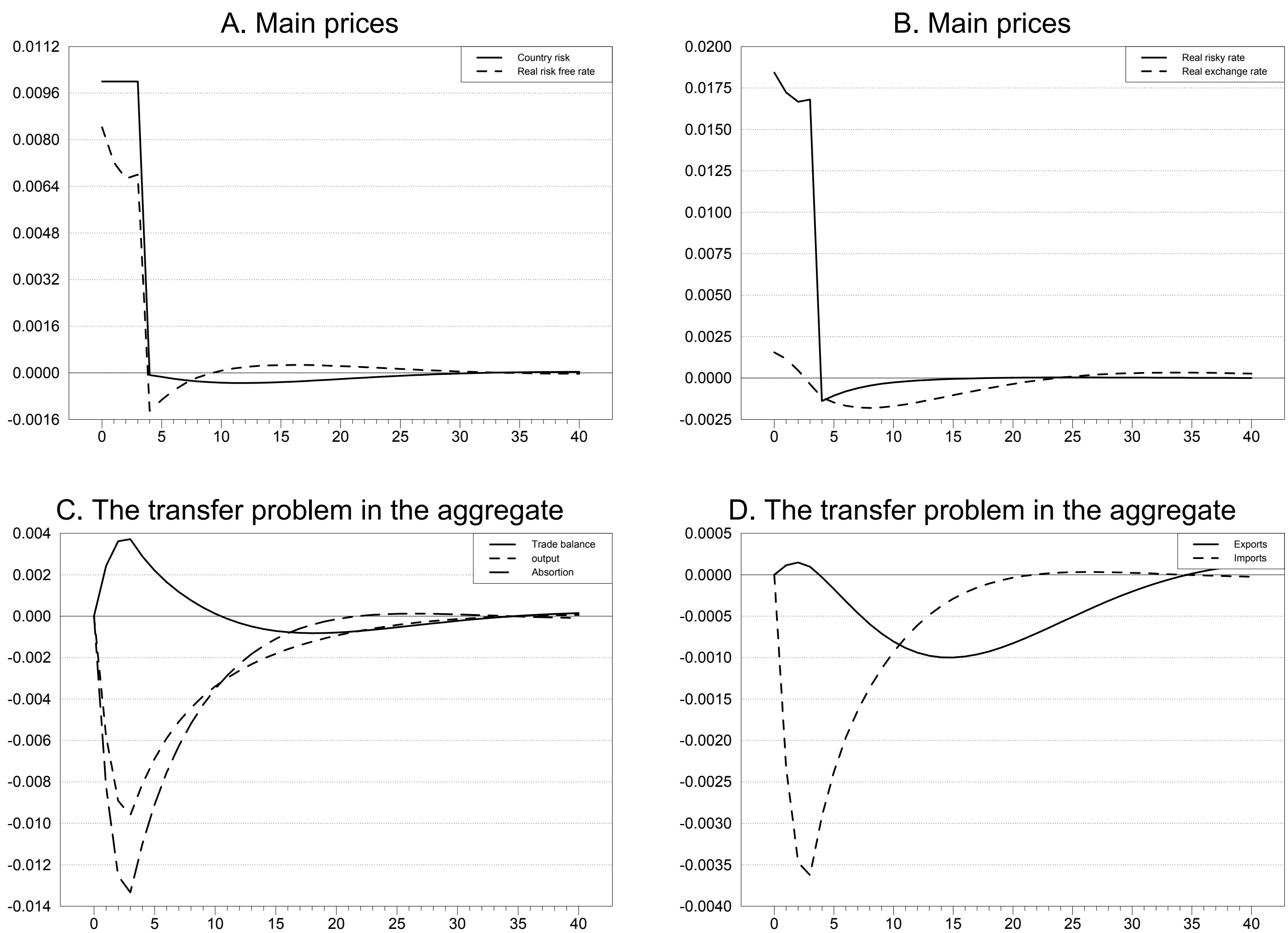

Figure 2. A shock to the country risk premium,
The transfer problem by sector

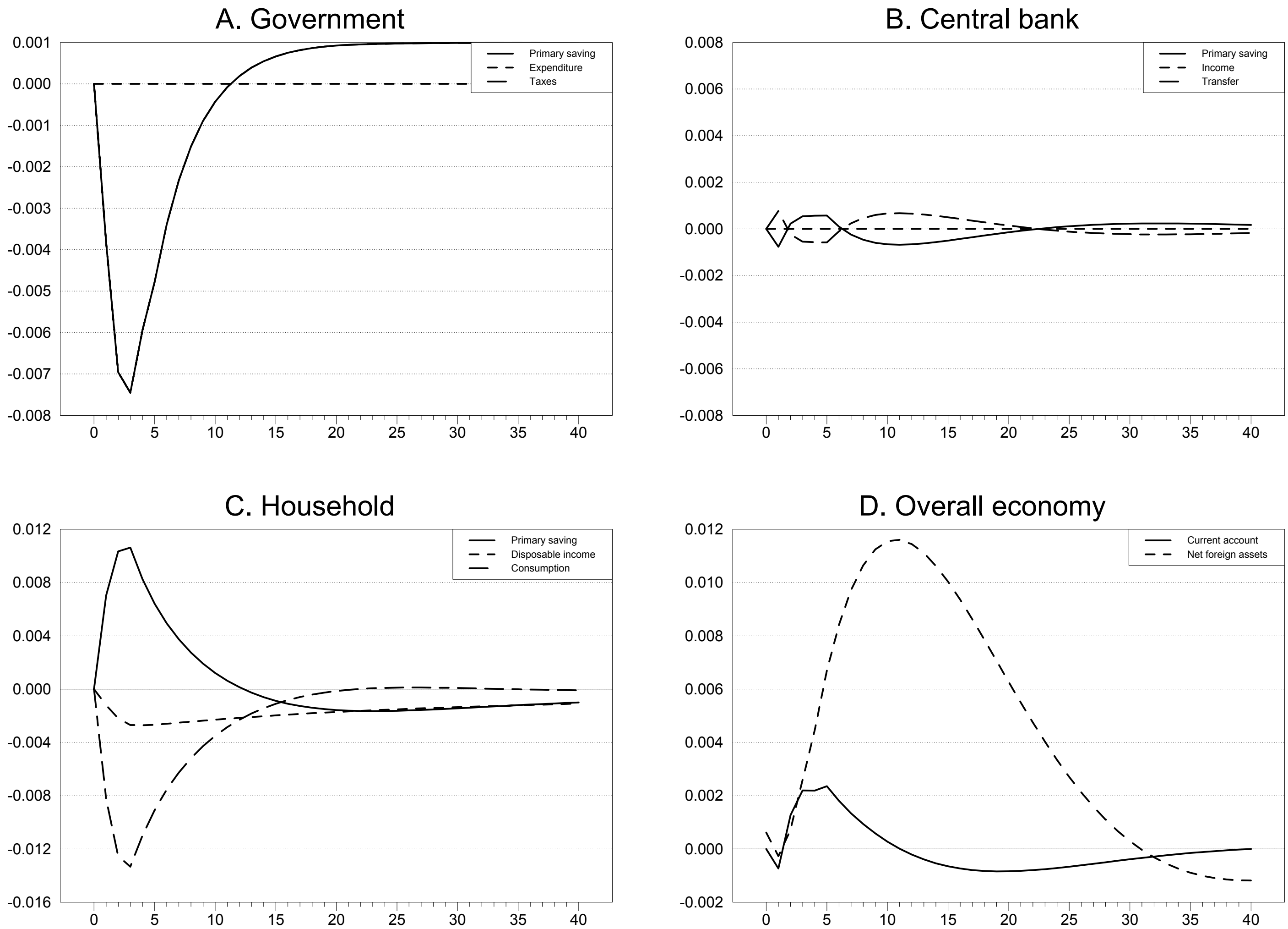

Figure 3. A shock to the country risk premium,
Impact of savings and of the cost of interst on net worth

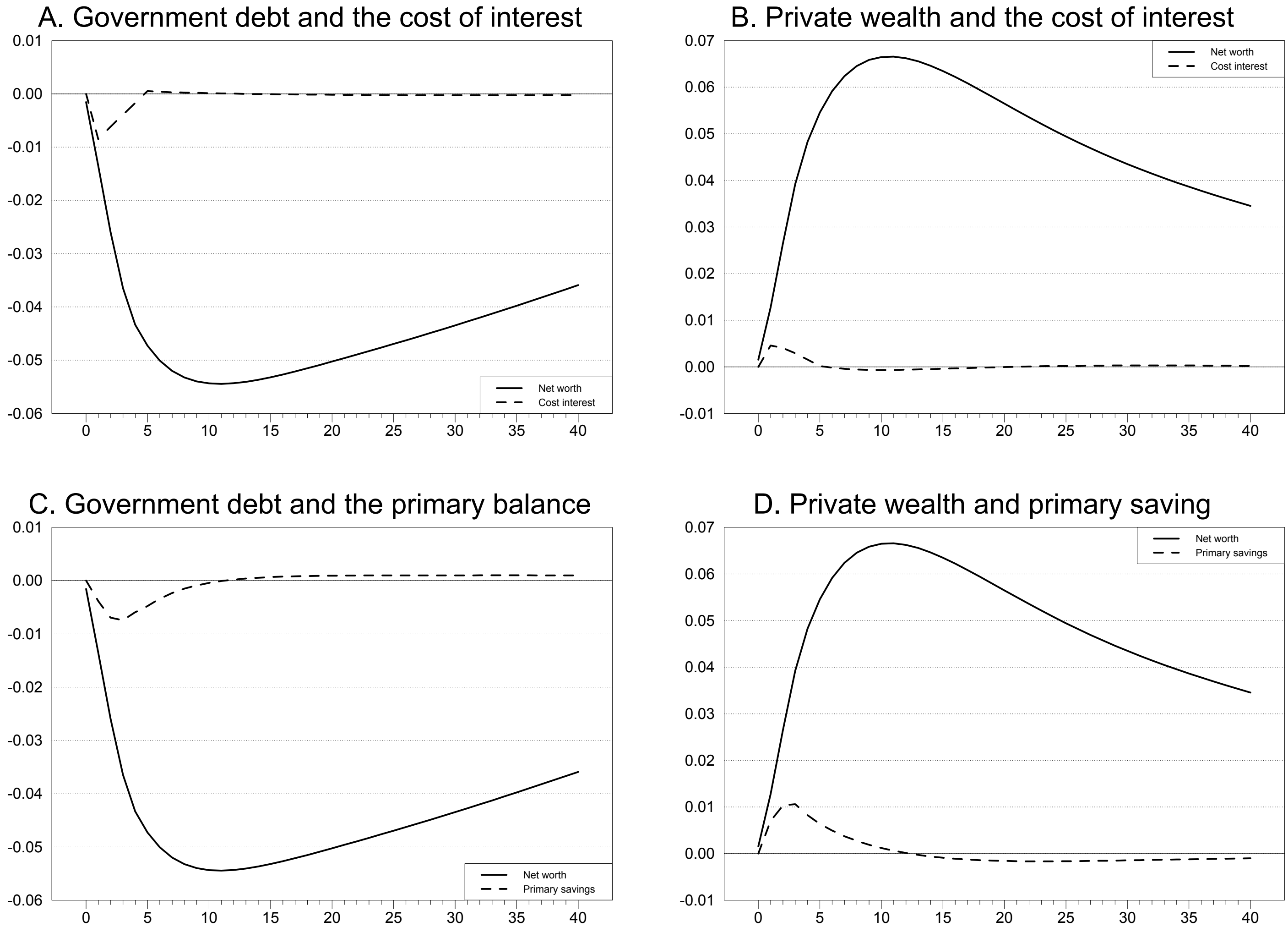

Figure 4. Effect of floating the exchange rate on the main prices and flows

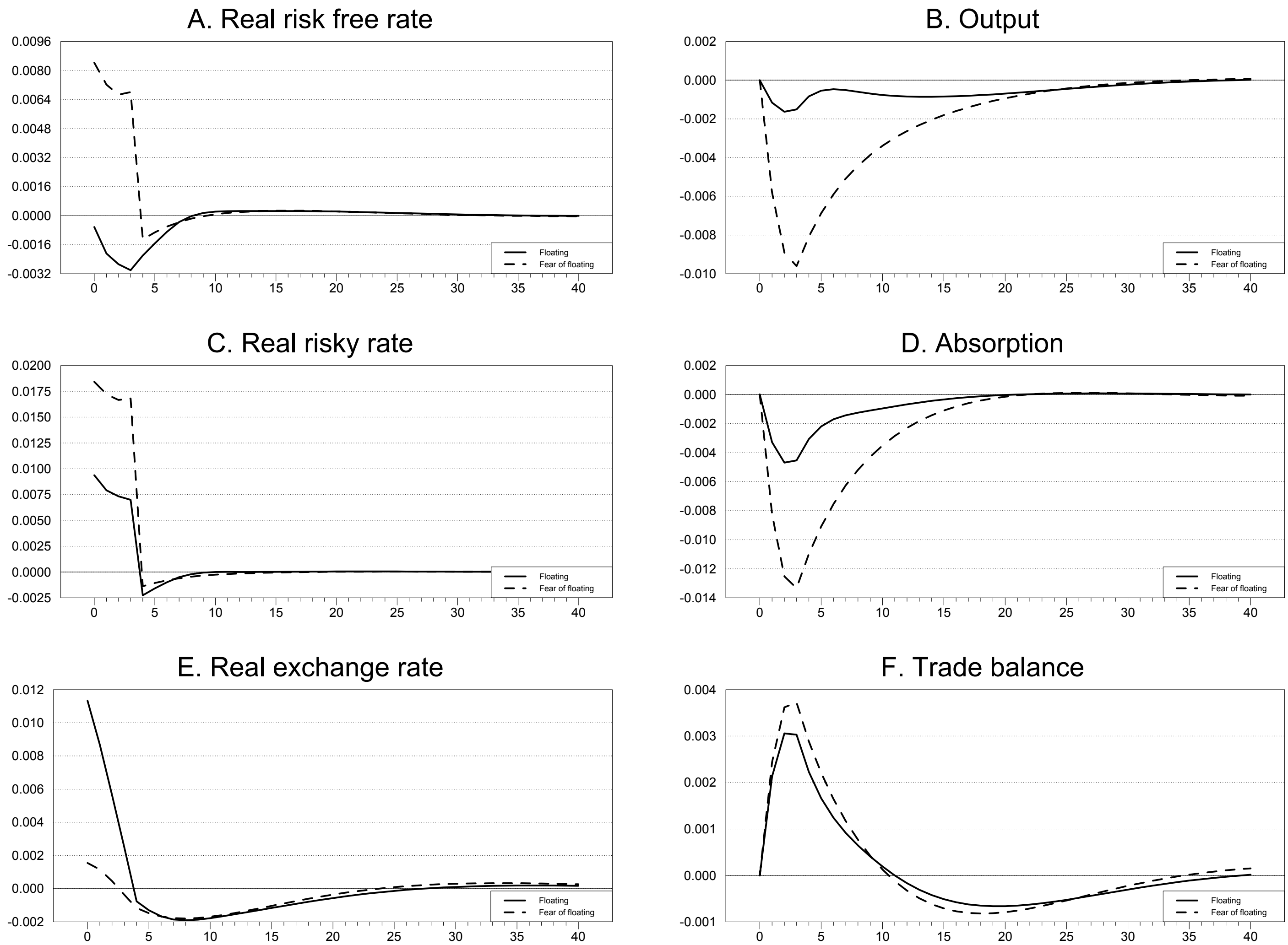

Figure 5. Effect of floating the exchange rate on net worth

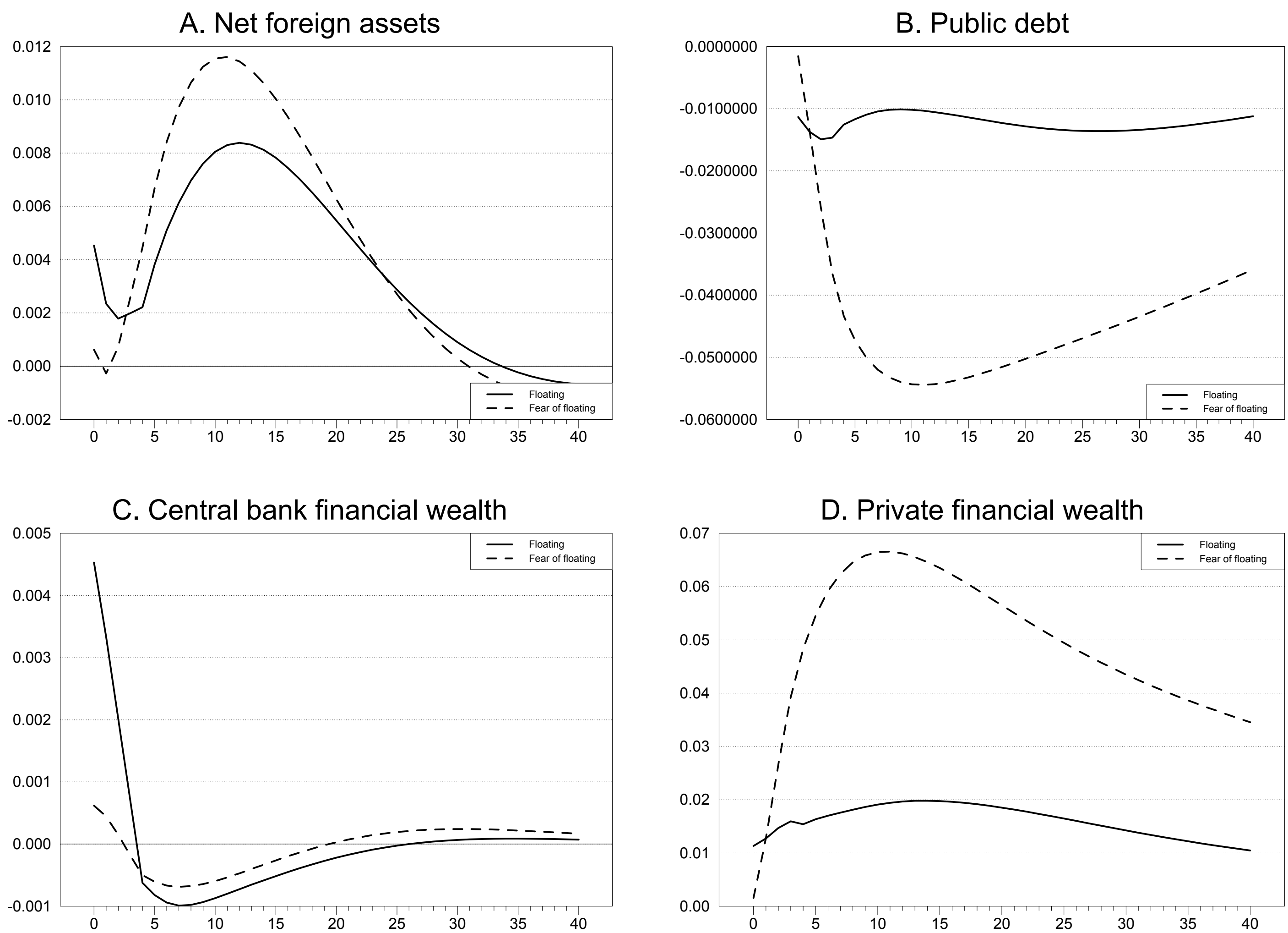

Figure 6. Effect of floating the exchange rate on the causes of the change in net worth

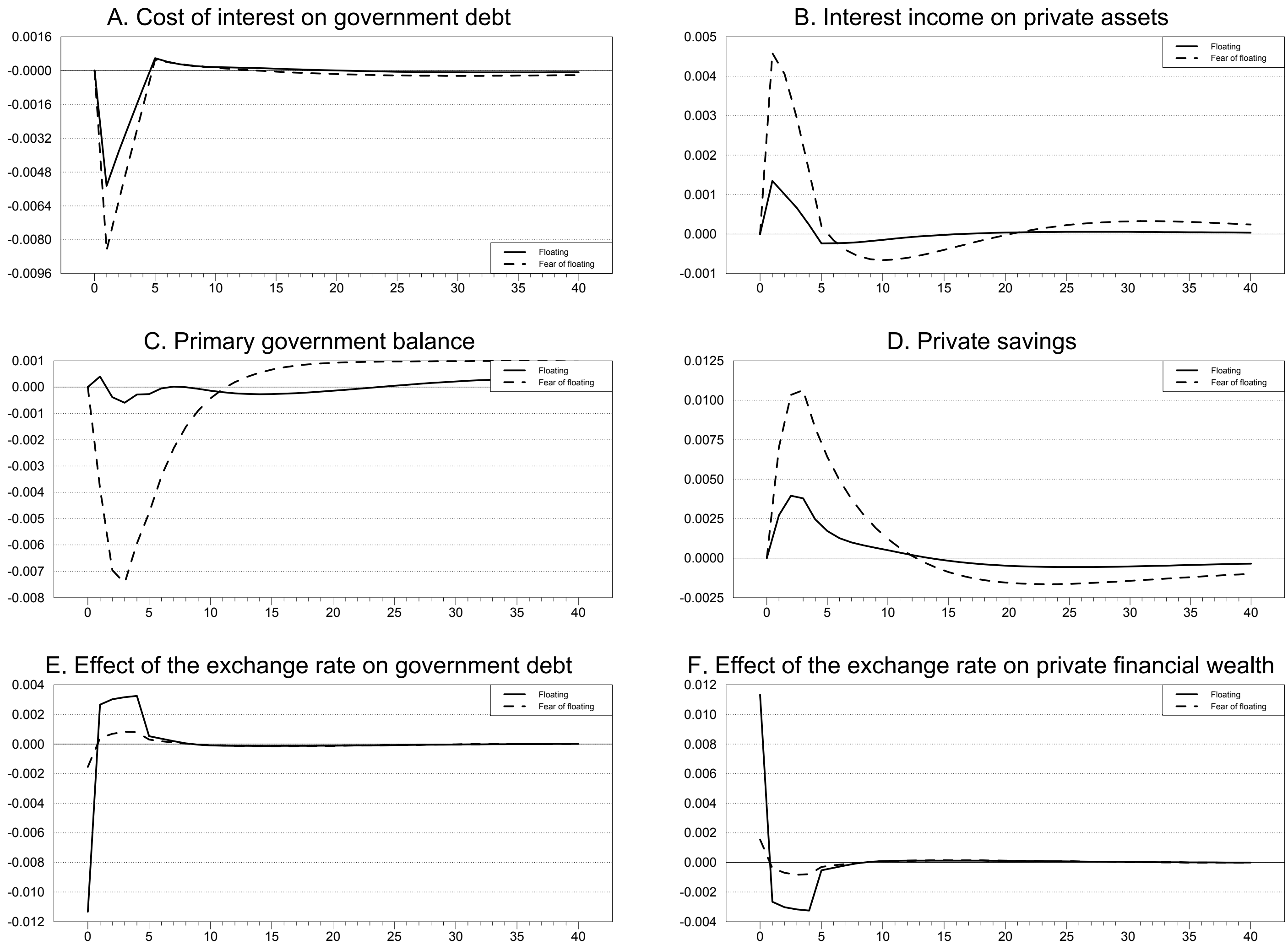

Figure 7. Effect of floating the exchange rate on the pass-through