Assessing Financial Vulnerability in Partially Dollarized Economies

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Abstract

The reduction of macroeconomic vulnerability in emerging markets is at the core of the research agenda. In this context, liability dollarization plays a vital role and its implications have been addressed in the literature via a "financial accelerator" mechanism. After allowing for different degrees of liability dollarization in a general equilibrium framework, this analysis uncovers some important implications about the role of the asset price channel and central bank's commitment with the exchange rate, when assessing financial vulnerability. If we asses vulnerability in terms of the evolution of investment, we claim that, in absence of an asset price channel, departures from a pure float will not only help mitigate vulnerability but will also be welfare improving. On the other hand, and with an active asset price channel, a tighter exchange rate policy will only have marginal effects on welfare and vulnerability when compared to that associated to a reduction in liability dollarization.

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1. Motivation

The reduction of macroeconomic vulnerability in emerging markets is now at the core of the research agenda. In this context, liability dollarization appears to play a vital role in the understanding of vulnerability and its implications (from a general equilibrium perspective) have been addressed in the literature via the inclusion of a "financial accelerator" mechanism[1]. In particular, its formalization is based on Bernanke's, *et al.* (1999) optimal contract, which predicts a negative relation between an external finance premium and firm's net worth.

The financial accelerator operates through basically two channels. The first, emphasized in Bernanke, *et al.* (1999) and Gertler, *et al.* (2001), implies fluctuations on asset prices that, in turn, affect the realized return on capital, net worth and investment decisions. The second channel is privileged in Céspedes, *et al.* (2000a and 2000b) and depends on unanticipated movements in firm's debt burden that directly affect their net worth. Not surprisingly, liability dollarization plays an important role in the activation of this second channel since the unexpected component of a real depreciation can greatly magnify the debt burden of firms indebted in dollars.

Based on this, Céspedes, *et al.* (2000a y 2000b) propose a first approximation to a definition of vulnerability. Particularly, an economy is classified as vulnerable if real exchange rate depreciations lead to increases in the risk premium faced by firms. This result is neatly summarized in a dynamic equation for risk premium and, crucially, depends on firms' leverage. Their framework, however, assumes complete depreciation of capital and thus, lacks the abovementioned asset price channel. Gertler, *et al.* (2001) recognize this issue and present some simulations using dollar denominated debt and an active asset price mechanism. They conclude that under full liability dollarization, an increase on the foreign interest rate leads to a fall in investment twice as large as under peso denominated debt. Interestingly, under both frameworks, a flexible exchange rate is preferred. In Céspedes, *et al.* (2000a) the impact of a depreciation on net exports more than compensates the effect on real indebtedness. In Gertler, *et al.* (2001), on the other hand, a fixed regime turns to be more damaging because of the effects of the domestic interest rate on the value of capital, which are magnified due to the asset price channel.

Despite these significant contributions to the understanding of the consequences of liability dollarization for investment and output fluctuations, some important extensions are in order. First, if we want to address the implications of the degree of dollarization, we need a general equilibrium model that admits firm's debt to be

[1] See Bernanke and Gertler (1989) and Kiyotaki and Moore (1997).

denominated in both local and foreign currency (the two models just described assume full liability dollarization). Second, central bank's response to exchange rate innovations (given a degree of dollarization) must be assessed from a welfare point of view; and given both a dollarization level and central bank's reaction function to shocks, a new, more general, definition of vulnerability must be provided to adequately address the way in which it can be mitigated.

Our paper is organized as follows. Section 2 presents a general equilibrium model with an extended financial accelerator mechanism that allows for debt to be denominated in two different currencies. Section 3 summarizes the results of a series of simulations for different types of shock, degrees of dollarization, exchange rate regime, and weights given to the asset price channel. Finally, section 4 concludes and suggests some avenues for further research.

2. An extended financial accelerator framework

In this section we develop a general equilibrium model for policy and welfare analysis under partial liability dollarization. With the exception of the financial block of the model, the setup though simpler is very close to that of Gertler, *et al.* (2001). After allowing for inner solutions regarding liability dollarization, this framework would permit us to assess the role of the asset price channel, the degree of central bank's concern on exchange rate fluctuations and the type of shock that hits the economy. This multidimensional analysis is required if we are to understand vulnerability from a general equilibrium perspective and its policy implications with those that stem from a welfare point of view.

2.1 The model

The model refers to a small open economy which has six representative agents: (i) a household that demands consumption goods, offers labor and saves in pesos and dollars; (ii) a firm that demands capital and labor to produce the final domestic good and exports. This agent faces the agency problem that leads to a financial accelerator; (iii) a capital producer who sells capital to the firm; (iv) a retailer that buys the firm's production and introduces price rigidities in the domestic good market; (v) a Central Bank that sets the domestic interest rate in response to the developments of the economy; and (vi) the rest of the world that shocks the economy through changes in the exports demand and the international interest rate.

2.1.1 The household

The household owns the profit-generating firm and each period receives the monetary profits Π_t for retailing the domestic good. It also earns a nominal wage W_t in exchange of labor. At time t, the household chooses the consumption C_t and labor supply L_t paths that maximize its discounted stream of utility. Additionally, it can save or borrow in assets denominated in two different currencies: pesos B_t , acquired in the domestic market and in dollars B_t^* , obtained in the international market. Since capital markets are imperfect the household must pay or is paid a random exchange rate premium Ψ_t with expected value Ψ .

Consumption and saving

The household intertemporal problem is:

$$\begin{aligned}
&\max \quad E_t \sum\nolimits_{s=0}^{\infty} \beta^{s-t} U(C_s, L_s) \\
&\text{st} \quad U(C_t, L_t) = \frac{C_t^{1-\nu}}{1-\nu} - \frac{L_t^{1+\xi}}{1+\xi} \\
&\qquad P_t C_t = W_t L_t + \Pi_t - B_{t+1} + (1+i_{t-1})B_t - S_t B_{t+1}^* + S_t \Psi_{t-1}(1+i_{t-1}^*)B_t^*
\end{aligned}$$

where β is the discount factor, i_t and i_t^* are the domestic and international nominal interest rates, respectively and S_t is the nominal exchange rate. Since P_t denotes the CPI index, the budget constraint is expressed in nominal terms. The utility function parameters are such that $\nu \in \{0,1\}$ and $\xi > 0$.

The FOCs of the above problem lead us to a familiar Euler Equation for consumption:

$$C_t^{-\nu} = \beta E_t \{ C_{t+1}^{-\nu} R_t \} \tag{2.1}$$

where, provided that π_t is the CPI inflation, the gross real interest rate is defined by the Fisher equation:

$$R_t = \frac{1+i_t}{1+E_t\{\pi_{t+1}\}} \tag{2.2}$$

On the other hand, the labor supply choice is determined according to:

$$L_t^{\xi} C_t^{\nu} = \frac{W_t}{P_t} \tag{2.3}$$

Finally, the Euler Equations for saving in both currencies imply:

$$E_t\left\{(1+i_t) - \Psi_t(1+i_t^*)\frac{S_{t+1}}{S_t}\right\} = 0 \quad \rightarrow \quad E_t\left\{\frac{S_{t+1}}{S_t}\right\} = \frac{1+i_t}{\Psi_t(1+i_t^*)} \tag{2.4}$$

which is nothing but the uncovered interest rate parity (UIP) condition.

Consumer prices

Domestic and imported goods compose aggregate consumption. The Law of One Price holds for the imported good and since the foreign price is normalized to one, the price of the imported good is equal to the exchange rate. On the other hand, the price of the domestic good is P_t^h and is set by the retailer (see below).

The following CES index defines household's preferences over the consumption of the domestic good C_t^h and the imported good C_t^m,

$$C_t = \left[(\gamma)^{\frac{1}{\theta}} (C_t^h)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (C_t^m)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

where $\theta > 1$ is the degree of sustainability between the two goods and $\gamma \in \{0,1\}$ is usually interpreted as the degree of openness of the economy.

The CES aggregator implies the demands:

$$C_t^h = \gamma \left(\frac{P_t^h}{P_t} \right)^{-\theta} C_t \quad \text{and} \quad C_t^m = (1-\gamma) \left(\frac{S_t}{P_t} \right)^{-\theta} C_t \tag{2.5}$$

The corresponding consumer price index is given by

$$P_t = \left[\gamma (P_t^h)^{1-\theta} + (1-\gamma)(S_t)^{1-\theta} \right]^{\frac{1}{\theta-1}} \tag{2.6}$$

For simplicity, we assume that the investment good is the same used for consumption. Moreover, we impose that the aggregation of domestic and imported investment is the same as that of consumption, thus

$$I_t = \left[(\gamma)^{\frac{1}{\theta}} (I_t^h)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (I_t^m)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

and the CPI (2.6) is the price of investment as well. The corresponding demands are:

$$I_t^h = \gamma \left(\frac{P_t^h}{P_t} \right)^{-\theta} I_t \quad \text{and} \quad I_t^m = (1-\gamma) \left(\frac{S_t}{P_t} \right)^{-\theta} I_t \tag{2.7}$$

2.1.2 Production, financing and retailing

Wholesale production and capital accumulation

An entrepreneur produces the domestic good and exports in a competitive market. It demands labor from households and buys capital from the capital producer to create output Y_t according to the production function

$$Y_t = A_t (K_t)^{\alpha} (L_t)^{1-\alpha} \tag{2.8}$$

where A_t is a technological shock with $E_t\{A_t\} = 1$.

If P_t^W denotes the wholesale price index, then labor demand is determined by the cost-minimizing FOC:

$$(1-\alpha)\frac{Y_t}{L_t} = \frac{W_t}{P_t^W} \tag{2.9}$$

On the other hand, capital stock evolves in accordance with the accumulation rule:

$$K_{t+1} = (1-\delta)K_t + \Phi\left(\frac{I_t}{K_t}\right)K_t\,, \tag{2.10}$$

where δ is the depreciation rate and the concave function $\Phi(.)$ captures adjustment costs of aggregate investment I_t.

Capital Production

Given (2.10), the capital producer supplies the quantity of investment good implied in the Q-investment condition:

$$E_t\left\{Q_{t+1}\Phi'\left(\frac{I_{t+1}}{K_{t+1}}\right) - 1\right\} = 0\,, \tag{2.11}$$

where Q_t is the real market value of capital.

The financial accelerator

In period t, the firm's gross project output equals the sum of real output revenues and the real market value of the capital stock, net of depreciation,

$$Y_t^W = \frac{P_t^W}{P_t}Y_t + Q_t(1-\delta)K_t \tag{2.12}$$

Equations (2.9) and (2.12) allow us to define the marginal gross return to capital (in pesos) as

$$E_t\{R_{t+1}^k\} = E_t\left\{\frac{Y_{t+1}^W - \frac{W_{t+1}}{P_{t+1}}L_{t+1}}{Q_t K_{t+1}}\right\} = \frac{E_t\left\{\alpha\frac{P_{t+1}^W}{P_{t+1}}\frac{Y_{t+1}}{K_{t+1}} + Q_{t+1}(1-\delta)\right\}}{Q_t} \tag{2.13}$$

which is simply the ratio of next period's ex-post gross output minus labor costs to period t market value of capital.

The capital producer will sell to the firm the amount of capital that equalizes (2.13) to her marginal financing costs. To derive such condition, the balance sheet identity of the entrepreneur is given by:

$$Q_t K_{t+1} = N_t + \frac{D_{t+1}}{P_t} + S_t \frac{D^*_{t+1}}{P_t} \qquad (2.14)$$

Capital acquisitions are financed either with the entrepreneur net worth or by contracting debt. The debt could be denominated in pesos (bonds sold to households) or in dollars (acquired in the international market).

For a given dollar debt ratio λ_t, pesos and dollar debts obey to:

$$\begin{aligned} S_t D^*_{t+1} &= \lambda_t P_t (Q_t K_{t+1} - N_t) \\ D_{t+1} &= (1-\lambda_t) P_t (Q_t K_{t+1} - N_t) \end{aligned} \qquad (2.15)$$

Marginal costs equal the debt cost plus a risk premium. Thus, in equilibrium:

$$E_t\{R^k_{t+1}\} = (1+\eta_{t+1})\left[\lambda_t \Psi_t (1+i^*_t) + (1-\lambda_t)(1+i_t) E_t\left\{\frac{S_t}{S_{t+1}}\right\}\right] E_t\left\{\frac{S_{t+1}}{S_t}\frac{P_t}{P_{t+1}}\right\}$$

which, using (2.2) and (2.4), is simply reduced to

$$E_t\{R^k_{t+1}\} = (1+\eta_{t+1}) R_t \qquad (2.16)$$

In (2.16) η_t is the risk premium that arises because of the existence of agency costs. The optimal contract implies (according to Bernanke *et al.* (1999)) a positive relationship between the risk premium and the capital to net worth (leverage) ratio,

$$(1+\eta_{t+1}) = F\left(\frac{Q_t K_{t+1}}{N_t}\right), \quad F' > 0 \qquad (2.17)$$

As in all previous general equilibrium settings that include a financial accelerator mechanism, this risk premium plays a vital role. In particular, a fall in net worth due to either an increase in the realized debt burden or a fall in the realized return on capital will imply an increase in financing costs and a fall in next period's investment following the Euler equation (2.16). It is important to notice that a negative shock on the realized return on capital is enough to trigger the financial accelerator mechanism since a fall in investment has also a negative effect on the market value of capital and, hence, on next period's realized return (see equation (2.13)). Thus, the initial shock not only transpires within a period but is also magnified dynamically due to the forward-looking nature of both investment decisions and the market value of capital setting[2].

[2] See Kiyotaki and Moore (1997). This "asset price channel" reveals that a financial accelerator is not only a feature of dollarized or partially dollarized economies. In fact, an increase in the

As already mentioned, Gertler, *et al.* (2001) recognize the importance of the asset price channel and conduct some experiments under full liability dollarization, allowing for the market value of capital to affect investment returns. The extension we propose here is summarized in equation (2.15). In particular, we introduce a framework that allows different degrees of liability dollarization, as revealed by the presence of the term λ_t.

Because of the UIP condition it might seem that, ex ante, the firm is indifferent between any combinations of peso or dollar debt. In fact, the term λ_t is no longer present in equation (2.16). However, and despite the fact that we can express the Euler condition for investment decisions in terms of the domestic real interest rate even under full dollarization ($\lambda_t = 1$)[3], we claim that the degree of liability dollarization has already been determined and is implicit because of the presence of a **unique risk premium**. This result stems from Castro and Morón (2003a) and is described in Appendix A.

Although the degree of liability dollarization is not present in the Euler equation governing investment decisions, its role becomes evident if we explore the evolution of net worth. For notational convenience we define the real foreign interest rate *expressed in pesos* as:

$$R_t^* = \frac{1+i_t^*}{1+E_t\{\pi_{t+1}\}} E_t\left\{\frac{S_{t+1}}{S_t}\right\} \tag{2.18}$$

In each period, the value of the entrepreneur depends on the **ex-post** (once all shocks have occurred) return to capital and the **ex-post** cost of borrowing

$$V_t^e = R_t^k Q_{t-1} K_t - (1+\eta_t)\left[\Psi_{t-1}(1+i_{t-1}^*)\frac{S_t D_t^*}{P_t} + (1+i_{t-1})\frac{D_t}{P_t}\right]$$

Using (2.15), (2.2) and (2.18) the last expression simplifies to:

$$V_t^e = R_t^k Q_{t-1} K_t - (1+\eta_t)\left[\lambda_{t-1}\Psi_{t-1}R_{t-1}^* + (1-\lambda_{t-1})R_t\right]\left[Q_{t-1}K_t - N_{t-1}\right] \tag{2.19}$$

It is clear from (2.19) that the higher the value of λ_{t-1} (the degree of liability dollarization), the more negative the impact of a real depreciation on the evolution of the value of the entrepreneur.

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firm's debt burden (due to a real depreciation in the presence of liability dollarization) is just another channel by which the financial accelerator can be triggered.

[3] In fact, full liability dollarization does not render monetary policy as ineffective under any framework that includes a UIP condition and models investment as an ex-ante decision. Thus, financial dollarization should be regarded as a phenomenon that "complicates" rather than turns monetary policy ineffective.

Now consider that the entrepreneur consumes a (exogenous) proportion $(1 - \phi)$ of her value and, consequently, the remaining proportion ϕ is devoted to her net worth,

$$N_t = \phi V_t^e \quad \text{and} \quad C_t^e = (1-\phi)V_t^e \tag{2.20}$$

In (2.20), C_t^e is the entrepreneur's consumption.

Retailing and the domestic Phillips Curve

The retailer buys the firm's production at the wholesale price P_t^W, "brands it" and sells it to households for consumption and to the firm for investment. In setting the final good price, it affords menu costs. We use Rotemberg (1982) approach to model nominal rigidities. It consists, first, in finding desired prices, as being in a flexible price environment, and then introducing costs of adjustment to move observed prices toward the optimal ones.

It is well known that the optimal flexible price decision reduces to a standard markup pricing over marginal costs. Therefore, the optimal price is $P_t^{opt} = \mu P_t^W$, where $\mu > 1$ is the markup. Letting the lower cases being the logs of the upper cases variables, the retailer problem is then:

$$\min_{\{p_s^h\}_{s=t}^{\infty}} E_t\left\{\sum\nolimits_{s=t}^{\infty}\beta^{s-t}\left[(p_s^h - p_s^{opt})^2 + \frac{1}{c}(p_s^h - p_{s-1}^h)^2\right]\right\}$$

This problem is neatly solved in Vega and Winkelried (2004) and implies the equation

$$(1+\beta\rho^2)\pi_t^h = \beta\rho E_t\{\pi_{t+1}^h\} + \rho\pi_{t-1}^h + c\rho\Delta p_t^{opt} + iid$$

where $0 < \rho < 1$ is a stable root of the price path such that $\beta\rho^2 + 1 - c\rho = (1+\beta)\rho$.

Let $\varpi_t = p_t^W - p_t$ denote the real (log) marginal cost. Then, for a constant markup $\Delta p_t^{opt} = \Delta p_t^W = \Delta\varpi_t + \pi_t = \Delta\varpi_t + \gamma\pi_t^h + (1-\gamma)\Delta s_t$. Upon replacing, we obtain the domestic inflation equation:

$$\pi_t^h = \beta\kappa E_t\{\pi_{t+1}^h\} + \kappa\pi_{t-1}^h + (1-\kappa-\beta\kappa)\Delta s_t + c\kappa\Delta\varpi_t + \varepsilon_t^\pi \tag{2.21}$$

where $\kappa = \left[1+\beta+c(1-\gamma)\right]^{-1}$ and ε_t^π is an *iid* cost-push shock. Equation (2.21) is a linear-homogenous Phillips curve where inflation depends on real marginal costs. Nominal depreciation Δs_t appears in (2.21) due to the substitutability between the domestic and the imported good implied in (2.6).

2.1.3 Monetary Policy

The monetary policy instrument is the nominal interest rate and is set by the central bank to adjust to deviations of forecasted CPI inflation, domestic output and, possibly, currency depreciation, from their respective target or desired levels. The log-linearized version of such a rule is given by

$$i_t = f_\pi E_t\{\pi_{t+1}\} + f_y y_t + f_s \Delta s_t + \varepsilon_t^i \tag{2.22}$$

In the subsequent analysis, the parameter f_s will play an important role in controlling for the degree of central bank's concern about exchange rate fluctuations.

2.1.4 Clearing conditions

To close the model we need four additional equations. First, the resource constraint:

$$Y_t = C_t^h + C_t^e + I_t^h + X_t - (C_t^m + I_t^m) \tag{2.23}$$

where X_t stands for exports of the home produced good. If Y_t^* denotes real foreign output, exports demand is given by the simple equation:

$$X_t = \left(\frac{S_t}{P_t}\right)^{\theta^*} Y_t^* \tag{2.24}$$

Two further equilibrium conditions are required. Given exports and imports in the model, the balance of domestic and external payments is

$$C_t^m + I_t^m - X_t = S_t(D_t^* + B_t^*) - \left[(1+\eta_t)D_{t-1}^* + B_{t-1}^*\right]R_{t-1}^* \tag{2.25}$$

which simple states that the trade balance equals the capital account. Finally, equation (2.26) clears the domestic asset market.

$$B_t - D_t = 0 \tag{2.26}$$

2.1.5 A Welfare index

For policy analysis, we use a utility-based welfare indicator[4]. As is discussed in Erceg, *et al.* (2000) and Woodford (2003), a good candidate is the unconditional expectation of a second order approximation of the period utility function around its flexible-price steady state. The index is:

$$\mathbb{Z} = 1 - \text{var}(c_t) - \Upsilon\, \text{var}(l_t) \tag{2.27}$$

where $\text{var}(c_t)$ and $\text{var}(l_t)$ are the asymptotic variances of the deviations of consumption and labor, respectively, from their steady state values. The constant $\Upsilon > 0$ depends on utility and production parameters and on the participation of consumption in the steady state overall expenditure. Clearly, this parameter establishes the relative importance for the variability of consumption to the variability for labor in welfare.

[4] The derivations and some discussion are presented in Appendix C.

As evident from (2.27), welfare is negatively related to either variance and reaches its maximum when $\text{var}(c_t) = \text{var}(l_t) = 0$.

2.2 Steady state and calibration

We calibrate the model to replicate many short-run dynamic features of small open economies (the model period corresponds to a quarter). In this sense, the parameters governing preferences and technology are standard in the literature[5].

It is important to note however that three parameters are allowed to vary in the simulations of the subsequent sections. The first one is the depreciation rate δ. When capital totally depreciates in a period ($\delta = 1$) as in Céspedes, *et al.* (2000a and 2000b), the asset price channel plays no role. The alternative is to consider an active asset price channel, with an annual capital depreciation rate of 5 percent ($\delta = 0.05/4$). As we may see, different values of δ will lead to different values of some steady state ratios. In contrast, the other two varying parameters, the dollarization ratio λ and the response of the interest rate to nominal depreciation in the policy rule f_s, do not alter the steady state properties.

In the long-run, nominal variables grow at the inflation target, which is assumed to be an annual rate of 2 percent, and all real variables are driven by productivity shocks that grow at an exogenous rate. Since in our setting foreign inflation is zero, nominal depreciation must equal inflation in the long run to ensure a constant steady state real exchange rate.

We set the annual real interest rate to $r = 3$ percent, which implies a nominal rate of $i = 5$ percent and, using the Euler equation for consumption (2.1), a discount factor of $\beta = 0.99$. Following the UIP condition (2.4), we set the foreign interest rate steady state value to $i^* = 2$ percent annually which leads to an exchange rate premium of $\Psi = 100$ bps annually.

Regarding the utility function, we set the intertemporal elasticity of substitution ν to 0.9, which implies an elasticity of consumption to the real interest rate equal to -1.1. Additionally, we fix ξ so that the elasticity of labor demand to the real wage is 2.5. In the consumption and investment price aggregators (2.6) we calibrate an openness ratio of $1 - \gamma = 0.3$ and we set the elasticity of substitutability θ to 11, to have a steady state markup of the retailer of $\mu = 10$ percent.

[5] See, for instance, Obstfeld and Rogoff (2000) and Svensson (2000).

We consider a capital share of $\alpha = 0.35$ in (2.8), and an elasticity of the market value of capital to the investment to capital ratio of $\varphi = -(\Phi''/\Phi')(I\ /\ K) = 0.250$ (equation (2.11)). On other side, given β and γ, we fix the adjustment cost parameter of the retailer c so the domestic Phillips curve (2.21) becomes

$$\pi_t^h = 0.46 E_t\{\pi_{t+1}^h\} + 0.47\pi_{t-1}^h + 0.07\Delta s_t + 0.23\Delta\varpi_t + \varepsilon_t^{\pi}$$

which generates suitable dynamics of inflation.

In the financial block of the model, in a similar fashion than Céspedes, *et al.* (2000a) and Gertler, *et al.* (2001), we set a capital to net worth ratio (QK/N) to 3, which implies a leverage ratio of $\varsigma = 2$. This choice affects some important steady state figures. First, the risk premium and the return of capital. Following (2.17), we set a value of the elasticity of the risk premium to leverage ($\vartheta = (F'/F)(QK/N)$) to obtain an equilibrium annual risk premium of 350 bps. With this, $R^k - 1 = 6.5$ percent. Second, it is easy to show that the contribution of the capitalist's consumption to aggregate expenditure is

$$\frac{C^e}{Y} = \left(\frac{1}{1-\phi(1-\delta)}\right)\frac{\alpha(1-\phi)}{\mu}\left(\frac{QK}{N}\right)^{-1}$$

which is a small number that varies between 0.2 and 5.7 percent according to the value of δ. The damping parameter $\phi = 0.98$ is set to satisfy the steady state version of the net worth evolution equation (2.19). All this calculations lead to a maximum debt to GDP ratio of about 12 percent and a maximum capital to gross output ratio

$$\tau = \frac{PQ(1-\delta)K}{\alpha P^W Y + PQ(1-\delta)K}$$

of 0.96.

Regarding the resource constraint, we consider an aggregate consumption to GDP and aggregate investment to GDP ratios of 60 and 25 percent, respectively. Given the CPI aggregator, we set the exports to GDP ratio to ensure a long-run zero trade balance. This composition of expenditure is consistent with a value of $\Upsilon = 0.95$ in the welfare index (2.27) (see Appendix C).

Finally[6], the calibrated policy rule is

$$i_t = 1.50 E_t\{\pi_{t+1}\} + 0.50 y_t + f_s\Delta s_t + \varepsilon_t^i$$

[6] The remaining parameters of the log-linearized version of the model displayed in Appendix B are: the exports price elasticity ($\theta^* = 1.5$), the autoregressive coefficients of the exogenous forcing processes ($\rho_{\psi} = \rho_{i^*} = \rho_{y^*} = \rho_a = 0.5$) and the variance of shocks (0.01 for all shocks).

3. Financial vulnerability and welfare

As mentioned at the beginning of Section 2, our aim is not just to assess vulnerability as a function of the degree of financial dollarization, but to assess this phenomenon considering also the role of the asset price channel, the central bank's response to exchange rate movements, and the type of shock that hits the economy. We believe this multidimensional analysis is required because, given a degree of liability dollarization and a shock that calls for a real depreciation, the effects of this shock on output and inflation will determine the central bank's response depending on the specific weights given to the arguments in its reaction function. The resulting evolution of the domestic interest rate will, in turn, hit investment decisions in a way that may end up reinforcing or mitigating the negative effect of a higher debt burden. In this way, the resulting path of investment will be the result of this combination of forces that, in addition, may or may not be magnified depending on the importance given to the asset price channel.

3.1 The multiple dimensions of our analysis

Based on our model, we simulated the effects of a negative shock on export demand and a positive shock on the international interest rate[7]. For each type of shock, we computed impulse responses considering combinations of: (i) a pure ($f_s = 0$) vs. a managed float ($f_s = 1.25$); and (ii) the asset price channel "switched" on ($\delta = 0.05/4$) and off ($\delta = 1$), for different degrees of liability dollarization. We also estimated level contours for both the response of investment and the welfare index under different degrees of liability dollarization ($\lambda \in [0, 1]$) and central bank's concern with the exchange rate ($f_s \in [0, 2]$).

The analysis we propose will definitely drive us away from a neat analytical presentation as the one suggested in Céspedes, *et al.* (2000a). However, an appealing feature of our model is that we are able to link vulnerability and the financial condition of firms without relying on changes in steady states values, but on the degree of liability dollarization[8].

[7] To solve the rational expectations equilibrium, we use the algorithm outlined in Klein (2000).

[8] For example, the debt to GDP steady state ratio proves essential for Céspedes, *et al.* (2000a) results regarding their flex-fix discussion. According to Elekdag and Tchakarov (2004), Céspedes, *et al.* model requires a very high debt to GDP ratio steady state value (approximately 31%) to justify a peg. Under Elekdag and Tchakarov's welfare metrics, however, this threshold falls to 16%. Beyond this discussion, and insulating from the risk of extreme parameterizations, our model can directly assess the role of dollarization for a given indebtedness level.

Since the contributions of our model (and of any other which introduces a financial accelerator mechanism) are focused on capitalists' decisions, the path of investment will be the source of novel results. Therefore, in all subsequent experiments we will assess vulnerability by measuring the response of investment. In particular, and in order to allow for the dynamic effects of our model to become evident (and avoid on-impact responses to dominate), investment contours were computed adding the quarterly response of investment for the first year, under both types of shock. Since this evaluation may seem arbitrary, we complement this analysis with welfare assessments.

3.1.1 The asset price channel, liability dollarization and the type of shock

Given a degree of central bank's concern with the exchange rate, the asset price channel plays a crucial role in determining the effect of liability dollarization and the type of shock on the evolution of investment.

As revealed if we compare Figures 1 and 2, under a managed float the degree of liability dollarization will imply no significant difference in the evolution of investment if the asset price channel is not allowed to operate. Crucially, net worth depends on both the realized return to capital and realized debt burden and, as expected, return to capital falls on impact for any dollarization level (following the fall in output). However, net worth falls less in the non-dollarized economy because the debt burden does not increase with depreciation. Accordingly, the risk premium experiences a smaller increase in the non-dollarized economy. So, why is that investment behaves in the same manner for dollarized and non-dollarized economies when the asset price channel is switched off? Because the effect of a higher risk premium is not magnified via the asset price channel.

Both the market value of capital and investment decisions are forward-looking variables that respond to each other's expected path. If we switch off the asset price channel, we mitigate the impact of the market value of capital on investment. Thus, and without the magnifying effect brought by this channel, the effect of a higher debt burden (because of a dollarized debt) is not strong enough to cause a significant deviation in the path of investment if we compare a dollarized with a non-dollarized economy.

This result highlights the importance of the asset price channel in understanding vulnerability. By looking only at the evolution of the risk premium, one could be tempted to classify a highly dollarized economy in Figure 2 as vulnerable. Nonetheless, and faced with the evidence presented in Figure 1, no clear distinction can be made in terms of vulnerability without the asset price channel.

This result, however, heavily depends on the degree of Central Bank's concern about exchange rate fluctuations. The balance sheet channel requires the magnifying effect of the asset price channel to render an economy as vulnerable when the Central Bank is mitigating the former. Figure 3 depicts the evolution of investment and several other variables under a pure float with no asset price channel. In this case, we can establish a clear distinction between a vulnerable and a robust economy solely as a function of the level of liability dollarization.

Interestingly, the asset price channel also plays an important role in determining the impact of the type of shock on investment decisions. Figures 5 and 6 present responses for a managed float with the asset price channel switched on and off, respectively, under a positive shock to the international interest rate.

If we compare Figures 1 and 5, it is clear that an increase in the foreign interest rate is much more damaging (in terms of investment) than a negative shock to exports. Despite the fact that both types of shock imply a depreciation and the central bank shows the same degree of concern regarding exchange rate fluctuations, its resulting response is markedly different. A positive shock on the foreign interest rate provokes a sharp increase in the bank's policy instrument in an attempt to stabilize output, inflation and the exchange rate. This has a negative effect on investment which is magnified by the presence of the asset price channel. Contrary to what happens with a negative shock on exports, an increase in the foreign interest rate has a positive effect on aggregate demand on impact (via the effect of the real depreciation on exports) and this claim for a restrictive monetary policy.

On the other hand, and with the asset price channel switched off, the negative shock on exports reveals more damaging in terms of investment. This is evident if we compare Figures 2 and 6. The reason for this is that output fluctuations dominate in the determination of the realized return on capital if the asset price channel is switched off. A rapid exploration of the log linear version of the equation for the ex-post return on capital (equation (B14) in Appendix B), reveals that as $\delta \rightarrow 1$ the fall in parameter τ will imply that more weight is given to output in the determination of this return and, consistent with the presence of a weaker asset price channel, less weight is given to the market value of capital (Q_t). Therefore, and if we trigger the asset price channel off, the increase in output (on impact) given the shock on the foreign interest rate will foster investment via the realized return on capital.

3.1.2 Central bank's response to the exchange rate, investment and welfare

Since the degree of Central Bank's concern about the exchange rate is a policy variable, we would like to stress its role in the determination of vulnerability and complement these results with a policy evaluation based on welfare considerations.

If we compare Figures 2 and 3 and focus our attention on a highly dollarized economy $(\lambda \rightarrow 1)$, it seems that the central bank retains some ability to improve the performance of investment by increasing its degree of concern about the exchange rate, if the asset price channel is sufficiently weak. Evidence is less clear, however, if we allow the asset price channel to operate (compare Figures 1 and 4). In order to shed more light on this respect, Figures 7 and 8 present investment and welfare contours for different degrees of liability dollarization and central bank's response to the exchange rate.

The evidence presented is suggestive in various aspects. First, and as already mentioned after comparing Figures 2 and 3, an increase in central bank's concern with the exchange rate in an economy characterized by the absence of an asset price channel, can help improve investment performance after a negative shock on exports demand. In particular, and if we center our attention on Panel A of Figure 7, a fully dollarized economy can still exhibit a positive evolution in investment for a sufficiently large degree of central bank's concern with the exchange rate. Moreover, and given the large positive slope that characterizes investment level contours when the asset price channel is switched off, the investment response can be rapidly increased as we move from a pure float to a tighter managed float. This result resembles Gertler, *et al.* (2001) argument regarding exchange rate policy in the absence of an asset price channel: "For countries with capital markets that are not sufficiently developed to incorporate market value-based accounting and collateral, it might be possible to make a case for fixed rates".

Panel B in Figure 7 complements this evidence with a welfare evaluation. Interestingly, welfare level contours also exhibit a significantly large slope when the asset price channel is switched off. Thus, we can observe a rapid welfare improvement when moving away from a pure float. However, since we are concerned with second moments when talking about welfare, we can clearly identify a critical degree of central bank's concern with the exchange rate after which any further tightening in exchange rate policy will imply a welfare loss.

It is worth noticing that there is a correspondence between investment and welfare level contours. If we focus our attention on a highly dollarized economy, improving investment performance (mitigating vulnerability) by means of a tighter exchange rate policy is also welfare improving. However, the welfare assessment we propose complements this first result by imposing a limit to the degree of central bank's concern with the exchange rate. Interestingly too, this "optimal degree of fear of floating" is not only a feature of highly dollarized economies. In fact, a non-dollarized economy can also benefit from a managed float in terms of welfare.

As we will explore when analyzing Figure 8, this result crucially depends on the absence of an asset price channel and can help refine Gertler, *et al.* (2001) argument presented above. In particular, our analysis reveals that in those countries were market-based asset values do not play an important role in collateralizing lending, vulnerability can be mitigated and welfare improved by moving away from a pure float. However, welfare considerations suggest that this does not really imply a case for fixed rates nor is this a result valid only for highly dollarized economies. In fact, the crucial feature economies with different dollarization levels must share for the above to be true is the absence of an asset price channel for the financial accelerator. Under this scenario, a managed float would help stabilize output, consumption (and labor) without exacerbating investment (recall that weakening the asset price channel implies giving more weight to output, and less weight to the market value of capital, in the determination of investment return).

If we turn the asset price channel on (see Figure 8), one first obvious implication is that both investment performance and welfare deteriorates for a given degree of liability dollarization and central bank's concern with the exchange rate. One less obvious result is the sharp decline in both investment and welfare contours' slope. We can uncover two important implications from this result. First, the degree of liability dollarization does make a difference. In the same manner as the central bank of a highly dollarized economy remains unable to foster a positive response in investment through a tighter exchange rate policy, it remains unable to prompt a significant welfare improvement by these means. In fact, vulnerability is mitigated and welfare is improved as we move away from a pure float, but only marginally.

The second implication stems directly from the one just mentioned. If we seek a significant reduction in vulnerability and welfare improvement, reducing the degree of liability dollarization seems to be the most adequate route, rather than tightening the exchange rate policy.

4. Concluding remarks and avenues for further research

After allowing for different degrees of liability dollarization in a general equilibrium framework that incorporates an asset price channel for the financial accelerator mechanism, our model has uncovered some important implications about the role of (i) liability dollarization; (ii) the asset price channel; (iii) central bank's commitment with the exchange rate; and (iv) the type of shock that hits the economy, when assessing financial vulnerability.

In particular, the existence of an asset price channel proves important to understand the role of the degree of liability dollarization and the type of shock in explaining vulnerability. In fact, evidence suggests that in those economies characterized by a managed float and where market-based asset values do not play an important role in collateralizing lending (the asset price channel is sufficiently weak), a high degree of liability dollarization is not enough to explain significant departures in the evolution of investment when compared to non-dollarized economies. Moreover, and in the absence of this magnifying mechanism, external shocks that hit aggregate demand negatively on impact (as a negative shock on export demand) prove more damaging in terms of investment performance than shocks that foster aggregate demand (as a positive shock on the foreign interest rate).

More importantly in terms of monetary policy options, the asset price channel plays also a crucial role to understand the effects of different exchange rate regimes on investment performance and welfare. If we assess vulnerability in terms of the evolution of investment, we claim that, in absence of an asset price channel, departures from a pure float will not only help mitigate vulnerability but will also be welfare improving. This result, however, cannot be linked to the degree of liability dollarization. Evidence suggests that a managed float may be the optimal even for non-dollarized economies.

Given this result, can we make a case for "fear of floating" as a welfare improving and "vulnerability mitigating" policy option for highly dollarized economies that exhibit a strong asset price channel? Evidence reveals that under such scenario, a tighter exchange rate policy will only have a marginal effect on welfare and vulnerability when compared to that associated to a reduction in liability dollarization.

If policymakers take the degree of liability dollarization as exogenous, "fear of floating" may seem a natural feature of highly dollarized economies after invoking welfare and vulnerability considerations. The above result, however, suggests that this is a second best. Despite the fact we cannot characterize it a pure policy variable, dedollarization reveals to be much more effective in fostering welfare and mitigating vulnerability if we regard an economy as characterized by the presence of a strong asset price channel.

In the dedollarization debate, which our analysis reveals to be particularly important only under the presence of an asset price channel for the financial accelerator, one of the main issues that still awaits further research in a general equilibrium context is the connection between central bank actions and the degree of liability dollarization. Partial equilibrium models that stress portfolio considerations (see Ize and Levy Yeyati (1998) and Castro and Morón (2003b)) point out the importance of reducing the relative variance of inflation to real depreciation[9]. They claim that an inflation targeting scheme should account for the numerator while less "fear of floating" should help increase the denominator, thus fostering financial dedollarization. However, policy recommendations that stem from these models face the risk of triggering now (via a more volatile exchange rate) the "balance sheet effects" that the dedollarization effort seeks to avoid in the future.

When assessing this risk, two elements must be accounted for: (i) the effects that moving towards a pure float has on investment and welfare under a context of significant liability dollarization; (ii) central bank's ability to reduce dollarization by means of a more volatile exchange rate. Regarding this, our analysis has uncovered some important results related to the first of the two elements just mentioned. Given the above evidence, we could claim that *if* moving towards a pure float effectively reduces dollarization, this should be the preferred policy option in those economies were, in Gertler, *et al.* (2001) terms, capital markets that are sufficiently developed to incorporate market value-based accounting and collateral[10]. Crucially, the "if" part in the preceding argument depends on the second element. Thus, further research should now be devoted to assess this "ability" in a general equilibrium context as the one just presented: one that allows for different degrees of liability dollarization and accounts for a financial accelerator with a balance sheet and an asset price channel.

Interestingly, if we combine the results presented in the previous section and if the "if" part of the above argument accords with the prediction of partial equilibrium portfolio models, "fear of floating" could no longer be regarded as the best policy option (since moving towards a pure float would prompt a dedollarization and this will be welfare improving with an active asset price channel), nor a particular feature (since a managed float is also the best policy option for non-dollarized economies when the asset price channel is not significant) of highly dollarized economies.

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[9] Others, like Broda and Levy Yeyati (2003), stress the role of currency-blind regulations when explaining deposit dollarization.

[10] If we rely on Broda and Levy Yeyati's (2003) results, safety nets that discriminate between currencies could also be regarded as welfare improving in economies characterized by the existence of a strong asset price channel.

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Appendix A: Partial dollarization and a unique risk premium

Castro and Morón (2003a) propose an extension to the Bernanke *et al.* (1999) optimal contract to account for the presence of a mismatch between the denomination of debt and firm's revenues and show, within a simple partial equilibrium setting, how debt can be denominated in both dollars and pesos with the existence of a unique relevant external finance premium.

In particular, they extend Bernanke *et al.* (1999) model and show that the financial intermediary will charge a higher risk premium to a firm that asks for credit denominated in a different currency than its revenues. In fact, the presence of a larger premium is attached to the existence of a mismatch rather that to the existence of dollar debt. In this way, they identify two risk premia (η_1 in the absence of a mismatch and η_2 for a debt contract that implies a mismatch), and show that $\eta_2 > \eta_1$.

On the other hand, their partial equilibrium setting assumes a continuum of firms that seek financing indexed by $\varphi_i \in [0,1]$, which measures the firm's ability to "transmit" to the financial intermediary information about the denomination of its revenues. Therefore, the intermediary will face discrimination costs when trying to determine the denomination of each firm's revenues, and will find it optimal to discriminate (and classify a firm as a "peso earner") only up to a certain point (φ_i^*). Thus, all firms $\varphi_i \in [0,\varphi_i^*]$ will be classified as "peso earners" and charged with a higher risk premium (η_2) when asking for a credit denominated in dollars. The same will happen with all firms $\varphi_i \in]\varphi_i^*,1]$ when asking for a credit denominated in pesos. Thus, and since all firms will choose, ex-ante, the debt denomination with the smallest cost, there will only be one relevant risk premium ($\eta = \eta_1$) and debt denominated in both currencies. In particular, the degree of liability dollarization will be given by $\lambda = 1 - \varphi_i^*$.

This result can be easily carried into a general equilibrium setting as the one suggested in Gertler, *et al.* (2001). Thus, this framework is the preferred one since it includes forward looking consumers (the providers of local currency funding) and allows for the existence of the asset price channel associated to the financial accelerator.

Appendix B: The Log-linearized version of the model

Below, each lower case variable is the log deviation of the upper case variable in the main text, $x_t = \log(X_t / X)$. However, some variables depart from this notation: the interest rates (i_t and i_t*), aggregate inflation (π_t) and investment (ι_t). The ε-variables denote shocks.

Consumption and Saving

Euler equation (2.1)

$$c_t = E_t\{c_{t+1}\} - \tfrac{1}{\nu} r_t \quad \text{(B1)}$$

Fisher equations (2.2) and (2.18)

$$r_t = i_t - E_t\{\pi_{t+1}\} \quad \text{(B2)}$$

$$r_t^* = i_t^* - E_t\{\pi_{t+1}\} + E_t\{s_{t+1}\} - s_t \quad \text{(B3)}$$

Labor supply (2.3)

$$\xi l_t + \nu c_t = w_t \quad \text{(B4)}$$

UIP condition (2.4)

$$E_t\{s_{t+1}\} - s_t = i_t - i_t^* - \psi_t \quad \text{(B5)}$$

Consumer prices

Domestic and imported consumption (2.5) (in differences)

$$c_t^h = c_{t-1}^h - \theta(\pi_t^h - \pi_t) + \Delta c_t \quad \text{and} \quad c_t^m = c_{t-1}^m - \theta(\Delta s_t - \pi_t) + \Delta c_t \quad \text{(B6)}$$

Domestic and imported investment (2.7) (in differences)

$$\iota_t^h = \iota_{t-1}^h - \theta(\pi_t^h - \pi_t) + \Delta \iota_t \quad \text{and} \quad \iota_t^m = \iota_{t-1}^m - \theta(\Delta s_t - \pi_t) + \Delta \iota_t \quad \text{(B7)}$$

CPI inflation (2.6) (in differences)

$$\pi_t = \gamma \pi_t^h + (1-\gamma)\Delta s_t \quad \text{(B8)}$$

Wholesale production and capital accumulation

Production function (2.8)

$$y_t = a_t + \alpha k_t + (1-\alpha) l_t \quad \text{(B9)}$$

Labor demand (2.9)

$$y_t - l_t = w_t - \varpi_t \quad \text{(B10)}$$

Capital accumulation (2.10)

$$k_{t+1} = \delta \iota_t + (1-\delta) k_t \quad \text{(B11)}$$

Q-investment condition (2.11)

$$E_t\{q_t\} = \varphi(E_t\{\iota_{t+1}\} - k_{t+1}) \quad \text{(B12)}$$

Retailing

Phillips curve (2.21)

$$\pi_t^h = \beta\kappa E_t\{\pi_{t+1}^h\} + \kappa\pi_{t-1}^h + (1-\kappa-\beta\kappa)\Delta s_t + c\kappa\Delta\varpi_t + \varepsilon_t^\pi \tag{B13}$$

The financial accelerator

Ex-post gross return to capital (2.13)

$$r_t^k = (1-\tau)(\varpi_t + y_t - k_t) + \tau q_t - q_{t-1} \tag{B14}$$

Risk premium equation (2.16) and (2.17)

$$E_t\{r_{t+1}^k\} - r_t = \vartheta(q_t + k_{t+1} - n_t) \tag{B15}$$

Network evolution (2.19) and (2.20)

$$n_t = \phi R^k(r_t^k + n_{t-1}) + \lambda\varsigma\phi R^k(r_{t-1}^* + \psi_{t-1} - r_{t-1}) \tag{B16}$$

Monetary Policy

Monetary policy rule (2.22) and (2.20)

$$i_t = f_\pi E_t\{\pi_{t+1}\} + f_y y_t + f_s \Delta s_t + \varepsilon_t^i \tag{B17}$$

Macroeconomic equilibrium

Resource constraint (2.23) and (2.20)

$$y_t = \frac{C^h}{Y}c_t^h + \frac{C^e}{Y}n_t + \frac{I^h}{Y}\iota_t^h + \frac{X}{Y}x_t - \left(\frac{C^m}{Y}c_t^m + \frac{I^m}{Y}\iota_t^m\right) \tag{B18}$$

Exports demand (2.24) (in differences)

$$x_t = x_{t-1} + \theta^*(\Delta s_t - \pi_t) + \Delta y_t^* \tag{B19}$$

Forcing processes

Exchange rate premium

$$\psi_t = \rho_\psi \psi_{t-1} + \varepsilon_t^\psi \tag{B20}$$

Foreign interest rate

$$i_t^* = \rho_{i^*} i_{t-1}^* + \varepsilon_t^{i^*} \tag{B21}$$

Foreign real income

$$y_t^* = \rho_{y^*} y_{t-1}^* + \varepsilon_t^{y^*} \tag{B22}$$

Technology

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{B23}$$

Appendix C: Derivation of the Welfare Index

Following Erceg, *et al.* (2000), the expectation of the quadratic term of the second order approximation of the period utility function is

$$\Theta = U_{CC} C^2 \operatorname{var}(c_t) + U_{CL} \operatorname{cov}(c_t, l_t) + U_{LL} L^2 \operatorname{var}(l_t) \tag{C1}$$

where c_t and l_t are the deviations of consumption and labor, respectively, from its steady state values, C and L, and "var" stands for the asymptotic variance operator. In (C1) we have suppressed any constant term.

Note that the simple utility function used in the text implies that $U_{CL} = 0$, $U_{CC} < 0$ and $U_{LL} < 0$. With this, expression (C1) is unambiguously negative and measures the welfare losses related to fluctuations in consumption and labor. In order to get an index decreasing in both asymptotic variances, we shall consider instead

$$\mathbb{Z} = 1 - \frac{\Theta}{U_{CC} C^2} \tag{C2}$$

so the bigger $\mathbb{Z}$ is, the higher the welfare (the smaller the welfare losses).

We now move to express (C2) in terms of the model's parameters and steady state values. Note that

$$\mathbb{Z} = 1 - \operatorname{var}(c_t) - \frac{U_{LL} L^2}{U_{CC} C^2} \operatorname{var}(l_t) \tag{C3}$$

It is useful to recall some of the properties of the utility function. In particular,

$$\begin{aligned} U_C &= C^{-\nu} & & & U_L &= -L^{\xi} \\ U_{CC} &= -\frac{\nu}{C} U_C & &\text{and} & U_{LL} &= \frac{\xi}{L} U_L \end{aligned} \tag{C4}$$

On the other hand, the labor supply (2.3) and the firm's labor demand (2.9) implies in steady state that

$$-\frac{U_L}{U_C} = \frac{W}{P} \quad \text{and} \quad (1-\alpha)\frac{Y}{L} = \frac{W}{P^W} \tag{C5}$$

Finally, the flexible-price pricing over marginal cost implies in equilibrium that

$$\frac{P^h}{P^W} = \frac{P}{P^W} = \mu \tag{C6}$$

Combining (C4), (C5) and (C6) is easy to verify that

$$\frac{U_{LL} L^2}{U_{CC} C^2} = \frac{\xi}{\nu} \frac{(1-\alpha)}{\mu} \frac{Y}{C} \tag{C7}$$

So that the welfare index becomes

$$\mathbb{Z} = 1 - \text{var}(c_t) - \left(\frac{\xi}{\nu} \frac{(1-\alpha)}{\mu} \frac{Y}{C} \right) \text{var}(l_t) = 1 - \text{var}(c_t) - \Upsilon \, \text{var}(l_t) \tag{C8}$$

which is equation (2.27) in the main text.

Figure 1: Shock to exports, managed float, asset price channel on

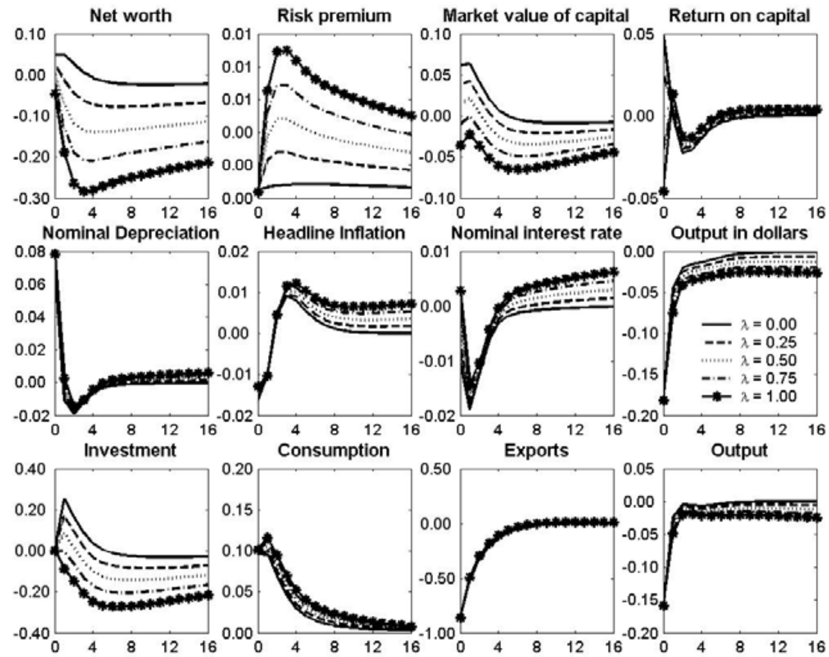


Figure 2: Shock to exports, managed float, asset price channel off

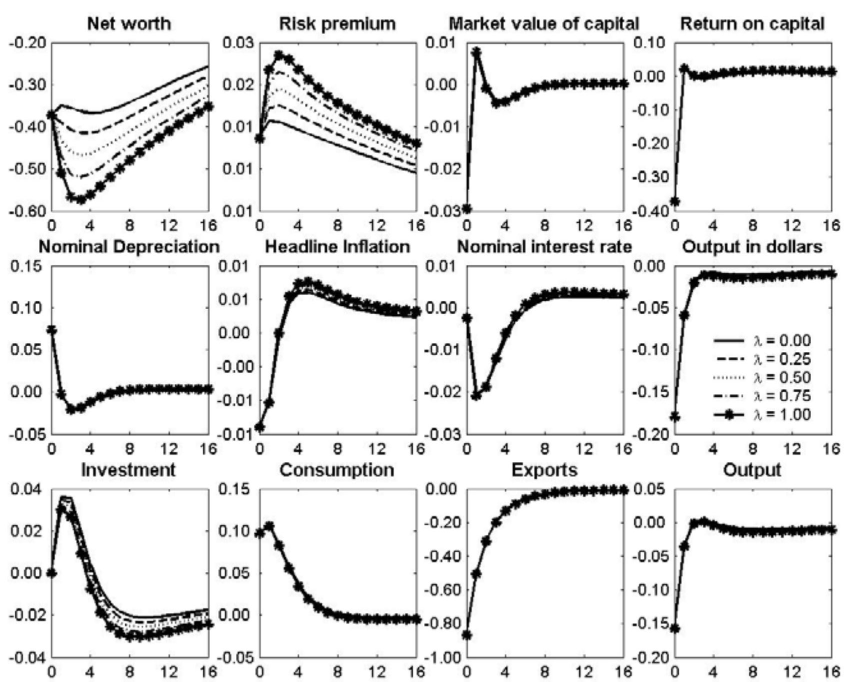


Figure 3: Shock to exports, pure float, asset price channel off

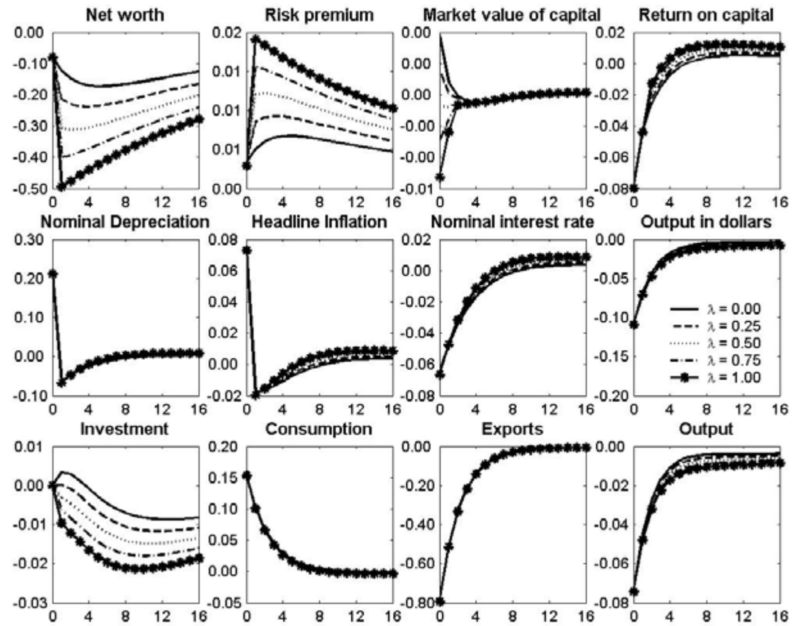


Figure 4: Shock to exports, pure float, asset price channel on

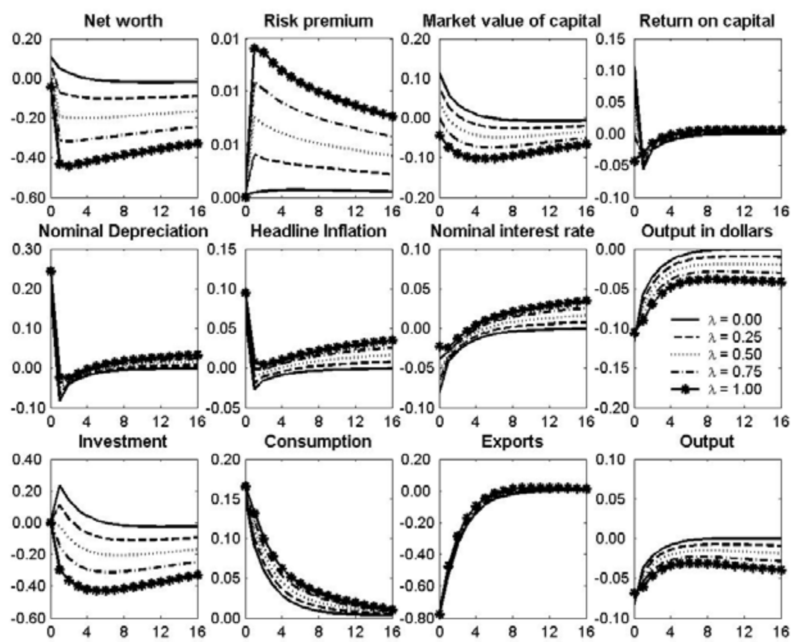


Figure 5: Shock to i*, managed float, asset price channel on

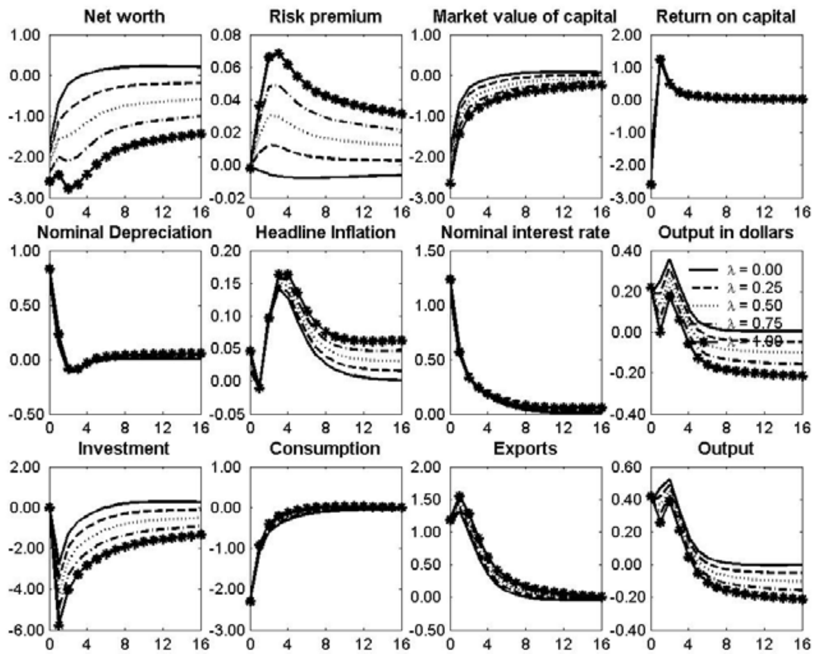


Figure 6: Shock to i*, managed float, asset price channel off

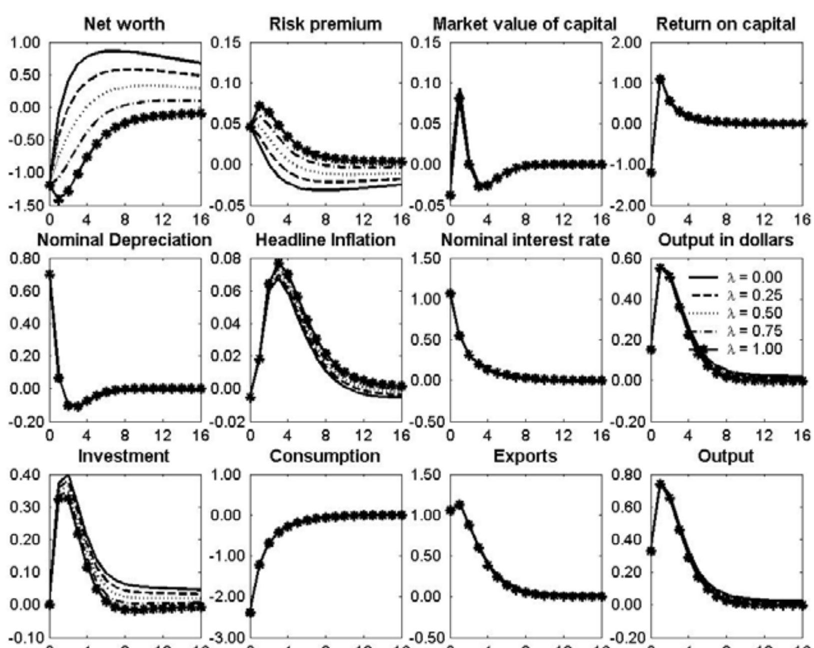
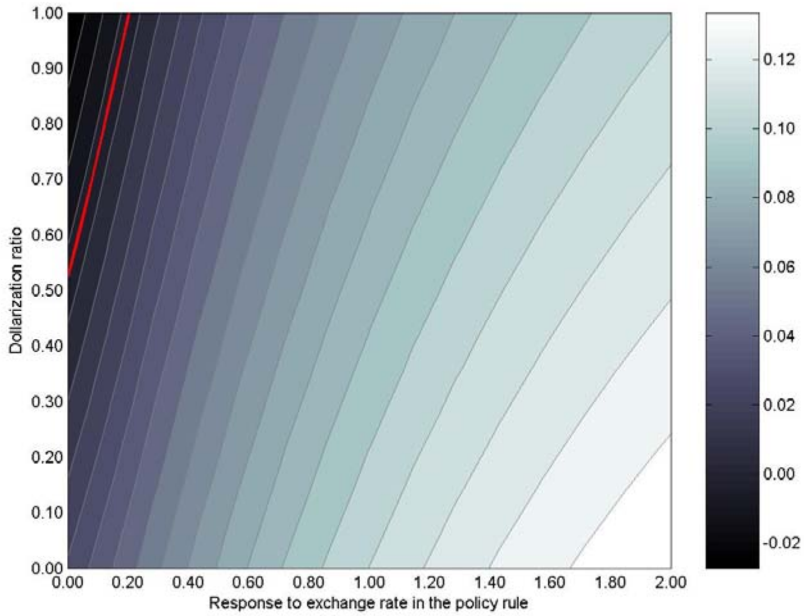


Figure 7: Investment and welfare contours, asset price channel off

Panel A: Investment response, first four quarters, shock to exports



Panel B: Welfare index

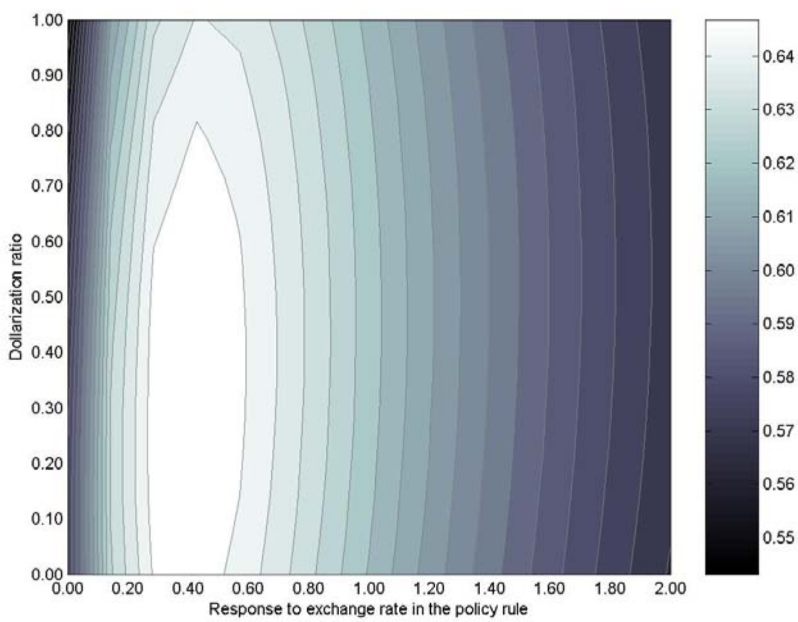
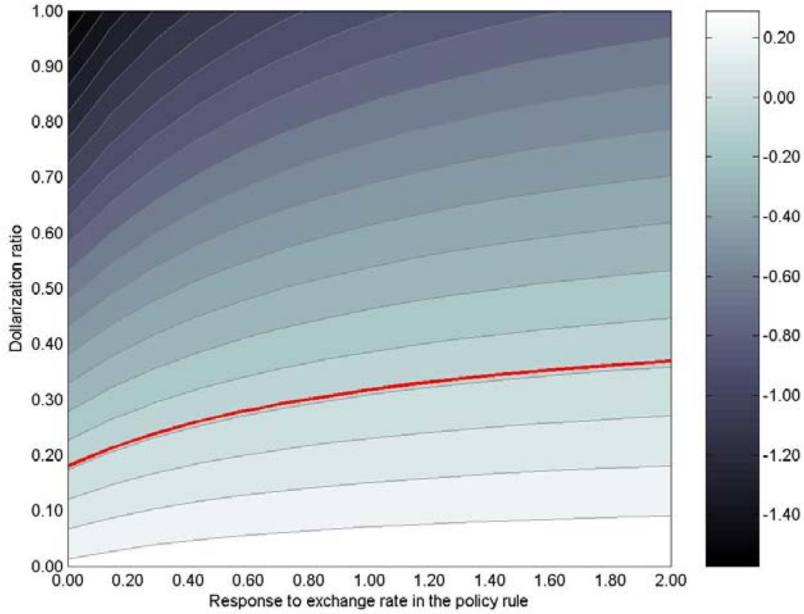


Figure 8: Investment and welfare contours, asset price channel on

Panel A: Investment response, first four quarters, shock to exports



Panel B: Welfare index