# Understanding Financial Vulnerability in Partially Dollarized Economies

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**Abstract**

The reduction of macroeconomic vulnerability in emerging markets is now at the core of the research agenda. Liability dollarization plays a vital role in the understanding of vulnerability and its implications have been addressed in the literature via a "financial accelerator" mechanism. We can identify two channels by which the financial accelerator can be triggered. The first, operates via shocks on asset prices which, in turn, affect the realized return on capital and net worth. The second channel, depends on unanticipated movements in firm's debt burden which 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 if their debt is denominated in dollars.

Despite significant contributions to the understanding of the consequences of liability dollarization for output fluctuations, we believe some important extensions are now in order: (i) 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 denominated in both local and foreign currency (the two models just described assume full liability dollarization); (ii) central bank's response to exchange rate innovations (given a degree of dollarization) must be assessed from a welfare point of view; and (iii) given a dollarization level and central bank's response to shocks, a new, encompassing, definition of vulnerability must be provided in order to adequately address the way in which it can be mitigated.

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# 1. Motivation

The reduction of macroeconomic vulnerability in emerging markets is now at the core of the research agenda. Liability dollarization plays 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.* (1998) optimal contract, which predicts a negative relation between an external finance premium and firm's net worth.

We can identify two channels by which the financial accelerator can be triggered. The first, emphasized in Bernanke, *et al.* (1998) and Gertler, *et al.* (2001), operates via shocks on asset prices which, in turn, affect the realized return on capital, net worth and investment decisions. The second channel, privileged in Céspedes, *et al.* (2000a and 2000b), depends on unanticipated movements in firm's debt burden which 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 if their debt is denominated in dollars.

Based on this, Céspedes, *et al.* (2000a y 2000b) present a first approximation to a definition of vulnerability. In particular, an economy is classified as vulnerable if a real exchange rate depreciation implies an increase in the risk premium faced by firms. This result is neatly summarized in the log linear version of the risk premium equation and depends, crucially, on firms indebtness level. Their model, however, assumes complete depreciation and, thus, lacks the asset price channel explained above. Gertler, *et al.* (2001) recognize this issue and present some simulations using dollar denominated debt and an active asset price mechanism.

Despite these significant contributions to the understanding of the consequences of liability dollarization for investment and output fluctuations, we believe some important

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

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

# 2. An extended financial accelerator framework

In this section we describe the main relations of our model. 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 solutions other than corner regarding liability dollarization, this framework would permit us to asses the role of: (i) the asset price channel; (ii) the degree of central bank´s concern regarding exchange rate fluctuations and; (iii) 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 try to compatibilize its policy implications with those that stem from a welfare point of view.

## 2.1 The model

There are six representative agents in the model: (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: it follows a policy rule that allows for different degrees of concern about exchange rate fluctuations. Finally, (vi) the rest of the world shocks the economy through changes in the exports demand, the international interest rate and the exchange rate premium.

### 2.1.1 The household

The household owns the profit-generating firm and each period receives the monetary profits $\Pi_t$ for retailing the domestic good. It also earns a nominal wage $W_t$ in exchange of labor supply. 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 be paid a random exchange rate premium $\Psi_t$ with expected value $\Psi$[2].

***Consumption and saving***

The household intertemporal problem is

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

where $\beta$ 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:

$$C_t^{-\nu} = \beta E_t \{ C_{t+1}^{-\nu} R_t \} \tag{0.1}$$

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

$$R_t = \frac{1+i_t}{1+E_t\{\pi_{t+1}\}} \tag{0.2}$$

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

$$L_t^{\xi} C_t^{\nu} = \frac{W_t}{P_t} \tag{0.3}$$

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[2] Note that we assumed $\Psi = 1$ in section 2.

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

$$E_t\left\{(1+i_t)-\Psi_t(1+i_t^*)\frac{S_{t+1}}{S_t}\right\} \quad\rightarrow\quad E_t\left\{\frac{S_{t+1}}{S_t}\right\}=\frac{1+i_t}{\Psi_t(1+i_t^*)} \tag{0.4}$$

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:

$$C_t^h=\gamma\left(\frac{P_t^h}{P_t}\right)^{-\theta}C_t \quad\text{and}\quad C_t^m=(1-\gamma)\left(\frac{S_t}{P_t}\right)^{-\theta}C_t \tag{0.5}$$

The corresponding consumer price index is given by

$$P_t=\left[\gamma(P_t^h)^{1-\theta}+(1-\gamma)(S_t)^{1-\theta}\right]^{\frac{1}{\theta-1}} \tag{0.6}$$

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 (0.6) is the price of investment as well. The corresponding demands are:

$$I_t^h = \gamma\left(\frac{P_t^h}{P_t}\right)^{-\theta} I_t \quad \text{and} \quad I_t^m = (1-\gamma)\left(\frac{S_t}{P_t}\right)^{-\theta} I_t \tag{0.7}$$

### 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

$$Y_t = A_t (K_t)^{\alpha} (L_t)^{1-\alpha} \tag{0.8}$$

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:

$$(1-\alpha)\frac{Y_t}{L_t} = \frac{W_t}{P_t^W} \tag{0.9}$$

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

$$K_{t+1} = (1-\delta)K_t + \Phi\left(\frac{I_t}{K_t}\right)K_t\,, \tag{0.10}$$

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

***Capital Production***

Given (0.10), the capital producer supplies the quantity of investment good implied in the Q-investment condition:

$$E_t\left\{Q_{t+1}\Phi'\left(\frac{I_{t+1}}{K_{t+1}}\right) - 1\right\} = 0\,, \tag{0.11}$$

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,

$$Y_t^W = \frac{P_t^W}{P_t} Y_t + Q_t(1-\delta)K_t \tag{0.12}$$

Equations (0.9) and (0.12) allow us to define the marginal gross return to capital (in pesos) as

$$E_t\{R_{t+1}^k\} = E_t\left\{\frac{Y_{t+1}^W - \frac{W_{t+1}}{P_{t+1}}L_{t+1}}{Q_t K_{t+1}}\right\} = \frac{E_t\left\{\alpha \frac{P_{t+1}^W}{P_{t+1}}\frac{Y_{t+1}}{K_{t+1}} + Q_{t+1}(1-\delta)\right\}}{Q_t} \tag{0.13}$$

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 (0.13) to her marginal financing costs. To derive such condition, the balance sheet identity of the entrepreneur is given by:

$$Q_t K_{t+1} = N_t + \frac{D_{t+1}}{P_t} + S_t \frac{D_{t+1}^*}{P_t} \tag{0.14}$$

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 $\lambda_t$, pesos and dollar debts obey to

$$\begin{aligned} S_t D_{t+1}^* &= \lambda_t P_t (Q_t K_{t+1} - N_t) \\ D_{t+1} &= (1-\lambda_t) P_t (Q_t K_{t+1} - N_t) \end{aligned} \tag{0.15}$$

so that marginal costs equal the debt cost plus a risk premium. That is:

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

which, using (0.2) and (0.4), is simply reduced to

$$E_t\{R_{t+1}^k\} = (1+\eta_{t+1})R_t \tag{0.16}$$

In (0.16) $\eta_t$ is the risk premium that arises because of the existence of agency costs. The optimal contract implies (according to Bernanke *et al.* (1998)) a positive relationship between the risk premium and the capital to net worth (leverage) ratio,

$$(1+\eta_{t+1}) = F\left(\frac{Q_t K_{t+1}}{N_t}\right), \quad F' > 0 \tag{0.17}$$

As in all previous general equilibrium settings that formalice the existence of the financial accelerator, 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 a increase in financing costs and a fall in next period´s investment according to the Euler equation given in (0.16). 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 invesment has also a negative effect on the market value of capital and, hence, on next period's realized return (see equation 0.13). Thus, the initial shock not only transpires intertemporally but is also magnified intratemporally due to the forward looking nature of both investment decisions and the market value of capital. This "asset price channel" is the one emphazised in Bernanke, *et al.* (1998) and Gertler, *et al.* (2001) and reveals that a financial accelerator is not only a feature of dollarized or partially dollarized economies. In fact, an increase in the firm's debt burden (due to a real depreciation in the presence of liability dollarization) is another channel by which the financial accelerator can be triggered, and its effects may or may not be magnified intratemporally depending on the importance given to the market value of capital on firm's return to investment.

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 (0.15). In particular, we introduce a framework that allows different degrees of liability dollarization, as revealed by the presence of the term $\lambda_t$.

Because of the UIP condition it might seem that, ex ante, the firm is indifferent between any combination of peso or dollar debt. In fact, the term $\lambda_t$ is no longer present in equation (0.16). 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 ($\lambda_t = 1$), 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).

They propose an extension to Bernanke *et al.* (1998) optimal contract to account for the presence of a mismatch between the denomination of debt and firm's revenues and show, based on 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 claim that the financial intermediary will charge a higher risk premium if a firm is believed to be asking for credit denominated in a different currency than its revenues. With a continuun of firms that seek financing $\varphi_i \in [0,1]$ and a financial intermediary facing discrimantion costs when trying to determine the denomination of each firm's revenues, the intermediary will find it optimal to discriminate (and classify a firm as a "peso earner") only up to a certain point ($\varphi_i^*$). Thus, all firms $\varphi_i \in [0, \varphi_i^*]$ will be classified as "peso earners" and charged with a higher risk premium 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 ($\eta_t$) 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.

As mentioned above, the degree of liability dollarization is not present in the Euler equation governing investment decisions. However, 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

$$R_t^* = \frac{1+i_t^*}{1+E_t\{\pi_{t+1}\}} E_t\left\{\frac{S_{t+1}}{S_t}\right\} \quad (0.18)$$

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 (0.15), (0.2) and (0.18) the last expression simplifies to:

$$V_t^e = R_t^k Q_{t-1}K_t - (1+\eta_t)\left[\lambda_{t-1}\Psi_{t-1}R_{t-1}^* + (1-\lambda_{t-1})R_t\right]\left[Q_{t-1}K_t - N_{t-1}\right] \quad (0.19)$$

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

$$N_t = \phi V_t^e \quad \text{and} \quad C_t^e = (1-\phi)V_t^e \quad (0.20)$$

In (0.20), $C_t^e$ is the entrepreneur's consumption. It is clear from (0.19) that the higher the value of $\lambda_{t-1}$ (the higher the degree of liability dollarization), the larger the negative impact of a real depreciation on the evolution of net worth.

***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 towards 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 μ > 1 is the markup. Letting the lower cases being the logs of the upper cases variables, the retailer problem is then

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

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

$$\pi_t^h = \beta\kappa E_t\{\pi_{t+1}^h\} + \kappa\pi_{t-1}^h + (1-\kappa-\beta\kappa)\Delta s_t + c\kappa\Delta\varpi_t + \varepsilon_t^\pi \quad (0.21)$$

where $\kappa = \left[1+\beta+c(1-\gamma)\right]^{-1}$ and $\varepsilon_t^\pi$ is an *iid* cost-push shock. Equation (0.21) is a linear-homogenous Phillips curve where inflation depends on real marginal costs. Nominal depreciation $\Delta s_t$ appears in (0.21) due to the substitutability between the domestic and the imported good implied in (0.6).

### 2.1.3 Monetary Policy

The monetary policy instrument is the nominal interest rate. It 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

$$i_t = f_\pi E_t\{\pi_{t+1}\} + f_y y_t + f_s \Delta s_t + \varepsilon_t^i \quad (0.22)$$

which is indeed a very standard way to model monetary policy. In the subsequent analysis, the parameter $f_s$ will play an important role when 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 resources constraint

$$Y_t = C_t^h + C_t^e + I_t^h + X_t - (C_t^m + I_t^m) \quad (0.23)$$

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

$$X_t = \left(\frac{S_t}{P_t}\right)^{\theta^*} Y_t^* \quad (0.24)$$

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

$$C_t^m + I_t^m - X_t = S_t(D_t^* + B_t^*) - \left[(1+\eta_t)D_{t-1}^* + B_{t-1}^*\right]R_{t-1}^* \tag{0.25}$$

which simple states that the trade balance equals the capital account. Finally, equation (0.26) clears the domestic asset market.

$$B_t - D_t = 0 \tag{0.26}$$

### 2.1.5 A Welfare index

For policy analysis, we use a utility-based welfare indicator[3]. As is discussed in Woodford (2000) a good candidate is the unconditional expectation of a second order approximation around the steady state of the period utility function. The index is:

$$\mathbf{Z} = 1 - \mathrm{var}(c_t) - \Upsilon\,\mathrm{var}(l_t) \tag{0.27}$$

where var($c_t$) and 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.

As evident from (0.27), welfare is negatively related to either variance and reaches its maximum in a deterministic world, that is, when $\mathrm{var}(c_t) = \mathrm{var}(l_t) = 0$.

# 3. Understanding vulnerability from a general equilibrium perspective

As mentioned earlier, Céspedes, *et al.* (2000a y 2000b) present a first approximation to a definition of vulnerability by assessing the effect of a real depreciation on the evolution of the risk premium. In particular, they claim that an economy can be classified as vulnerable when a real depreciation implies an increase in the risk premium, and this result depends on the steady state debt to capital ratio. Despite the fact that the firm's indebtness level plays a crucial role in this classification, it should be noticed that vulnerability is not linked to the degree of liability dollarization since their

[3] The derivations are presented in Appendix B.

model assumes that all debt is denominated in dollars. In this sense, the model proposed above should permit a richer definition since it allows different degrees of dollarization.

As mentioned at the beginning of Section 2, our aim is not just to asses vulnerability as a function of the degree of financial dollarization, but to asses this phenomenon considering also the role of the asset price channel, 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 which, 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 the model proposed in Section 2, we simulated the effects of a negative shock on export demand and a positive shock on the international interest rate. For each type of shock, we computed impulse responses considering combinations of: (i) a pure ($f_s$ = 0 in equation 0.22) vs. a managed float ($f_s$ = 1.25); and (ii) the asset price channel "switched" on (δ = 0.05) and off (δ = 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). Because of this, in all subsequent experiments we will asses vulnerability by measuring the response of investment. In particular, investment contours were computed adding the quarterly response of investment for the first year, under both types of shock. 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 definitely be the source of novel results.

Selected impulse-responses and contours are presented below as we uncover the role of each of the variables of interest.

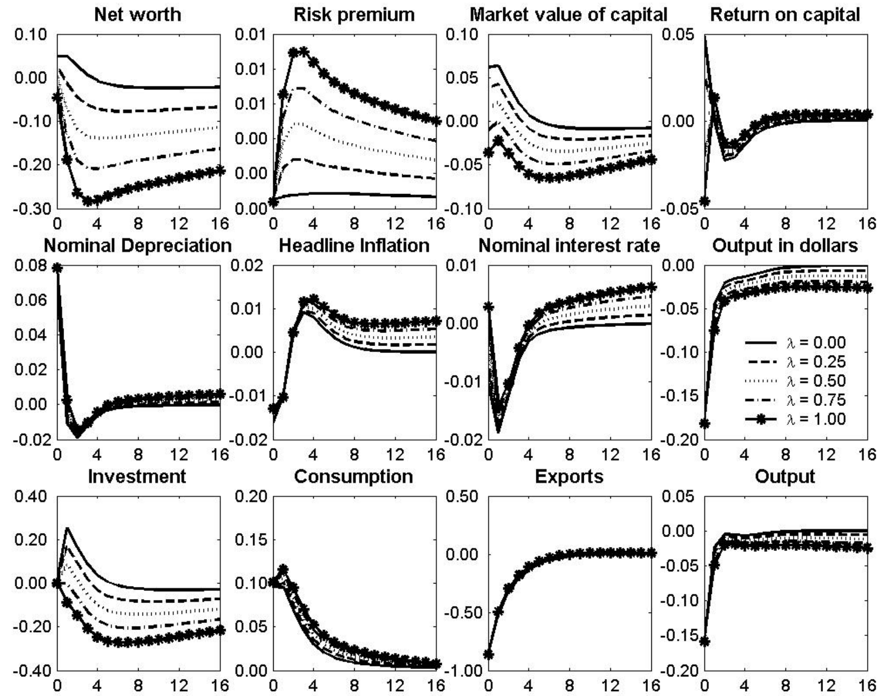
### 3.1.1 The asset price channel, liability dollarization and the type of shock

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.

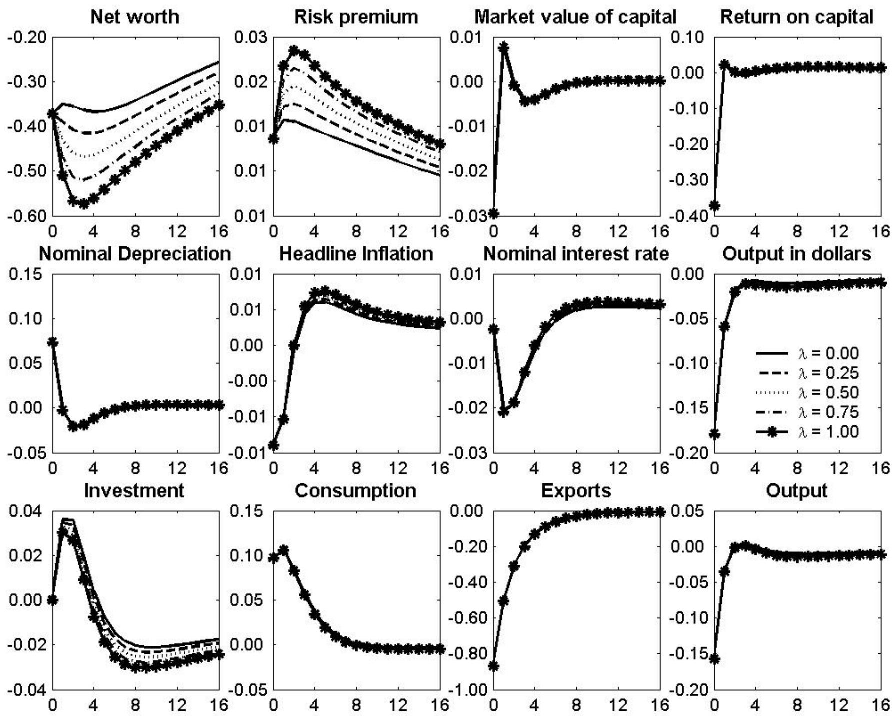
As revealed if we compare Figures 1 and 2 below, under a managed float the degree of liability dollarization will imply no significant difference in the evolution of investment if the asset price channel is not allowed to operate. Crucially, net worth depends on both the realized return to capital and realized debt burden. With the asset price channel switched off, 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.

The market value of capital and investment decisions are both 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 fully dollarized debt) is not strong enough to cause a significant deviation in the path of investment if we compare a dollarized and non-dollarized economy.

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




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



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. In fact, 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, cannot be generalized. It depends on the degree of Central Bank's concern about exchange rate fluctuations. In other words, 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.

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

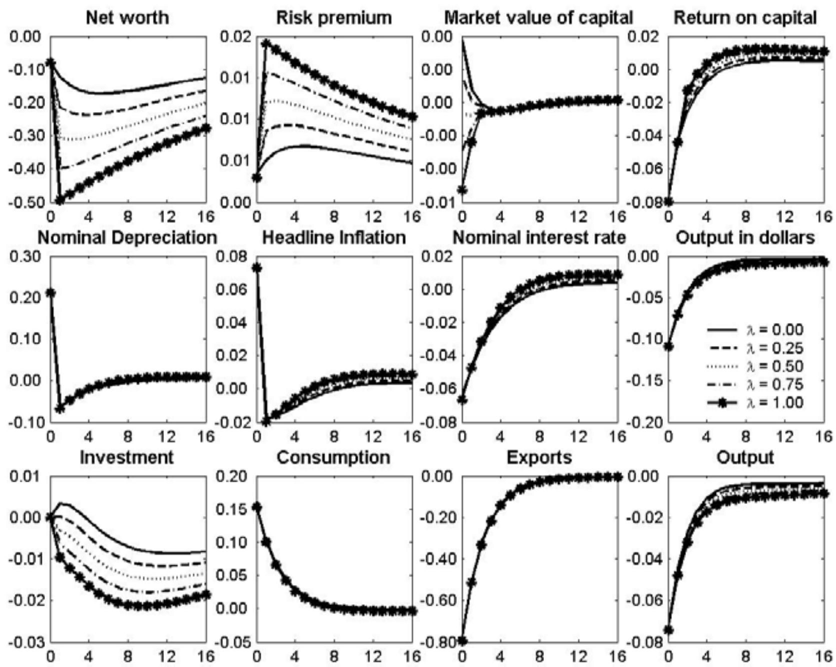
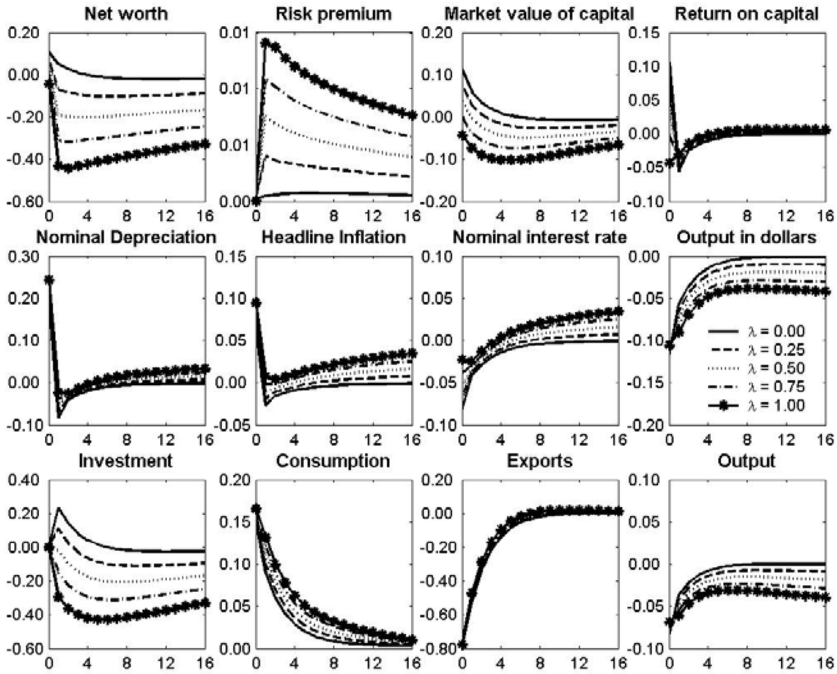


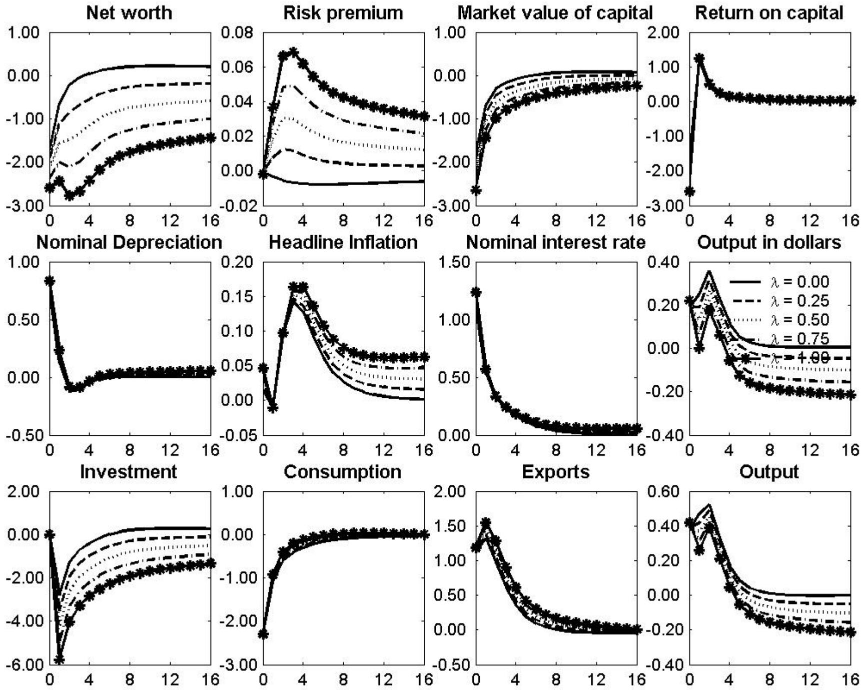
**Figure 4: Shock to exports, pure float, asset price channel on**



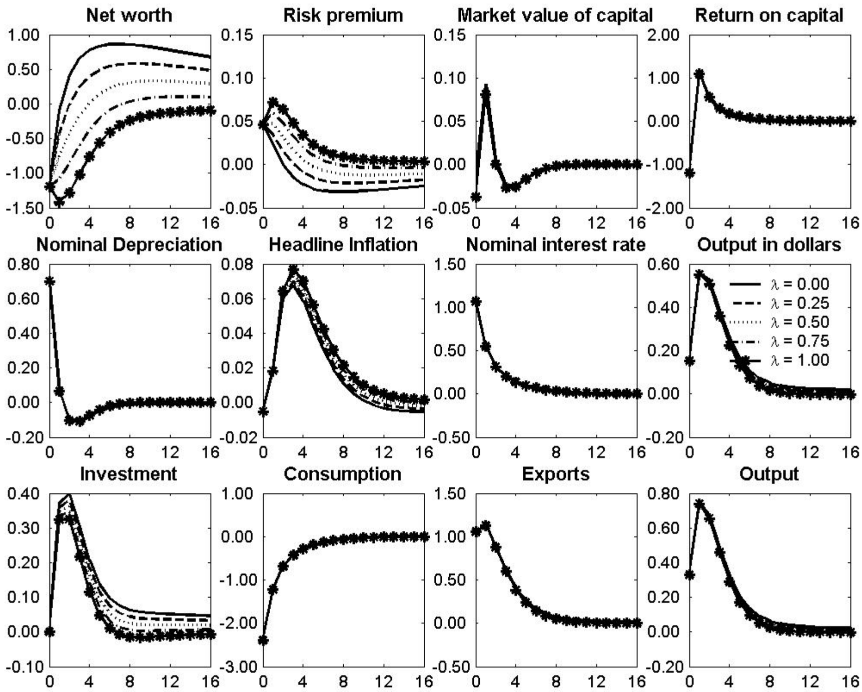

Interestingly, the asset price channel also plays an important role in determining the impact of the type of shock on investment decisions. Figures 5 and 6 present impulse-responses for a managed float with the asset price channel switched on and off, respectively, under a positive shock to the international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

If we compare Figures 1 and 5, its 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. Crucially, and 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 exports) and this triggers a restrictive monetary policy.

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




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



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 above. 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 1.14 in Appendix A), reveals that as $\delta \rightarrow 1$ the fall in parameter $\tau$ 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.

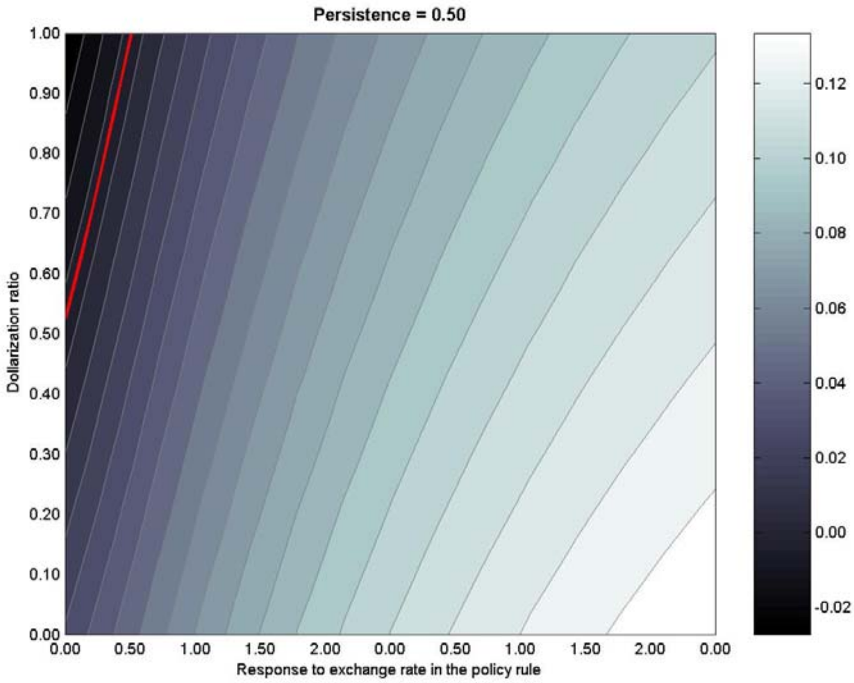
### 3.1.2 Central bank's response to the exchange rate, investment and welfare in highly dollarized economies

Since the degree of central bank's concern about the exchange rate is a policy variable under direct control of the Bank, we would like to stress its role in the determination of vulnerability and complement this 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, with the asset price channel switched off and on, respectively. As mentioned earlier, investment contours were calculated adding the quarterly response of this variable for the first year.

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

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




**Panel B: Welfare index**

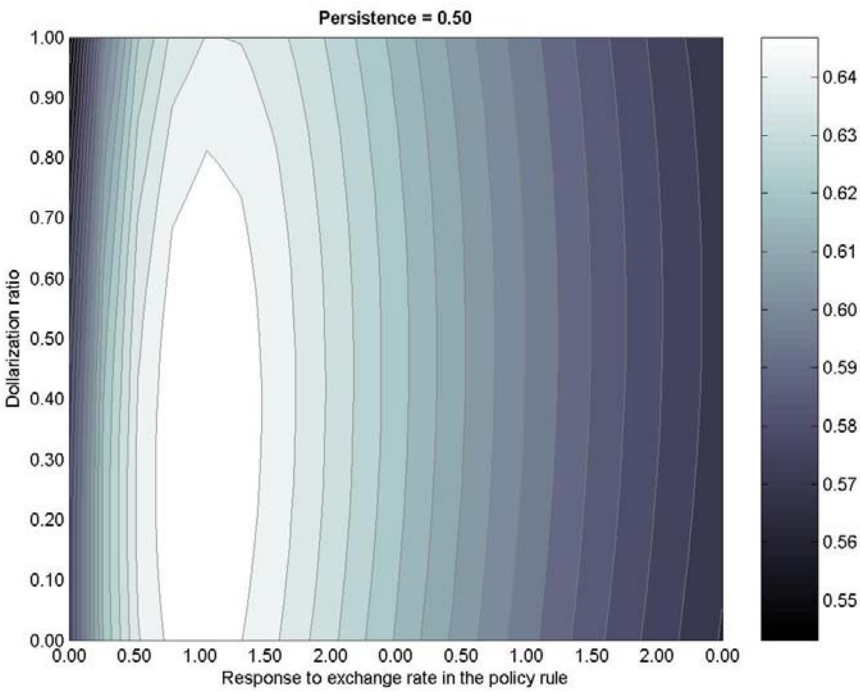
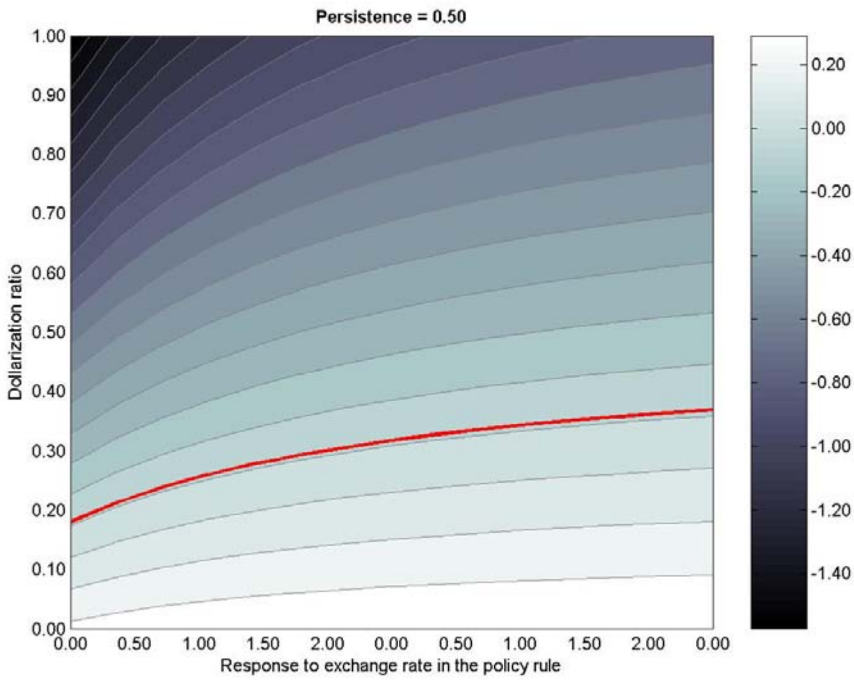
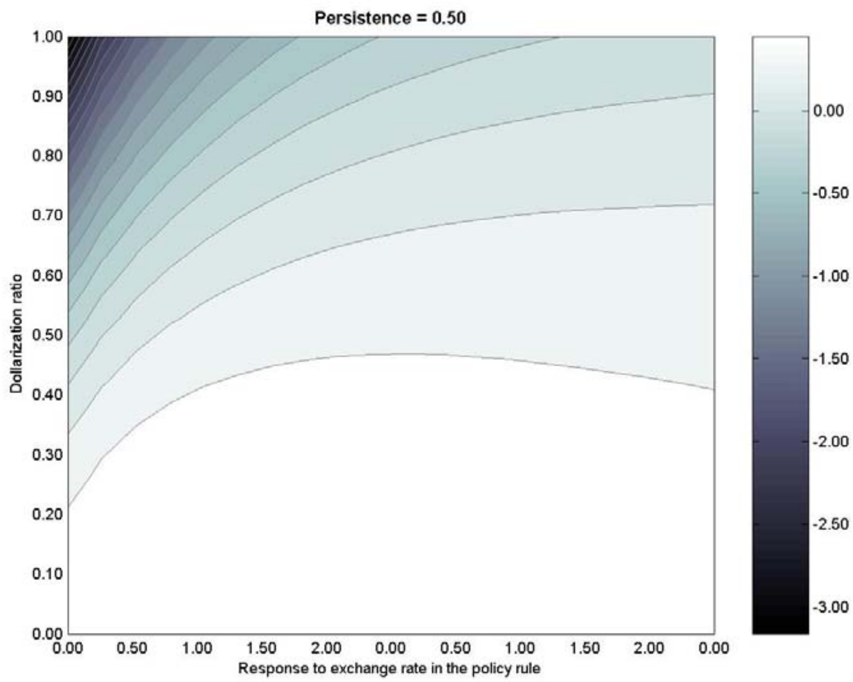


**Figure 8: Investment and welfare contours, asset price channel on**

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




**Panel B: Welfare index**



The fours graphs presented above are 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 perforce after a negative shock on export 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 the first four quarters after the shock, 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 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".

Since the evaluation of investment's response for the first four quarters after the shock when talking about vulnerability may seem arbitrary, 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, and since we are concerned with second moments when talking about welfare, we can clearly identify a critical degree 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. In particular, and 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, and in line with the evidence presented in the previous section and the correspondence exhibited by investment and welfare contours, the degree of liability dollarization does make a difference. In particular, and 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, in the understanding of vulnerability.

In particular, the existence of an asset price channel proves important when understanding 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 were 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 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).

In line with the first result, and more importantly in terms of monetary policy options, the asset price channel plays also a crucial role when understanding the effects of different exchange rate regimes on investment performance and welfare. 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. This result, however, cannot be linked to the degree of liability dollarization. In other words, a managed float proves to be the optimal policy option even for non-dollarized economies.

Given this result, can make a case for "fear of floating" as a welfare improving and "vulnerability mitigating" policy option when talking about 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 this analysis reveals to be particularly important 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. 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. Crucially, the if part in the preceding argument depends on the second element. Thus, further research should now be devoted to asses 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, invoking vulnerability or welfare considerations, as the best policy option (nor a particular feature) of highly dollarized economies.

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## Appendix A: The Log-linearized version of the model

***Consumption and Saving***

Euler equation (0.1)

$$c_t = E_t\{c_{t+1}\} - \tfrac{1}{\nu} r_t \tag{1.1}$$

Fisher equations (0.2) and (0.18)

$$r_t = i_t - E_t\{\pi_{t+1}\} \tag{1.2}$$

$$r_t^* = i_t^* - E_t\{\pi_{t+1}\} + E_t\{s_{t+1}\} - s_t \tag{1.3}$$

Labor supply (0.3)

$$\xi l_t + \nu c_t = w_t \tag{1.4}$$

UIP condition (0.4)

$$E_t\{s_{t+1}\} - s_t = i_t - i_t^* - \psi_t \tag{1.5}$$

***Consumer prices***

Domestic and imported consumption (0.5) (in differences)

$$c_t^h = c_{t-1}^h - \theta(\pi_t^h - \pi_t) + \Delta c_t \quad \text{and} \quad c_t^m = c_{t-1}^m - \theta(\Delta s_t - \pi_t) + \Delta c_t \tag{1.6}$$

Domestic and imported investment (0.7) (in differences)

$$\iota_t^h = \iota_{t-1}^h - \theta(\pi_t^h - \pi_t) + \Delta\iota_t \quad \text{and} \quad \iota_t^m = \iota_{t-1}^m - \theta(\Delta s_t - \pi_t) + \Delta\iota_t \tag{1.7}$$

CPI inflation (0.6) (in differences)

$$\pi_t = \gamma\pi_t^h + (1-\gamma)\Delta s_t \tag{1.8}$$

***Wholesale production and capital accumulation***

Production function (0.8)

$$y_t = a_t + \alpha k_t + (1-\alpha) l_t \tag{1.9}$$

Labor demand (0.9)

$$y_t - l_t = w_t - \varpi_t \tag{1.10}$$

Capital accumulation (0.10)

$$k_{t+1} = \delta\iota_t + (1-\delta)k_t \tag{1.11}$$

Q-investment condition (0.11)

$$E_t\{q_t\} = \varphi(E_t\{\iota_{t+1}\} - k_{t+1}) \tag{1.12}$$

$\varphi = -\dfrac{\Phi''}{\Phi'}\dfrac{I}{K}$ is the SS elasticity of price capital to the investment-capital ratio

***Retailing***

Phillips curve (0.21)

$$\pi_t^h = \beta\kappa E_t\{\pi_{t+1}^h\} + \kappa\pi_{t-1}^h + (1-\kappa-\beta\kappa)\Delta s_t + c\kappa\Delta\varpi_t + \varepsilon_t^\pi \tag{1.13}$$

$$\kappa = \left[1+\beta + c(1-\gamma)\right]^{-1}$$

***The financial accelerator***

Ex-post gross return to capital (0.13)

$$r_t^k = (1-\tau)(\varpi_t + y_t - k_t) + \tau q_t - q_{t-1} \quad (1.14)$$

$\tau = \dfrac{PQ(1-\delta)K}{\alpha P^W Y + PQ(1-\delta)K}$ is the SS capital to gross output ratio

Risk premium equation (0.16) and (0.17)

$$E_t\{r_{t+1}^k\} - r_t = \vartheta(q_t + k_{t+1} - n_t) \quad (1.15)$$

$\vartheta = \dfrac{F'}{F}\dfrac{QK}{N}$ is the SS elasticity of risk premium to leverage

Network evolution (0.19) and (0.20)

$$n_t = \phi R^k (r_t^k + n_{t-1}) + \lambda\varsigma\phi R^k (r_{t-1}^* + \psi_{t-1} - r_{t-1}) \quad (1.16)$$

$1+\varsigma = \dfrac{QK}{N}$ is the capital to investment ratio and $\phi$ is a damping factor

***Monetary Policy***

Monetary policy rule (0.22) and (0.20)

$$i_t = f_\pi E_t\{\pi_{t+1}\} + f_y y_t + f_s \Delta s_t + \varepsilon_t^i \quad (1.17)$$

***Macroeconomic equilibrium***

Resources constraint (0.23) and (0.20)

$$y_t = \frac{C^h}{Y}c_t^h + \frac{C^e}{Y}n_t + \frac{I^h}{Y}\iota_t^h + \frac{X}{Y}x_t - \left(\frac{C^m}{Y}c_t^m + \frac{I^m}{Y}\iota_t^m\right) \quad (1.18)$$

Exports demand (0.24) (in differences)

$$x_t = x_{t-1} - \theta^*(\Delta s_t - \pi_t) + \Delta y_t^* \quad (1.19)$$

***Forcing processes***

Exchange rate premium

$$\psi_t = \rho_\psi \psi_{t-1} + \varepsilon_t^\psi \quad (1.20)$$

Foreign interest rate

$$i_t^* = \rho_{i^*} i_{t-1}^* + \varepsilon_t^{i^*} \quad (1.21)$$

Foreign real income

$$y_t^* = \rho_{y^*} y_{t-1}^* + \varepsilon_t^{y^*} \quad (1.22)$$

Technology

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \quad (1.23)$$

**Appendix B: Derivation of the Welfare Index**

The expectation of the quadratic term of the second order approximation is

$$\Theta = U_{CC}C^2 \operatorname{var}(c_t) + U_{CL}\operatorname{cov}(c_t, l_t) + U_{LL}L^2 \operatorname{var}(l_t) \tag{B24}$$

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 (B24) we have suppressed any constant term.

Note that the simple utility function used in this document implies that $U_{CL} = 0$, $U_{CC} < 0$ and $U_{LL} < 0$. With this, expression (B24) is unambiguously negative. In order to get an index decreasing in both asymptotic variances, we shall consider instead

$$\mathbf{Z} = 1 - \frac{\Theta}{U_{CC}C^2} \tag{B25}$$

The bigger $\mathbf{Z}$ is, the higher the welfare.

We now move to express (B25) in terms of the model's parameters and steady state values. Note that

$$\mathbf{Z} = 1 - \operatorname{var}(c_t) - \frac{U_{LL}L^2}{U_{CC}C^2}\operatorname{var}(l_t) \tag{B26}$$

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

$$U_C = C^{-\nu} \qquad U_L = -L^{\xi}$$
$$U_{CC} = -\frac{\nu}{C}U_C \quad \text{and} \quad U_{LL} = \frac{\xi}{L}U_L \tag{B27}$$

On the other hand, the labor supply (0.3) and the firm's labor demand (0.9) implies in steady state that

$$-\frac{U_L}{U_C} = \frac{W}{P} \quad \text{and} \quad (1-\alpha)\frac{Y}{L} = \frac{W}{P^W} \tag{B28}$$

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

$$\frac{P^h}{P^W} = \frac{P}{P^W} = \mu \tag{B29}$$

Combining (B27), (B28) and (B29) is easy to verify that

$$\frac{U_{LL}L^2}{U_{CC}C^2} = \frac{\xi}{\nu}\frac{(1-\alpha)}{\mu}\frac{Y}{C} \tag{B30}$$

So that the welfare index becomes

$$\mathbf{Z} = 1 - \operatorname{var}(c_t) - \left(\frac{\xi}{\nu}\frac{(1-\alpha)}{\mu}\frac{Y}{C}\right)\operatorname{var}(l_t) = 1 - \operatorname{var}(c_t) - \Upsilon \operatorname{var}(l_t) \tag{B31}$$

which is equation (0.27) in the main text.