
# POLÍTICA Y ESTABILIDAD MONETARIA EN EL PERÚ

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# 8

# Monetary policy, financial dollarization and agency costs

*Marco Vega*[*]

This chapter models an emerging economy with financial dollarization features within an optimizing, stochastic general equilibrium setup. One key result in this framework is that unexpected nominal exchange rate fluctuations are positively correlated with the probability of default by borrowing firms and turn out to be a relevant driver of economic activity. In particular, the sign of the unexpected depreciation is positively correlated to the real value of assets and negatively correlated to aggregate consumption. This result supports the idea that unexpected increases in the exchange rate are contractionary, and not expansionary, when dollarization and agency costs in the financial sector are considered.

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## 8.1 Introduction

The basis of modern monetary policy is the achievement of price and financial stability by means of controlling a set of policy instruments available to the monetary authority. The efforts of recent research have been devoted to understand the mechanisms whereby monetary policy maps into final outcomes. Crucial in this understanding are Phillips-curve theories, as in Clarida et al. (1999) or Woodford (2003).

Within the spirit of this framework, the purpose of this chapter hinges on modeling an economy with financial dollarization features. The role of financial dollarization in this type of models is tantamount to the existence of a non-trivial role for financial intermediation (through the presence of agency costs) and therefore to the presence of a general credit channel of monetary policy. The specific form of this credit channel in the context of a New-Keynesian Phillips curve has not been directly treated in the extant literature. One contribution of this chapter is to provide an inflation equation that takes into account the presence of agency costs and financial dollarization.

A second objective is to study the link between agency costs, financial dollarization and the restrictions they impose on monetary policy. In particular, the question the chapter intends to address is how different inflation targeting regimes affect the evolution of the economy under the presence of agency costs.

In our model, financial dollarization is explicit as both the assets of households and the liabilities of firms that produce and generate non-tradable income are dollarized. We assume the existence of two productive sectors in the home country: a sector that produces non-tradable goods, and a sector that produces an exogenous amount of a "traditional" tradable good. The non-tradable goods sector is composed of heterogeneous wholesalers (borrowers) who face a credit-in-advance constraint, as in Cooley and Nam (1998) or Carlstrom and Fuerst (2001). This heterogeneity stems from idiosyncratic productivity shocks. The resulting structure allows for the existence of standard debt contracts between banks and each wholesaler. A particular feature of this contract is the existence of a mark-up margin in wholesale prices that results in order to cover the deadweight losses imposed by the existence of agency costs.

In order to model a non-trivial role for monetary policy, sticky prices are introduced by assuming monopolistic retailers, as in Bernanke et al. (1999). As known, retailers will also sell at a mark-up over marginal cost due to their market power structure. As a result, price dynamics are influenced by these two distortions: agency costs and monopolistic competition.

The model economy in question can be described by a set of canonical equations in log-linearized form. Among these equations, it is worth mentioning a Phillips curve which incorporates a term that depends on agency costs and thereby on business default conditions. Another key equation represents the interaction between financial conditions and real activity. Qualitative exercises can be performed with this set of equations. In particular, the aim of the research is addressed by changing the parameters that control the degree of financial dollarization and agency costs to evaluate the responses of the economy to the diverse shocks to which it is subject. For instance, a world interest rate shock would affect domestic variables (real activity, prices, default probabilities, among others) according to the type of monetary policy response, degree of financial dollarization and the extent of agency costs.

The rest of the chapter is organized as follows. In Section 8.2 we present our general modeling framework. In Section 8.3 we set up the canonical log-linearized system and discuss its calibration. In Section 8.4 we assess the workings of two different types of inflation targeting regimes under a series of shocks. Finally, Section 8.5 concludes. To save space, we do not present the full algebraic details on the solution to the optimization problems faced by economic agents, on steady state calculations and on the log-linearization of the model. These results, however, are available upon request.

## 8.2 Framework

We consider a small open economy with the following features. Domestic consumers do not have access to internationally traded assets. The country is not financially sophisticated, as the financial market is fairly incomplete. However, there is foreign trade in goods. Consumers are offered foreign goods and imports are traded using the US dollar, firms depend on foreign inputs and there are export-only firms that produce primary commodities, a "traditional" tradable good $Y_{f,t}$ whose price is determined internationally. A non-tradable good $Y_{h,t}$ is also produced by monopolistic competitive firms that set prices in a staggered way. Also, within the borders of the economy consumers do have access to assets denominated in both *pesos* (the domestic currency) and dollars (the international currency), offered by domestic financial intermediaries. This feature captures dollarization of assets on the portfolio of domestic consumers. Finally, domestic financial intermediaries do have access to foreign borrowing/lending.

Next, we describe the behavior of the economic agents in the model. Throughout the chapter, $\mathbb{E}_t$ denotes the expectation made with information up to period $t$.

### 8.2.1 Households

A typical household maximizes the expected present value of utility over future consumption $C_t$ and labor $N_t$:

$$\sum_{s=t}^{\infty} \mathbb{E}_t \left\{ \beta^{s-t} \left( \frac{C_s^{1-\delta} - 1}{1-\delta} - \frac{N_s^{1+\nu} - 1}{1+\nu} \right) \right\} , \tag{8.1}$$

where $1/\nu$ and $1/\delta$ measure constant intertemporal elasticities of substitution, subject to the following resource constraint:

$$D_{s+1} + \mathcal{E}_s B_{s+1} = \mathcal{I}_{s-1} D_s + \mathcal{E}_s \mathcal{I}_{s-1}^f B_s + (\mathcal{E}_s - \mathbb{E}_{s-1}\{\mathcal{E}_s\}) B_{s-1} + W_s N_s - P_s C_s + \Omega_s , \tag{8.2}$$

for every period $s = t, t+1, \ldots$. Here, $D_s$ and $B_s$ represent peso and dollar denominated assets purchased at the beginning of time $s-1$ and held up to the beginning of time $s$, when a new decision about assets holdings takes place. $\mathcal{I}_{s-1} = (1 + i_{s-1})$ is the gross interest rate paid by the peso assets bought at the beginning of time $s-1$, and $\mathcal{I}_{s-1}^f = (1 + i_{s-1}^f)$ is the corresponding gross interest rate paid by the dollar asset. $\mathcal{E}_s$ is the nominal exchange rate defined as the peso price of one dollar. Both types of assets ($D_s$ and $B_s$) have a one-period maturity and can be thought of as deposits in a domestic financial intermediary. Households in this economy do not trade assets directly with the foreign sector, they are net savers. The term $(\mathcal{E}_s - \mathbb{E}_{s-1}\{\mathcal{E}_s\})B_{s-1}$ captures the accounting adjustment associated to capital gains or losses: if there is an unexpected depreciation of the currency, then there is a positive peso valued capital gain from holding dollar-denominated assets.

The variable $C_t$ is an aggregate consumption index:

$$C_t = \left[ (1-\alpha)^{\frac{1}{\eta}} C_{h,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{f,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} , \tag{8.3}$$

where $\eta > 1$ is the elasticity of substitution between home and foreign goods. Home goods (non-tradables) are consumed in a variety of ways which are aggregated in the index $C_{h,t}$, defined as:

$$C_{h,t} = \left[ \int_0^1 C_{h,t}(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}} , \tag{8.4}$$

where $\theta > 1$ measures the degree of substitutability among the different types of home goods. High substitutability implies lower market power to the producers of the different types.

We now define two important relative prices. First, the real domestic price is the ratio of non-tradable prices to the consumer based price index $P_t$ (to be defined later): $S_t = P_{h,t}/P_t$. Second, the real exchange rate is defined as the ratio of the peso price of imports to the consumer based price index $Q_t = P_{f,t}/P_t = \mathcal{E}_t P_t^*/P_t$, where we assume that the law of one price holds for imports. Thus, the domestic price of the imported good moves one-to-one with the nominal exchange rate which implies a pass-through equal to one; however, the pass-through to $P_t$ will also depend on the effect of the exchange rate on domestic producer prices set by firms that sell final goods.

Given an optimal choice of $C_t$, the intratemporal consumption decision hinges on the choices of home and foreign consumption that minimizes the expenditure for given prices $P_{h,t}$ and $P_{f,t}$. The solution is given by the following decision rules:

$$C_{h,t} = (1-\alpha)S_t^{-\eta}C_t \qquad \text{and} \qquad C_{f,t} = \alpha Q_t^{-\eta}C_t\,. \tag{8.5}$$

Home and foreign good consumption levels depend negatively on the real domestic price ratio and on the real exchange rate, respectively. Given $C_t$, a depreciation reduces $S_t$ and rises $Q_t$, rendering a substitution in the consumption from foreign goods to home goods. The consumption based price index summarizes the relationship between $P_{h,t}$ and $P_{f,t}$ and is given by:

$$P_t = \left[(1-\alpha)P_{h,t}^{1-\eta} + \alpha P_{f,t}^{1-\eta}\right]^{\frac{1}{1-\eta}} \qquad \text{or} \qquad (1-\alpha)S_t^{1-\eta} + \alpha Q_t^{1-\eta} = 1\,. \tag{8.6}$$

To derive the demand for the different varieties of goods produced domestically, we proceed in the same way and find the following consumption rule for each of the varieties indexed by $j$:

$$C_{h,t}(j) = \left(\frac{P_{h,t}}{P_{h,t}(j)}\right)^{\theta} C_{h,t} \tag{8.7}$$

These consumption rules are defined given an overall home price index $P_{h,t}$, a price for the specific good of the variety (set by the retailer) $P_{h,t}(j)$ and by the level of overall home consumption $C_{h,t}$. Likewise, the aggregate home price index is defined by:

$$P_{h,t} = \left[\int_0^1 P_{h,t}(j)^{1-\theta}dj\right]^{\frac{1}{1-\theta}}\,. \tag{8.8}$$

On the other hand, the first order condition for the optimal intertemporal consumption decision that solves (8.1) subject to (8.2) is:

$$\frac{C_t^{-\delta}}{P_t} = \beta \mathbb{E}_t \left\{ \frac{C_{t+1}^{-\delta}}{P_{t+1}} \mathcal{I}_t \right\} . \tag{8.9}$$

This Euler equation has a standard interpretation: the left hand side is the utility loss of forgoing consumption of $1/P_t$ units of the composite consumption basket, while the right hand side is the gain from the extra utility generated by the additional next period consumption made possible by higher current savings.

From the same problem, in order for both types of assets to be valued positively in consumer's preferences and hence to avoid corner solutions, it must be true that the uncovered interest parity holds between the peso asset returns and dollar asset returns:

$$\mathcal{I}_t = \mathbb{E}_t \left\{ \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right\} \mathcal{I}_t^f . \tag{8.10}$$

Finally, the labor supply decision is made according to a standard condition that equates the real wage and the marginal disutility of labor:

$$N_t^{\nu} C_t^{\delta} = \frac{W_t}{P_t} . \tag{8.11}$$

As with the previous household choice rules, the dynamic properties of labor supply depend upon the dynamics of $C_t$ through the Euler equation.

### 8.2.2 Banks

Banks receive deposits from households and foreigners and lend to domestic firms. The timing of their actions is as follows:

- At the beginning of period $t$ they pay the outstanding deposit debt plus the interest rate accrued to households and foreigners for funds offered the previous period:

$$\mathcal{I}_{t-1} D_t + \mathcal{E}_t \mathcal{I}_{t-1}^f B_t + \mathcal{E}_t \mathcal{I}_{t-1}^f B_t^* + \left( \mathcal{E}_t - \mathbb{E}_{t-1} \{ \mathcal{E}_t \} \right) \left( B_t + B_t^* \right) , \tag{8.12}$$

  where $\mathcal{I}_t^f = \mathcal{I}_t^* V_t$, so the domestic dollar interest rate incorporates the foreign benchmark interest rate $\mathcal{I}_t^*$ and a factor $V_t > 1$ that accounts for country risk. This variable can be endogenized following Mendoza (2001) or Cespedes et al. (2004), but we choose not to do so since our modeling purpose is different.

- Immediately afterwards, banks offer households new stocks of both types of deposits, $D_{t+1}$ and $B_{t+1}$. At the same time, an amount of deposits is offered to foreigners at the return $\mathcal{I}_t^f$, higher than the riskless foreign rate due to country risk.
- Next, banks offer loans to wholesale firms, who borrow in advance to buy production inputs, both in pesos and dollars ($L_{h,t}$ and $L_{f,t}$, respectively). The sources of funds available to the bank are twofold: the pesos and dollars deposited by domestic consumers, plus any amount of pesos borrowed from the central bank or dollars borrowed abroad.

  Financial intermediaries have to hold compulsory reserves calculated as a fraction of deposits made last period. Thus:

$$L_{h,t}^s \equiv D_{t+1} + \Delta M_{b,t} - \zeta_D D_t \,, \tag{8.13}$$

$$L_{f,t}^s \equiv B_{t+1} + B_{t+1}^* - \zeta_B (B_t + B_t^*) \,. \tag{8.14}$$

  Here, $\Delta M_{b,t}$ is the net position of the bank's assets at the central bank and $B_{t+1}^*$ is the net position of the bank's dollar assets with the foreign sector.[1] If $\Delta M_{b,t}$ is positive then the financial intermediary takes a short-term loan (to be re-paid in the same period), otherwise banks deposit at the central bank.
- The loan repayment is subject to agency costs because there is asymmetric information regarding the productivity of firms. Firms learn about their idiosyncratic productivity before due repayment of their debts. Unproductive firms are insolvent and cannot pay their debt. Hence, the bank has to sign the same debt contract with all firms so that it can raise "enough" expected funds from intermediation.

### 8.2.3 Wholesale Firms

Every period a continuum of firms in the unit interval is born. They all produce a homogeneous good, and face a credit-in-advance constraint in their purchases of production inputs. As in Cooley and Nam (1998), this means that before production takes place, they have to borrow an amount equal to their entire input bill.

They borrow pesos and dollars before the idiosyncratic productivity shock realizes and they repay or default after production and sale, but before the next period starts.

[1] The presence of $\Delta M_{b,t}$ mimics the typical standing facility offered by the central bank at date $t$ (a marginal lending facility or a deposit facility). In fact, this is the rationale whereby the central bank can influence the short term interest rate of the economy, even though we do not model the specific process of nominal interest rate setting.

At the end of each period all firms die, either after setting their transfers to households or after default. This crucial assumption precludes accumulation of net worth by firms.

The technology they use to produce these goods is given by:

$$Y_{h,t}(i) = \varpi_{it} A_t N_{it}^{a} J_{it}^{1-a}\,, \tag{8.15}$$

where $\varpi_{it}$ is an idiosyncratic productivity shock, which is assumed *iid* with density function $\phi(\varpi)$, cdf $\Phi(\varpi)$, unconditional expectation $\mathbb{E}\{\varpi_{it}\} = 1$ and support on the bounded interval $[\varpi_l, \varpi_u]$; $A_t$ is an aggregate productivity shock; $N_{it}$ is the labor input; and $J_{it}$ is an imported intermediate input.

The credit-in-advance constraints for any firm $i$ in pesos and dollars are given, respectively, by:

$$L_{h,i,t} = W_t N_{it} \qquad \text{and} \qquad L_{f,i,t} = P_t^{*} J_{it}\,, \tag{8.16}$$

where $W_t$ and $P_t^{*}$ are the peso price of labor and the dollar price of the imported input, respectively. The nominal value of wholesale production considers the fact that non-tradable production is sold at the wholesale home price $P_{h,t}^{w}$. Conveniently replacing (8.16) into (8.15) yields:

$$P_{h,t}^{w} Y_{h,t}(i) = G_t \varpi_{it} L_{h,i,t}^{a} L_{f,i,t}^{1-a} \quad \text{where} \quad G_t = A_t S_t^{w} \left(\frac{P_t}{W_t}\right)^{a} \left(\frac{P_t}{P_t^{*}}\right)^{1-a}. \tag{8.17}$$

Here, $G_t$ groups the aggregate determinants of firm $i$ production, and $S_t^{w} = P_{h,t}^{w}/P_t$ represents the relative price of wholesale goods.

We now turn to the discussion of the design of the financial contract. A key assumption to endogenize financial intermediation is that after loans are taken and inputs enter into production, each firm $i$ privately observes its idiosyncratic shock $\varpi_{it}$. If any other agent wants to learn about firm $i$'s shock, that agent has to incur in auditing or monitoring costs. The existence of asymmetric information between firms and the rest of the agents and the introduction of a costly hidden-state verification induces the existence of financial intermediation as shown in Diamond (1984). The optimal contract that emerges from this type of setup has been solved in Gale and Hellwig (1985), and applied in Bernanke et al. (1999), Carlstrom and Fuerst (2001) among others. For risk neutral firms and financial intermediaries, the optimal incentive compatible contract is a risky-debt contract.

The contract at each time $t$ and for every firm $i$ hinges on finding the optimal loan demand levels of $L_{h,i,t}$ and $L_{f,i,t}$, the return to the financial intermediary $\widetilde{I}_t$ and a cutoff level of idiosyncratic productivity shock $\varpi_{o,i,t}$ that breaks even performing and non-performing loans.[2] These optimal values are such that (i) they maximize the expected return of the firm, equation (8.18) below, and (ii) they allow the financial intermediary to get expected returns from intermediation at least as high as its cost of funds, i.e. its participation constraint, equation (8.19) below. Formally:

$$\max_{L_{h,i,t},L_{f,i,t},\widetilde{\mathcal{I}}_t,\varpi_{o,i,t}} \int_{\varpi_{o,t}}^{\varpi_u} \left[G_t\varpi L_{h,i,t}^{a}L_{f,i,t}^{1-a} - \widetilde{\mathcal{I}}_t\left(L_{h,i,t} + \mathcal{E}_t L_{f,i,t}\right)\right]\phi(\varpi)d\varpi\,, \tag{8.18}$$

subject to:

$$\int_{\varpi_{o,t}}^{\varpi_u} \widetilde{\mathcal{I}}_t\left[L_{h,i,t} + \mathcal{E}_t L_{f,i,t}\right]\phi(\varpi)d\varpi + \cdots$$

$$\cdots + \int_{\varpi_l}^{\varpi_{o,t}} \left[G_t\varpi L_{h,i,t}^{a}L_{f,i,,t}^{1-a} - \lambda G_t\varpi L_{h,i,t}^{a}L_{f,i,,t}^{1-a}\right]\phi(\varpi)d\varpi + Z_t \geq X_t\,, \tag{8.19}$$

$$G_t\varpi_{o,t}L_{h,i,t}^{a}L_{f,i,t}^{1-a} = \widetilde{\mathcal{I}}_t\left(L_{h,i,t} + \mathcal{E}_t L_{f,i,t}\right)\,, \tag{8.20}$$

where:

$$X_t = \mathcal{I}_t D_{t+1} + \mathcal{I}_t \Delta M_{b,t} + \mathcal{E}_t \mathcal{I}_t^f\left(B_{t+1} + B_{t+1}^*\right) + \left(\mathcal{E}_t - \mathbb{E}_{t-1}\{\mathcal{E}\}_t\right)\left(B_t + B_t^*\right)$$

$$Z_t = \zeta_D D_t + \zeta_B \mathcal{E}_t\left(B_t + B_t^*\right)\,.$$

The expected return of the firm is given by the expected production value minus the loan repayment. Loan repayment is only possible if the firm does not default. If the firm defaults, it obtains nothing. On the other hand, the expected return of lending considers the expected repayment received from firms and the expected residual claims of the financial intermediary over the firms production in the case of default. Monitoring costs are a proportion of the size of the production value. The constraint (8.19) means that the expected return of the bank plus the zero gross return from holding "required reserves" have to be at least equal to the funds the financial intermediaries promised to depositors ($X_t$), which also includes the funds to make up for the expected capital losses or gains. Also, $Z_t$ is an exogenous amount of cash that financial intermediaries

[2] The contract in our setup has an intra-periodic nature. Long-term contracting is not possible given our assumption about the type of borrowers (short-lived and atomistic). Inter-periodic contracting made by long-lived agents would induce less severe agency costs.

have to hold (compulsory reserve requirements as is standard in emerging market economies). We assume that this amount of reserves is determined as a fraction $\zeta$ of the value of deposits made in the previous period.

Following Gertler et al. (2007), it is possible to show that this problem can be written in the following compact form:

$$\max_{L_{h,i,t},L_{f,i,t},\varpi_{o,i,t}} \left[1-\Gamma(\varpi_{o,i,t})\right] G_t L_{h,i,t}^{a} L_{f,i,t}^{1-a} , \tag{8.21}$$

subject to:

$$\left[\Gamma(\varpi_{o,i,t}) - \lambda\Upsilon(\varpi_{o,i,t})\right] G_t L_{h,i,t}^{a} L_{f,i,t}^{1-a} + \zeta_D D_t + \zeta_B \mathcal{E}_t \left(B_t + B_t^*\right) \geq X_t . \tag{8.22}$$

The functions $\Gamma(.)$ and $\lambda\Upsilon(.)$ represent the expected share of output that goes to the financial intermediary and the expected monitoring costs, respectively.[3] We can show that the cutoff point $\varpi_{o,i,t}$ is positive and finite and does not depend on idiosyncratic factors (hence $\varpi_{o,i,t} = \varpi_{o,t}^{e}$). A variable that arises as an important determinant for the solutions is the ratio $S_t^w/mc_t$ which represents how much higher the real price of wholesale goods ($S_t^w$) has to be in excess of the marginal financial cost $mc_t$ that arises in the absence of agency costs.

The optimal equilibrium loan levels are given by:

$$L_{h,t} = \frac{a}{\mathcal{I}_t}\frac{R_{r,t}}{f_{m,t}} \qquad \text{and} \qquad L_{f,t} = \frac{1-a}{\mathcal{E}_t \mathcal{I}_t^{f}}\frac{R_{r,t}}{f_{m,t}} , \tag{8.23}$$

where $R_{r,t}$ represent the provisions to deal with the opportunity cost of holding non-interest bearing reserves and capital gains or losses:

$$R_{r,t} = \zeta_D(\mathcal{I}_t - 1)D_t + \zeta_B \mathcal{E}_t(\mathcal{I}_t^{f} - 1)\left(B_t + B_t^*\right) + \left(\mathcal{E}_t - E_{t-1}\mathcal{E}_t\right)\left(B_t + B_t^*\right) , \tag{8.24}$$

and $f_{m,t}$ is the financial margin, defined as the return of the lending activity in excess of the payment of interests to depositors:

$$f_{m,t} = \left[\Gamma(\varpi_{o,t}^{e}) - \lambda\Upsilon(\varpi_{o,t}^{e})\right]\left(\frac{S_t^w}{mc_t}\right) - 1 .$$

Both equilibrium peso and dollar loan levels depend positively on the corresponding share in the production function and on the provision $R_{r,t}$, whereas they depend

[3] The properties of $\Gamma(.)$ and $\Upsilon(.)$ are along the lines of Bernanke et al. (1999).

negatively on the financial margin $f_{m,t}$. The sign of the dependence on the interest rate is not conclusive, as rising interest rates also mean that the provisions rise.

Lastly, the lending interest rate determined by the financial contract is proportional to both the cutoff productivity point and the ratio $S_t^w/mc_t$. Namely, the size of the lending rate is directly given by the extent of agency costs:

$$\widetilde{\mathcal{I}}_t = \varpi_{o,t}\left(\frac{S_t^w}{mc_t}\right) . \tag{8.25}$$

### 8.2.4 Retailers and price setting

Following Bernanke et al. (1999) and Gertler et al. (2007), we assume that there is a continuum of monopolistically competitive retailers on the unit interval. Retailers buy the amount $\widetilde{Y}_{h,t}$ of wholesale goods from firms and financial intermediaries at the price $P_{h,t}^w$ and then costlessly differentiate the product.[4] The cost function results in:

$$\text{Cost}(P_{h,t}^w) = P_{h,t}^w \widetilde{Y}_{h,t} . \tag{8.26}$$

Importantly, prices are set in a staggered way, and we follow Calvo (1983) and Yun (1996) to derive a Phillips curve relationship between home inflation and "marginal costs" incurred in the acquisition of non-tradables from wholesalers.

It is assumed that at any time, state of the world and regardless of history, any firm $j$ has a probability $\gamma$ to face institutional restrictions that make it impossible to set current prices in an optimal way. Thus, $\gamma$ is a measure of price stickiness. Instead, with probability $1-\gamma$, any firm has the opportunity to choose a new optimal price $P_{h,t}^{op}(j)$ that maximizes the discounted sum of expected future profits. Because each home producer that chooses its new price in period $t$ faces exactly the same problem, the optimal price $P_{h,t}^{op}(j)$ is the same for all of them, $P_{h,t}^{op}(j) = P_{h,t}^{op}$.

We also introduce non-optimal indexation of prices which implies that the home price index evolves according to:

$$P_{h,t}^{1-\theta} = (1-\gamma)\left[P_{h,t}^{op}\right]^{1-\theta} + \gamma\left[\Pi_{h,t-1}P_{h,t-1}\right]^{1-\theta} . \tag{8.27}$$

The dynamics of this price index is determined recursively by knowing its initial value and the single new price $P_{h,t}^{op}$ that is chosen each period. The determination of $P_{h,t}^{op}$, in

[4] Given that a fraction of firms default, financial intermediaries get the scrap value of production after the monitoring cost is incurred. Afterwards, they sell the seized product to retailers. Basically $\widetilde{Y}_{h,t} < Y_{h,t}$.

turn, depends upon current and expected future demand conditions for the individual home good. The choice of $P^{op}_{h,t}$ is such that it maximizes the present value of the expected future profit conditional on the price being indexed through past accumulated inflation whenever it can not be adjusted optimally:

$$\max_{P^{op}_{h,t}} \mathbb{E}_t \left\{ \sum_{k=0}^{\infty} \gamma^k \bar{\beta}_{t,t+k} \left\{ \left[ \frac{P_{h,t-1+k}}{P_{h,t-1}} \right] P^{op}_{h,t} - P^{w}_{h,t+k} \right\} \widetilde{Y}_{h,t+k} \right\} , \tag{8.28}$$

subject to a sequence of demand constraints:

$$\widetilde{Y}_{h,t+k}(j) = \left[ \frac{P_{h,t+k}}{(P_{h,t-1+k}/P_{h,t-1}) P^{op}_{h,t}(j)} \right]^{\theta} C_{h,t+k} , \tag{8.29}$$

where $\bar{\beta}_{t,t+k}$ is the discount factor of the $t + k$ monetary flows back to period $t$. Given that households are the ultimate owners of all type of firms, this monetary discount factor takes into account the discount factor implicit in the consumption Euler equation. Namely, $\bar{\beta}_{t,t+k} = \beta^k P_t U_c(C_{t+k}) / \left[ P_{t+k} U_c(C_t) \right]$. Maximization of the above problem yields:

$$\mathbb{E}_t \left\{ \sum_{k=0}^{\infty} \gamma^k \bar{\beta}_{t,t+k} \widetilde{Y}_{h,t+k} \left[ \left( \frac{P_{h,t-1+k}}{P_{h,t-1}} \right) P^{op}_{h,t} - \mu P_{t+k} S^{w}_{t+k} \right] \right\} = 0 . \tag{8.30}$$

This condition states that the best retailers can do, given that they cannot set prices flexibly every period, is to set the price such that it incorporates all the chances that they will keep it in the future. Instead of setting prices $P^{op}_{h,t}$ equal to a mark-up over marginal cost (as a flexible price-setter would do), these are set roughly equal to a weighted average of future expected marginal costs that will prevail given that $P^{op}_{h,t}$ remains unchanged.

### 8.2.5 Foreigners

Foreigners' decisions are exogenous from the point of view of the small economy treated here. The balance of payment identity comprises the current account balance and the financial position against foreigners:

$$P_{f,t}(Y_{f,t} - C_{f,t} - J_t) + \mathcal{E}_t B^*_{t+1} - \mathcal{I}^f_{t-1} \mathcal{E}_t B^*_t - \left( \mathcal{E}_t - \mathbb{E}_{t-1} \{ \mathcal{E}_t \} \right) B^*_t = 0 . \tag{8.31}$$

### 8.2.6 Monetary policy

Monetary policy is conducted by means of an *ad-hoc* rule. The instrument is the gross domestic interest rate $\mathcal{I}_t$ which is assumed to behave according to a rule that reacts systematically to inflation and output:

$$\mathcal{I}_t = (\mathcal{I}_{t-1})^{\rho} \left[ \left( \frac{\Pi_{h,t+1}}{\Pi} \right)^{\chi_{\pi h}} \left( \frac{Q_t}{Q_{t-1}} \right)^{\frac{\alpha}{1-\alpha}\chi_{\pi}} \left( \frac{\widetilde{Y}_{h,t}}{\widetilde{Y}_h} \right)^{\chi_y} \mathcal{I}^f \right]^{(1-\rho)} \exp(\xi_t^m) , \tag{8.32}$$

where $\mathcal{I}^f$ is the steady state domestic dollar interest rate and $\xi_t^m$ represents a monetary policy shock. The parameter $\rho$ captures monetary policy inertia. Within the systematic component of the rule, $\chi_{\pi h}$ and $\chi_{\pi}$ measure the sensitivity of the instrument to inflation deviations and $\chi_y$ measures the policymakers concern about economic activity.

The systematic behavior defines two possible types of central banker. If an inflation targeting regime is in place, the values of the coefficients $\chi_{\pi h}$, $\chi_{\pi}$ and $\chi_y$ characterize possible types of inflation targeting. In particular, in a *strict CPI inflation* targeting regime, interest rates react to total CPI inflation only ($\chi_{\pi h} = \chi_{\pi} > 0$ and $\chi_y = 0$), which implies a concern for imported goods prices as well and therefore a stronger concern about real exchange rate movements. On the other hand, in a *flexible inflation targeting* regime, where $\chi_{\pi h} = \chi_{\pi} > 0$ with $\chi_y > 0$, the monetary authority also tries to smooth fluctuations in non-tradable output, and so the monetary authority may be even more concerned about real exchange rate movements.

## 8.3 Log-linear form and calibration

We approximate the dynamic system described in the previous section in terms of percentage deviations from the deterministic steady state. In the approximation we express the variables in the form $\widehat{x}_t = (x_t - x)/x$, where $x$ is the steady state value of the variable $x_t$. A linear system is obtained, which can be solved numerically for given values of the deep parameters using standard methods such the algorithm described in Klein (2000).

### 8.3.1 The log-linear approximation

The model outlined here can be approximated by the following 10 blocks of structural equations:

1. The equation for home prices is a typical hybrid Neo-Keynesian Phillips curve with past and expected inflation. It also depends positively on the real exchange rate and the wholesale real price:

$$\widehat{\Pi}_{h,t} = (1 - B_1)\widehat{\Pi}_{h,t-1} + B_1\mathbb{E}_t\left\{\widehat{\Pi}_{h,t+1}\right\} + B_2\widehat{S}_t^w + B_3\widehat{Q}_t\,, \tag{8.33}$$

where:

$$B_1 = \frac{\beta}{1+\beta} > 0\,, \quad B_2 = \frac{1}{1+\beta}\frac{1-\gamma}{\gamma}(1-\gamma\beta) > 0 \quad \text{and} \quad B_3 = \frac{\alpha}{1-\alpha}B_2 > 0\,.$$

The wholesale real price $\widehat{S}_t^w$ represents the marginal cost the retailer has to face, and is affected by agency costs (see equation (8.39) below). The extent of how the wholesale real price affects home inflation is determined by the parameter $B_2$. In particular, when the degree of price stickiness $\gamma$ is small (more firms can adjust their prices in every period), $B_2$ tends to be larger.

The real exchange $\widehat{Q}_t$ appears in the equation as it affects the pricing decisions of those retailers that can optimally choose new prices in period $t$. An increase in the real exchange prompts a consumption substitution towards home goods and therefore affects the demand conditions home-good producers face. The parameter $B_3$ can be interpreted as a pass-through coefficient, which is positively related to the degree of openness $\alpha$ but negatively related to $\gamma$.

2. The aggregate consumption equation is the standard log-linearized form of the consumption Euler equation (8.9):

$$\widehat{C}_t = \mathbb{E}_t\left\{\widehat{C}_{t+1}\right\} - \frac{1}{\delta}\left(\widehat{\mathcal{I}}_t - \mathbb{E}_t\left\{\widehat{\Pi}_{t+1}\right\}\right)\,. \tag{8.34}$$

Movements in the nominal policy rate $\widehat{\mathcal{I}}_t$, insofar as they produce similar movements in the real interest rate, affect consumption directly via the intertemporal elasticity of consumption substitution $\delta^{-1}$.

3. The policy rate set by the monetary authority has the simple log-linear form:

$$\widehat{\mathcal{I}}_t = \rho\widehat{\mathcal{I}}_{t-1} + (1-\rho)\left[\chi_{\pi h}\mathbb{E}_t\left\{\widehat{\Pi}_{h,t+1}\right\} + \left(\frac{\alpha}{1-\alpha}\right)\chi_\pi(\widehat{Q}_t - \widehat{Q}_{t-1}) + \chi_y\widehat{C}_{h,t}\right] + \xi_t^m\,, \tag{8.35}$$

and is a weighted average of persistent and systematic behavior.

4. The standard uncovered interest parity condition:

$$\widehat{\mathcal{I}}_t = \mathbb{E}_t \left\{\widehat{\mathcal{E}}_{t+1}\right\} - \widehat{\mathcal{E}}_t + \widehat{\mathcal{I}}_t^f , \tag{8.36}$$

which governs the nominal exchange rate dynamics.

5. From the definition of the real exchange rate we obtain:

$$\widehat{Q}_t - \widehat{Q}_{t-1} = \widehat{\mathcal{E}}_t - \widehat{\mathcal{E}}_{t-1} + (\widehat{\Pi}_t^* - \widehat{\Pi}_t) . \tag{8.37}$$

6. We can also define the overall CPI inflation rate in terms of home inflation and the change in the real exchange rate:

$$\widehat{\Pi}_t = \widehat{\Pi}_{h,t} + \frac{\alpha}{1-\alpha}\left(\widehat{Q}_t - \widehat{Q}_{t-1}\right) . \tag{8.38}$$

7. The wholesale real price $\widehat{S}_t^w$ depends on two broad terms:

$$\widehat{S}_t^w = \left[a(\widehat{\mathcal{I}}_t + \widehat{w}_t) + (1-a)(\widehat{Q}_t + \widehat{\mathcal{I}}_t^f) - \widehat{A}_t\right] + \frac{H_2}{H_1}\varpi_o\widehat{\varpi}_{o,t} . \tag{8.39}$$

The term in braces represents the real marginal costs the wholesale producer would face in the absence of agency costs. The second term describes the additional amount the wholesale producer would have to charge in order to recoup the deadweight losses imposed by the presence of agency costs.

The real marginal cost in turn has two parts. The first represents the "peso" financial cost of hiring labor, whereas the second is the "dollar" financial cost. Monetary policy affects $\widehat{S}_t^w$ through its effect on real wages ($\widehat{w}_t$) and the real exchange rate ($\widehat{Q}_t$).

The effect of variations in the cutoff level $\widehat{\varpi}_{o,t}$ on the real price $\widehat{S}_t^w$ depends on the magnitude of $H_1$ and $H_2$. These two quantities, in turn, depend on the specific parametrization of the probabilistic process for idiosyncratic productivity $\varpi$ and on steady state levels of $\varpi_o$ and $S^w/mc$:

$$H_1 = \frac{1}{[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\left(\frac{S^w}{mc}\right) - 1} > 0 ,$$

$$H_2 = \left[\frac{\lambda\Upsilon''(\varpi_o) - \Gamma''(\varpi_o)}{\lambda\Upsilon'(\varpi_o) - \Gamma'(\varpi_o)} - \frac{\Gamma''(\varpi_o)}{\Gamma'(\varpi_o)} - \frac{\Gamma'(\varpi_o)}{1-\Gamma(\varpi_o)} - \frac{[\Gamma'(\varpi_o) - \lambda\Upsilon'(\varpi_o)]\left(\frac{S^w}{mc}\right)}{[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\left(\frac{S^w}{mc}\right) - 1}\right] .$$

8. The real wage depends on a direct income effect, represented by a term in consumption, and on the level of real peso loans:

$$\widehat{w}_t = \frac{\nu}{1+\nu}\widehat{l}_{h,t} + \frac{\delta}{1+\nu}\widehat{C}_t \,. \tag{8.40}$$

If $\nu$ is large (i.e. the elasticity of intertemporal elasticity of substitution is small), then labor supply is inelastic. In such a case, real wage changes are driven by labor demand movements derived from movements in real peso loans. On the other hand, the elasticity of consumption substitution has to be very low in order for consumption to have a strong effect on wage dynamics.

9. The loanable funds equilibrium dynamics is governed by equation (8.16) in log-linearized form.

Real peso loans are increasing in the amount of reserves that banks need to hold:

$$\widehat{l}_{h,t} = \left(\frac{\mathcal{I}^f}{\mathcal{I}^f - 1}\right)\left[A_{DR}\widehat{\mathcal{I}}^f_t + (1-A_{DR})\widehat{\mathcal{I}}_t\right] + (1-A_{DR})\widehat{d}_t + A_{DR}\left(\widehat{Q}_t + \widehat{b}_t + \frac{b^*_t}{b}\right) + \cdots$$
$$\cdots + \frac{A_{DR}}{\zeta(\mathcal{I}^f - 1)}(\widehat{\mathcal{E}}_t - \mathbb{E}_{t-1}\left\{\widehat{\mathcal{E}}_t\right\}) - A_{DR}\widehat{\Pi}^*_t - (1-A_{DR})\widehat{\Pi}_t - \widehat{\mathcal{I}}_t - H_3\widehat{\varpi}_{o,t} \,. \tag{8.41}$$

where:

$$A_{DR} = \frac{b}{d+b} \quad \text{and} \quad H_3 = \left(\frac{[\Gamma'(\varpi) - \lambda\Upsilon'(\varpi)]\left(\frac{S^w}{mc}\right)}{G_1/mc - 1} + \frac{G_1/mc}{G_1/mc - 1}\frac{H_2}{H_1}\right)\varpi_o \,.$$

The overall effect of the interest rate is negative and the effect of the cutoff value $\widehat{\varpi}_{o,t}$ is determined by the sign of $H_3$.

On the other hand, equilibrium loans denominated in dollars is given by:

$$\widehat{l}_{f,t} = \widehat{l}_{h,t} + \widehat{\mathcal{I}}_t - \widehat{Q}_t - \widehat{\mathcal{I}}^f_t \,. \tag{8.42}$$

This equation results from the Cobb-Douglas form of the production function.

Additionally, the supply of both peso and dollar-denominated loans is linked to the evolution of both denominations of deposits:

$$\widehat{l}_{h,t} = \left(\frac{1}{1-\zeta/\Pi^*}\right)\widehat{d}_{t+1} + \left(\frac{1}{1-\zeta/\Pi^*}\right)\frac{\Delta m_{b,t}}{d} - \left(\frac{\zeta/\Pi^*}{1-\zeta/\Pi^*}\right)\left(\widehat{d}_t - \widehat{\Pi}_t\right) , \tag{8.43}$$

$$\widehat{l}_{f,t} = \left(\frac{1}{1-\zeta/\Pi^*}\right)\widehat{b}_{t+1} + \left(\frac{1}{1-\zeta/\Pi^*}\right)\frac{b^*_{t+1}}{b} - \left(\frac{\zeta/\Pi^*}{1-\zeta/\Pi^*}\right)\left(\widehat{b}_t + \frac{b^*_t}{b} - \widehat{\Pi}^*_t\right). \quad (8.44)$$

An increase in the policy rate will tend to reduce peso loans as the cost of peso funds increases. However, the increase in the peso cost of funds also means that the relative dollar cost of funds falls. This substitution effect is partially offset by the production scale effect. As production grows, the economy does not want to depart from the optimal combination of peso and dollar loan levels. The extent of the effect is given by the weight of dollar loans, the parameter $A_{DR} < 1$.

10. The log-linearized form of the foreign sector equilibrium is given by:

$$J\left[\widehat{l}_{h,t} + \widehat{I}_t - \widehat{Q}_t - \widehat{I}^f_t - \frac{1}{b}b^*_{t+1}\right] = \eta C_f \widehat{Q}_t - C_f \widehat{C}_t - \frac{1}{\beta}b^*_t + Y_f \widehat{Y}_{f,t}. \quad (8.45)$$

### 8.3.2 Calibration

In order to calibrate the model, we use Peruvian data whenever it is possible. The Peruvian economy is a typical emerging market country with financial dollarization features, just what the present model attempts to portray. The calibrated parameters allow us to determine the steady state solution shown in Table 8.1 at the end of this section.[5]

*Parameters describing household preferences*

- The subjective discount factor $\beta$ is calibrated such that it implies a steady state domestic real interest rate equal to 6% per year, considering that the US steady state real rate is considered to be 4% per year. This implies $\beta = 0.9852$, $\beta^* = 0.9901$ and a risk premium factor $V = 1.005$.
- The elasticity of intertemporal consumption substitution measures the degree of reactiveness of aggregate consumption to real interest rate movements. We set this value to $1/\delta = 1/5$ which is relatively low and suggests that this channel might be weak in emerging market economies.
- The elasticity of intertemporal labor substitution $1/\nu$ is set to 2.2. This value is relatively high and reflects the idea that labor demand might be more responsive to wages in these type of economies.

[5] We note that our calibration implies a probability of default in steady state as high as 78 percent. This number is not realistic. Yet, very different calibrations leading to more sensible default probabilities led to the same qualitative conclusions as in this chapter.

- For the elasticity of intratemporal substitution between consumption of foreign goods and home goods we have chosen a value $\eta = 2$, suggesting an environment where people find it difficult to substitute foreign goods by home goods.
- The elasticity of substitution across the different varieties of home goods is set at $\theta = 11$. This value is consistent with a steady state mark-up of $\mu = \theta/(\theta - 1) = 10\%$.
- The proportion of foreign consumption out of total consumption in steady state is given by the parameter $\alpha = 0.25$, as in Cespedes et al. (2004).

*Parameters describing the production technology*

- The production scale parameter is normalized to $A = 1$.
- The Cobb-Douglas coefficient $a$ is estimated to be between 0.6 and 0.8; we take the mean value of 0.68 which means that the liability dollarization ratio is about 32%.
- We assume that the idiosyncratic productivity shock follows a uniform distribution with unconditional mean equal to one. Specifically we use a pdf $\phi(\varpi) = \frac{1}{2\Delta}$ and a cdf given by $\Phi(\varpi) = \frac{1}{2\Delta}(\varpi - 1 + \Delta)$, with $\Delta = \frac{1}{2}$.

*Parameter describing the institutional restriction on price setting*

- The probability that an individual firm does not change its price at any date is $\gamma$ and the average duration of this price quotation is $1/(1-\gamma)$ quarters. The standard value for a developed, stable economy is $\gamma = 0.75$. Instead, we choose a value $\gamma = 0.5$ which means that price quotations last two quarters only, that is, prices are more flexible than the standard case.

*Parameters describing monetary policy*

- The interest rate smoothing coefficient is set to $\rho = 0.7$
- We set the two regimes as follows. For strict CPI inflation targeting, $\chi_{\pi h} = \chi_{\pi} = 1.5$ and $\chi_y = 0$. For flexible inflation targeting, $\chi_{\pi h} = \chi_{\pi} = 1.5$ with $\chi_y = 0.5$.

*Parameters describing the foreign nominal variables*

- The foreign steady state inflation rate is set to be 2% per year.
- The mean nominal interest rate is considered to be 6% per year (given a real rate of 4% and an inflation rate of 2%).

*Parameters describing financial conditions*

- Financial conditions depend heavily on monitoring costs as a proportion of the size of borrowers' production ($\lambda$) and the reserve requirement ratio ($\zeta$). The value of these two parameters are likely to be high in emerging markets and they should be such that the steady state lending interest rate results in reasonable values. Hence, we set $\lambda = 0.2$ and $\zeta = 0.2$, such that the lending interest rate is $\widetilde{\mathcal{I}} = 17\%$.

*Parameters describing the data generating process of exogenous variables*

- We assume that the exogenous variables of the model follow an AR(1) representation. The respective AR(1) coefficients and standard deviations are grossly estimated from the data. We do not report the specific values here.

**Table 8.1** *Steady state values*

| | | | |
|---|---|---|---|
| *Real quantities* | Aggregate consumption | $C$ | 0.745 |
| | Home consumption | $C_h$ | 0.559 |
| | Foreign consumption | $C_f$ | 0.186 |
| | Labor | $N$ | 1.276 |
| | Imported input | $J$ | 0.154 |
| | Households peso deposits | $d$ | 0.409 |
| | Households dollar deposits | $b$ | 0.192 |
| | Peso credit | $l_h$ | 0.328 |
| | Dollar credit | $l_f$ | 0.154 |
| | Wholesale production | $Y_h$ | 0.649 |
| | Retailer production | $Y_{hr}$ | 0.559 |
| *Transfers* | From financial intermediaries | $\omega_b$ | 0.003 |
| | From wholesale producers | $\omega_{wh}$ | 0.014 |
| | From retailers | $\omega_r$ | 0.051 |
| | From tradable production | $\omega_f$ | 0.340 |
| *Prices and interest rates* | Nominal gross interest rate | $R$ | 1.020 |
| | Real wholesale price | $S^w$ | 0.909 |
| | Real domestic price | $S$ | 1.000 |
| | Real exchange rate | $Q$ | 1.000 |
| | Real wage | $w$ | 0.257 |
| *Mark-ups* | Domestic prices over wholesale prices | $S/S^w$ | 1.100 |
| | Wholesale prices over marginal costs | $S^w/mc$ | 1.201 |
| *Financial frictions* | Idiosyncratic productivity cutoff value | $\omega_0$ | 1.281 |
| | Lending rate | $\mathcal{I}$ | 1.165 |
| | Probability of default | $PD$ | 0.781 |
| | Failure rate | $h$ | 1.141 |

**Source:** Author's own calculations.

## 8.4 The agency cost channel and the Phillips curve

A key feature that emerges from our setup is a positive correlation between unexpected depreciations and the probability that borrowers default on their loans. Higher default probabilities constitute a heavy burden on wholesale price setting which is then transmitted to final goods.

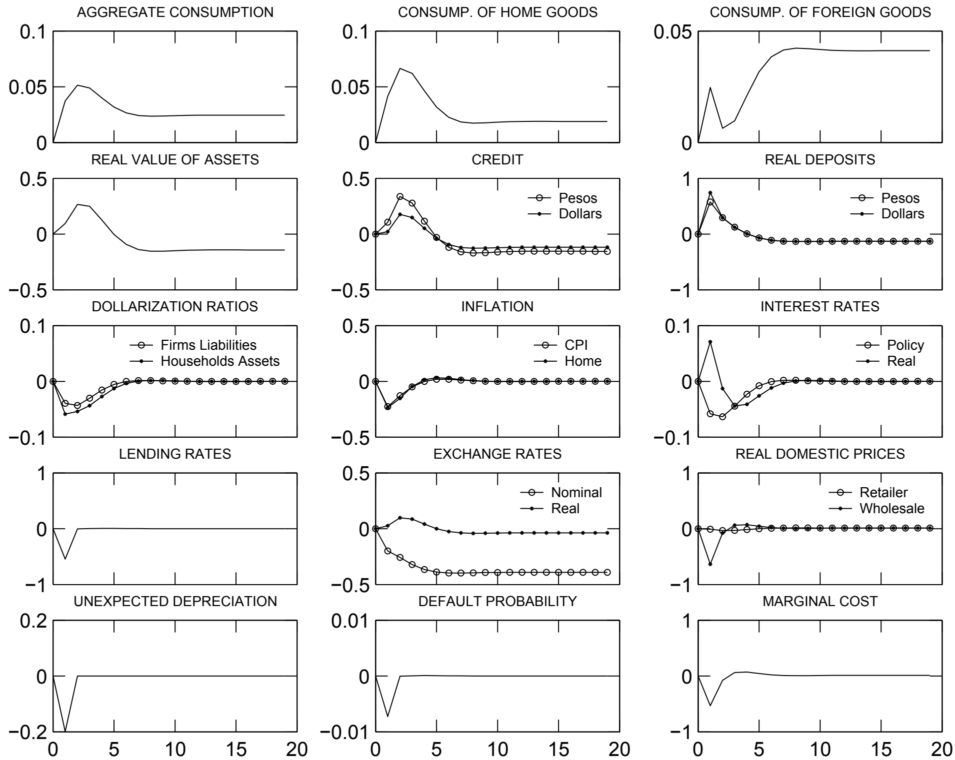
Financial intermediaries have liabilities denominated in both pesos and dollars. When an unexpected depreciation occurs, they suffer capital losses against households. Nonetheless they also hold assets denominated in both currencies and they have agreed on loan contracts stipulating that loan quantities are adjusted in the same direction as movements in their liabilities, see equation (8.41). However, the amount of loans offered cannot quickly jump to recoup capital losses. The variable that does adjust quickly is the cutoff productivity value that determines the shares of production that goes to both borrowers and financial intermediaries. An increase in this cutoff value associated to an unexpected depreciation is built in the structure of the contract as an equilibrium outcome: firms that did not default are better off and financial intermediaries can compensate their capital losses by increasing the share they can grab from the production process. The hidden cost of the above mechanism, however, is the increasing amount of business defaults that emerge in equilibrium due to an unexpected depreciation of the exchange rate.

Next, we analyze the responses of the model economy to three types of shocks relevant to an emerging market economy: an aggregate productivity shock, a commodity production shock and an international interest rate shock. We compare these shocks under the two possible types of monetary policy regimes discussed above: *strict CPI inflation targeting* (CIT) and *flexible inflation targeting* (FIT). The responses are measured as percentage deviations from the steady state values.

### 8.4.1 Aggregate productivity shock

When a positive aggregate productivity shock hits the economy (see Figures 8.1 and 8.2), marginal costs and inflation tend to fall, whereas consumption and output tend to increase. Also, the reduction in marginal costs translates into a reduction in the cutoff productivity value so that more firms are able to repay their debts. In other words, there is an increase in the share of wholesale production that goes to producers (efficiency) and a reduction in the share that goes to banks (inefficiency). The increase in the share that goes to wholesale producers works as an incentive mechanism to produce more.

**Figure 8.1** *Responses to a productivity shock, CPI inflation targeting*



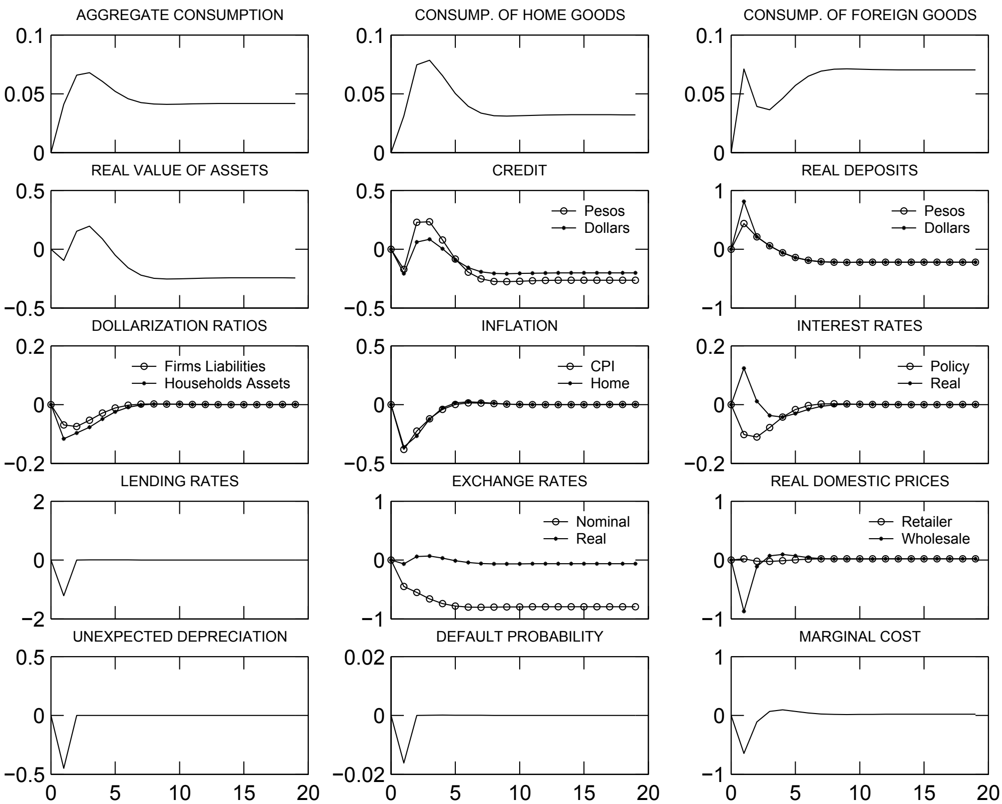

**Source:** Author's own calculations.

The presence of agency costs magnifies the standard effects of productivity shocks. However, the policy rules in place offset the agency cost effects by smoothing exchange rate fluctuations. Under both CIT (Figure 8.1) and FIT (Figure 8.2) regimes there is a concern for smoothing real exchange rate deviations per se and not using them as an offsetting device. This implies that disinflationary pressures brought about by a productivity shock are absorbed by a nominal appreciation, see equation (8.37).

### 8.4.2 Commodity production shock

A positive shock to commodity production (see Figures 8.3 and 8.4) triggers various effects in this economy, the most notorious being an increase in the demand for imports (intermediate goods).

**Figure 8.2** *Responses to a productivity shock, flexible inflation targeting*

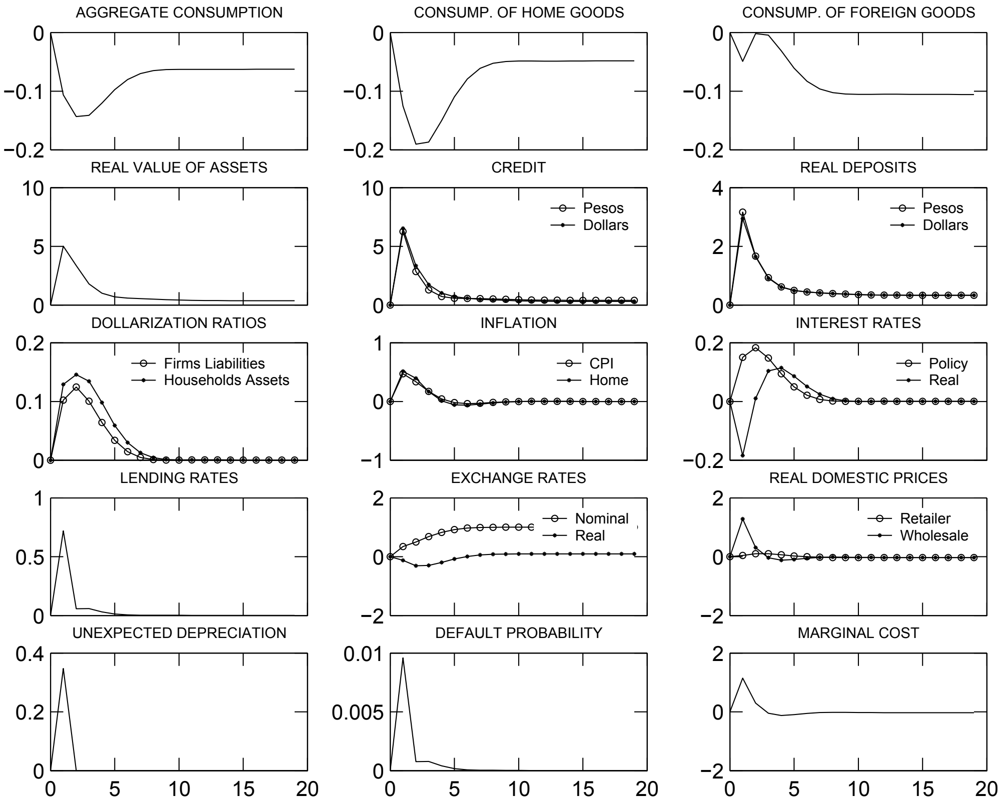



**Source:** Author's own calculations.

This occurs as an immediate external adjustment whereby higher exports are matched with higher imports to equilibrate the position against foreigners. The higher consumption of intermediate goods prompts a jump in credit denominated in pesos and dollars because there is also a higher demand for labor due to the complementarity of inputs. However, the higher demand for inputs raises real wages and the exchange rate and, therefore, the marginal cost of wholesale production is higher.

The increase in marginal cost is tied to the increase in the cutoff value $\omega_0$ and thus a reduction in the incentives for wholesale domestic production. This increased cost is translated to retailers who will also adjust their optimal prices upwards, leading to higher inflation.

**Figure 8.3** *Responses to a commodity production shock, CPI inflation targeting*

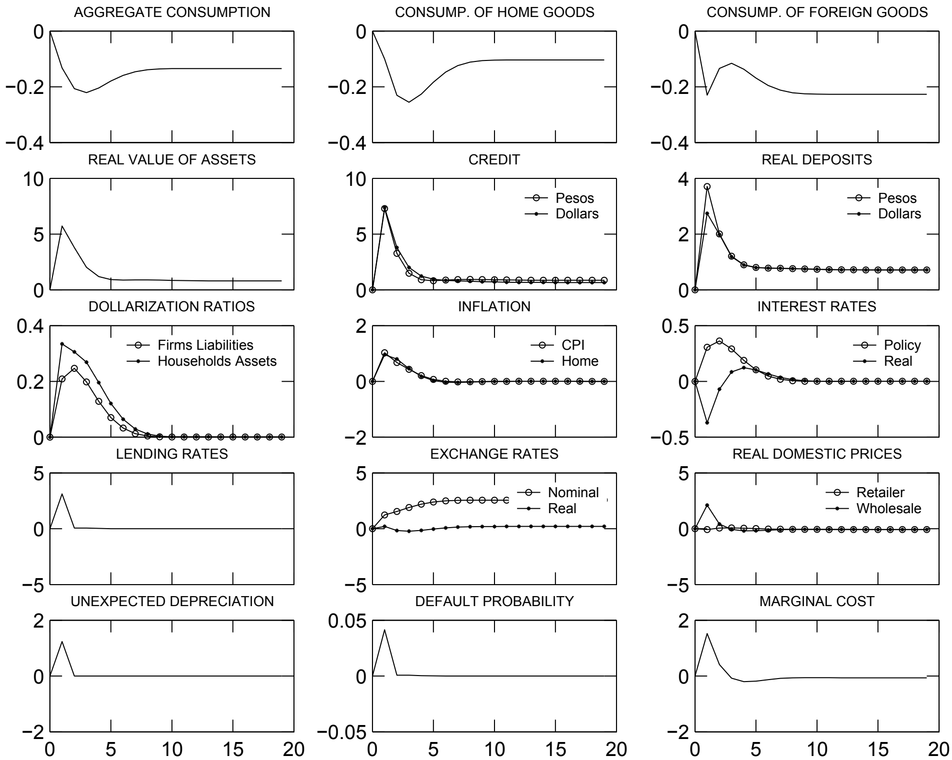



**Source:** Author's own calculations.

The reduction in aggregate consumption is coupled to the increase in deposits denominated in both currencies which support the funding level compatible with the higher level of credit. Lower aggregate consumption in turn generates lower consumption demand for home and foreign goods which matches the reduction in wholesale and home production.

Put differently, a sort of Dutch disease effect is produced as the windfall commodity production damages domestic production. Once again, as intended, the CIT and FIT regimes smooth changes in the nominal exchange to lessen its effect over inflation and increased agency costs associated with a jump in the cutoff value.

**Figure 8.4** *Responses to a commodity production shock, flexible inflation targeting*



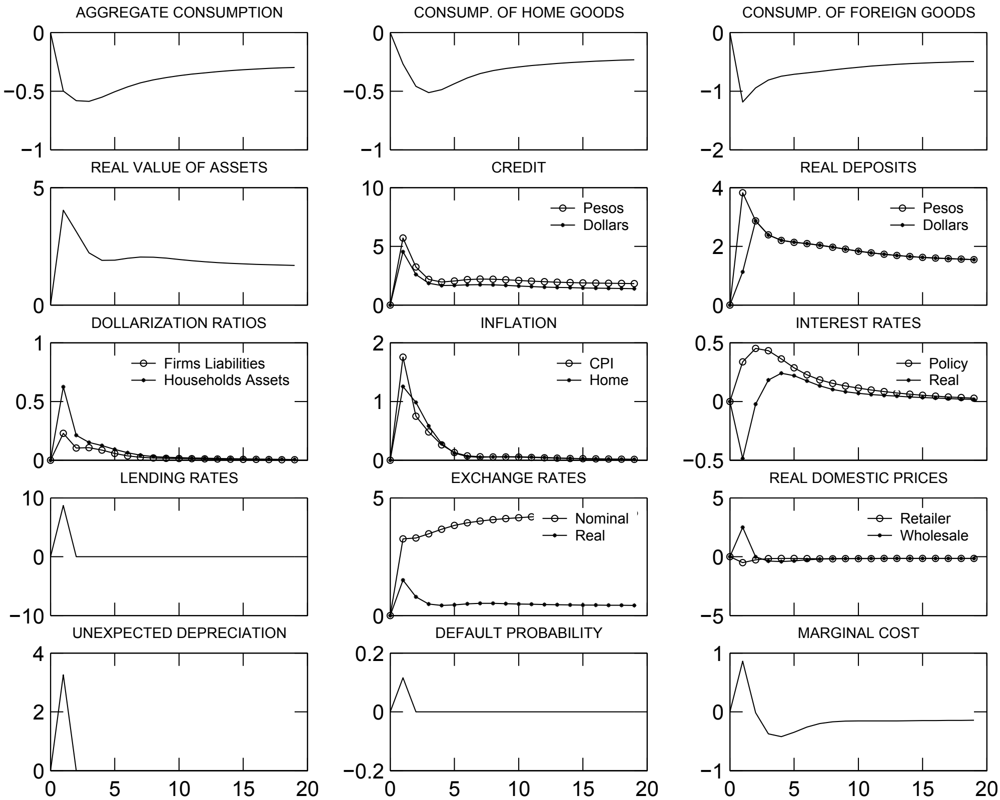

**Source:** Author's own calculations.

### 8.4.3 International interest rate shock

An increase in the dollar interest rate (see Figures 8.5 and 8.6) has a standard effect of causing an increase in the spot nominal exchange rate, which generates an unexpected depreciation. Also, this increases the cost of funds and, therefore, marginal costs rise prompting domestic production of wholesale and retail goods to diminish, just like an aggregate negative productivity shock.

On the other hand, the increase in the dollar interest rate induces more real savings in dollars as well as domestic currency deposits (due to complementarities) that are linked to the increase in real credit in both currencies. In this economy, then, the shock causes an increase in both types of credit due to the increased availability of loanable funds that overcomes the negative effects of higher cost of credit.

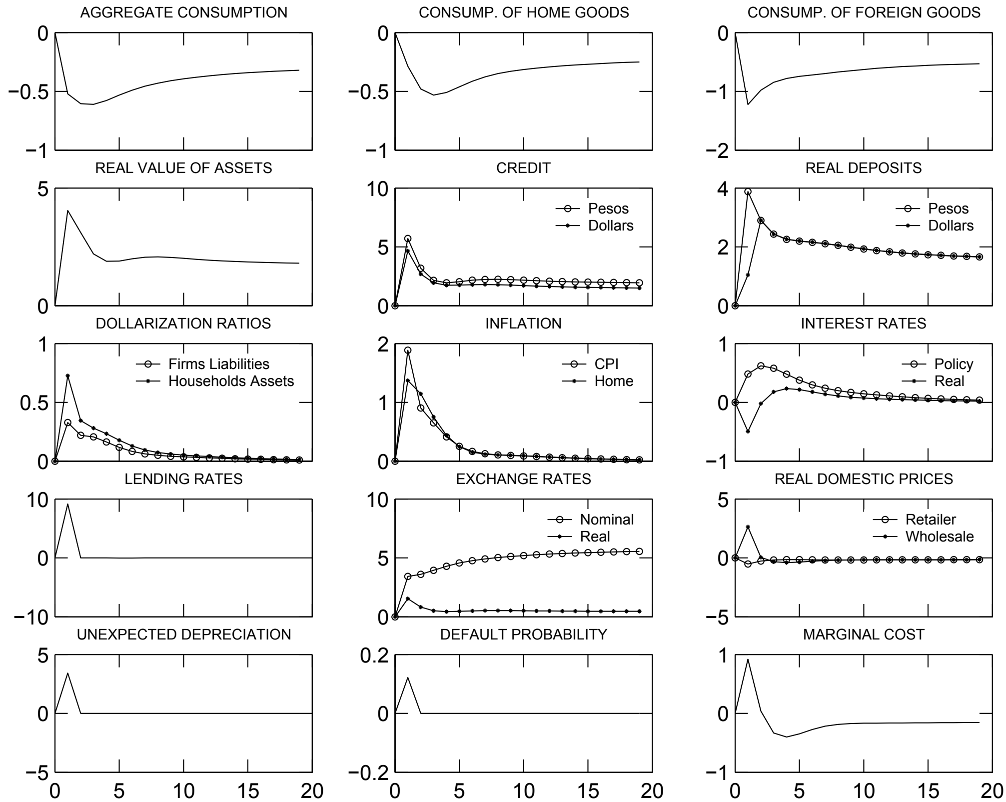
**Figure 8.5** *Responses to a dollar interest rate shock, CPI inflation targeting*




**Source:** Author's own calculations.

The conventional view and recent experience with ultra low dollar interest rates are contrary to the effects shown in this model economy. According to recent experience, a reduction in the dollar interest rate does increase credit levels. However, the source of the dollar interest rate reduction observed in the data is a overwhelming expansion of liquidity. In the model economy presented here, a positive shock to dollar funding (due to quantitative easing) expands credit, consumption and home production, the domestic dollar interest rate falls and the domestic policy interest rate mildly increases to avert inflation.

**Figure 8.6** *Responses to a dollar interest rate shock, flexible inflation targeting*




**Source:** Author's own calculations.

## 8.5 Concluding Remarks

The model presented in this chapter captures one element often disregarded in the analysis of dollarization in emerging market economies: the fact that both assets and liabilities are dollarized and that increasing dollarization might not be necessarily bad for certain types of agents and certain types of shocks. In fact, they result from the optimizing behavior of agents.

The key mechanism captured in the model is that unexpected depreciations are closely linked with the probability of default by borrowing firms. Any unexpected movement of the exchange rate turns out to be a powerful mechanism to move the real value of households assets (savings) and therefore to move aggregate consumption. On the other hand, the default probability is a manifestation of whether agency costs become higher or not. When agency costs increase (increasing probability of default) the markup of real wholesale prices over wholesale marginal costs increases, which in turn shapes the dynamics of home inflation.

Within this environment, we evaluate two possible inflation targeting regimes: strict *CPI-inflation targeting* (CIT) and *flexible inflation targeting* (FIT). An important mechanism that arises in both regimes is the use of the real exchange rate as a marginal cost stabilizing device in order to smooth home inflation deviations. The concern about real exchange rate fluctuations is built within the structure of the equilibrium.

We analyze three types of shocks dominant in emerging market economies: an aggregate non-tradable productivity shock, a tradable commodity production shock, and a shock to the international dollar interest rate. In all the cases, the sign of the unexpected depreciation is positively correlated to the real value of assets, and negatively correlated to aggregate consumption.

In our setup, monetary policy is conducted without any concern about the financial health of firms. Namely, firms' defaults produce no further costs to society other than the liquidation costs incurred by financial firms. In reality, defaults or potential systemic failures are seen as a fundamental threat to central bankers. Further research is necessary to seek monetary policy regimes that take into account a loss function for the monetary authority that considers these financial stability aspects, besides the usual inflation and real activity concerns.

## References

Bernanke, B., Gertler, M., and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In Taylor, M. and Woodford, M., editors, *Handbook of Macroeconomics*, volume 1, pages 1341–1393. Elsevier.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3):383–398.

Carlstrom, C. and Fuerst, T. (2001). Monetary shocks, agency costs and business cycles. *Carnegie-Rochester Conference Series on Public Policy*, 54(1):1–27.

Cespedes, L., Chang, R., and Velasco, A. (2004). Balance sheets and exchange rate policy. *American Economic Review*, 94(4):1183–1193.

Clarida, R., Gali, J., and Gertler, M. (1999). The science of monetary policy: A New Keynesian perspective. *Journal of Economic Literature*, 37(4):1661–1707.

Cooley, T. and Nam, K. (1998). Asymmetric information, financial intermediation, and business cycles. *Journal of Economic Literature*, 12(3):599–620.

Diamond, D. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies*, 51(3):393–414.

Gale, D. and Hellwig, M. (1985). Incentible-compatible debt contracts: The one-period problem. *Review of Economic Studies*, 52(4):647–663.

Gertler, M., Gilchrist, S., and Natalucci, F. (2007). External constraints on monetary policy and the financial accelerator. *Journal of Money, Credit and Banking*, 39(2):295–330.

Klein, P. (2000). Using the generalized Schur form to solve a multivariate linear rational expectations model. *Journal of Economic Dynamics and Control*, 24(10):1405–1423.

Mendoza, E. (2001). The benefits of dollarization when stabilization policy lacks credibility and financial markets are imperfect. *Journal of Money, Credit and Banking*, 33(2):440–474.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.

Yun, T. (1996). Nominal price rigidity, nominal price endogeneity, and business cycles. *Journal of Monetary Economics*, 37(2):345–370.