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Monetary Policy, Financial Dollarization and Agency Costs

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Abstract

This paper 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 depreciations are positively correlated with the probability of default by borrower firms and turn out to be a powerful mechanism to affect aggregate consumption. Throughout the monetary policy evaluation exercises performed, 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 exchange rate depreciations are contractionary and not expansionary if dollarization and agency costs in the financial sector are considered.

JEL Classification: E31, E44, F41, G21

Keywords: Phillips Curve, Monetary Policy, Financial Dollarization, Financial Intermediation, Agency Costs, Small Open Economy.

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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. To this purpose, the efforts of recent research have been devoted to the understanding of the mechanisms whereby the monetary policy instrument setting maps into final outcomes. Crucial in this understanding are theories of Phillips curves as proposed in Clarida et al. (1999) or Woodford (2003).

In the spirit of this framework, the purpose of this paper hinges on modelling 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 New-Keynesian Phillips curves has not been directly treated in the current literature. One contribution of this paper is to provide an inflation equation that takes into account the presence of agency costs and financial dollarization.

A second purpose of the paper is to study the link between agency costs, financial dollarization and the restrictions they impose to monetary policy. In particular, the question the paper intends to address is to what extent different types of inflation targeting regime affect the evolution of the economy under the presence of agency costs.

In the paper, financial dollarization is explicit as both the assets of households and the liabilities of firms that produce and generate non-tradeable income are dollarized. The paper assumes the existence of two productive sectors in the home country; the sector that produces non-tradable goods $Y_{h,t}$ and a sector that produces an exogenous amount of a "traditional" tradable good $Y_{f,t}$. The sector that produces non-tradable goods is composed of heterogeneous wholesalers who face a credit-in-advanced constraint as in Cooley and Nam (1998) or Carslstrom and Fuerst (2001). The heterogeneity of wholesalers (borrowers) stems from idiosyncratic productivity shocks affecting these firms. 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 (1998). As known, retailer prices will also sell at a mark-up over marginal cost due to the market power structure assumed. The overall result is a dynamics of prices and inflation 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-linearised 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. With the whole set of equations, qualitative exercises can be performed. In particular, the purpose of the research is tackled by changing the parameters that control for the degree of financial dollarization and agency costs and evaluating the responses of the economy to diverse shocks hitting the economy. For example, a world interest rate shock affects domestic variables (real activity, prices, default probabilities, etc.) according to the type of monetary policy response, degree of financial dollarization and the extent of agency costs.

The paper is divided as follows: In section 2 we provide our general modelling framework, in section 3 we set up the canonical log-linearised system and in section 4 we perform describe the assessment of two different types of inflation targeting regimes under a series of shocks and section 5 concludes.

2 Framework

We model a small open economy where imports are traded using the dollar as a medium of exchange within the boundaries of the domestic country. In order to have a role for monetary policy the nominal rigidity introduced is a staggered price setting structure on the part of firms. The broad view is that there are two productive sectors in the home country. The country produces non-tradable goods $Y_{h,t}$ and an exogenous amount of a "traditional" tradable good $Y_{f,t}$ whose price is determined internationally. This last component is typical in commodity producer countries. Non-tradable goods production is made by monopolistic competitive firms that set prices. However, the setting of prices is made in a staggered way due to the fact that pricing decisions can not be made continuously. In our framework this results in a Phillips kind of curve for the supply of non-tradables with both a backward and a forward looking component in inflation.

In the next subsections, we are going to analyse the behavior of households, firms, foreigners and the monetary authority. Before doing that, it is convenient to summarise the structure of the paper:

- We model a monetary economy in a small, open-economy setting.
- To be precise, it's a semi-open economy because domestic consumers do not have access to internationally traded assets. The country is not financially sophisticated. In this sense the financial market is fairly incomplete.
- However there is foreign trade in goods. Consumers are offered foreign goods, firms depend on foreign inputs and there are export-only firms that produce primary commodities.
- Within the borders of the economy, consumers do have access to assets denominated in both, pesos and dollars. These are offered by domestic financial intermediaries. This feature captures dollarization of assets on the portfolio of domestic consumers.

- Domestic financial intermediaries do have access to foreign borrowing/lending.

Households: A typical household maximises the expected present value of utility[1] over future consumption levels and labor.

$$\sum_{s=t}^{\infty} E_t \left[\beta^{s-t} \left(\frac{C_s^{1-\delta} - 1}{1-\delta} - \frac{N_s^{1+\nu} - 1}{1+\nu} \right) \right] \tag{1}$$

subject to the following resource constraint

$$D_{s+1} + \mathcal{E}_s B_{s+1} = \mathcal{I}_{s-1} D_s + \mathcal{E}_s \mathcal{I}^f_{s-1} B_s + (\mathcal{E}_s - E_{s-1}\mathcal{E}_s) B_s + W_s N_s - P_s C_s + \Omega_s \tag{2}$$

For every period $s = t, t+1, \ldots$ and where 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 is made, $\mathcal{I}_{s-1} = (1 + i_{s-1})$ is the gross interest rate paid by the peso assets bought at the beginning of time $s-1$, likewise $\mathcal{I}^f_{s-1} = (1 + i^f_{s-1})$ 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 only 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 [2]. The term $(\mathcal{E}_s - E_{s-1}\mathcal{E}_s)B_{s-1}$ captures the accounting adjustment needed to explain capital gains or losses. This means that if there is an unexpected depreciation[3] of the currency, then there is a positive peso valued capital gain from holding dollar-denominated assets.

There are two arguments in the above utility function[4]; an overall consumption index C_t and a measure of labor supply N_t. The variable C_t is an aggregate consumption index

$$C_t = \left[(1-\alpha)^{\frac{1}{\eta}} C_{h,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{f,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{3}$$

Where $\eta > 1$ is the elasticity of substitution between home and foreign goods. A large value of η indicates high substitution while a value of $\eta \to 1$ imposes almost no possibility of substitution.

In this world, home goods (non tradables) are consumed in a variety of ways which are aggregated in the index $C_{h,t}$ which we define in turn as:

$$C_{h,t} = \left[\int_0^1 C_{h,t}(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}} \tag{4}$$

[1] Given that monetary policy uses the nominal interest rate rule as instrument, we can simply leave out money holdings from the utility function.

[2] To ensure that households are net savers in the steady-state, certain conditions on the parameters are needed.

[3] A depreciation of the currency means an increase in the peso value of the dollar.

[4] In this equation the parameters $1/\nu$, and $1/\delta$ measure constant intertemporal elasticities of substitution.

Here the parameter $\theta > 1$ measures the degree of substitutability among the different home goods. High substitutability implies lower market power to the producers of the different types. Let's define two important relative prices: First, the real domestic price is the ratio of non-tradable prices $P_{h,t}$ to the consumer based price index P_t (to be defined later) such that $S_t = \frac{P_{h,t}}{P_t}$ and second, the real exchange rate is defined as the ratio of the peso price of imports $P_{f,t}$ to the consumer based price index[5]: $Q_t = \frac{P_{f,t}}{P_t} = \frac{\mathcal{E}_t P_t^*}{P_t}$

Note that from the perspective of the home country, the dollar price of the imported good abroad P_t^* is given[6], which means that the domestic price of that good evolves according to: $P_{f,t} = \mathcal{E}_t P_t^*$. 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 the consumer price index P_t depends also on the effect of the exchange rate on domestic producer prices set by firms that sell final goods.

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

$$C_{h,t} = (1 - \alpha)\, S_t^{-\eta} C_t \tag{5}$$

$$C_{f,t} = \alpha Q_t^{-\eta} C_t \tag{6}$$

Home and foreign good consumption levels depend negatively on the real domestic price ratio and on the real exchange rate respectively. For a constant overall consumption level C_t, an exchange rate spot depreciation reduces S_t and rises Q_t, thereby there is a substitution in consumption from foreign goods to home goods. The consumption based price index summarises the relationship between $P_{h,t}$ and $P_{f,t}$ and it is given by[7]

$$P_t = \left[(1 - \alpha)P_{h,t}^{1-\eta} + \alpha P_{f,t}^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{7}$$

We still have to derive the demand for the different varieties of goods produced domestically. In order to do so, we proceed in the same way as we did previously and find the following consumption rule for each of the varieties indexed by j

$$C_{h,t}(j) = \left(\frac{P_{h,t}}{P_{h,t}(j)}\right)^{\theta} C_{h,t} \tag{8}$$

[5]It is perhaps important to define a more accurate measure of real exchange rate; the price of tradeables in terms of non-tradeables (sometimes also refereed as terms of trade): $\mathcal{T}_t = \frac{P_{f,t}}{P_{h,t}} = \frac{Q_t}{S_t}$

[6]As usual, starred variables designate variables in the foreign country

[7]Note that from the definition of the overall consumer price index we can infer that: $(1-\alpha)S_t^{1-\eta} + \alpha Q_t^{1-\eta} = 1$

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

$$P_{h,t} = \left[\int_0^1 P_{h,t}(j)^{1-\theta} dj \right]^{\frac{1}{1-\theta}} \tag{9}$$

Knowledge of these equations is important insofar as they will give us the evolution of prices, given the retailer's price setting behavior to be described in Subsection 2.

Intertemporal consumption decision: The first order condition for the optimal intertemporal consumption decision that solves [1] subject to [2] is

$$\frac{C_t^{-\delta}}{P_t} = \beta E_t \left[\frac{C_{t+1}^{-\delta}}{P_{t+1}} \mathcal{I}_t \right] \tag{10}$$

This equation has the standard meaning; the left hand side is the utility loss of forgoing consumption of $\frac{1}{P_t}$ 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.

Intratemporal portfolio decisions: 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 (see Appendix A)

$$\mathcal{I}_t = \frac{E_t [\mathcal{E}_{t+1}]}{\mathcal{E}_t} \mathcal{I}_t^f \tag{11}$$

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

$$N_t^{\nu} C_t^{\delta} = \frac{W_t}{P_t} \tag{12}$$

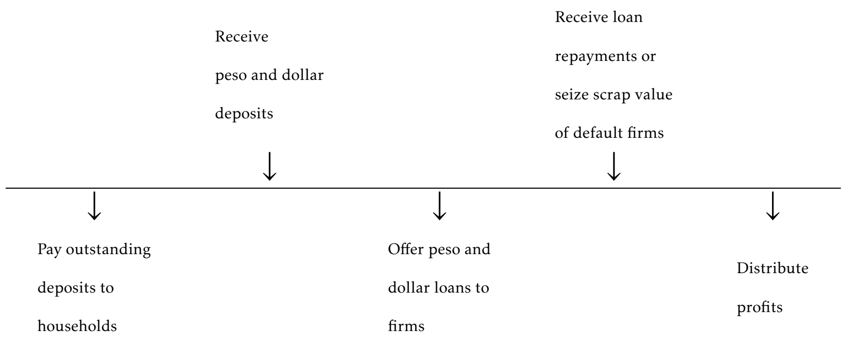
As with the previous household choice rules, the supply of labor depends on the aggregate consumption index. The dynamic properties of labor supply depend upon the dynamics of the aggregate consumption index C_t through the Euler condition.

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

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

$$\mathcal{I}_{t-1} D_t + \mathcal{E}_t \mathcal{I}_{t-1}^f B_t + \mathcal{E}_t \mathcal{I}_{t-1}^f B_t^* + (\mathcal{E}_t - E_{t-1}\mathcal{E}_t)(B_t + B_t^*) \tag{13}$$

Figure 1. *Timeline of bank's actions within any period*



Where: $\mathcal{I}_t^f = \mathcal{I}_t^* V_t$. The domestic dollar interest rate incorporates the foreign benchmark interest rate $\mathcal{I}_t^*$ and a factor $V_t = (1+\nu_t)$ that accounts for country risk. This variable can be endogenised on the lines of Céspedes et.al (2001) or Mendoza (2001). However, we choose not to do so because our 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[8] $\mathcal{I}_t^f$.

- Next, banks offer loans to wholesale firms. These firms need to borrow in advance to be able to buy production inputs. The amounts lent by banks in pesos and dollars are $L_{h,t}$ and $L_{f,t}$ respectively. The sources of fund available to the bank are twofold; the pesos and dollars deposited by domestic consumers plus any amount of pesos borrowed from the central bank and dollars borrowed abroad. Financial intermediaries have to hold compulsory reserves calculated as a fraction of deposits made last period.

$$L_{h,t}^s \equiv D_{t+1} + \Delta M_{b,t} - \zeta_D D_t \tag{14}$$

$$L_{f,t}^s \equiv B_{t+1} + B_{t+1}^* - \zeta_B (B_t + B_t^*) \tag{15}$$

Here $\Delta M_{b,t}$ is the net position of bank's assets at the central bank and B_{t+1}^* is the net position of bank's dollar assets with the foreign sector[9]. 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.

[8] Due to the country-risk parameter, foreigners need to be paid more than the riskless benchmark foreign rate $\mathcal{I}_t^f > \mathcal{I}_t^*$.

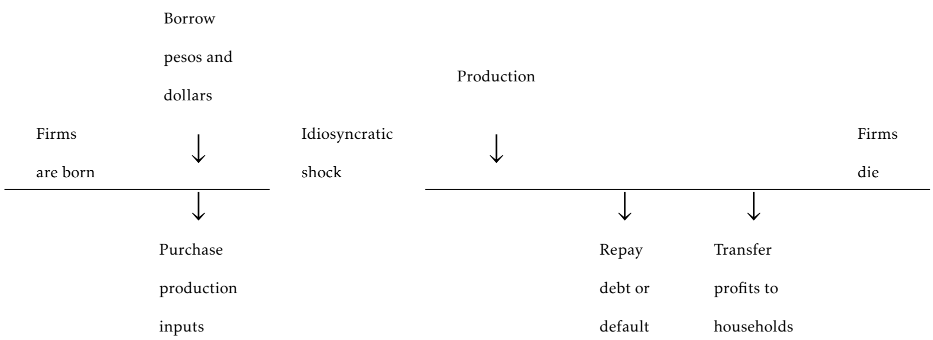
[9] The presence of $\Delta M_{b,t}$ mimics the typical standing facility offered by the central bank at date t (a marginal lending facility or a deposit facility). In fact, this is the rationale whereby the central bank can control the short term interest rate of the economy. Though, we do not model the specific process of nominal interest rate setting. Here $\Delta M_{b,t}$ only works as an extra variable left to clear the market.

- The loan repayment is subject to agency costs because there is asymmetric information regarding the productivity of firms. Firms learn about their idiosyncratic shock to 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.

Wholesale Firms: Every period a continuum of firms in the unit interval is born. They all produce a homogeneous good. We assume that they 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 realises and they repay or default after production and sale but before the next period starts. At the end of each period all firms die; either after setting their transfers to households or after default.[10]

Figure 2. *Timeline of firms actions within any period*



The technology they use to produce these goods is given by

$$Y_{h,t}(i) = \varpi_{it} A_t N_{it}^{a} J_{it}^{1-a} \tag{16}$$

Where:

ϖ_{it}: Idiosyncratic productivity shock assumed to be *i.i.d* across time and firms with density function $\phi(\varpi)$, c.d.f $\Phi(\varpi)$, with unconditional expectation $E[\varpi_{it}] = 1$ and support on the bounded interval $[\varpi_l, \varpi_u]$.

A_t: Aggregate productivity shock.

N_{it} Labor input

J_{it} Imported intermediate input

[10]This crucial assumption precludes accumulation of net worth by firms.

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

$$L_{h,i,t} \equiv W_t N_{it} \tag{17}$$

$$L_{f,i,t} \equiv P_t^* J_{it} \tag{18}$$

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-tradeable production is sold at the wholesale home price $P_{h,t}^w$. Conveniently replacing [17] and [18] into [16] yields

$$P_{h,t}^w Y_{h,t}(i) = G_t \varpi_{it} L_{h,i,t}^a L_{f,i,t}^{1-a} \tag{19}$$

Where $G_t = A_t S_t^w \left(\frac{P_t}{W_t}\right)^a \left(\frac{P_t}{P_t^*}\right)^{1-a}$ groups the aggregate determinants of firm i production and $S_t^w = \frac{P_{h,t}^w}{P_t}$ represents the relative price of wholesale goods.

The design of the financial contract: A key assumption to endogenise financial intermediation is that after loans are taken and inputs enter into production, each firm i privately observes its idiosyncratic shock ϖ_{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)[11]. For risk neutral firms and financial intermediaries, the optimal, incentive compatible contract is a risky-debt contract.

The contract[12] at each time t and for every firm i hinges on finding the optimal loan demand levels of $L_{h,i,t}$, $L_{f,i,t}$, the return to the financial intermediary $\widetilde{\mathcal{I}}_t$ and a cutoff level of idiosyncratic productivity shock $\varpi_{o,i,t}$ that breaks even performing and non-performing loans. These optimal values are such that a) they maximise the expected return of the firm (Equation [20]) and b) they allow the financial intermediary to get expected returns from intermediation at least as high as its cost of funds (its participation constraint - Equation [21]). Formally,

$$\max_{L_{h,i,t}, L_{f,i,t}, \widetilde{\mathcal{I}}_t, \varpi_{o,i,t}} \int_{\varpi_{o,t}}^{\varpi_u} \left[G_t \varpi L_{h,i,t}^a L_{f,i,t}^{1-a} - \widetilde{\mathcal{I}}_t \left(L_{h,i,t} + \mathcal{E}_t L_{f,i,t} \right) \right] \phi(\varpi) d\varpi \tag{20}$$

[11] And applied in Bernanke et.al (1998), Carslstrom and Fuerst (2001) among others.

[12] 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.

subject to:

$$\int_{\varpi_{o,t}}^{\varpi_u} \widetilde{\mathcal{I}}_t \left[L_{h,i,t} + \mathcal{E}_t L_{f,i,t} \right] \phi(\varpi) d\varpi + \cdots$$
$$\int_{\varpi_l}^{\varpi_{o,t}} \left[G_t \varpi L_{h,i,t}^{a} L_{f,i,,t}^{1-a} - \lambda G_t \varpi L_{h,i,t}^{a} L_{f,i,,t}^{1-a} \right] \phi(\varpi) d\varpi + Z_t \geq X_t \tag{21}$$

$$G_t \varpi_{o,t} L_{h,i,t}^{a} L_{f,i,t}^{1-a} = \widetilde{\mathcal{I}}_t \left(L_{h,i,t} + \mathcal{E}_t L_{f,i,t} \right) \tag{22}$$

Where

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

The expected return of the firm is given by the expected production value minus the loan repayment. Loan repayment is only possible if the firms 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 case of default. Monitoring costs are a proportion of the size of the production value. The constraint [21] 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[13]. On the other hand, Z_t is an exogenous amount of cash that financial intermediaries have to hold (obligatory reserve requirements as is standard in some emerging market economies). We assume that this amount of reserves is determined as a fraction ζ of the value of deposits made in the previous period.

In Appendix A, we follow Gertler et.al (2001) to show that this problem can be written in the following compact form

$$\max_{L_{h,i,t}, L_{f,i,t}, \varpi_{o,i,t}} \left[1 - \Gamma(\varpi_{o,i,t}) \right] G_t L_{h,i,t}^{a} L_{f,i,t}^{1-a} \tag{23}$$

subject to:

$$\left[\Gamma(\varpi_{o,i,t}) - \lambda \Upsilon(\varpi_{o,i,t}) \right] G_t L_{h,i,t}^{a} L_{f,i,t}^{1-a} + \zeta_D D_t + \zeta_B \mathcal{E}_t \left(B_t + B_t^{*} \right) \geq X_t \tag{24}$$

The functions $\Gamma(.)$ and $\lambda \Upsilon(.)$ represent the expected share of output that goes to the financial intermediary and the expected monitoring costs[14] respectively. We 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 raises as an important determinant on

[13] The funds to be obtained by financial intermediation treat realised capital gains and losses alike. Ceteris-paribus, more funds are needed to make up for capital losses and less funds for the case of capital gains. This does not need be so.

[14] The properties of $\Gamma(.)$ and $\Upsilon(.)$ are outlined in the appendix along the lines of Bernanke et.al (1998).

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 give by

$$L_{h,t} = \frac{a}{\mathcal{I}_t} \frac{R_{r,t}}{f_{m,t}} \tag{25}$$

$$L_{f,t} = \frac{(1-a)}{\mathcal{E}_t \mathcal{I}_t^f} \frac{R_{r,t}}{f_{m,t}} \tag{26}$$

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

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

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 respective share in the Cobb-Douglas production function and on the provision $R_{r,t}$, whereas they depend negatively on the financial margin $f_{m,t}$. The sign of the dependence of the interest rate is not conclusive because rising interest rates mean also that the provisions must also 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.

$$\widetilde{\mathcal{I}}_t = \varpi_{o,t}\left(\frac{S_t^w}{mc_t}\right) \tag{27}$$

Retailers and price setting: Following Bernanke et.al (1998) and Gertler et.al (2001), we assume that there is a continuum of monopolistically competitive retailers on the unit range. Retailers buy the amount $\widetilde{Y}_{h,t}$ of wholesale goods from firms and financial intermediaries[15] at the price $P_{h,t}^w$ and then costlessly differentiate the product. As a result the cost function results in:

$$Cost\left(P_{h,t}^w\right) = P_{h,t}^w \widetilde{Y}_{h,t}\left(P_{h,t}^w\right) \tag{28}$$

[15]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 $\widetilde{Y}_{h,t} < Y_{h,t}$.

Importantly, prices are set in a staggered way, 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 γ to face institutional restrictions that make it impossible to set current prices in an optimal way[16]. With probability $1-\gamma$ instead, any firm has the opportunity to choose a new optimal price $P^{op}_{h,t}(j)$ that maximises 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 $P^{op}_{h,t}(j)$ is the same for each of them. Hence, in equilibrium, all optimally chosen prices are equal to $P^{op}_{h,t}$.

Woodford (2003) shows that in order to account for reasonable impulse response functions (hump-shaped response of inflation) after a monetary policy shock, the inflation rate must have some backward looking component. This is achieved through non-optimal indexation of prices through past inflation. Which implies that the home price index evolves according to:

$$P_{h,t}^{1-\theta} = (1-\gamma)\left[P^{op}_{h,t}\right]^{1-\theta} + \gamma\left[\Pi_{h,t-1}P_{h,t-1}\right]^{1-\theta} \tag{29}$$

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

$$\underset{P^{opt}_{h,t}}{Max} E_t\left[\sum_{k=0}^{\infty}\gamma^k\beta^f_{t,t+k}\left\{\left[\frac{P_{h,t-1+k}}{P_{h,t-1}}\right]P^{op}_{h,t} - P^w_{h,t+k}\right\}\widetilde{Y}_{h,t+k}\right] \tag{30}$$

Subject to a sequence of demand constraints

$$\widetilde{Y}_{h,t+k}(j) = \left[\frac{P_{h,t+k}}{\left(\frac{P_{h,t-1+k}}{P_{h,t-1}}\right)P^{op}_{h,t}(j)}\right]^{\theta} C_{h,t+k} \tag{31}$$

Where $\beta^f_{t,t+k}$ 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 $\beta^f_{t,t+k} = \beta^k\frac{U_c(C_{t+k})}{U_c(C_t)}\frac{P_t}{P_{t+k}}$. Maximisation of the above problem yields

$$E_t\left[\sum_{k=0}^{\infty}\gamma^k\beta^{firm}_{t,t+k}\widetilde{Y}_{h,t+k}\left\{\left[\frac{P_{h,t-1+k}}{P_{h,t-1}}\right]P^{op}_{h,t} - \mu P_{t+k}.S^w_{t+k}\right\}\right] = 0 \tag{32}$$

[16] So γ is a measure of price stickiness. A high value of this parameter on the unit range means that the degree of price stickiness is high.

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 the chosen price in the future. Instead of setting prices $P_{h,t}^{op}$ equal to a mark-up over marginal cost (as a flexible price-setter would do), these constrained price setters set $P_{h,t}^{op}$ roughly equal to a weighted average of future expected marginal costs that will prevail given that $P_{h,t}^{op}$ remains unchanged.

Foreigners: This small open economy model does not feature foreigners decisions. Those 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:

$$P_{f,t}(Y_{f,t} - C_{f,t} - J_t) + \mathcal{E}_t B_{t+1}^* - \mathcal{I}_{t-1}^f \mathcal{E}_t B_t^* - (\mathcal{E}_t - E_{t-1}\mathcal{E}_t) B_t^* = 0 \tag{33}$$

Monetary Policy Authority: 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.

$$\mathcal{I}_t = (\mathcal{I}_{t-1})^{\rho} \left[\left(\frac{\Pi_{h,t+1}}{\widetilde{\widetilde{\Pi}}} \right)^{\chi_{\pi h}} \left(\frac{Q_t}{Q_{t-1}} \right)^{\frac{\alpha \chi_\pi}{1-\alpha}} \left(\frac{\widetilde{Y}_{h,t}}{\widetilde{\widetilde{Y}}_h} \right)^{\chi_y} \mathcal{I}^f \right]^{(1-\rho)} \exp(\xi_t^m). \tag{34}$$

Where $\mathcal{I}^f$ is the steady-state domestic dollar interest rate and ξ_t^m represents monetary policy shocks. The parameter ρ captures monetary policy inertia. Within the systematic component of the rule $\chi_{\pi h}$ and χ_π measure the sensitivity of the instrument to inflation deviations and χ_y measures the policy makers concern about economic activity.

The systematic behavior defines two possible types of central banker[17]. If the inflation targeting regime is in place, the values of the coefficients $\chi_{\pi h}$, χ_π abd χ_y characterise possible types of inflation targeting.

We define the *strict CPI inflation* targeting regime as interest rates reacting to total CPI inflation only ($\chi_{\pi h} = \chi_\pi > 0$ and $\chi_y = 0$). This implies a concern for imported goods prices as well and therefore for a stronger concern about real exchange rate movements.

The second regime to be considered is a *flexible inflation targeting* regime where $\chi_{\pi h} = \chi_\pi > 0$ with $\chi_y > 0$. In this case the monetary authority also tries to smooth fluctuations in non-tradeable output. In this regime therefore, the monetary authority is even more concerned about real exchange rate movements.

[17]A third type named *strict home-inflation* targeting regime as reacting only to deviations of home inflation from target $\Pi_{h,t+1}$, ($\chi_{\pi h} > 0$, $\chi_\pi = \chi_y = 0$) is left out as no small open economy actually uses it.

3 The solution to the Log-linear approximation

3.1 The steady-state

The deterministic steady-state[18] is characterised by values of exogenous variables equal to their unconditional means: $Y_{f,t} = Y_f$, $I_t^* = I^*$, $I_t^f = I^* V$, $\Pi_t^* = \Pi^* = \beta^* I^*$, $A_t = A$ and a long-run monetary policy stance that sets the domestic interest rate such that: $I = I^f$. Also, in the long run, the real exchange rate Q_t clears the market for both the imported and exported goods. Given an infinitely elastic world net demand, we can assume that the real exchange rate at which world net demand is infinitely elastic is $Q = 1$. This assumption is helpful insofar as it allows the real retail price $S = 1$ and $p_h^{op} = 1$. The direct implication is that aggregate consumption of non-tradeables and imported goods are $C_h = (1-\alpha)C$ and $C_f = \alpha C$.

Inasmuch as the monetary authority sets the domestic nominal interest rate in such away that it will not depart from the foreign monetary policy, then the nominal exchange rate evolution, as defined by the UIP condition (equation [11]), will result in a constant path ($\mathcal{E}_{t+1} = \mathcal{E}_t = \mathcal{E}$). Namely, the long-run trajectory of the nominal exchange rate is basically a function of the long-run monetary policy stance. From the Euler equation, the real interest rate $\mathcal{R}$ consistent with consumption decisions is assumed to be equal to the long-run US real interest $\mathcal{R}^* = \frac{1}{\beta^*}$ rate adjusted by country risk V. With the real interest rate already pinned down by preference parameters, we can obtain the resulting steady-state inflation conditional on the long-run monetary policy stance using $\mathcal{I}/\Pi = 1/\beta$. Since monetary policy sets the interest rate $\mathcal{I}$ equal to $\mathcal{I}^f = \mathcal{I}^* V$ then the inflation rate achieved in the steady-state is exactly the same as the steady-state world inflation: $\Pi = \Pi^*$. The households budget constraint in real terms can be determined denoting $d_{t+1} = \frac{D_{t+1}}{P_t}$, $b_{t+1} = \frac{B_{t+1}}{P_t^*}$ and $b_{t+1}^* = \frac{B_{t+1}^*}{P_t^*}$.

After some manipulation of the households budget constraint - equation [2] in the text - we derive the budget constraint condition.

$$d + b = \left(\frac{\beta}{1-\beta}\right)(C - wN - \omega) \tag{35}$$

Here, $wN + \omega$ denotes the total real wage income and the real value of transfers households receive from all firms and financial intermediaries. A positive amount of steady-state real deposits is only possible if $C > wN + \omega$. This is tantamount to households being able to afford high real consumption given the steady stream of interest rate gains on deposits.

Tradeable production

Since tradeable production is obtained from a costless and laborless random effort, its net production value is transferred to their ultimate owners, the households. Then from equation [a12] in the appendix

$$\omega^f = Y_f \tag{36}$$

[18] The steady-state value of any variable x_t will be denoted by x.

Non-tradeable wholesale production

The marginal cost[19] of the wholesaler if there were no agency costs is denoted by mc

$$mc = \frac{\Lambda}{A}\mathcal{I}^f w^a \tag{37}$$

The real wholesale price S^w has been defined as the ratio of the wholesale price to the CPI price level . The presence of frictions in the financial system implies that S^w needs to be larger than the real marginal cost mc. Wholesale goods are sold at a premium due to the deadweight losses imposed by the presence of agency costs. The ratio $\frac{S^w}{mc}$ is defined by

$$\frac{S^w}{mc} = \frac{A}{\mu\Lambda\mathcal{I}^f w^a} \tag{38}$$

The amount of real profits that non-tradeable wholesale firms have to transfer to households (their ultimate owners) is determined by the expected value of production kept by firms (see Appendix A, equation [a11])

$$\omega^h = \frac{[1-\Gamma(\varpi_o)]}{\mu}Y_h \tag{39}$$

Retailers

The pricing equation [32], together with the fact that $p_h^{op} = \left(P_{h,t}^{op}/P_t\right) = 1$ imposes the standard result whereby the marginal cost to the retailer S^w has to equal the inverse of the markup $\frac{1}{\mu}$. On the other hand, the equilibrium aggregate supply of retailer firms has to equal non-tradeable consumption

$$\widetilde{Y}_h = C_h = (1-\alpha)C \tag{40}$$

Finally, retailers transfer monopolistic profits due to the mark-up of retailer prices over wholesale prices.

$$\omega^r = \left(\frac{\mu-1}{\mu}\right)\widetilde{Y}_h = \left(\frac{\mu-1}{\mu}\right)[1-\lambda\Upsilon(\varpi_o)]\,Y_h \tag{41}$$

Financial intermediaries

From equation [a10] in the appendix, the transfers from financial intermediaries to households amounts to

$$\omega^b = \left(\mathcal{I}^f - \frac{\mathcal{I}^f}{\Pi^*}\right)(d+b+b^*) \tag{42}$$

Total transfers

[19] See the Definition 4 in Appendix A.

Summing up all the transfers in [36], [39], [41] and [42] allows us to obtain the total transfers going to households

$$\omega = Y_f + \left(\frac{\Pi^*}{\beta} - \frac{1}{\beta}\right)(d+b+b^*) + \left(\frac{1-\Gamma(\varpi_o)}{1-\lambda\Upsilon(\varpi_o)} + \mu - 1\right)\frac{(1-\alpha)}{\mu}C \tag{43}$$

Replacing [43] in [35]

$$(\Pi^* - \beta)(d+b) + (\Pi^* - 1)b^* = \left[1 - \left(\frac{1-\Gamma(\varpi_o)}{1-\lambda\Upsilon(\varpi_o)} + \mu - 1\right)\frac{1-\alpha}{\mu}\right]\beta C - \beta w N - \beta Y_f \tag{44}$$

Labor market

The supply of labor is given by $N = w^{\frac{1}{\nu}} C^{\frac{-\delta}{\nu}}$ while the demand is $N = \frac{l_h}{w}$. The demand for labor depends on the real peso loan quantity[20] l_h which is given by[21]

$$l_h = \frac{a}{\mathcal{I}^f} \frac{(\mathcal{I}^f - 1)\frac{\zeta}{\Pi^*}(d+b+b^*)}{\frac{\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)}{\mu}\frac{1}{mc} - 1} \tag{45}$$

Importantly, this real peso loan quantity is equal to the real peso deposits

$$l_h = wN = d\left(1 - \frac{\zeta}{\Pi^*}\right) \tag{46}$$

Market for imported input

In steady-state equilibrium, the quantity of imported input is determined by the real dollar loan quantity which is equal to the real dollar deposits in the domestic financial system

$$J = l_f = (b+b^*)\left(1 - \frac{\zeta}{\Pi^*}\right) \tag{47}$$

Given this condition, the imported input is determined by

$$J = \frac{1-a}{\mathcal{I}^f} \frac{(\mathcal{I}^f - 1)\frac{\zeta}{\Pi^*}(d+b+b^*)}{\frac{\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)}{\mu}\frac{1}{mc} - 1}$$

Asset and liability dollarization in the steady state

From the previous equations we can easily determine the asset and liability dollarization ratios are the same and equal to the share of imported inputs in the production of non-tradable goods

$$LDR = \frac{l_f}{l_f + l_h} = 1 - a \quad \text{and} \quad ADR = \frac{b+b^*}{b+b^*+d} = 1 - a$$

[20] Derived from the equilibrium loan equation [25].

[21] We assume that $\zeta_D = \zeta_B = \zeta$ for ease of solution.

In steady-state, non-tradable production can be defined in terms of the loan capacity of the financial system (long run liquidity) $(d+b+b^*)$ net of compulsory reserves, the nominal cost of funds $\mathcal{I}^f$ and the benchmark financial marginal cost mc. From solving the first order conditions in Appendix A and using equations [46] and [47] we get

$$Y_h = \frac{\mathcal{I}^f}{mc}\left(1-\frac{\zeta}{\Pi^*}\right)(d+b+b^*) \tag{48}$$

External sector

From equation [33], equilibrium vis-a-vis the rest of the world implies

$$Y_f = \alpha C + J + \left(\frac{1-\beta}{\beta}\right)b^* \tag{49}$$

Solution procedure

In [44] we replace $wN = d(1-\frac{\zeta}{\Pi^*})$ and $Y_f = \alpha C + (b+b^*)(1-\frac{\zeta}{\Pi^*}) + (\frac{1-\beta}{\beta})b^*$ to get

$$\left(\Pi^* - \frac{\beta\zeta}{\Pi^*}\right)(d+b+b^*) = \left(\frac{\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)}{1-\lambda\Upsilon(\varpi_o)}\right)\frac{1-\alpha}{\mu}\beta C \tag{50}$$

Taking the market clearing condition for retail goods $\widetilde{Y}_h = (1-\alpha)C$ and knowing that the amount of retail goods is related to the amount of wholesale goods via $\widetilde{Y}_h = [1-\lambda\Upsilon(\varpi_o)]\,Y_h$, we have

$$Y_h = \frac{1-\alpha}{1-\lambda\Upsilon(\varpi_o)}C \tag{51}$$

This allows to write [48] as

$$d+b+b^* = \frac{mc}{\mathcal{I}^f(1-\frac{\zeta}{\Pi^*})}\frac{1-\alpha}{1-\lambda\Upsilon(\varpi_o)}C \tag{52}$$

And combining the expressions for $(d+b+b^*)$ in [50] we obtain an expression that relates $\frac{S^w}{mc}$ to the equilibrium cutoff level ϖ_o

$$SW1: \quad \dots \quad \frac{S^w}{mc} = \frac{1-\frac{\beta\zeta}{(\Pi^*)^2}}{(1-\frac{\zeta}{\Pi^*})(\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o))} \tag{53}$$

Equation [53] together with the solution for ϖ_o in terms of $\frac{S^w}{mc}$ characterised in the intra-period equilibrium analysed in [a6] and [a7]

$$SW2: \quad \dots \quad \varpi_o = \varpi_o(\tfrac{S^w}{mc}) \tag{54}$$

determine the equilibrium values for ϖ_o and $\frac{S^w}{mc}$

Once this values are pinned down, it is straightforward to disentangle the other variables. The equilibrium real wage rate is determined using the definition of mc

$$w = \left(\frac{Amc}{\Lambda\mathcal{I}^f}\right)^{\frac{1}{a}} \tag{55}$$

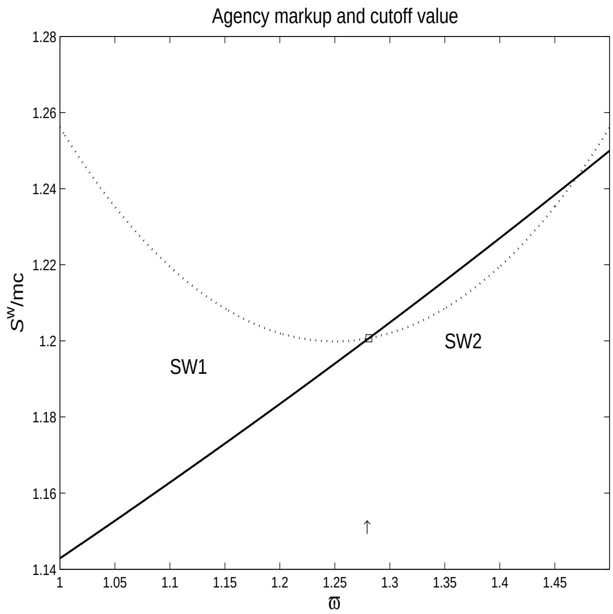


FIGURE 3. *Equilibrium values of* $\frac{S^w}{mc}$ *and* ϖ_o

In order to determine the steady-state consumption level, we need to solve for equilibrium labor first. On the labor supply schedule we have

$$N = (w)^{\frac{1}{\nu}} (C)^{\frac{-\delta}{\nu}} = A_1 (C)^{\frac{-\delta}{\nu}} \tag{56}$$

So $A_1 = (w)^{\frac{1}{\nu}}$. On the other hand, the labor demand schedule

$$N = \frac{a}{w\left(\mathcal{I}f\right)^2} \frac{\zeta (1-\alpha) mc}{\Pi^* \left(1 - \frac{\zeta}{\Pi^*}\right)(1 - \lambda \Upsilon (\varpi_o))} \frac{1}{\left[\frac{\Gamma(\varpi_o) - \lambda \Upsilon(\varpi_o)}{\mu} \frac{1}{mc} - 1\right]} C = A_2 C \tag{57}$$

Where $A_2 = \frac{a}{w(\mathcal{I}f)^2} \frac{\zeta(1-\alpha)mc}{\Pi^*(1-\frac{\zeta}{\Pi^*})(1-\lambda\Upsilon(\varpi_o))} \frac{1}{\left[\frac{\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)}{\mu}\frac{1}{mc}-1\right]}$

Therefore

$$C = \left(\frac{A_1}{A_2}\right)^{\frac{1}{1+\frac{\delta}{\nu}}} \tag{58}$$

Once consumption is determined all the rest of the variables are uniquely pinned down.

3.2 The log-linear approximation

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. The model outlined here can be approximated by 10 structural equations[22].

1. The equation for home prices is a typical hybrid Neo-Keynesian Phillips curve with past and expected next-period inflation. It also depends positively on the real exchange rate and the wholesale real price (See Section B.1 in Appendix B)

$$\widehat{\Pi}_{h,t} = (1-B_1)\widehat{\Pi}_{h,t-1} + B_1 E_t[\widehat{\Pi}_{h,t+1}] + B_2\widehat{S}_t^w + B_3\widehat{Q}_t \tag{59}$$

   Where:

$$\begin{aligned} B_1 &= \frac{\beta}{1+\beta} > 0 \\ B_2 &= \frac{1}{1+\beta}\frac{1-\gamma}{\gamma}(1-\gamma\beta) > 0 \\ B_3 &= \frac{\alpha}{1-\alpha}B_2 > 0 \end{aligned}$$

   The wholesale real price $\widehat{S}_t^w$ represents the marginal cost the retailer has to face. This wholesale real price is affected by agency costs as we later see in [65]. The extent of how $\widehat{S}_t^w$ affects home inflation is determined by the parameter B_2. When the degree of price stickiness γ is small (more firms can adjust their prices in every period) then B_2 tends to be large and therefore home inflation is more responsive to changes in $\widehat{S}_t^w$.

   The real exchange $\widehat{Q}_t$ appears in the equation because it affects the pricing decisions of those retailers that can optimally choose new prices in period t. An increase in $\widehat{Q}_t$ 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 the pass-through coefficient. Note that the pass-through coefficient is positively related to the degree of openness α but it is negatively related to the degree of price stickiness γ.

2. The aggregate consumption equation is the standard log-linearised form of the consumption Euler equation [10]. Movements in the nominal policy rate $\widehat{\mathcal{I}}_t$, insofar as they produce similar movements in the real interest rate[23], affect consumption directly via the intertemporal elasticity of consumption substitution δ^{-1}. A higher value of δ^{-1} makes aggregate consumption more reactive to changes in nominal interest rates

$$\widehat{C}_t = E_t\left[\widehat{C}_{t+1}\right] - \frac{1}{\delta}\left(\widehat{\mathcal{I}}_t - E_t\left[\widehat{\Pi}_{t+1}\right]\right) \tag{60}$$

[22] See Appendix B for the derivation of the structural equations.

[23] Note that [60] can be solved forward:

$$\widehat{C}_t = \lim_{s\to\infty} E_t\left[\widehat{C}_{t+s}\right] - \frac{1}{\delta}E_t\left[\sum_{s=0}^{\infty}\left(\widehat{\mathcal{I}}_{t+s} - \widehat{\Pi}_{t+s+1}\right)\right]$$

From here we can define the long-run real interest as: $\mathcal{R}_t^{lr} = E_t\left[\sum_{s=0}^{\infty}\left(\widehat{\mathcal{I}}_{t+s} - \widehat{\Pi}_{t+s+1}\right)\right]$. Then $\widehat{C}_t = -\frac{1}{\delta}\mathcal{R}_t^{lr}$ i.e consumption is affected only to the extent that $\mathcal{R}_t^{lr}$ is affected.

3. The policy rate set by the monetary authority has a simple log-linear form (See Appendix B). It is a weighted average of persistent and systematic behavior. We describe the systematic behavior as interest rates reacting to two possible components. The way these components are weighted characterise the types of policy regime under analysis. For example, a *strict CPI inflation* targeter is obtained by setting $\chi_{\pi h} = \chi_\pi > 0$ and $\chi_y = 0$ and a *flexible inflation* targeter is obtained by setting $\chi_{\pi h} = \chi_\pi > 0$ with $\chi_y > 0$.

$$\widehat{\mathcal{I}}_t = \rho \widehat{\mathcal{I}}_{t-1} + (1-\rho)\left[\chi_{\pi h} E_t[\widehat{\Pi}_{h,t+1}] + (\frac{\alpha}{1-\alpha})\chi_\pi(\widehat{Q}_t - \widehat{Q}_{t-1}) + \chi_y \widehat{C}_{h,t}\right] + \xi_t^m \quad (61)$$

4. From the non-arbitrage condition between peso and dollar interest rates we obtain the following equality

$$\widehat{\mathcal{I}}_t = E_t[\widehat{\mathcal{E}}_{t+1}] - \widehat{\mathcal{E}}_t + \widehat{\mathcal{I}}_t^f \quad (62)$$

This is the standard uncovered interest parity condition. This equation governs the nominal exchange rate dynamics[24]

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

$$\widehat{Q}_t - \widehat{Q}_{t-1} = \widehat{\mathcal{E}}_t - \widehat{\mathcal{E}}_{t-1} + (\widehat{\Pi}_t^* - \widehat{\Pi}_t) \quad (63)$$

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

$$\widehat{\Pi}_t = \widehat{\Pi}_{h,t} + \frac{\alpha}{1-\alpha}\left(\widehat{Q}_t - \widehat{Q}_{t-1}\right) \quad (64)$$

7. The wholesale real price $\widehat{S}_t^w$ depends on two broad terms, the first term in braces represents the real marginal costs the wholesale producer would face in the absence of agency costs. The second term in braces 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 terms represents the "peso" financial cost of hiring labor. The second term is the "dollar" financial cost. Monetary policy has direct and indirect effects on the real wholesale price: the direct effect stems from the fact that a rise in $\widehat{\mathcal{I}}_t$ affects marginal costs and hence inflation positively through the parameter a which measures the weight of domestic factors in production, the indirect effects are manifold. Monetary

[24] Note that [62] can be solved forward to get $\widehat{\mathcal{E}}_t = \lim_{i\to\infty} E_t\left[\widehat{\mathcal{E}}_{t+s}\right] - E_t\left[\sum_{s=0}^{\infty}\left(\widehat{\mathcal{I}}_{t+s} - \widehat{\mathcal{I}}_{t+s}^f\right)\right]$

policy affect $\widehat{S}_t^w$ through its effect on real wages ($\widehat{w}_t$), the real exchange rate ($\widehat{Q}_t$) and the benchmark idiosyncratic productivity level ($\widehat{\varpi}_{o,t}$).

$$\widehat{S}_t^w = \left[a(\widehat{\mathcal{I}}_t + \widehat{w}_t) + (1-a)(\widehat{Q}_t + \widehat{\mathcal{I}}_t^f) - \widehat{A}_t\right] + \frac{H_2}{H_1}\varpi_o\widehat{\varpi}_{o,t} \tag{65}$$

Where the two parameters H_1 and H_2 depend on steady-state levels of ϖ_o and mc

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

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

The effect of variations in the cutoff level $\widehat{\varpi}_{o,t}$ upon the real price $\widehat{S}_t^w$ depends on the magnitude of H_1 and H_2 which in turn depends on the specific parameterisation of the probabilistic process for idiosyncratic productivity ϖ. In the solution, the special case of a uniform distribution for ϖ is considered.

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

$$\widehat{w}_t = \frac{\nu}{1+\nu}\widehat{l}_{h,t} + \frac{\delta}{1+\nu}\widehat{C}_t \tag{66}$$

If ν is large (i.e. the elasticity of intertemporal elasticity of substitution 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 [17] in log-linearised form. Real peso loans are increasing in the amount of reserves that banks need to hold. 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.

$$\begin{aligned}\widehat{l}_{h,t} = (\tfrac{\mathcal{I}^f}{\mathcal{I}^f-1})\left[A_{DR}\widehat{\mathcal{I}}_t^f + (1-A_{DR})\widehat{\mathcal{I}}_t\right] + (1-A_{DR})\widehat{d}_t + A_{DR}(\widehat{Q}_t + \widehat{b}_t + \tfrac{b_t^*}{b}) + \ldots \\ + \tfrac{A_{DR}}{\varsigma(\mathcal{I}^f-1)}(\widehat{\mathcal{E}}_t - E_{t-1}\widehat{\mathcal{E}}_t) - A_{DR}\widehat{\Pi}_t^* - (1-A_{DR})\widehat{\Pi}_t - \widehat{\mathcal{I}}_t - H_3\widehat{\varpi}_{o,t}\end{aligned} \tag{67}$$

Where $A_{DR} = \frac{b}{d+b}$ and $H_3 = \left(\frac{[\Gamma'(\varpi)-\lambda\Upsilon'(\varpi)](\frac{S^w}{mc})}{G_1/mc-1} + \frac{G_1/mc}{G_1/mc-1}\frac{H_2}{H_1}\right)\varpi_o$. In turn, equilibrium loans denominated in dollars is given by

$$\widehat{l}_{f,t} = \widehat{l}_{h,t} + \widehat{\mathcal{I}}_t - \widehat{Q}_t - \widehat{\mathcal{I}}_t^f \tag{68}$$

This equation results from the Cobb-Douglas specification of the production function. Additionally, the supply of both peso and dollar-denominated loans is linked to the evolution of both denomination of deposits

$$\widehat{l}_{h,t} = \left(\frac{1}{1-\zeta/\Pi^*}\right)\widehat{d}_{t+1} + \left(\frac{1}{1-\zeta/\Pi^*}\right)\frac{\Delta m_{b,t}}{d} - \left(\frac{\zeta/\Pi^*}{1-\zeta/\Pi^*}\right)\left(\widehat{d}_t - \widehat{\Pi}_t\right) \tag{69}$$

$$\widehat{l}_{f,t} = \left(\frac{1}{1-\zeta/\Pi^*}\right)\widehat{b}_{t+1} + \left(\frac{1}{1-\zeta/\Pi^*}\right)\frac{b^*_{t+1}}{b} - \left(\frac{\zeta/\Pi^*}{1-\zeta/\Pi^*}\right)\left(\widehat{b}_t + \frac{b^*_t}{b} - \widehat{\Pi}^*_t\right) \tag{70}$$

We observe for example that the policy rate has two type of effects: It will tend to reduce peso loans as the cost of peso funds increases. However, the increase in the peso cost of funds 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

$$J\left(\widehat{l}_{h,t} + \widehat{\mathcal{I}}_t - \widehat{Q}_t - \widehat{\mathcal{I}}^f_t - \frac{1}{b}b^*_{t+1}\right) = \eta C_f \widehat{Q}_t - C_f \widehat{C}_t - \frac{1}{\beta}b^*_t + Y_f \widehat{Y}_{f,t} \tag{71}$$

Solution procedure

The system of linear expectational difference equations [59] to [71] summarises the dynamics of the model which can be solved numerically for given values of the deep parameters. In order to perform the solution exercise we resort to a standard solution algorithm[25]. First we define a set of endogenous state variables grouped in the vector $\mathcal{Y}_t$

$$\mathcal{Y}_t = \left[\begin{array}{cccccccccccccc} \widehat{C}_t & \widehat{\Pi}_t & \widehat{\Pi}_{h,t} & \widehat{\mathcal{I}}_t & \widehat{\mathcal{E}}_t & \widehat{Q}_t & \widehat{l}_{h,t} & \widehat{l}_{f,t} & \widehat{S}^w_t & \widehat{\varpi}_{o,t} & \widehat{w}_t & \widehat{d}_{t+1} & \widehat{b}_{t+1} & \widehat{i}^*_t & \widehat{b}^*_{t+1} \end{array}\right]^t$$

The solutions will depend on a vector of predetermined state variables called $\mathcal{X}_t$ and a vector of exogenous variables $\mathcal{Z}_t$ which are defined respectively as

$$\mathcal{X}_t = \left[\begin{array}{ccccccccc} \widehat{Q}_{t-1} & \widehat{\Pi}_{h,t-1} & \widehat{\mathcal{E}}_{t-1} & \widehat{\mathcal{I}}_{t-1} & E_t(\widehat{\mathcal{E}}_{t-1}) & \widehat{i}^*_{t-1} & \widehat{b}^*_t & \widehat{b}_t & \widehat{d}_t \end{array}\right]^t$$

$$\mathcal{Z}_t = \left[\begin{array}{ccccccc} \widehat{A}_t & \xi^i_t & \widehat{\Pi}^*_t & \widehat{Y}_{f,t} & \xi^{i^*}_t & \xi^{b^*}_t & \xi^{\Delta mb}_t \end{array}\right]^t$$

The system can be written in compact form as:

$$AE_t\left[\begin{array}{c} \Upsilon_{t+1} \\ K_{t+1} \end{array}\right] = B\left(\begin{array}{c} \Upsilon_t \\ K_t \end{array}\right) + C\mathcal{Z}_t \tag{72}$$

[25]We use the algorithm described in Klein (2000)

$$\mathcal{Z}_{t+1} = \Theta \mathcal{Z}_t + U_{t+1} \quad (73)$$

The solution is given in a state-space representation where the predetermined state variables are updated according to:

$$\begin{pmatrix} K_{t+1} \\ \mathcal{Z}_{t+1} \end{pmatrix} = \begin{pmatrix} P & Q \\ 0 & \Phi \end{pmatrix} \begin{pmatrix} K_t \\ \mathcal{Z}_t \end{pmatrix} + \begin{pmatrix} 0 \\ U_{t+1} \end{pmatrix} \quad (74)$$

And the endogenous state is observed according to:

$$\Upsilon_t = \begin{pmatrix} M & N \end{pmatrix} \begin{pmatrix} K_t \\ \mathcal{Z}_t \end{pmatrix} \quad (75)$$

3.3 Calibration of model parameters

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 tries to portrait.
Parameters describing household preferences:

- The subjective discount factor β 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 the 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 however relatively high and reflects the idea that labor demand might be more responsive to wages in these type of economies.

- 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 difficult to substitute consumption of foreign goods by that of home goods.

- The elasticity of substitution across the different varieties of home goods is set to be $\theta = 11$. This value is consistent with a steady-state mark-up of 10%[26]

- The proportion of foreign consumption out of total consumption in steady state is given by the parameter α. This parameter is set to $\alpha = 0.25$ as Céspedes et.al (2001).

[26] Recall that the mark-up is expressed in terms of that elasticity $\mu = \frac{\theta}{\theta - 1}$

Parameters describing the production technology

- Production scale parameter $A = 1$
- 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 p.d.f $\phi(\varpi) = \frac{1}{2\Delta}$ and a c.d.f given by $\Phi(\varpi) = \frac{1}{2\Delta}(\varpi - 1 + \Delta)$, with $\Delta = 0.5$.

Parameter describing the institutional restriction on price setting

- The probability that an individual firm does not change its price at any date is γ 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, namely, 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:
  Strict CPI inflation: $\chi_{\pi h} = \chi_{\pi} = 1.5$ and $\chi_y = 0$.
  Flexible inflation targeting: $\chi_{\pi h} = \chi_{\pi} = 1.5$ with $\chi_y = 0.5$

Parameters describing the foreign nominal variables

- The US steady-state inflation rate is set to be 2% per year, which means that $\Pi^* = 1 + 0.02/4$
- The mean US nominal interest rate is considered to be 6% per year (given a real rate of 4% and an inflation rate of 2%). Hence $\mathcal{I}^* = 1 + 0.06/4$

Parameters describing financial conditions Financial conditions depend heavily on two parameters; monitoring costs as a proportion λ of the size of borrowers production and the reserve requirement ration ζ. The value of these two parameters are likely to be high in emerging market economies and they should be such that the steady-state lending interest rate results in reasonable values. Hence, we set this values to $\lambda = 0.2$ 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 contained in the vector $\mathcal{Z}_t$ follow an AR(1) representation. The respective AR(1) coefficients and standard deviations are grossly estimated from data. We do not report the specific values here.

A Note about the steady-state solution: The calibrated parameters allows us to determine a steady-state solution shown in Table [1]. We can note that the probability of default in steady-state is as high as 78 percent. We reckon that this number is not realistic.

Real quantitites		
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	ω_b	0.003
From wholesale producers	ω_{wh}	0.014
From retailers	ω_r	0.051
From tradable production	ω_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	ω_0	1.281
Lending rate	$\mathcal{I}$	1.165
Probability of default	PD	0.781
Failure rate	h	1.141

Table 1. *Steady-state values*

4 The Agency Cost Channel and the Phillips Curve

We analyse the responses of the model economy to three types of shocks relevant to an emerging market economy; an aggregate productivity shock, a dollar interest rate shock and a commodity production shock. We compare these shocks under two possible types of monetary policy regimes; *strict CPI-inflation* (CIT) and *flexible inflation targeting* regimes (FIT).

A key feature that emerges from our set up is the 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. The good news is that financial intermediaries also hold assets denominated in both currencies and that they have agreed on loan contracts stipulating that loan quantities are adjusted in the same direction as movements in their liabilities[27]. However, the amount of loans offered cannot quickly jump to recoup capital losses, the variable that does adjust quickly is the cutoff productivity value[28] that determines the shares of production that goes to both borrowers and financial intermediaries. An increase in the cutoff value due associated to a an unexpected depreciation is built in the structure of the contract as an equilibrium outcome; firms that did not default are better off even though they have a small proportion of the cake because they were able to produce more and financial intermediaries are not worse off because they 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.

4.1 A positive aggregate productivity shock

When a positive aggregate productivity shock hits the economy (See figures [4] and [7]) the standard result is that the marginal cost of producers firms, producer prices and final goods inflation all 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 ia a increase in the share of wholesale production that goes to producers (efficiency) and a reduction in the share of wholesale production that goes to banks (inefficiency). The increase in the share that goes to wholesale producers works as an incentive mechanism to produce more.

In our setup, the presence of agency costs magnifies standard effects of productivity shocks. However, the policy rules in place offset the agency cost effects by smoothing exchange rate fluctuations.Under both the CIT and FIT regimes there is a concern for smoothing real exchange rate deviations per se and not to use it as an offsetting device. This implies that disinflationary pressures brought about by a positive productivity shock are absorbed by a nominal exchange rate appreciation [see equation 63].

[27]See equation [67].

[28]The cutoff productivity value moves in the same direction of the lending rate and the probability of default.

4.2 A Commodity Production Shock

A positive shock to commodity production triggers various effects in this economy. The most notorious effect of this windfall production of the exportable commodity is the increase in the demand for imports (intermediate goods). 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 thus, the marginal cost of wholesale production is higher (see figures [5] and [8]).

The increase in marginal cost is tied to the increase in the cutoff value ω_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 which will mean more inflation.

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.

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

4.3 A Dollar Interest Rate Shock

An increase in the dollar interest rate has a standard effect of causing a spot depreciation of the nominal exchange rate which generates an unexpected depreciation. Also, this increases the cost of funds and therefore marginal costs rise (see figures [6] and [9]) prompting domestic production of wholesale and retail goods to diminish just like an aggregate negative productivity shock.

The increase in the dollar interest rate induces more real savings in dollar denominated assets 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, an increase in the dollar interest rate rises both types of credit due to the increased availability of loanable funds that dominates the negative effects of higher cost of credit.

The conventional view and recent experience with ultra low dollar interest rates is contrary to the effects show in this model economy. According to the recent experience, a reduction in the dollar interest rate does increase credit levels. However, the source of this dollar interest rate reduction observed in the data is a overwhelming expansion of dollar 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.

5 Concluding Remarks

The model presented in this paper tries to capture 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 optimising behavior of agents.

The key mechanism captured in the model is that unexpected nominal exchange rate depreciations are closely linked with the probability of default by borrower 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 three possible inflation targeting regimes; a strict *home-inflation targeting* (HIT), a strict *CPI-inflation targeting* (CIT) and a *flexible inflation targeting* (FIT). The core mechanism in the HIT regime is the use of the real exchange rate as a marginal cost stabilising devise in order to smooth home inflation deviations. The CIT and FIT regimes are defined such that the concern about real exchange rate fluctuations are built within the structure of the equilibrium. In order to assess three regimes we analyse three types of shocks dominant in emerging market economies; an aggregate non-tradeable productivity shock, a shock to the dollar interest rate and a tradeable commodity production shock. As is standard in these evaluations, the HIT regime renders in small inflation fluctuations at the cost of higher real exchange rate and consumption fluctuations whereas the CIT and FIT regimes produce the converse results. 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 absolute concern about the financial health of firms; namely, firms defaults produce no further costs to society other than the liquidation costs that financial firms have to incur. In reality, a firms defaults or a potential systemic failure are seen as a fundamental threat to central bankers. Further research is necessary to seek for monetary policy regimes that take into account a loss function for the monetary authority that considers for example financial stability aspects in addition to the usual inflation and real activity concerns.

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Appendix

A Optimal decisions

A.1 Households

Given the reward function and the budget constraint outlined in the main text, the households problem can be expressed as

$$V(D_t, B_t) = \underset{\{C_t, N_t, B_{t+1}\}}{Max} \left\{ \frac{C_t^{1-\delta} - 1}{1-\delta} - \frac{N_t^{1+\nu} - 1}{1+\nu} + \beta E_t \left[V(D_{t+1}, B_{t+1}) \right] \right\}$$

Where

$$D_{t+1} = -\mathcal{E}_t B_{t+1} + \mathcal{I}_{t-1} D_t + \mathcal{E}_t \mathcal{I}_{t-1}^f B_t + (\mathcal{E}_t - E_{t-1}\mathcal{E}_t) B_t + W_t N_t - P_t C_t + \Omega_t$$

The standard optimality conditions are:

Consumption	:	$C_t^{-\delta} = \beta E_t \left[V_{D_{t+1}} P_t \right]$
Labor supply	:	$N_t^{\nu} = \beta E_t \left[V_{D_{t+1}} W_t \right]$
Nominal dollar deposits	:	$E_t V_{B_{t+1}} = \mathcal{E}_t E_t V_{D_{t+1}}$
Envelope Theorems:	:	$V_{D_t} = \beta E_t \left[V_{D_{t+1}} \mathcal{I}_{t-1} \right]$
		$V_{B_t} = \beta E_t \left[V_{D_{t+1}} \left\{ \mathcal{I}_{t-1}^f \mathcal{E}_t + (\mathcal{E}_t - E_{t-1}\mathcal{E}_t) \right\} \right]$

Combining the equation for nominal dollar deposits and envelope theorems:

$$E_t \left[V_{D_{t+2}} \left(\mathcal{I}_t - \left\{ \mathcal{I}_t^f \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} + \frac{(\mathcal{E}_{t+1} - E_t \mathcal{E}_{t+1})}{\mathcal{E}_t} \right\} \right) \right] = 0$$

Knowing that $\mathcal{I}_t$ and $\mathcal{I}_t^f$ are known as of time t, then after some algebraic manipulation:

$$\frac{1}{\beta^2} \frac{C_t^{-\delta}}{P_t} E_t \left[\mathcal{I}_t - \left\{ \mathcal{I}_t^f \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} + \frac{(\mathcal{E}_{t+1} - E_t \mathcal{E}_{t+1})}{\mathcal{E}_t} \right\} \right] = 0$$

Hence we get the standard UIP condition:

$$\mathcal{I}_t = \mathcal{I}_t^f \frac{E_t [\mathcal{E}_{t+1}]}{\mathcal{E}_t}$$

Likewise, we derive equations [10] and [12] appearing in the main text

A.2 Financial intermediaries, firms and financial contracting

First, we define the expected return level to the financial intermediary and firms. We abstract from time and firm subscripts. We also note that $\phi(\varpi)$ is the density function and $\Phi(\varpi)$ is the cumulative distribution function

Expected return to the financial intermediary

$$ER_{fint} = \int_{\varpi_o}^{\varpi_u} \widetilde{\mathcal{I}}\Big[L_h + \mathcal{E}L_f\Big]\phi(\varpi)d\varpi + ...$$
$$\int_{\varpi_l}^{\varpi_o} G\varpi L_h^a L_f^{1-a}\phi(\varpi)d\varpi - \lambda \int_{\varpi_l}^{\varpi_o} \varpi G L_h^a L_f^{1-a}\phi(\varpi)d\varpi \geq X$$

In the problem outlined in the text, we specify

$$G\varpi_o L_h^a L_f^{1-a} = \widetilde{\mathcal{I}}\Big(L_h + \mathcal{E}L_f\Big)$$

Then

$$ER_{fint} = GL_h^a L_f^{1-a}\left[\int_{\varpi_o}^{\varpi_u} \varpi_o\phi(\varpi)d\varpi + \int_{\varpi_l}^{\varpi_o} \varpi\phi(\varpi)d\varpi - \lambda\int_{\varpi_l}^{\varpi_o} \varpi\phi(\varpi)d\varpi\right]$$

We make the following definitions:
Definition 1:
$\Gamma(\varpi_o)$ is the gross share of output that goes to the financial intermediary $\Gamma(\varpi_o) = \varpi_o\int_{\varpi_o}^{\varpi_u}\phi(\varpi)d\varpi + \int_{\varpi_l}^{\varpi_o}\varpi\phi(\varpi)d\varpi$. This share $\Gamma(\varpi_o)$ has the following features:

- It is increasing in $\varpi_o : \Gamma'(\varpi_{o,t}) = 1 - \Phi(\varpi_{o,t}) > 0$
- $\Phi(\varpi_{o,t})$ represents the default probability

Definition 2:
$\lambda\Upsilon(\varpi_o)$ is the expected monitoring cost. $\lambda\Upsilon(\varpi_o) = \lambda\int_{\varpi_l}^{\varpi_o}\varpi\phi(\varpi)d\varpi$
It is increasing in $\varpi_o : \lambda\Upsilon'(\varpi_{o,t}) = \lambda\varpi_0\phi(\varpi_{o,t}) > 0$
And by definition: $0 < \Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o) < 1 - \lambda$
Definition 3:
$h(\varpi_o)$ is the firm's failure (or hazard) rate defined as $h(\varpi) = \frac{\phi(\varpi)}{1-\Phi(\varpi)}$
Using these definitions, we can define the expected return to the financial intermediary as

$$ER_{fint} = [\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\, GL_h^a L_f^{1-a}$$

Expected returns to the firm

$$ER_{firm} = \int_{\varpi_o}^{\varpi_u} G\varpi L_h^a L_f^{1-a}\phi(\varpi)d\varpi - \int_{\varpi_o}^{\varpi_u}\widetilde{\mathcal{I}}\Big(L_h + \mathcal{E}L_f\Big)\phi(\varpi)d\varpi$$

Applying the definition of $\widetilde{\mathcal{I}}\Big(L_h + \mathcal{E}L_f\Big)$

$$ER_{firm} = \left[\int_{\varpi_o}^{\varpi_u}\varpi\phi(\varpi)d\varpi - \varpi_o\int_{\varpi_o}^{\varpi_u}\phi(\varpi)d\varpi\right]GL_h^a L_f^{1-a}$$

Using the same notation as above

$$ER_{firm} = [1 - \Gamma(\varpi_{o,t})]\, G_t L_{h,t}^{a} L_{f,t}^{1-a}$$

This expressions for expected returns allows us to formulate the problem in compact form in the main text

The solution in the general case

The Lagrangian function for problem [20] in the main text, with associated multiplier ψ is

$$\begin{aligned}\mathcal{L}\left(L_h, L_f, \varpi_o, \psi\right) &= [1-\Gamma(\varpi_o)]\, G L_h^a L_f^{1-a} + \\ &\quad \psi\left[X - [\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\, G L_h^a L_f^{1-a} - \zeta\,[D + \mathcal{E}\,(B + B^{*})]\right]\end{aligned} \tag{76}$$

The f.o.c's are

$$\{1-\Gamma(\varpi_o) - \psi\,[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\}\, Ga \frac{L_h^a L_f^{1-a}}{L_h} + \psi\mathcal{I} = 0 \tag{a2}$$

$$\{[1-\Gamma(\varpi_o)] - \psi\,[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\}\,(1-a)\, G \frac{L_h^a L_f^{1-a}}{L_f} + \psi\mathcal{E}\mathcal{I}^f = 0 \tag{a3}$$

$$[-\Gamma'(\varpi_o) - \psi\,(\Gamma'(\varpi_o) - \lambda\Upsilon'(\varpi_o))]\, G L_h^a L_f^{1-a} = 0 \tag{a4}$$

$$-[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]\, G L_h^a L_f^{1-a} + \mathcal{I}L_h + \mathcal{E}\mathcal{I}^f L_f + \zeta\left[(I-1)D + \mathcal{E}(I^f - 1)\,(B+B^{*})\right] + (\mathcal{E} - E_{-1}\mathcal{E})\,(B+B^{*}) = 0 \tag{a5}$$

From [a4] we can solve for the equilibrium value of ψ in terms of the cutoff value ϖ_o

$$\psi^e = \frac{\Gamma'(\varpi_o)}{\lambda\Upsilon'(\varpi_o) - \Gamma'(\varpi_o)} \tag{a6}$$

Provided $\psi > 0$, we divide [a3] from [a2]:

$$\frac{a}{(1-a)} \frac{L_f}{L_h} = \frac{\mathcal{I}}{\mathcal{E}\mathcal{I}^f}$$

This allows to express both the unconditionally expected product and loan repayment in terms of L_h only

$$G L_h^a L_f^{1-a} = G\left(\frac{1-a}{a}\right)^{1-a} \left(\frac{\mathcal{I}}{\mathcal{E}\mathcal{I}^f}\right)^{1-a} L_h$$

$$\left(\mathcal{I}L_h + \mathcal{E}\mathcal{I}^f L_f\right) = \frac{1}{a}\mathcal{I}L_h$$

Also, we make the following definition

Definition 4:

The marginal cost of the wholesale firm for producing one unit of its good in the absence of agency costs is defined as:

$mc = \frac{\Lambda}{A}(\mathcal{I}w)^a \left(Q\mathcal{I}^f\right)^{1-a}$ with $\Lambda = \left(\frac{1}{a}\right)^a \left(\frac{1}{1-a}\right)^{1-a}$

We replace these expressions in [a2] or [a3] (actually one of them is redundant) to get

$$\psi^e = \frac{[1-\Gamma(\varpi_o)]\left(\frac{S^w}{mc}\right)}{[\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)]\left(\frac{S^w}{mc}\right)-1} \tag{a7}$$

In order to characterise the solution, we make the following assumptions:

Assumption 1: $1 < \left(\frac{S^w}{mc}\right) < \frac{1}{1-\lambda}$

Assumption 2: We assume that $\varpi h(\varpi)$ is increasing in ϖ.

Solution in the case ϖ follows a uniform distribution

In this case we have: $\phi(\varpi) = \frac{1}{2\Delta}$ and $\Phi(\varpi) = \frac{1}{2\Delta}(\varpi - 1 + \Delta)$ with $\varpi \in [1-\Delta, 1+\Delta]$. The expressions for $\Gamma(\varpi_o)$ and $\lambda\Upsilon(\varpi_o)$ are given respectively by $\Gamma(\varpi_o) = \frac{1}{2\Delta}\varpi_o(1+\Delta) - \frac{\varpi_o^2}{4\Delta} - \frac{(1-\Delta)^2}{4\Delta}$ and $\lambda\Upsilon(\varpi_o) = \lambda\frac{1}{4\Delta}\left(\varpi_o^2 - (1-\Delta)^2\right)$

The derivatives of the above two functions are given by

$\Gamma'(\varpi_o) = \frac{1}{2\Delta}[1+\Delta-\varpi_o]$ and $\lambda\Upsilon'(\varpi_o) = \lambda\frac{1}{2\Delta}\varpi_o$

Hence, $\Gamma'(\varpi_o) - \lambda\Upsilon'(\varpi_o) = \frac{1}{2\Delta}[1+\Delta-(1+\lambda)\varpi_o]$

Using these definitions, the corresponding expressions for the Lagrangian multiplier as outlined in [a6] and [a7] are

$$\psi^e = \frac{1+\Delta-\varpi_o}{\varpi_o(1+\lambda)-1-\Delta} \tag{a8}$$

$$\psi^e = \frac{[1-\Gamma(\varpi_o)]\left(\frac{S^w}{mc}\right)}{[\Gamma(\varpi_o)-\lambda\Upsilon(\varpi_o)]\left(\frac{S^w}{mc}\right)-1} \tag{a9}$$

From the budget constraint of financial intermediaries

we calculate the transfers

$$\omega_t^b = \mathcal{I}_t d_{t+1} + Q_t\mathcal{I}_t^f\left(b_{t+1}+b_{t+1}^*\right) - \frac{\mathcal{I}_{t-1}}{\Pi_t}d_t - Q_t\frac{\mathcal{I}_{t-1}^f}{\Pi_t^*}\left(b_t+b_t^*\right) \tag{a10}$$

Budget constraint of wholesale producers

$$\omega_t^h = [1-\Gamma(\varpi_{o,t})]\,S_t^w Y_{h,t} \tag{a11}$$

A.3 Tradeable production and retailers

Export producer firms: They produce the exogenous exportable good $Y_{f,t}$ at zero cost, hence the profits generated are given by: $\Omega_t^f = P_{f,t} Y_{f,t}$. These profits are transferred to households. In real terms we express this transfers as

$$\omega_t^f = Q_t Y_{f,t} \tag{a12}$$

It is assumed that this exportable output follows is i.i.d: $Y_{f,t} \sim N(Y_f, \sigma_{yf}^2)$

Retailers Production of retailers is lower than the expected production of wholesalers due to agency costs

$$\widetilde{Y}_{h,t} = [1 - \lambda \Upsilon(\varpi_{o,t})] Y_{h,t} \tag{a13}$$

Transfers to households

$$\omega_t^r = (S_t - S_t^w)[1 - \lambda \Upsilon(\varpi_{o,t})] Y_{h,t} \tag{a14}$$

B The Log-linearised approximation to the dynamical system

B.1 The Phillips Curve

In this appendix we log-linearise the optimal pricing decision of the firm (equation [32] in the main text) and express it in terms of the percentage deviations of the home price inflation. There are two logical steps in this log-linearisation. First, using the definition of the home price index, we derive a relationship between the home price inflation and the optimal home price ratio, second using the optimality condition [32] we find an equation for the optimal price ratio

First Step

From the definition of the home price index $P_{h,t}$ in equation [9] under the assumed indexation scheme, we can arrive at the following relationship:

$$\widehat{\Pi}_{h,t} = \widehat{\Pi}_{h,t-1} + \frac{1-\gamma}{\gamma}\left[\widehat{\rho}_{h,t}^{op} + \frac{\alpha}{1-\alpha}\widehat{Q}_t\right] \tag{b1}$$

There is a positive relationship between deviations of the optimal price ratio and deviations of current home inflation. A raise in $\widehat{\rho}_{h,t}^{op}$ produces a similar reaction in the domestic price index (and hence it affects home price inflation in the same way). Also, as the domestic price index increases, so does the total consumer price index and hence, the real exchange rate falls for given nominal exchange rates and foreign prices. The increase in both $\widehat{\rho}_{h,t}^{op}$ and $\widehat{\Pi}_{h,t}$, together with the fall in $\widehat{Q}_t$ are governed by equation [b1] just derived. If the probability γ is on the vicinity of 1, then the desired optimal price has a small effect on both domestic inflation and real exchange rates. On the contrary, when γ is close to zero, optimal price changes are strongly transmitted to domestic prices and to the consumer price index.

The sensitivity to the real exchange rate strongly depends on the degree of openness of the economy (α); when α is low the economy puts little weight on foreign goods consumption and therefore purely domestic price changes have a strong impact over total CPI which at the same time implies larger changes in the real exchange rate. Thus, it seems that low backward-lookingness (high forward-lookingness, i.e.γ low) of price setters and an economy relatively closed (α) is associated with strong real exchange rate movements in response of the set of factors that affect optimal price setting decisions.

Second Step

Taking the optimisation condition of firms:

$$\begin{aligned} & E_t\left[\sum_{k=0}^{\infty}(\gamma\beta)^k \frac{U_c(C_{t+k})}{P_{t+k}}\left(\frac{P_{h,t+k}}{\left[\frac{P_{h,t-1+k}}{P_{h,t-1}}\right]P_{h,t}^{op}}\right)^{\theta}\left[\frac{P_{h,t-1+k}}{P_{h,t-1}}\right]P_{h,t}^{op}C_{h,t+k}\right] \\ = \; & E_t\left[\mu\sum_{k=0}^{\infty}(\gamma\beta)^k U_c(C_{t+k})\left(\frac{P_{h,t+k}}{\left[\frac{P_{h,t-1+k}}{P_{h,t-1}}\right]P_{h,t}^{op}}\right)^{\theta} C_{h,t+k}S_{t+k}^{w}\right] \end{aligned}$$

We make the following definitions[29]:

Definition 5:

$$\frac{P_{h,t}^{op}}{P_{t+k}} = \frac{P_t}{P_{t+1}}\frac{P_{t+1}}{P_{t+2}}...\frac{P_{t+k-1}}{P_{t+k}}\frac{P_{h,t}^{op}}{P_t} = \frac{1}{\Pi_{t+1}}\frac{1}{\Pi_{t+2}}...\frac{1}{\Pi_{t+k}}\rho_{h,t}^{op} = \frac{\nu_{h,t}^{op}}{\Pi_{t+1.t+k}}$$

Definition 6:

$$\frac{P_{h,t+k}}{P_{h,t}^{op}} = \frac{P_{h,t+k}}{P_{h,t+k-1}}\frac{P_{h,t+k-1}}{P_{h,t+k-2}}...\frac{P_{h,t+1}}{P_{h,t}}\frac{P_{h,t}/P_t}{P_{h,t}^{op}/P_t} = \Pi_{h,t+k}\Pi_{h,t+k-1}...\Pi_{h,t+1}\frac{S_t}{\rho_{h,t}^{op}} = \Pi_{h,t+1.t+k}\frac{S_t}{\rho_{h,t}^{op}}$$

Definition 7:

$$\frac{P_{h,t+k-1}}{P_{h,t-1}} = \frac{P_{h,t}}{P_{h,t-1}}\frac{P_{h,t+1}}{P_{h,t}}...\frac{P_{h,t+k-1}}{P_{h,t+k-2}} = \Pi_{h,t}\Pi_{h,t+1}...\Pi_{h,t+k-1} = \Pi_{h,t.t+k-1}$$

Then we can write the above optimality condition as:

$$\begin{aligned} & E_t\left[\sum_{k=0}^{\infty}(\gamma\beta)^k U_c(C_{t+k})\left(\frac{\Pi_{h,t+1.t+k}}{\Pi_{h,t.t+k-1}}\frac{S_t}{\rho_{h,t}^{op}}\right)^{\theta}\frac{[\Pi_{h,t.t+k-1}]}{\Pi_{t+1.t+k}}\rho_{h,t}^{op}C_{h,t+k}\right] \\ = \; & E_t\left[\mu\sum_{k=0}^{\infty}(\gamma\beta)^k U_c(C_{t+k})\left(\frac{\Pi_{h,t+1.t+k}}{\Pi_{h,t.t+k-1}}\frac{S_t}{\rho_{h,t}^{op}}\right)^{\theta} C_{h,t+k}S_{t+k}^{w}\right] \end{aligned}$$

[29]Note that $\Pi_{t.t+k}$ represents the cumulative inflation rate from period t to $t+k$.

Working with the term inside the expectation operator in the left hand side of the above equation and calling it LHS_t.

$$LHS_t = \sum_{k=0}^{\infty} (\gamma\beta)^k \, U_c(C_{t+k}) \frac{[\Pi_{h,t.t+k-1}]}{\Pi_{t+1.t+k}} \left(\frac{\Pi_{h,t+1.t+k}}{\Pi_{h,t.t+k-1}} \frac{S_t}{\rho_{h,t}^{op}} \right)^{\theta} \rho_{h,t}^{op} C_{h,t+k}$$

The value of this expression in the deterministic steady state is:

$$LHS = \sum_{k=0}^{\infty} (\gamma\beta)^k \, U_c(C) C_h = \frac{U_c(C) C_h}{1 - \gamma\beta}$$

A similar kind of argument can be applied to expression on the expectation operator in the right hand side:

$$RHS_t = \mu \sum_{k=0}^{\infty} (\gamma\beta)^k \, U_c(C_{t+k}) \left(\frac{\Pi_{h,t+1.t+k}}{\Pi_{h,t.t+k-1}} \frac{S_t}{\rho_{h,t}^{op}} \right)^{\theta} C_{h,t+k} S_{t+k}^{w}$$

In steady state:

$$RHS = \mu \sum_{k=0}^{\infty} (\gamma\beta)^k \, U_c(C) C_h S^w = \frac{\mu U_c(C) C_h S^w}{1 - \gamma\beta}$$

And hence, a standard result emerges:

$$1 = \mu S^w$$

In steady-state monopolistic pricing is embedded in the total domestic price because all firms have monopolistic power. Hence the ratio of optimal domestic prices to overall prices is equal to 1 (the left hand side of the above equation). At the same time, this optimal price ratio has to be equal to a mark-up over marginal cost (the right hand side)

$$\widehat{LHS}_t = (1 - \gamma\beta) \left[\begin{array}{c} \sum_{k=0}^{\infty} (\gamma\beta)^k \left(\widehat{C}_{h,t+k} + \widehat{U}_{c,t+k} \right) + \frac{\left\{ \theta \left(\widehat{S}_t - \widehat{\rho}_{h,t}^{op} \right) + \widehat{\rho}_{h,t}^{op} \right\}}{1 - \gamma\beta} \\ + \sum_{k=1}^{\infty} (\gamma\beta)^k \sum_{j=1}^{k} \left\{ \widehat{\Pi}_{h,t+j-1} - \widehat{\Pi}_{t+j} + \theta \left(\widehat{\Pi}_{h,t+j} - \widehat{\Pi}_{h,t+j-1} \right) \right\} \end{array} \right]$$

$$\widehat{RHS}_t = (1 - \gamma\beta) \left[\begin{array}{c} \sum_{k=0}^{\infty} (\gamma\beta)^k \left(\widehat{U}_{c,t+k} + \widehat{C}_{h,t+k} + \widehat{S_{t+k}^{w}} \right) + \frac{\theta \left(\widehat{S}_t - \widehat{\rho}_{h,t}^{op} \right)}{1 - \gamma\beta} + \\ \sum_{k=1}^{\infty} \left\{ (\gamma\beta)^k \sum_{j=1}^{k} \theta \left(\widehat{\Pi}_{h,t+j} - \widehat{\Pi}_{h,t+j-1} \right) \right\} \end{array} \right]$$

Taking expectations conditional on information at time t both terms and disregarding Jensen's inequality:

$$\frac{\widehat{\rho}_{h,t}^{op}}{1-\gamma\beta} = E_t\left[\sum_{k=0}^{\infty}(\gamma\beta)_{t+k}^{k}\, S_{t+k}^{w}\right] - E_t\left[\sum_{k=1}^{\infty}(\gamma\beta)^{k}\sum_{j=1}^{k}\left(\Pi_{h,t+j-1}-\widehat{\Pi}_{t+j}\right)\right]$$

This is the link between the deviations of the optimal price relative to the overall price index and the expected future values of the real marginal cost and future overall inflation rate differentials

$$\frac{\gamma\beta}{(1-\gamma\beta)}E_t\left[\widehat{\rho}_{h,t+1}^{op}\right] = E_t\left[\sum_{k=0}^{\infty}(\gamma\beta)^{k+1}\,\widehat{S}_{t+k+1}^{w}\right] + E_t\left[\sum_{k=1}^{\infty}(\gamma\beta)^{k+1}\sum_{j=1}^{k}\left(\Pi_{h,t+j}-\widehat{\Pi}_{t+1+j}\right)\right]$$

On the original expression:

$$\frac{1}{(1-\gamma\beta)}\widehat{\rho}_{h,t}^{op} = \widehat{S}_{t}^{w} + E_t\left[\sum_{k=1}^{\infty}(\gamma\beta)^{k}\,\widehat{S}_{t+k}^{w}\right] + E_t\left[\sum_{k=1}^{\infty}(\gamma\beta)^{k}\sum_{j=1}^{k}\left(\Pi_{h,t+j-1}-\widehat{\Pi}_{t+j}\right)\right]$$

Then, summing both last expressions adequately:

$$\widehat{\rho}_{h,t}^{op} = (\gamma\beta)\,E_t\left[\widehat{\rho}_{h,t+1}^{op}\right] + (1-\gamma\beta)\,\widehat{S}_{t}^{w} + (\gamma\beta)\,E_t\left[\widehat{\Pi}_{t+1}-\widehat{\Pi}_{h,t}\right] \tag{b2}$$

Plugging the definition of $\widehat{\rho}_{h,t}^{op}$ found in [b1] and the definition of the overall price index:

$$\widehat{\Pi}_{h,t}-\widehat{\Pi}_{h,t-1} = \beta E_t\left[\widehat{\Pi}_{h,t+1}-\widehat{\Pi}_{h,t}\right] + \frac{1-\gamma}{\gamma}\frac{\alpha(1-\gamma\beta)}{1-\alpha}\widehat{Q}_t + \frac{1-\gamma}{\gamma}(1-\gamma\beta)\,\widehat{S}_{t}^{w}$$

From here:

$$\widehat{\Pi}_{h,t} = \left(\frac{1}{1+\beta}\right)\widehat{\Pi}_{h,t-1} + \left(\frac{\beta}{1+\beta}\right)E_t\left[\widehat{\Pi}_{h,t+1}\right] + \frac{\alpha}{1-\alpha}\frac{1}{(1+\beta)}\frac{1-\gamma}{\gamma}(1-\gamma\beta)\,\widehat{Q}_t + \frac{1}{(1+\beta)}\frac{1-\gamma}{\gamma}(1-\gamma\beta)\,\widehat{S}_{t}^{w}$$

we can get equation [56] in the main text

B.2 Consumption dynamics

Log-linearisation of the Euler equation implies

$$\widehat{C}_t = E_t\left[\widehat{C}_{t+1}\right] - \frac{1}{\delta}\left(\widehat{\mathcal{I}}_t - E_t\left[\widehat{\Pi}_{t+1}\right]\right) \tag{b3}$$

It is straightforward to derive the dynamics of consumption of home and foreign goods

$$\widehat{C}_{h,t} = -\eta \widehat{S}_t + \widehat{C}_t$$

$$\widehat{C}_{f,t} = -\eta \widehat{Q}_t + \widehat{C}_t$$

The real prices $\widehat{S}_t$ and $\widehat{Q}_t$ are related through

$$\widehat{S}_t = -\frac{\alpha}{1-\alpha}\widehat{Q}_t \tag{b4}$$

B.3 Monetary Policy

The rule is described as

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

Replacing the equilibrium condition for home goods

$$\widehat{\widehat{Y}}_{h,t} \equiv \widehat{C}_{h,t} = \frac{\alpha\eta}{1-\alpha}\widehat{Q}_t + \widehat{C}_t$$

Allows us to obtain

$$\widehat{\mathcal{I}}_t = \rho\widehat{\mathcal{I}}_{t-1} + R_\pi E_t\left[\widehat{\Pi}_{h,t+1}\right] + R_q\widehat{Q}_t + R_{q1}\widehat{Q}_{t-1} + R_c\widehat{C}_t + \xi_t^m \tag{b5}$$

Where
$R_\pi = (1-\rho)\chi_{\pi h}$
$R_q = (1-\rho)\left(\chi_y \frac{\alpha\eta}{1-\alpha} + \chi_\pi \frac{\alpha}{1-\alpha}\right)$
$R_{q1} = -(1-\rho)\chi_\pi \frac{\alpha}{1-\alpha}$
$R_c = (1-\rho)\chi_y$

B.4 The wholesale real price

In order to derive the dynamics of the wholesale real price, we need to derive first the equation for the frictionless marginal cost (from A.2 in Appendix A)

$$\widehat{mc}_t = a\left(\widehat{\mathcal{I}}_t + \widehat{w}_t\right) + (1-a)\left(\widehat{Q}_t + \widehat{\mathcal{I}}_t^f\right) - \widehat{A}_t \tag{b6}$$

On the other hand, the relationship between the agency cost mark up S_t^w/mc_t and the cutoff level is given by equations [a6] and [a7] in Appendix A

$$\frac{[1-\Gamma(\varpi_{o,t})]\left(\frac{S_t^w}{mc_t}\right)}{[\Gamma(\varpi_{o,t}) - \lambda\Upsilon(\varpi_{o,t})]\left(\frac{S_t^w}{mc_t}\right) - 1} = \frac{\Gamma'(\varpi_o)}{\lambda\Upsilon'(\varpi_o) - \Gamma'(\varpi_o)}$$

The log-linearisation of the above expression takes the form

$$\widehat{S}_t^w - \widehat{mc}_t = \frac{H_2}{H_1}\varpi_o \widehat{\varpi}_{o,t} \tag{b7}$$

Then:

$$\widehat{S}_t^w = a\left(\widehat{\mathcal{I}}_t + \widehat{w}_t\right) + (1-a)\left(\widehat{Q}_t + \widehat{\mathcal{I}}_t^f\right) - \widehat{A}_t + \frac{H_2}{H_1}\varpi_o \widehat{\varpi}_{o,t} \tag{b8}$$

Where

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

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

In the special case of a uniform distribution for the idiosyncratic shock we have

$\Gamma(\varpi_o) = \frac{1}{2\Delta}\varpi_o(1+\Delta) - \frac{1}{2}\frac{\varpi_o^2}{2\Delta} - \frac{(1-\Delta)^2}{4\Delta}$ $\quad\lambda\Upsilon(\varpi_o) = \lambda\frac{1}{4\Delta}\left(\varpi_o^2 - (1-\Delta)^2\right)$

$\Gamma'(\varpi_o) = \frac{1}{2\Delta}[1+\Delta-\varpi_o]$ $\quad\lambda\Upsilon'(\varpi_o) = \lambda\frac{1}{2\Delta}\varpi_o$

$\Gamma''(\varpi_o) = \frac{-1}{2\Delta}$ $\quad\lambda\Upsilon''(\varpi_o) = \frac{\lambda}{2\Delta}$

We also define the following auxiliary variables $G_1 = [\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]S^w = \frac{[\Gamma(\varpi_o) - \lambda\Upsilon(\varpi_o)]}{\mu}$

$G_2 = 1 - \lambda\Upsilon(\varpi_o)$

B.5 Labor market equilibrium and the real wage rate

The interaction between the labor demand and labor supply gives a market equilibrium representation for wage rates. The supply of labor is

$$\nu\widehat{N}_t + \delta\widehat{C}_t = \widehat{w}_t$$

Labor demand given by

$$\widehat{N}_t = \widehat{l}_{h,t} - \widehat{w}_t$$

Hence

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

B.6 Loans

From the solution for peso loans - equation [25] in the main text - we have

$$l_{h,t} = \frac{ar_{r,t}}{\mathcal{I}_t f_{m,t}}$$

Where, assuming $\zeta_D = \zeta_B = \zeta$ we have

$$r_{r,t} = \zeta\left((\mathcal{I}_t - 1)\frac{d_t}{\Pi_t} + \frac{Q_t}{\Pi_t^*}\left(\mathcal{I}_t^f - 1\right)(b_t + b_t^*)\right) - \left(1 - \frac{E_{t-1}\mathcal{E}_t}{\mathcal{E}_t}\right)\frac{Q_t}{\Pi_t^*}(b_t + b_t^*)$$

And

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

Log-linearisation of the above expressions yields

$$\begin{aligned} \widehat{l_{h,t}} &= \left(\frac{\mathcal{I}^f}{\mathcal{I}^f - 1}\right)\left[A_{DR}\widehat{\mathcal{I}_t^f} + (1 - A_{DR})\widehat{\mathcal{I}_t}\right] + (1 - A_{DR})\widehat{d_t} + A_{DR}\left(\widehat{Q_t} + \widehat{b_t} + \frac{b_t^*}{b}\right) + \ldots \\ &+ \frac{A_{DR}}{\zeta\left(\mathcal{I}^f - 1\right)}\left(\widehat{\mathcal{E}_t} - E_{t-1}\widehat{\mathcal{E}_t}\right) - A_{DR}\widehat{\Pi}_t^* - (1 - A_{DR})\widehat{\Pi}_t - \widehat{\mathcal{I}_t} - \widehat{f}_{m,t} \end{aligned} \quad (77)$$

Where: A_{DR} stands for the asset dollarization ratio
$A_{DR} = \frac{b}{d+b}$ (with $b^* = 0$ in steady state)
The log-linearised form $\widehat{f}_{m,t}$, considering equation [b7] is given by

$$\widehat{f}_{m,t} = \left[\frac{[\Gamma'(\varpi) - \lambda\Upsilon'(\varpi)]\left(\frac{S^w}{mc}\right)}{G_1/mc - 1} + \frac{G_1/mc}{G_1/mc - 1}\frac{H_2}{H_1}\right]\varpi_o\widehat{\varpi}_{o,t} \quad (b10)$$

Plugging equation [b10] into [77]

$$\begin{aligned} \widehat{l_{h,t}} &= \left(\frac{\mathcal{I}^f}{\mathcal{I}^f - 1}\right)\left[A_{DR}\widehat{\mathcal{I}_t^f} + (1 - A_{DR})\widehat{\mathcal{I}_t}\right] + (1 - A_{DR})\widehat{d_t} + A_{DR}\left(\widehat{Q_t} + \widehat{b_t} + \frac{b_t^*}{b}\right) + \ldots \\ &+ \frac{A_{DR}}{\zeta\left(\mathcal{I}^f - 1\right)}\left(\widehat{\mathcal{E}_t} - E_{t-1}\widehat{\mathcal{E}_t}\right) - A_{DR}\widehat{\Pi}_t^* - (1 - A_{DR})\widehat{\Pi}_t - \widehat{\mathcal{I}_t} - H_3\widehat{\varpi}_{o,t} + \end{aligned} \quad (78)$$

Where:
$H_3 = \left(\frac{[\Gamma'(\varpi) - \lambda\Upsilon'(\varpi)]\left(\frac{S^w}{mc}\right)}{G_1/mc - 1} + \frac{G_1/mc}{G_1/mc - 1}\frac{H_2}{H_1}\right)\varpi_o$

We need to find suitable expressions for the real asset values in terms of the loan quantities, for that we consider the log-liberalisations of equations [14] and [15]

$$\widehat{l_{h,t}} = \left(\frac{1}{1 - \zeta/\Pi^*}\right)\widehat{d}_{t+1} + \left(\frac{1}{1 - \zeta/\Pi^*}\right)\frac{\Delta m_{b,t}}{d} - \left(\frac{\zeta/\Pi^*}{1 - \zeta/\Pi^*}\right)\left(\widehat{d_t} - \widehat{\Pi}_t\right) \quad (b12)$$

$$\widehat{l_{f,t}} = \left(\frac{1}{1 - \zeta/\Pi^*}\right)\widehat{b}_{t+1} + \left(\frac{1}{1 - \zeta/\Pi^*}\right)\frac{b_{t+1}^*}{b} - \left(\frac{\zeta/\Pi^*}{1 - \zeta/\Pi^*}\right)\left(\widehat{b_t} + \frac{b_t^*}{b} - \widehat{\Pi}_t^*\right) \quad (b13)$$

From appendix A, the relationship between peso and dollar loan dynamics is given by

$$\widehat{l_{f,t}} = \widehat{l_{h,t}} + \widehat{\mathcal{I}_t} - \widehat{Q_t} - \widehat{\mathcal{I}_t^f} \quad (b14)$$

Equation [78] to [b14] characterise the equilibrium dynamics in the market for loanable funds

B.7 The foreign sector resource constraint

Log-linearising equation [33] and after replacing the expressions for $\widehat{J}_t$ and $\widehat{C}_{f,t}$ we have:

$$0 = \eta C_f \widehat{Q}_t - C_f \widehat{C}_t - J\widehat{b}_{t+1} - \frac{1}{\beta} b_t^* + Y_f \widehat{Y}_{f,t}$$

Replacing the expression for $\widehat{b}_{t+1}$ we get equation [71] in the main text

B.8 Additional equations

Production of wholesale goods

From appendix B we take the value of wholesale production and log-linearise to get

$$\widehat{Y}_{h,t}^{whole} = \widehat{A}_t - a\widehat{w}_t - (1-a)\widehat{Q}_t + (1-a)\left(\widehat{I}_t - \widehat{I}_{f,t}\right) + \widehat{l}_{h,t}$$

Non-tradable consumption in equilibrium is equal to the net production of goods, this comes from equation [a13] in Appendix A

$$\ln \widetilde{Y}_{h,t} = \ln\left[1 - \lambda \Upsilon\left(\varpi_{o,t}\right)\right] + \ln Y_{h,t}$$

$$\widehat{\widetilde{Y}}_{h,t}^{whole} = \widehat{Y}_{h,t} - \left[\frac{\lambda \Upsilon'\left(\varpi_o\right)\varpi_o}{1 - \lambda\Upsilon\left(\varpi_o\right)}\right]\widehat{\varpi}_{o,t}$$

Asset dollarization ratio: This ratio is defined as:

$$A_{DR,t} = \frac{\left(B_{t+1} + B_{t+1}^*\right)\mathcal{E}_t}{\left(B_{t+1} + B_{t+1}^*\right)\mathcal{E}_t + D_t}$$

Which, upon linearisation becomes

$$A_{DR,t} = \frac{d}{d+b+b^*}\left(\widehat{Q}_t - \widehat{d}_{t+1}\right) + \frac{db}{(b+b^*)(d+b+b^*)}\left(\widehat{b}_{t+1} + \frac{\widehat{b}_{t+1}^*}{b}\right)$$

Households dollarization ratio:

$$H_{DR,t} = \frac{B_{t+1}\mathcal{E}_t}{B_{t+1}\mathcal{E}_t + D_t}$$

$$H_{DR,t} = \frac{d}{d+b}\left(\widehat{Q}_t + \widehat{b}_{t+1} - \widehat{d}_{t+1}\right)$$

Real value of assets to households:

$$rva_t = d_{t+1} + b_{t+1}$$

$$\widehat{rva}_t = \frac{d}{d+b}\widehat{d}_{t+1} + \frac{b}{d+b}\widehat{b}_{t+1}$$

Liability dollarization ratio:

$$L_{DR,t} = \frac{\left(L_{f,t}\right)\mathcal{E}_t}{\left(L_{f,t}\right)\mathcal{E}_t + L_{h,t}}$$

$$\widehat{L_{DR}}_t = L_{DR}\left(\widehat{Q}_t + \widehat{l}_{f,t} - \widehat{l}_{h,t}\right)$$

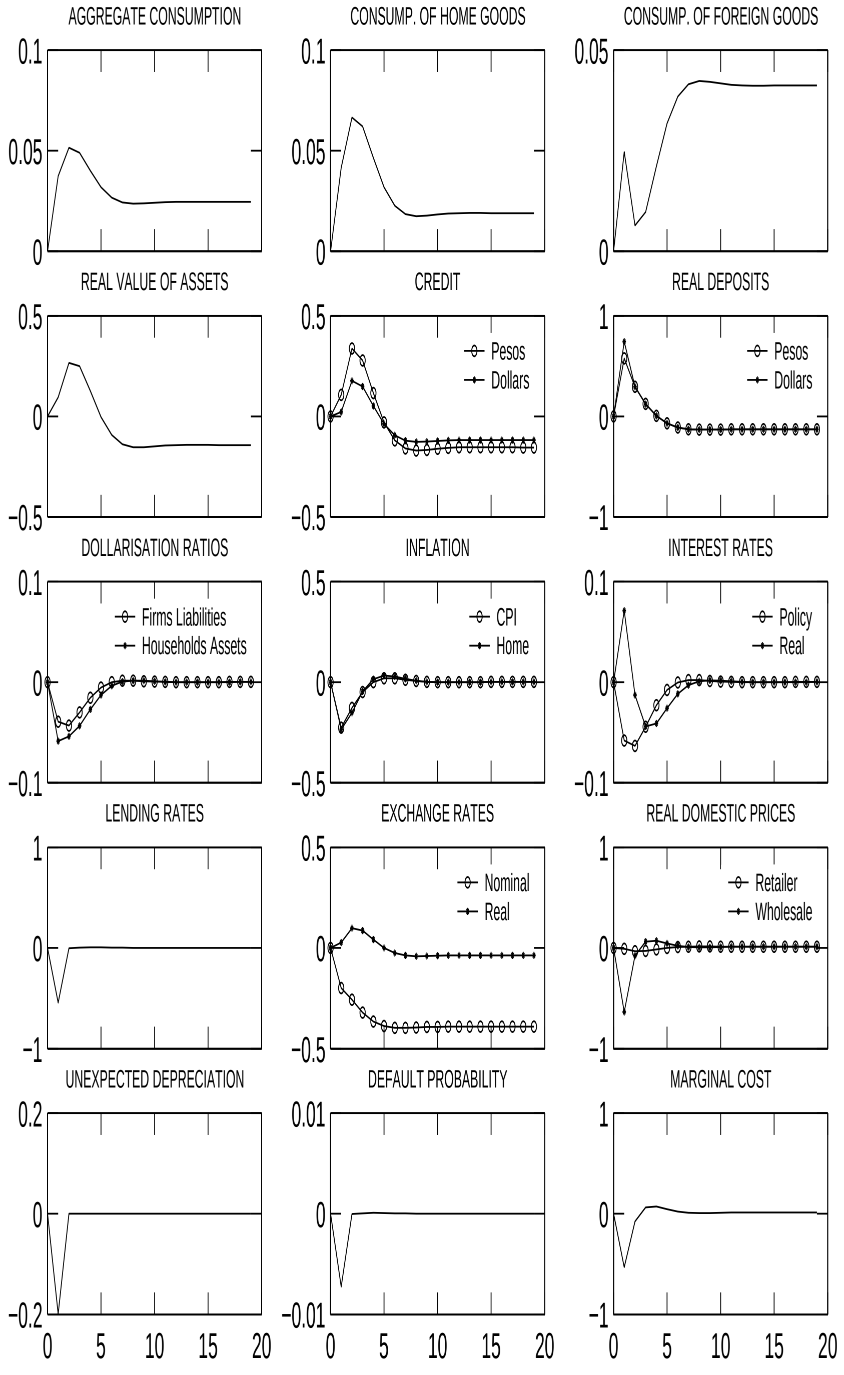

Figure 4. *CPI-HOME INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***positive productivity shock****: (Responses are measured as percentage deviations from the respective steady-state values)*

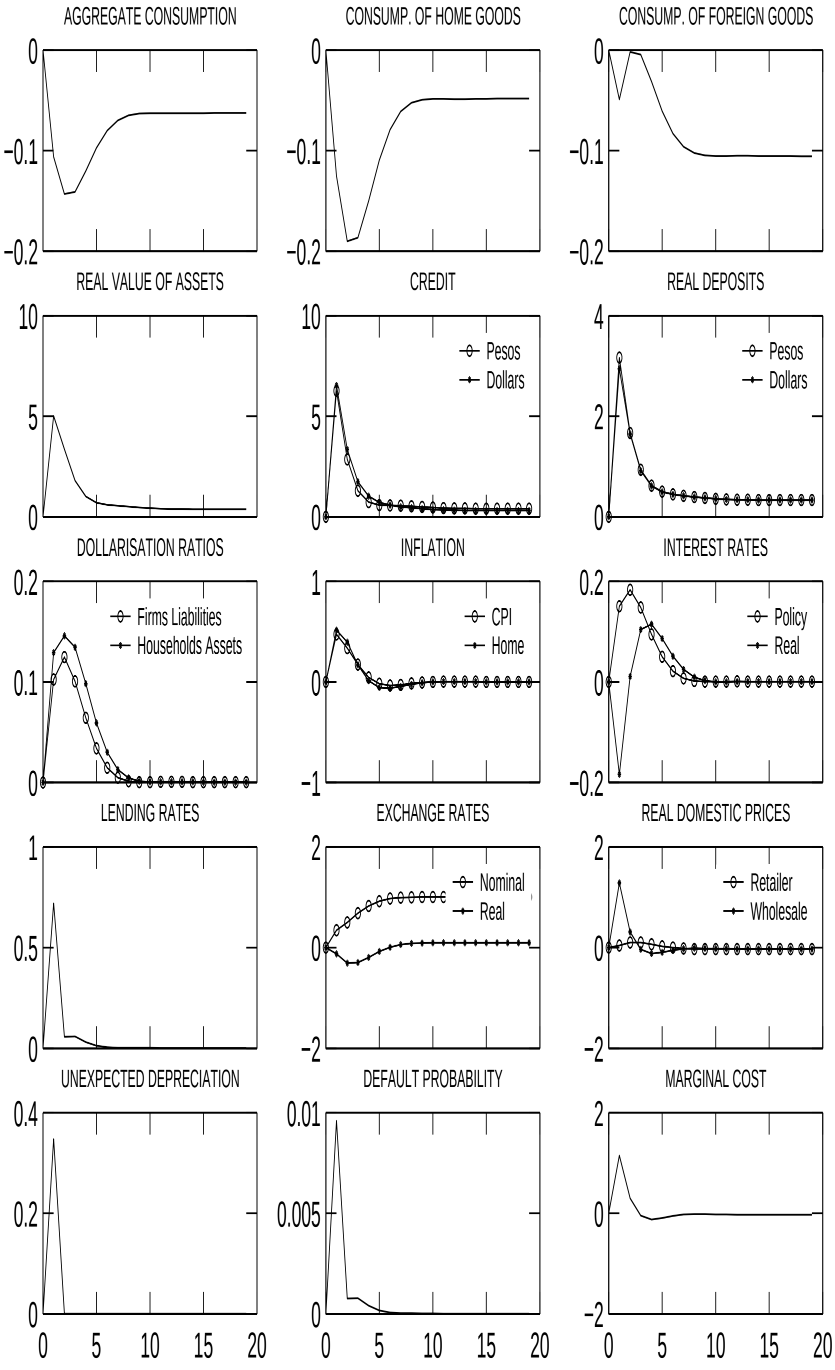

FIGURE 5. *CPI-HOME INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***positive commodity production shock****: (Responses are measured as percentage deviations from the respective steady-state values)*

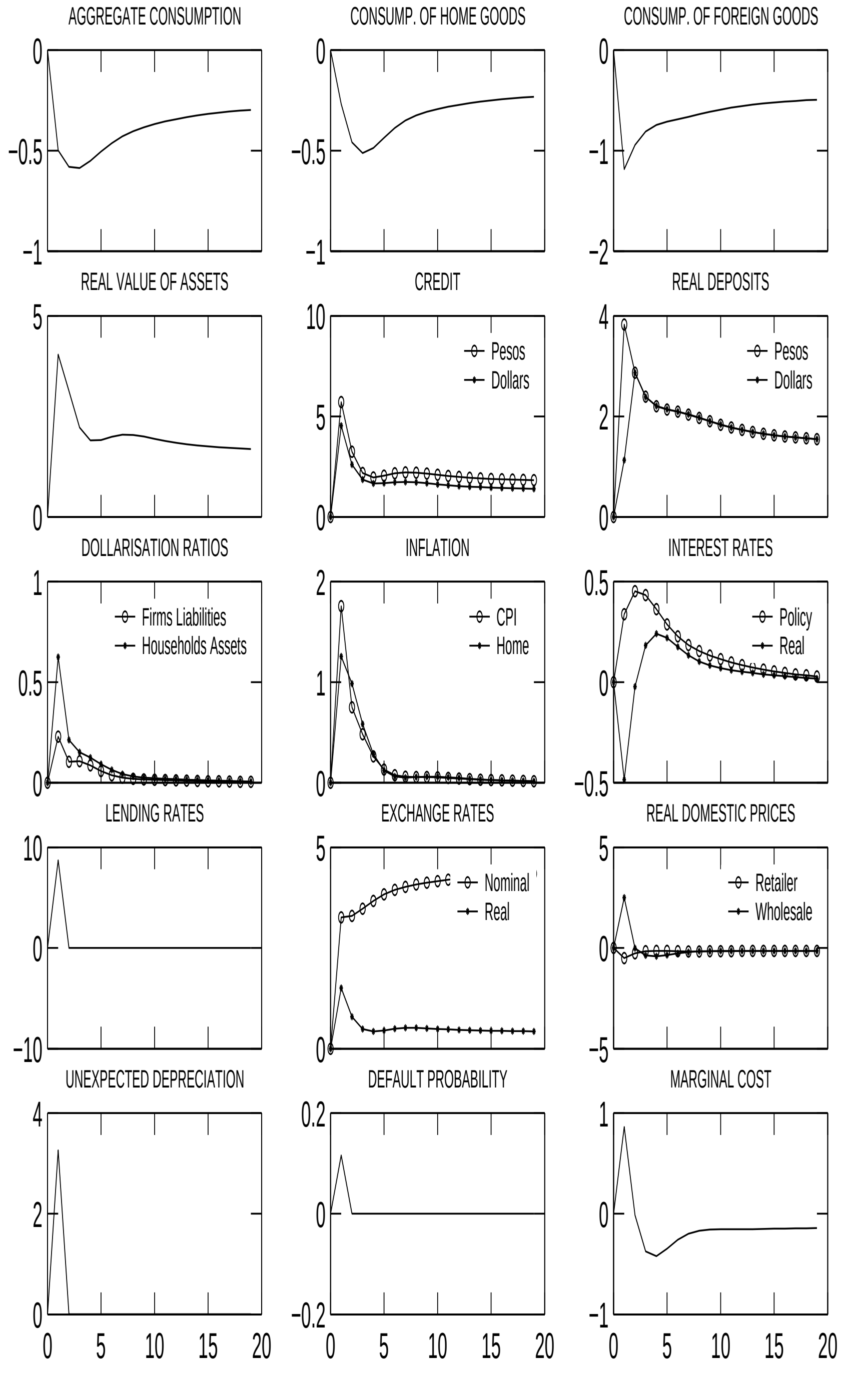

Figure 6. *CPI-HOME INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***dollar interest rate shock****: (Responses are measured as percentage deviations from the respective steady-state values)*

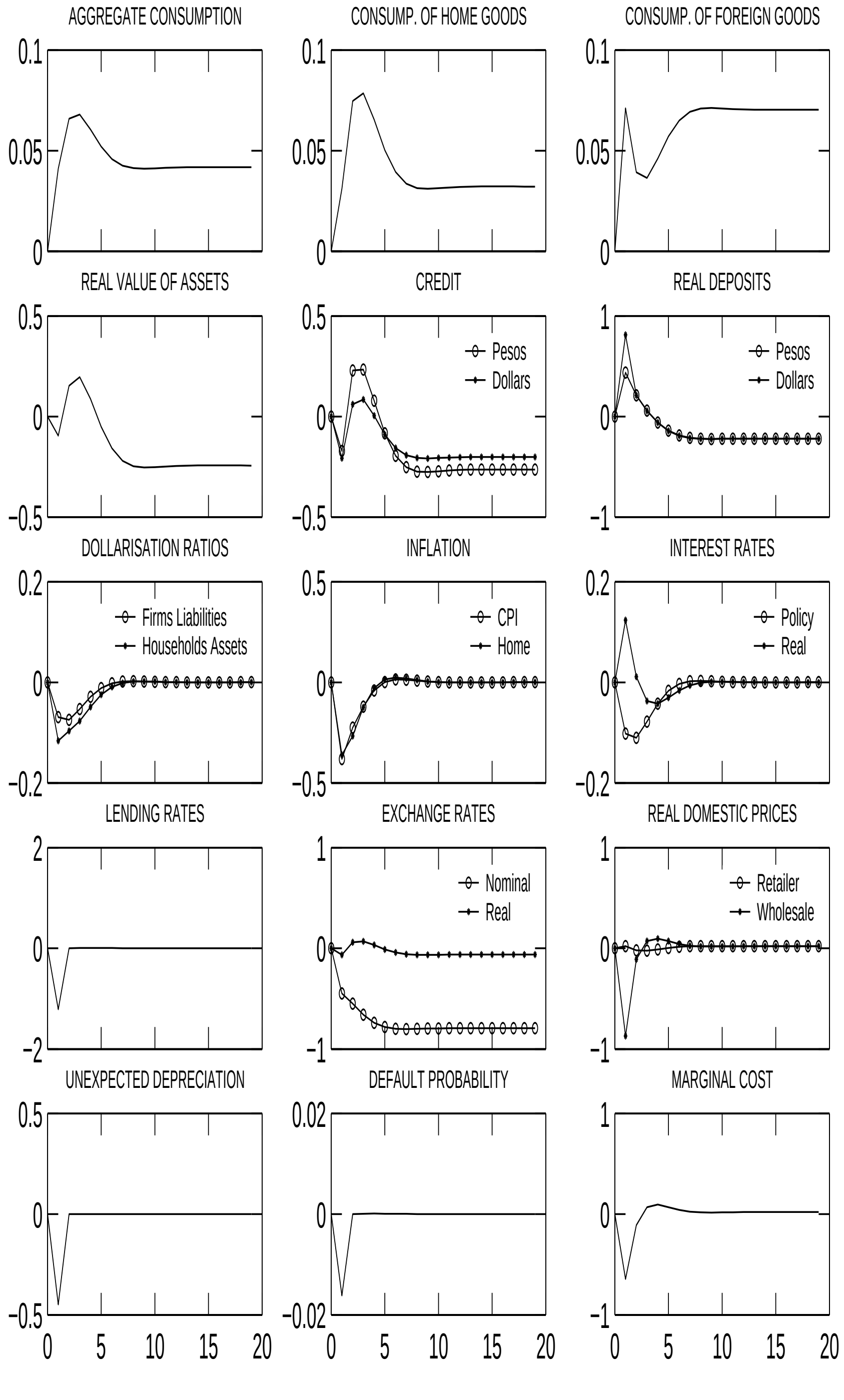

Figure 7. *FLEXIBLE INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***positive productivity shock****:(Responses are measured as percentage deviations from the respective steady-state values)*

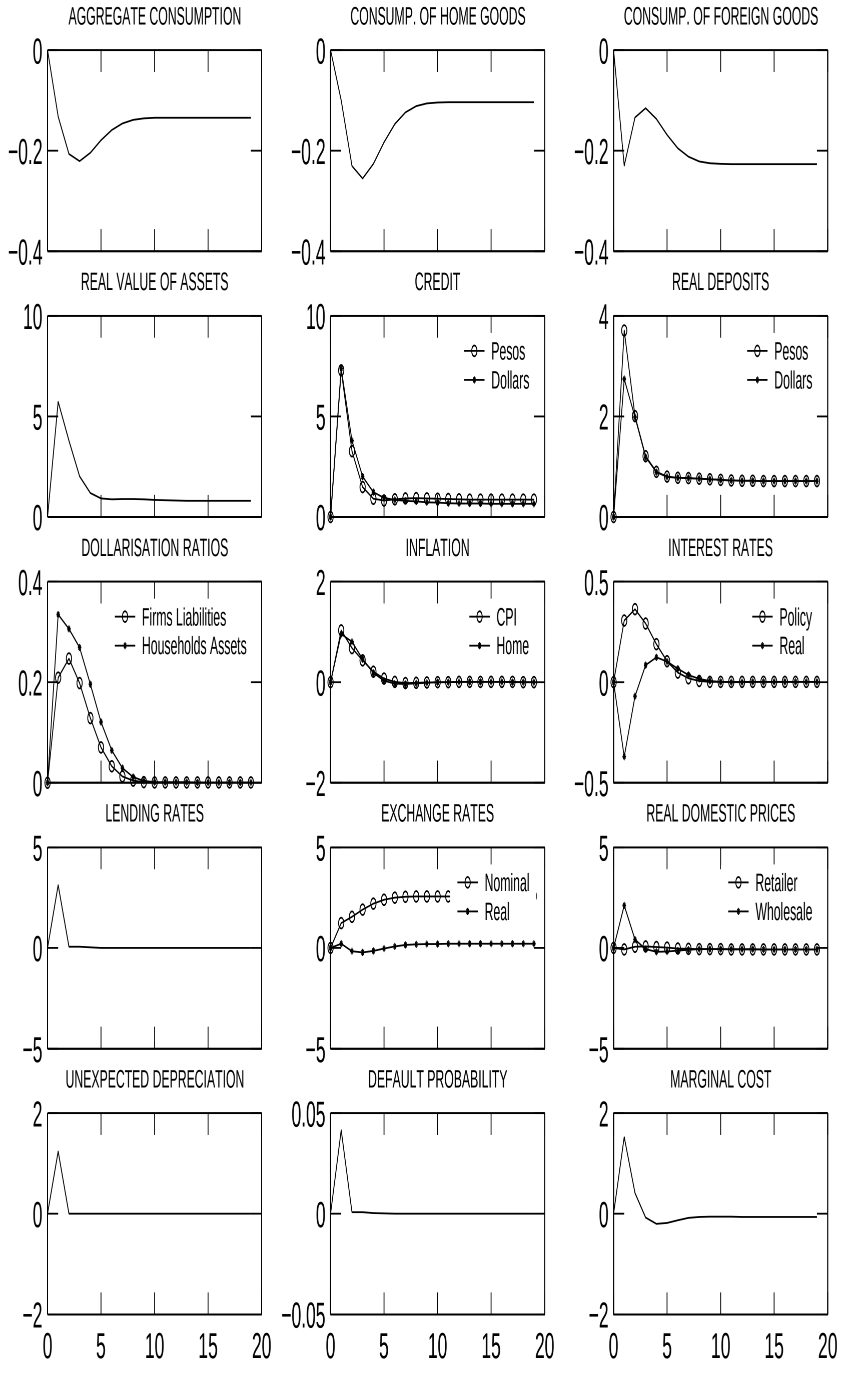

Figure 8. *FLEXIBLE INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***positive commodity production shock****: (Responses are measured as percentage deviations from the respective steady-state values)*

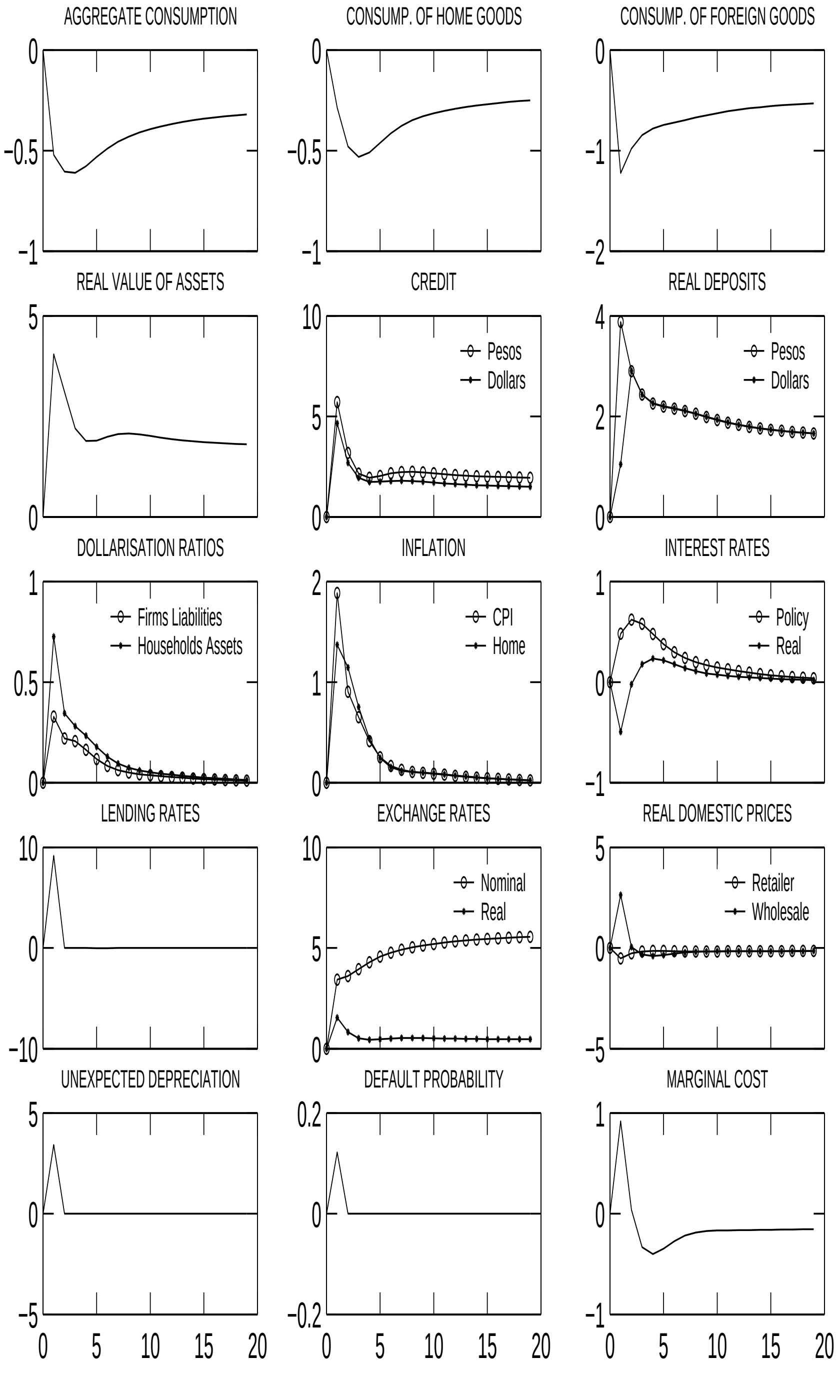

Figure 9. *FLEXIBLE INFLATION TARGETING REGIME: Responses to a one-standard-deviation* ***dollar interest rate shock****:(Responses are measured as percentage deviations from the respective steady-state values)*