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Portfolio Shocks and the Financial Accelerator in a Small Open Economy

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Abstract

We study a small open economy with two salient properties: an entrepreneurial sector that borrows in foreign currency and is subject to costly state-verification and risk averse FX market intermediaries. This economy thus features a financial accelerator, an endogenous expected cost of capital, and foreign exchange dynamics dependent on the open position of financial intermediaries. we aim to quantitatively assess the extent to which portfolio shocks can reproduce contractionary depreciations and how central bank's optimal simple rules can improve welfare in a stylized economy.

Keywords: Exchange rate dynamics, exchange rate intervention, financial accelerator, incomplete financial markets

JEL: E4, E5, F3, G15

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1 Introduction

Global capital flows have long been known as a source of foreign exchange market disruption for small open economies. Since the seminal work of Leiderman et al. (1992), Bercuson and Koenig (1993) and Mathieson and Rojas-Suarez (1992), the literature has considered the access of developing economies to international flows as double-edged sword. On one hand, it allows for the lower interest rates and higher investment; on the other, it exposes developing countries to large real exchange rate swings and "sudden stops". One of the key concerning elements of granting access to foreign lending by private sector firms is the unhedged foreign currency debt positions. Céspedes et al. (2004) present a mechanism in which currency devaluations in a dollarized economy reduce entrepreneurial net worth and trigger a hike in risk premia due to financial frictions. Frankel (2005) highlights the role of balance sheet effects in explaining contractionary depreciations. Bebczuk et al. (2006) test this hypothesis using a panel of 57 countries and find that countries with high dollarization experience contractionary depreciations. An additional finding from the authors is that the adjustment on output occurs through contraction in investment expenditures. Finally, Gertler et al. (2007) build a small open economy model with a financial accelerator to study the effects of the exchange rate regime on the financial stability of a country. As in Céspedes et al. (2004), they find support that even in the presence of currency mismatch and balance sheet effects, flexible exchange rate policies are preferred over fixed exchange rate regimes.

Recent research has focused on the role of international financial architecture, particularly segmented international financial markets, as a source of inefficient fluctuations in the exchange rate. Maggiori et al. (2020), Cavallino (2019) and Itskhoki and Mukhin (2021) present models with these characteristics and create a role for an optimal FX intervention policy. Cavallino (2019) presents the LQ optimal policy exercise in a continuous time model, finding support for this policy. Montoro and Ortiz (2020b) complements this analysis with simple optimal rules for FXI, finding that the FX intervention can improve welfare in a more general setup. In this paper, we follow these to branches of the literature by present a model with segmented and incomplete international financial markets. Additionally, we introduce a financial accelerator in the spirit of Bernanke et al. (1999) and Gertler et al. (2007). The combination of these two features allows for the study of the amplification of inefficient exchange rate dynamics through the domestic financial system. Specifically, the presence of a financial accelerator will amplify the shocks of the foreign exchange (FX) markets into the economy through currency mismatches. Also, this setup allows for richer policy options than the ones presented in Gertler et al. (2007) and Céspedes et al. (2004) since this framework allows for the use of FX interventions in a more precise manner.[1]

In the FX markets, we introduce risk averse financial intermediaries, who operate as market-makers and absorb the changes in portfolio positions of the rest of agents. The central bank FX intervention becomes an effective instrument as it operates through the portfolio channel and can affect agent expectations through the intervention rules. In the financial market, the introduction of a financial accelerator activates the balance sheet effect mechanism when firms hold dollarized liabilities. We do not endogenize the dollarization of debt.[2]

Findings. Our results show that negative portfolio shocks in FX markets are amplified through the financial accelerator. A fall in investment becomes the main channel through which markets clear. In the presence of a higher risk premia, firms reduce their capital. Households try to smooth consumption precisely when FX intermediaries demand a higher compensation for their short positions, leading to an increase in the effective interest rate and a drop in consumption. The lower domestic consumption when the home good price is lower, breaks the Backus-Smith condition, leading to welfare losses. FX intervention can be used to limit the amplification mechanism.

Related Literature. The paper follows the literature of FX determination in general equilibrium with imperfect financial markets. Our closest references are Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021) which show how the role of risk-averse financiers creates a risk-bearing channel that can explain the puzzles of disconnect and determination of exchange rates. These frictions create a role for FX intervention. Cavallino (2019) studies the optimal FX intervention policy in a continuous-time SOE New Keynesian model, finding how this tool complements monetary policy. Gabaix and Maggiori (2015)

[1] See Cavallino (2019) and Montoro and Ortiz (2020b).

[2] Bacchetta and van Wincoop (2021) follows Froot and Thaler (1990) by presenting a model of delayed portfolio adjustment that can explain the link between portfolio and exchange rate dynamics.

and Cavallino (2019) work in an incomplete financial markets setup, in which financial intermediaries face a collateral constraint in the spirit of Kiyotaki and Moore (1997). The limit to their position in foreign currency is linked to a moment of the equilibrium distribution of the exchange rate in an ad-hoc manner. In this case, the FX intervention affects the economy by increasing or decreasing the value of the collateral of the financiers. Regarding the literature on credit market frictions, we follow Bernanke et al. (1999) and Gertler et al. (2007). Céspedes et al. (2004) who provide a framework to study the welfare implications of different exchange rate policy regimes.

Outline. The paper is organized as follows. Section 2 presents the models to be studied. We first introduce capital to small open economy model with segmented financial markets. Then, we introduce the financial accelerator. Then, we discuss the dynamics of the models. Section 5 discusses the role of FX intervention. Section 6 concludes.

2 The Economies

2.1 The SOE RBC with capital and segmented international financial markets.

Our baseline model is small open economy RBC with capital in line with Mendoza (1991). We modify that model to introduced segmented financial markets as in Itskhoki and Mukhin (2021) and Cavallino (2019). The environment presents capital, but no credit or nominal frictions. We have a flexible rental market and a continuum of identical households in the unit interval.

2.1.1 Households

Households consume, work, receive dividends, and trade only real bonds in domestic baskets. They obtain utility/disutility from consumption and hours worked according to the following utility function.

$$u\left(C_t, H_t\right)=\frac{1}{1-\gamma_{ghh}}\left(\frac{C_t^{1-\gamma_c}}{1-\gamma_c}-\psi_h \frac{H_t^{1+v}}{1+v}\right)^{1-\gamma_{ghh}}$$

where C_t is a CES basket of home and foreign goods, $C_t=\left[\gamma^{\frac{1}{\rho}}\left(C_t^H\right)^{\frac{\rho-1}{\rho}}+(1-\gamma)^{\frac{1}{\rho}}\left(C_t^F\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$. The corresponding consumer price index P_t is given by $P_t=\left[\gamma\left(P_t^H\right)^{1-\rho}+(1-\gamma)\left(P_t^F\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}$. The expenditure minimization problem yields:

$$\frac{C_t^H}{C_t^F}=\frac{\gamma}{(1-\gamma)}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho}. \tag{1}$$

The household decision program is as follows:

$$\max_{\{C_t, H_t, B_{t+1}, K_{t+1}\}_{t=0}^{\infty}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\gamma_{ghh}}\left[\frac{C_t^{1-\gamma_c}}{1-\gamma_c}-\psi \frac{H_t^{1+v}}{1+v}\right]^{1-\gamma_{ghh}}$$

with $\gamma_c \in(0,1)$ and $\chi>0$. The household budget constraint is then given by:

$$C_t+B_{t+1}+Q_t K_{t+1}=\frac{W_t}{P_t} H_t+\Pi_t+R_{t-1} B_t+R_{t-1}^k K_t+(1-\delta) Q_t K_t$$

The law of motion of capital is given by:

$$K_{t+1}=I_t+(1-\delta) K_t$$

The first-order conditions to these problems are:

$$
\begin{aligned}
C_t &: \left[\frac{C_t^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_t^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} C_t^{-\gamma_c} - \lambda_t = 0 \\
H_t &: -\left[\frac{C_t^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_t^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} \psi H_t^{\upsilon} + \lambda_t\frac{W_t}{P_t} = 0 \\
B_{t+1} &: -\lambda_t + \beta R_t \mathbb{E}\lambda_{t+1} = 0 \\
K_{t+1} &: -\lambda_t Q_t + \beta\mathbb{E}_t\left[\lambda_{t+1}\left(R_t^k + (1-\delta)Q_{t+1}\right)\right] \\
\lambda_t &: C_t + B_{t+1} - \frac{W_t}{P_t}H_t - \Pi_t - R_{t-1}B_t = 0.
\end{aligned}
$$

which yields:

$$H_t^{\upsilon} = C_t^{-\gamma_c}\frac{W_t}{P_t} \tag{2}$$

$$\left[\frac{C_t^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_t^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} C_t^{-\gamma_c} = \beta R_t\mathbb{E}_t\left[\left[\frac{C_{t+1}^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_{t+1}^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} C_{t+1}^{-\gamma_c}\right] \tag{3}$$

$$Q_t = \beta\mathbb{E}_t\left(\frac{\left[\frac{C_{t+1}^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_{t+1}^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} C_{t+1}^{-\gamma_c}}{\left[\frac{C_t^{1-\gamma_c}}{1-\gamma_c} - \psi\frac{H_t^{1+\upsilon}}{1+\upsilon}\right]^{-\gamma_{ghh}} C_t^{-\gamma_c}}\left(R_t^k + (1-\delta)Q_{t+1}\right)\right) \tag{4}$$

$$C_t + B_{t+1} = \frac{W_t}{P_t}H_t + \Pi_t + R_{t-1}B_t. \tag{5}$$

Investment is composed following a CES composite: $I_t = \left[\gamma_i^{\frac{1}{\rho_i}}\left(I_t^H\right)^{\frac{\rho_i-1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}}\left(I_t^F\right)^{\frac{\rho_i-1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i-1}}$. The composition of investment will respond to the elasticity of substitution and the relative prices of home and foreign goods resulting in the following intratemporal first-order condition:

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{(1-\gamma_i)}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_i}. \tag{6}$$

The corresponding investment price index (IPI) is: $P_{I,t} = \left[\gamma_i\left(P_t^H\right)^{1-\rho_i} + (1-\gamma_i)\left(P_t^F\right)^{1-\rho_i}\right]^{\frac{1}{1-\rho_i}}$. From the law of motion of capital, we obtain the following.

$$Q_t = \frac{P_{I,t}}{P_t} \tag{7}$$

2.2 International Financial Markets

2.2.1 Noise traders

We follow Itskhoki and Mukhin (2021). Home households only trade bonds that pay in units of domestic consumption baskets and cannot directly trade assets with foreign households. Foreign noise traders have an exogenous demand for the domestic economy assets. Both Home households and noise traders obtain their desired portfolios through domestic financial intermediaries. The overall position of noise traders is given by the following:

$$B_{t+1}^{t,*} = n\left(\exp\left(\psi_t\right) - 1\right)$$

where $\psi_t = \rho_\psi\psi_{t-1} + \sigma_\psi\varepsilon_t^\psi$; $\varepsilon_t^\psi \sim iid(0,1)$. Noise traders follow a zero capital strategy given by:

$$B_{t+1}^t + S_t B_{t+1}^{t*} = 0$$

Profits from (foreign) noise traders are given by:

$$\Gamma_t^n = \left(S_t R_{t-1}^* - S_{t-1}R_{t-1}\right)B_t^{t,*} \tag{8}$$

2.2.2 Intermediaries and the Modified UIP

Intermediaries operate as market makers. They provide a service to home households and foreign noise traders by absorbing their portfolio positions using their own wealth. Intermediaries maximize a CARA utility of the real return over investments in units of the domestic consumption good:

$$\max_{d^*_{t+1}} \mathbb{E}_t \left[-\frac{1}{\gamma_f} \exp\left(-\gamma_f \frac{\tilde{R}^*_{t+1}}{R_t} B^{f,*}_{t+1} \right) \right].$$

The return on intermediaries' strategy is given by:

$$\tilde{R}^*_{t+1} = R^*_t \frac{S_{t+1}}{S_t} - R_t$$

where $\mathbb{E}_t$ is the rational expectations operator, $\omega \geq 0$ is the coefficient of absolute risk aversion and $\tilde{R}^*_{t+1}$ is the peso carry trade return on the portfolio. Notice that the open position absorbed by each dealer (B^{*f}_{t+1}) will be an endogenous object as it will be derived from the domestic bonds demand from households (via current account flows), foreign carry traders and the central bank FX intervention.

FX dealers will quote a price for each equilibrium position they have to absorb. Since trade against all agents occurs simultaneously, the portfolio equation can be utilized to get the exchange rate at which FX dealers are willing to mirror the position of the rest of agents. Following Campbell and Viceira (2002) and Itskhoki and Mukhin (2021), we can write the discounted nominal return in domestic currency as:

$$\begin{aligned} \frac{\tilde{R}^*_{t+1}}{R_t} &= \frac{S_{t+1}R^*_t}{R_t S_t} - 1 \\ &= \exp\left\{ (\epsilon_{t+1} - 1) \right\} \end{aligned}$$

where:

$$\epsilon_{t+1} \equiv i^*_t - i_t + \Delta s_{t+1} = \log\left(R^*_t / R_t \right) + \Delta log S_{t+1}$$

$i_t \equiv log R_t$, $i^*_t \equiv log R^*_t$ and $\Delta \log S_{t+1} \equiv \log\left(\frac{S_{t+1}}{S_t} \right)$. In continuous time and assuming ϵ_{t+1} follows a normal diffusion process:

$$dX_t = \alpha_t dt + \sigma dZ_t$$

where Z_t is a Wiener or Brownian motion process, where the drift and diffusions are given by:

$$\alpha_t = \mathbb{E}_t \epsilon_{t+1} = i^*_t - i_t + \mathbb{E}_t \Delta s_{t+1}$$

and:

$$\sigma^2 = \sigma^2_{\Delta s_{t+1}}$$

where $\sigma^2_{\Delta s_{t+1}}$ is the time-invariant conditional variance of the exchange rate return. In line with Merton (1992), we approximate the period return by the variation in the diffusion process. This allows us to rewrite the problem in terms of dX_t:

$$\max_{B^{*f}_{t+1}} \mathbb{E}_t \left\{ -\frac{1}{\gamma_f} \exp\left(-\gamma_f \exp\left(dX_t \right) B^{f,*} \right) \right\}$$

Itö's lemma allows us to rewrite the objective function as:

$$\mathbb{E}_t \left\{ -\frac{1}{\gamma_f} exp\left(-\gamma_f \left(dX_t + \frac{1}{2}(dX_t)^2 \right) \right) B^{f,*} \right\}$$

since the period return follows a normal distribution, we can use the properties of the log-normal distribution to obtain the reformulate maximization problem as:

$$\max_{B^{f,*}}\left\{-\frac{1}{\gamma_f}\exp\left(-\gamma_f\left(\alpha_t+\frac{1}{2}\sigma^2\right)B^{*f}+\frac{\gamma_f^2\sigma^2}{2}(B^{f,*})^2\right)dt\right\}$$

The solution to the problem yields:

$$B^{*f}=\frac{\alpha_t+\frac{1}{2}\sigma^2}{\gamma_f\sigma^2}$$

substituting for α_t and σ we obtain the following.

$$B^{*f}_{t+1}=\frac{i^*_t-i_t+\mathbb{E}_t(s_{t+1})-s_t+\frac{1}{2}\sigma^2}{\gamma_f\sigma^2}$$

Here we obtain the portfolio solution of financial intermediaries under the CARA utility function. Which yields the modified UIP equation:

$$\mathbb{E}_t(s_{t+1})=s_t+i^*_t-i_t-\gamma_f\sigma^2B^{f,*}_{t+1}$$

We can now use the zero capital position for dealers too given by $S_{t-1}B^{f,*}_t=B^f_t$, thus we obtain the intermediaries' profits:

$$\Gamma^d_t=\left(S_tR^*_{t-1}-S_{t-1}R_{t-1}\right)B^{f,*}_{t+1} \tag{9}$$

2.2.3 Production

The supply side of the economy is standard. There is a representative perfectly competitive H goods producer with the following production technology:

$$Y_t=K^\alpha_t(A_tL_t)^{1-\alpha} \tag{10}$$

The solution to the firm's problem yields the following capital to labour ratio:

$$\frac{K_t}{L_t}=\frac{W_t}{R^k_t}\frac{\alpha}{1-\alpha} \tag{11}$$

We also obtain the real marginal cost:

$$MC_t=\frac{1}{A^{1-\alpha}_t}\left(\frac{W_t}{1-\alpha}\right)^{1-\alpha}\frac{{R^k_t}^\alpha}{\alpha} \tag{12}$$

where K_t denotes the capital demanded by firm j at time t, α denotes the steady state share of factor payments that accrues to capital and A_t is the labour augmenting productivity shock.

2.2.4 Foreign Behavior

We take as exogenous both the gross foreign nominal interest rate and the nominal price of the foreign tradable good, P^{F*}_t. The foreign demand for the tradable home good, $C^{H,*}_t$, is given by the following.

$$C^{H,*}_t=\left(\frac{P^{H,*}_t}{P^*_t}\right)Y^*_t. \tag{13}$$

Where Y^*_t is foreign output taken as given P^*_t is foreign CPI and $P^{H,*}_t$ is the price of the home good in foreign currency . Law of one price on foreign goods would imply:

$$P^{H,*}_t=S_tP^H_t \tag{14}$$

2.2.5 Central Bank

We introduce a central bank that intervenes in the FX markets. The Central Banks performs sterilized interventions of the form:

$$B^{cb}_{t+1} + S_t B^{cb,*}_{t+1} = 0 \tag{15}$$

Here, we assume that the central bank operates directly against all financial intermediaries in the same amount. When the Central Bank sells reserves it will do it against domestic bonds.

$$\Gamma^{cb}_t = \left(S_t R^*_{t-1} - S_{t-1} R_{t-1}\right) B^{cb,*}_t$$

Thus, central bank profits exhibit a valuation component and a return differential component.

2.2.6 Financial Market clearing

The domestic bond positions of households, noise traders, the central bank, and intermediaries net out:

$$B_{t+1} + B^t_{t+1} + B^f_{t+1} + B^{cb}_{t+1} = 0. \tag{16}$$

Zero-capital strategies and sterilized FX intervention yield

$$\begin{aligned} B^t_t + S_{t-1} B^{t,*}_t &= 0 \\ B^f_t + S_{t-1} B^{f,*}_t &= 0 \\ B^{cb}_t + S_{t-1} B^{cb,*}_t &= 0 \end{aligned}$$

The net foreign asset position is

$$S_t \left(B^{f,*}_{t+1} + B^{cb,*}_{t+1} - D^{e,*}_{t+1}\right) = \mathcal{A}_t$$

Aggregating over FX dealers, we obtain the modified uncovered interest rate parity (UIP) condition:

$$s_t = \mathbb{E}_t s_{t+1} + i^*_t - i_t + \frac{1}{2}\sigma^2 + \frac{\gamma_f}{m}\sigma^2 B^{f,*}_{t+1}$$

For exposition motives we define the adjusted foreign interest rate to take away the Jensen's inequality term:

$$\tilde{i}^*_t = i^*_t + \frac{1}{2}\sigma^2_{\Delta s_{t+1}}$$

This allows us to rewrite the modified UIP as:

$$s_t = \mathbb{E}_t s_{t+1} + \tilde{i}^*_t - i_t - \frac{\gamma_f}{m}\sigma^2 \left(B^{f,*}_{t+1}\right) \tag{17}$$

Notice that this equation holds exactly when the time between periods is small. Therefore, there is no need to approximate it around the non-stochastic steady state to obtain this expression.[3]

2.2.7 Goods Market Clearing

$$Y^H_t = C^H_t + C^{H*}_t + I^H_t \tag{18}$$

[3] To apply Ito's Lemma, the approximation point requires that the sum of period holdings returns forms a martingale and that the variance of returns are bounded.

2.2.8 Current Account

We start by expressing the current account in foreign baskets:

$$
\begin{aligned}
&MC_tY_t^H + Q_tK_{t+1} + R_{t-1}B_t + R_{t-1}^*S_tB_t^{f,*} + R_{t-1}B_t^f + R_{t-1}^*S_tB_t^{cb,*} + R_{t-1}B_t^{cb} = \\
&B_{t+1} + C_t + Q_tI_t + S_tB_{t+1}^{f,*} + B_{t+1}^f + S_tB_{t+1}^{cb,*} + B_{t+1}^{cb} + N_{t+1}
\end{aligned}
$$

Using the domestic bond market equilibrium and the zero net positions, we obtain the following.

$$
B_{t+1}^f + B_{t+1}^{cb} + B_{t+1} = -B_{t+1}^t = S_tB_{t+1}^{t,*} \tag{19}
$$

$$
B_{t+1}^f + B_{t+1}^{cb} + B_{t+1} = -B_{t+1}^t = S_tB_{t+1}^{t,*} \tag{20}
$$

Some algebra leads to:

$$
S_t\left(B_{t+1}^{f,*} + B_{t+1}^{cb,*}\right) = \mathcal{A}_t
$$

$$
\begin{aligned}
NX_t + R_{t-1}\left(S_tB_t^{t,*}\right) + R_{t-1}^*S_tB_t^{f,*} + R_{t-1}^*S_tB_t^{cb,*} - R_{t-1}^* &= \\
= S_tB_{t+1}^{t,*} + D_{t+1}^e + S_tB_{t+1}^{f,*} + S_tB_{t+1}^{cb,*} & \qquad (21) \\
NX_t + i_{t-1}S_tB_t^{t,*} + i_{t-1}^*S_tB_t^{f,*} + i_{t-1}^*S_tB_t^{cb,*} &= S_t\Delta B_{t+1}^{t,*} + S_t\Delta B_{t+1}^{f,*} + S_t\Delta B_{t+1}^{cb,*} \\
&= \Delta\left(S_tB_{t+1}^{t,*} + S_tB_{t+1}^{f,*} + S_tB_{t+1}^{cb,*}\right) \\
&= \Delta\mathcal{A}_t \qquad (22)
\end{aligned}
$$

$$
NX_{ss} = 0 \tag{23}
$$

Replacing the households bonds via the market clearing condition and zero capital strategies yields. The net foreign asset position is denoted by

$$
\mathcal{A}_t = S_tB_{t+1}^{t,*} + S_tB_{t+1}^{f,*} + S_tB_{t+1}^{cb,*}
$$

2.3 The SOE RBC with capital, segmented international financial markets and CSV.

We now augment the economy with a financial accelerator as in Bernanke et al. (1999) and Gertler et al. (2007). We obtain a small open economy model in which financial conditions can influence aggregate behaviour. The model encompasses Gertler et al. (2007) when the assumption of segmented international financial markets is dropped. Here we highlight the main differences with the previous model.

2.3.1 Households

The only change relative to the baseline model is that households do not choose investment.

2.3.2 Entrepreneur borrowing contract

Entrepreneurs are risk neutral, they work and produce goods using their own work, household labor and capital which they source from their own net worth and finance borrowing from a lender. They survive (exogenously) through the next period with probability $\phi \in (0,1)$[4]. Entrepreneurs who don't survive consume their share of start of period net worth (V_t). At the end of period t going into period $t+1$, the entrepreneur has available net worth N_{t+1} and to finance the difference between his expenditures on capital goods and his net worth he must borrow an amount D_{t+1}^{*e} of dollars satisfying,

$$
P_t\left(Q_tK_{t+1} - N_{t+1}\right) = S_tD_{t+1}^{*e}, \tag{24}
$$

[4]This is needed to induce stationarity in the net worth dynamics. If this was not the case, net worth could be accumulated up to the point of being self-financed.

that matures in the next period (short-term debt).

No aggregate uncertainty Assume there is no aggregate uncertainty in return on capital nor in exchange rate levels. Let ω be the idiosyncratic shock to entrepreneur's return on capital and assume that ω is i.i.d. across firms and time. In this case, the optimal contract may be characterized by a non-default loan gross interest rate, Z_{t+1}, and a threshold $\bar{\omega}$ of entrepreneur's idiosyncratic shock such that for values greater than the threshold the entrepreneur is able to repay the loan at the contractual rate, Z_{t+1}. That is, $\bar{\omega}$ is defined by

$$\begin{aligned}\bar{\omega}_{t+1}P_{t+1}R^k_{t+1}Q_tK_{t+1} &= Z_{t+1}S_{t+1}D^{*e}_{t+1},\\ \bar{\omega}_{t+1}\zeta_{t+1}Q_tK_{t+1} &= Z_{t+1}D^{*e}_{t+1},\end{aligned} \tag{25}$$

where $\zeta_{t+1} \equiv \frac{P_{t+1}}{S_{t+1}}R^k_{t+1}$. The opportunity cost of capital for the lender is the risk-free rate R^*_t because the only risk she is facing is perfectly diversifiable. Accordingly, the loan contract must satisfy:

$$\begin{aligned}\left[1-F\left(\bar{\omega}\right)\right]Z_{t+1}D^{*e}_{t+1} + \left(1-\mu\right)F\left(\bar{\omega}\right)\mathrm{E}\left[\omega R^k_{t+1}Q_tK_{t+1}\middle|\,\omega<\bar{\omega}0\right] &= R^*_t\frac{S_{t+1}}{P_{t+1}}D^{*e}_{t+1}\\ \left\{\left[1-F\left(\bar{\omega}\right)\right]\bar{\omega} + \left(1-\mu\right)\int_0^{\bar{\omega}}\omega dF\left(\omega\right)\right\}R^k_{t+1}Q_tK_{t+1} &= R^*_t\frac{S_{t+1}}{P_{t+1}}\frac{P_t}{S_t}\left(Q_tK^j_{t+1}-N^j_{t+1}\right)\end{aligned} \tag{26}$$

With aggregate uncertainty With aggregate uncertainty, $\bar{\omega}$ will depend on the ex-post realization of $R^k_{t+1}\frac{P_{t+1}}{S_{t+1}}$. However, the assumption of entrepreneurs being risk-neutral leads to a simple contract structure. In this setting, the contract is characterized by a schedule of $(Z_{t+1}, \bar{\omega}_{t+1})$ contingent on ζ_{t+1}. Notice that higher values of ζ_{t+1} imply lower values of the loan gross rate, as shown by (25). This value increases in case of greater realized aggregate return on capital, higher inflation or a lower realized exchange rate. Given the state-contingent debt form of the optimal contract, the expected return to the entrepreneur may be expressed as:

$$\begin{aligned}\max_{Z_{t+1},\bar{\omega}_{t+1}}\ &\mathbb{E}\left[\int_{\bar{\omega}_{t+1}}^{\infty}\omega\mathrm{d}F\left(\omega\right) - \left(1-F\left(\bar{\omega}_{t+1}\right)\right)\bar{\omega}_{t+1}\right]R^k_{t+1}Q_tK_{t+1},\\ \text{s.t.}\ &\left[\left(1-\mu\right)\int_0^{\bar{\omega}_{t+1}}\omega\mathrm{d}F\left(\omega\right) + \left(1-F\left(\bar{\omega}_{t+1}\right)\right)\bar{\omega}_{t+1}\right] = \frac{R^*_{t+1}D^{*,e}_{t+1}}{\zeta_{t+1}Q_tK_{t+1}}\end{aligned}$$

where expectations are taken with respect to to the random variable ζ_{t+1}, and it is understood that the threshold may be made contingent on the realization of this variable. Let $\Gamma\left(\bar{\omega}\right)$ be:

$$\Gamma\left(\bar{\omega}\right) \equiv \underbrace{\int_0^{\bar{\omega}_{t+1}}\omega\mathrm{d}F\left(\omega\right)}_{\text{share from defaults}} + \underbrace{\int_{\bar{\omega}_{t+1}}^{\infty}\bar{\omega}_{t+1}\mathrm{d}F\left(\omega\right)}_{\text{share from full repayment}},$$

the share of payments to the lender and let $\mu G\left(\bar{\omega}_{t+1}\right) \equiv \mu\int_0^{\bar{\omega}_{t+1}}\omega\mathrm{d}F\left(\omega\right)$ be the expected monitoring costs. So the net share of revenue to the lender is $\Gamma\left(\bar{\omega}_{t+1}\right) - \mu G\left(\bar{\omega}_{t+1}\right)$, the share going to the entrepreneur is $1-\Gamma\left(\bar{\omega}_{t+1}\right)$ and the share of resources used in monitoring is $\mu G\left(\bar{\omega}_{t+1}\right)$ (of course this shares sum up to one). To ease notation let us work without sub-indices and use primes to indicate next period variables. Let $s = R^k/\left(R^*\mathbb{E}\left[\frac{S'}{P'}\right]\frac{P}{S}\right)$ be the ex-post return on capital premium, $k = QK/N$ be the leverage level, $\tilde{u}_k = \left(R^k\right)'/\mathbb{E}\left\{\left(R^k\right)'\right\}$ be the aggregate shock to the return on capital, and $\tilde{u}_s \equiv \left(S'/P'\right)/\mathbb{E}\left[S'/P'\right]$ be the shock to the borrowing cost. The optimal contracting problem may now be written as entrepreneurs choosing leverage k and a schedule of cutoffs to maximize their expected return:

$$\begin{aligned}&\max_{k,\bar{\omega}}\mathbb{E}\left[\left(1-\Gamma\left(\bar{\omega}\right)\right)\tilde{u}_k sk\right]\\ &\quad\text{s.t}\ \left[\Gamma\left(\bar{\omega}\right)-\mu G\left(\bar{\omega}\right)\right]\tilde{u}_k sk = \tilde{u}_s\left(k-1\right)\end{aligned}$$

Comparative statics on first order conditions yield the following relationship:

$$\begin{aligned}\mathbb{E}\left[s\right] &= \chi\left(k\right), \quad \chi'\left(\cdot\right)>0,\\ \mathbb{E}\left[R^k\right] &= \chi\left(\frac{QK}{N}\right)R^*\mathbb{E}\left[\frac{S'}{P'}\right]\frac{P}{S},\end{aligned}$$

where the **ex-ante return on capital premium** is an increasing function of the leverage ratio. Now, introducing time sub-indeces we obtain:

$$\mathbb{E}\left[R_{t+1}^{k}\right]=\chi\left(\frac{Q_{t}K_{t+1}}{N_{t+1}}\right)R_{t}^{*}\mathbb{E}\left[\frac{S_{t+1}}{P_{t+1}}\right]\frac{P_{t}}{S_{t}}.$$

2.3.3 Entrepreneur's production, consumption and dynamics

Entrepreneur's production
Entrepreneur's individual production technology is given by:

$$Y_{t}^{j}=\omega^{j}A_{t}K_{t}^{\alpha}L_{t}^{1-\alpha} \tag{27}$$

while average output[5] is $Y_{t}^{H}=A_{t}K_{t}^{\alpha}L_{t}^{1-\alpha}$ and $L_{t}=\left(H_{t}^{e}\right)^{\Omega}H_{t}^{1-\Omega}$. Entrepreneurs profits on capital are composed by revenues from sales, net capital appreciation and labor costs. Firms real program is to maximize its profit on capital:

$$\max_{\{H_{t},H_{t}^{e}\}}\frac{P_{W,t}}{P_{t}}Y_{t}+\left(Q_{t}+r_{t}^{l}-\frac{P_{I,t}}{P_{t}}\delta\right)K_{t}-\frac{W_{t}}{P_{t}}H_{t}-\frac{W_{t}^{e}}{P_{t}}H_{t}^{e} \tag{28}$$

$$(1-\alpha)(1-\Omega)\frac{Y_{t}^{H}}{H_{t}}=\frac{W_{t}}{P_{W,t}} \tag{29}$$

$$(1-\alpha)\Omega\frac{Y_{t}^{H}}{H_{t}^{e}}=\frac{W_{t}^{e}}{P_{W,t}} \tag{30}$$

where entrepreneurial labor, H_{t}^{e}, is taken as parameter and set equal to 1. The definition of return on capital is equal to profits on capital divided by the value of capital

$$R_{t}^{k}=\frac{P_{W,t}}{P_{t}}\alpha\frac{Y_{t}^{H}}{K_{t}Q_{t-1}}-\frac{P_{I,t}}{P_{t}}\frac{\delta}{Q_{t-1}}+\frac{Q_{t}+r_{t}^{l}}{Q_{t-1}}.$$

Entrepreneur's consumption and dynamics
Entrepreneurs net worth at the start of the period is denoted by V_{t}. This includes profits on capital and debt repayment. Following, $(1-\phi)$ portion of entrepreneurs go out of business and consume their respective portion of V_{t}; then, current period net worth N_{t+1}[6] is composed of the portion left of V_{t} and entrepreneur's real wage. Notice that even in the case of $V_{t}=0$ net worth will be positive because of entrepreneur's real wage,

$$V_{t}=R_{t}^{k}Q_{t-1}K_{t}-\Lambda_{t}S_{t}D_{t}^{e,*}/P_{t}$$

$$V_{t}=R_{t}^{k}Q_{t-1}K_{t}-\left(R_{t}^{*}+\underbrace{\frac{\mu\int_{0}^{\bar{\omega}_{t}}\omega dF(\omega)R_{t}^{k}Q_{t}K_{t}}{S_{t}D_{t}^{e,*}/P_{t}}}_{\text{external finance premium}}\right)S_{t}D_{t}^{e,*}/P_{t}$$

$$V_{t}=\left[\left(1-\mu\int_{0}^{\bar{\omega}_{t}}\omega dF(\omega)\right)R_{t}^{k}-R_{t}^{*}\frac{S_{t}}{S_{t-1}}\frac{P_{t-1}}{P_{t}}\right]Q_{t-1}K_{t}+R_{t}^{*}\frac{S_{t}}{S_{t-1}}\frac{P_{t-1}}{P_{t}}N_{t} \tag{31}$$

$$N_{t+1}=\phi V_{t}+\frac{W_{t}^{e}}{P_{t}} \tag{32}$$

$$C_{t}^{e}=(1-\phi)V_{t}. \tag{33}$$

[5] Notice that because entrepreneurs are a indexed by a continuum, the law of large numbers guarantees that average output is "exactly" $\bar{Y}_{t}^{H}=A_{t}K_{t}^{\alpha}L_{t}^{1-\alpha}$.

[6] It is indexed $t+1$ because this is the net worth that is going to affect the conditions when financing K_{t+1} which is indexed according to the period in which it will be used.

where Λ_t is the **ex-post cost of external finance,** following Bernanke et al. (1999). Notice that (32) may be written as a first order difference equation in N_t. Collecting terms we can write the following budget constraint for entrepreneurs:

$$\underbrace{P_{W,t}Y_t^H + \left(Q_t + r_t^l\right) K_t}_{\text{Income and capital appreciation}} - \underbrace{(W_tH_t + P_{I,t}\delta K_t)}_{\text{production costs}} - \underbrace{\Lambda_t S_t D_t^{e,*}}_{\text{debt repayment}} - \underbrace{P_tC_t^e}_{\text{consumption}} = \underbrace{P_tN_{t+1}}_{\text{net worth}}.$$

2.4 Capital producers

To build new capital, producers use both investment goods and existing capital, which they lease from entrepreneurs. Then net investment follows:

$$I_t^n = I_t - \delta K_t. \tag{34}$$

Each capital producer operates a constant returns to scale technology to produce new capital. Consistent with the notion of adjustment costs for net investment, $\Phi(\cdot)$ is increasing and concave. The resulting economy-wide capital accumulation equation is:

$$K_{t+1} - K_t = \Phi\left(\frac{I_t^n}{K_t}\right) K_t$$

Capital producers choose net investment I_t^n and K_t to maximize expected profits from the construction of new investment goods. New capital goods are sold at a price Q_t (units of the consumption bundle). The investment good are used to produce new capital and to repair depreciated capital. Investment is composed following a CES composite: $I_t = \left[\gamma_i^{\frac{1}{\rho_i}} \left(I_t^H\right)^{\frac{\rho_i-1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}} \left(I_t^F\right)^{\frac{\rho_i-1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i-1}}$. The composition of investment will respond to the elasticity of substitution and the relative prices of home and foreign goods resulting in the following intratemporal first-order condition:

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{(1-\gamma_i)}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_i}. \tag{35}$$

The corresponding investment price index (IPI) is: $P_{I,t} = \left[\gamma_i \left(P_t^H\right)^{1-\rho_i} + (1-\gamma_i)\left(P_t^F\right)^{1-\rho_i}\right]^{\frac{1}{1-\rho_i}}$. Following Bernanke et al. (1999) capital producers make their decisions one period in advance. So the capital producer's t period program is:

$$\max_{\{I_t^n, K_t\}} \mathrm{E}_{t-1}\left[Q_t\Phi\left(\frac{I_t^n}{K_t}\right) K_t - \frac{P_{I,t}}{P_t} I_t^n - \frac{r_t^l}{P_t} K_t\right] \tag{36}$$

And first order conditions are:

$$\begin{aligned} I_t^n &: \mathrm{E}_{t-1}\left[Q_t\Phi'\left(\frac{I_t^n}{K_t}\right) - \frac{P_{I,t}}{P_t}\right] = 0 \\ K_t &: \mathrm{E}_{t-1}\left[Q_t\left(\Phi'\left(\frac{I_t^n}{K_t}\right)\left(-\frac{I_t^n}{K_t^2}\right)K_t + \Phi\left(\frac{I_t^n}{K_t}\right)\right) - r_t^l\right] = 0. \end{aligned} \tag{37}$$

2.4.1 Financial Accelerator

The financial accelerator main equation is the demand for capital:

$$\mathbb{E}\left[R_{t+1}^k\right] = \chi\left(\frac{Q_tK_{t+1}}{N_{t+1}}\right) R_t^*\mathbb{E}\left[\frac{S_{t+1}}{P_{t+1}}\right]\frac{P_t}{S_t}$$

where $\ell_t = Q_tK_{t+1}/N_{t+1}$.

2.4.2 Goods Market Clearing

In this section we include the consumption of entrepreneurs and the cost associated with the CSV friction.

$$Y_t^H = C_t^H + C_t^{eH} + C_t^{H*} + I_t^H + \mu \int_0^{\bar{\omega}_t} \omega \mathrm{d}F(\omega) R_t^k Q_{t-1} K_t \tag{38}$$

2.4.3 Current Account

We start expressing the current account in dollars:

$$P_{W,t} Y_t^H + P_t Q_t K_{t+1} + R_{t-1} B_t + R_{t-1}^* S_t B_t^{f,*} + R_{t-1} B_t^f + R_{t-1}^* S_t B_t^{cb,*} + R_{t-1} B_t^{cb} =$$
$$B_{t+1} + P_t \left(C_t + C_t^e + \mu G(\bar{\omega}) R_t^k Q_{t-1} K_t \right) + P_{I,t} I_t + S_t B_{t+1}^{f,*} + B_{t+1}^f + S_t B_{t+1}^{cb,*} + B_{t+1}^{cb} + P_t N_{t+1} + S_t R_{t-1}^* D_t^{e,*}$$

In pesos we obtain:

$$P_{W,t} Y_t^H + P_t Q_t K_{t+1} + R_{t-1} B_t + R_{t-1}^* S_t B_t^{f,*} + R_{t-1} B_t^f + R_{t-1}^* S_t B_t^{cb,*} + R_{t-1} B_t^{cb} = \tag{39}$$
$$B_{t+1} + P_t \left(C_t + C_t^e + \mu G(\bar{\omega}) R_t^k Q_{t-1} K_t \right) + P_{I,t} I_t + S_t B_{t+1}^{f,*} + B_{t+1}^f + S_t B_{t+1}^{cb,*} + B_{t+1}^{cb} + P_t N_{t+1} + R_{t-1}^* D_t^{e,*} \tag{40}$$

Using the pesos bond market equilibrium for the dollar expression:

$$B_{t+1}^f + B_{t+1}^{cb} + B_{t+1} = -B_{t+1}^t = S_t B_{t+1}^{t,*} \tag{41}$$

and for pesos:

$$B_{t+1}^f + B_{t+1}^{cb} + B_{t+1} = -B_{t+1}^t + D_{t+1}^e = S_t B_{t+1}^{t,*} + D_{t+1}^e \tag{42}$$

Some algebra leads to:

$$S_t \left(B_{t+1}^{f,*} + B_{t+1}^{cb,*} - D_{t+1}^{e,*} \right) = \mathcal{A}_t$$

$$\begin{aligned}
NX_t + R_{t-1} \left(S_t B_t^{t,*} + D_t^e \right) + R_{t-1}^* S_t B_t^{f,*} + R_{t-1}^* S_t B_t^{cb,*} - R_{t-1}^* D_t^{e,*} = \\
= S_t B_{t+1}^{t,*} + D_{t+1}^e + S_t B_{t+1}^{f,*} + S_t B_{t+1}^{cb,*} - D_{t+1}^{e,*} \qquad (43) \\
NX_t + i_{t-1} S_t B_t^{t,*} + i_{t-1}^* S_t B_t^{f,*} + i_{t-1}^* S_t B_t^{cb,*} = S_t \Delta B_{t+1}^{t,*} + S_t \Delta B_{t+1}^{f,*} + S_t \Delta B_{t+1}^{cb,*} \\
= \Delta \left(S_t B_{t+1}^{t,*} + S_t B_{t+1}^{f,*} + S_t B_{t+1}^{cb,*} \right) \\
= \Delta \mathcal{A}_t \qquad (44)
\end{aligned}$$

$$NX_{ss} = S_{ss} \left(\beta^{-1} - 1 \right) D_{ss}^{e,*} \tag{45}$$

Replacing the households bonds via the market clearing condition and zero capital strategies yields. The net foreign asset position is denoted by

$$\mathcal{A}_t = S_t B_{t+1}^{t,*} + S_t B_{t+1}^{f,*} + S_t B_{t+1}^{cb,*} - S_t D_{t+1}^{e,*}$$

3 Model Parametrization

In this section, we discuss the calibration of the model. We take as our baseline calibration the one in Gertler et al. (2007) to compare our results with theirs. Then, we depart from this baseline calibration to reflect parameters closer to the ones used in more recent literature.

Preferences. The quarterly discount factor β is set to 0.99, which implies a real interest rate of 4% in the steady state. The functional form of the utility is logarithmic GHH. The elasticity of the labor supply is set to 0.2, within the values found in empirical studies[7]. The value for the elasticity of substitution between home and foreign consumption goods, is set to 1. We follow previous studies in the DSGE literature, which consider values between 0.75 and 1.5.[8] We follow Gertler et al. (2007) by posting a lower intratemporal elasticity of substitution for the investment composite, setting $\rho_i = 0.25$. We also set the share of domestic goods in the CPI is set to 0.5, implying a participation of imported final goods of 50% in the domestic CPI. The elasticity of the labor supply is equal to 2.

Technology. For our baseline calibration we follow Gertler et al. (2007), who match the 1990-2002 data for South Korea. The main parameters are α, the share of capital in production, to 0.5, also γ_i equal to 0.5, and the steady state share of exports to domestic output to 0.4. The entrepreneurial labour is set to 1% and the capital depreciation rate to 0.025.

Financial Markets. The entrepreneurs' survival rate is 96% and monitoring costs are 12% as in Bernanke et al. (1999). The financial intermediaries' coefficient of absolute risk aversion is set to 0.1 and its size is set to 1. The elasticity of risk premium with respect to leverage is 1.13. Exchange rate volatility and the standard deviation of the exchange rate shock are 0.1; as well as the standard deviation of the foreign interest rate shock.

[7]See MaCurdy (1981)

[8]See Rabanal and Tuesta (2010). Other authors in the trade literature find values for this elasticity around 5, see Lai and Trefler (2002).

Table 1: Baseline Calibration

Parameter	Value	Description
Preference parameters		
β	0.99	Household time-preference parameter
$1/\upsilon$	0.2	Frisch elasticity
γ_c	2	Household CRRA
γ_{ghh}	5	Logarithmic GHH
γ	0.75	Share of domestic good in consumption
ρ_c	1	Consumption elasticity of substitution
Technology parameters		
α	0.5	Capital share in output
Ω	0.01	Entrepreneur share in labor composite
δ	0.02	Quarterly capital depreciation
γ_I	0.6	Share of domestic good in investment
σ_A	0.01	S.D. of TFP shock
Financial Markets parameters		
ϕ	0.96	Entrepreneur's survival rate
μ	0.12	Proportional monitoring cost
m	1	Size of FX dealer market
ω	500	Absolute risk aversion parameter (dealers)
υ_χ	0.7	Elasticity of risk premium to leverage
σ_ψ	0.03	S.D of Portfolio shock
σ_{r^*}	0.03	S.D. of foreign interest rate shock

4 Model Dynamics

4.1 Model with Capital, no accelerator

4.1.1 Reaction to an external portfolio flows shock

An external portfolio flows shock without the financial accelerator (see Fig. 3 and 4), generate a contractionary depreciation. As foreign investors pull out their funds, financial intermediaries demand a higher premia for holding a short dollar position by increasing the interest rate in domestic bonds and the exchange rate. The higher interest rate generates a fall in investment and consumption, together with wages, labour and output. The current account and trade balance expand, an we obtain a negative correlation between this variable and output.

4.1.2 Reaction to an external premium shock

An external risk premium shock without the financial accelerator (see Fig. 5 and 6), create similar dynamics. We observe a contraction of output, consumption, labor, wage, capital and the price of capital, together with an currency depreciation. The higher risk premium ends up being reflected in the interest rate agents face, leading to the contraction of the economy.

4.2 Model with Capital and a financial accelerator

Now we analyze the dynamics when the financial accelerator is active. With it, the dynamics of entrepreneurs' leverage ratio will impact the transmission mechanism of shocks.

4.2.1 Peso debt

When debt is in pesos, a portfolio shock still generates contractionary dynamics. The interest rate is pressured, although the requested capital return rate falls as the leverage drops. The FXI rule based on reactions to portfolio shocks are capable of offsetting this response.
In the case of a risk premium shock the dynamics are similar, although the impact of the shock is amplified relative to the case without the financial accelerator.

4.2.2 Dollar debt

When debt is dollarized, a capital outflow creates a depreciation of the currency towards the dollars, triggering a fall in the entrepreneurs net worth, the shock is notably amplified, however, since after the depreciation the model calls for an expected appreciation, this reduces the interest rate that entrepreneurs face. The opposite forces of a higher risk premia and a lower interest rate, due to the expected appreciation, end with a lower interest rate for firms, which increase their capital and investment. Due to segmented financial markets, families still face a higher interest rate as financial intermediaries remain short in foreign currency, which is reflected in a fall in consumption and output.
The risk premium shock with dollar debt generates dynamics that might seem puzzling at first. The higher interest rates faced by entrepreneurs affect investment and capital accumulation, with a contraction of output and labour. Nonetheless, consumption increases. The reason behind is again linked to the assumption of segmented financial markets. Domestic agents face the domestic rate in pesos and the depreciation triggered by the higher risk premia generates a long position in dollars for financial intermediaries, that lowers the borrowing costs in domestic currency. Thus, families' consumption initially increases, although the general dynamics of the episode are contractionary.

5 FX Intervention

Following Galí and Monacelli (2005), we evaluate a set of optimal simple rules and rank them by calculating the welfare loss, expressed in terms of the proportion of each period's consumption that a typical household in the home economy would need to give up in a deterministic world so that its welfare is equal to the expected conditional utility in the stochastic case. More precisely, we calculate ω_c that satisfies the following equation.

$$\mathbb{E}_t\left[\sum_{t=0}^{\infty}\beta^t \ln C_t - \frac{L_t^{1+\chi}}{1+\chi}\right] = \frac{1}{1-\beta}\left[\ln\left(1-\frac{\omega_c}{10000}\right)C - \frac{L^{1+\chi}}{1+\chi}\right] \tag{46}$$

where variables without time subscripts denote their respective steady-state values. We consider the measures for conditional and unconditional welfare.[9]
By contrasting these rules with the optimal linear-quadratic plans, we can observe the welfare losses from following different rules and how welfare changes in more general setups.

5.1 FXI rules

We follow Montoro and Ortiz (2020a) by presenting a set of simple rules that are commonly discussed among policy makers. The first one takes into account the changes in the exchange rate, constituting a pure 'leaning-against-the-wind' (LAW) strategy.

$$B_{t+1}^{cb,*} = -\phi_s(\mathbb{E}S_{t+1} - S_t) \tag{47}$$

According to this rule, when the economy faces depreciation (appreciation) pressures on the domestic currency, the central bank sells (purchases) foreign bonds to prevent the exchange rate from fluctuating.

[9]For this measure we calculate the constant that makes the measure equivalent to the unconditional and conditional ergodic means of the calculated welfare variable, starting from the steady state.

Under the second rule, the central bank reacts to misalignments of the real exchange rate relative to its steady-state value. We call this strategy the 'real exchange rate stabilization rule (RER-ST).

$$B_{t+1}^{cb,*} = -\phi_q \left(Q_t - \bar{Q}\right) \tag{48}$$

We present a third rule, in which the central bank reacts directly to the noise shocks. We call this the 'portfolio-flows' rule (PF).

$$B_{t+1}^{cb,*} = -\phi_{n^*} N_{t+1}^* \tag{49}$$

Finally, we introduce a rule that reacts to the risk premium (RP):

$$B_{t+1}^{cb,*} = -\phi_{n^*} \mathbb{E}(R_t^k / R_t^*) \tag{50}$$

In order to set the values of these rules, we use the optimal simple rules command in Dynare to make a search for the parameter that maximizes welfare. In this manner, we consider the maximum welfare the central bank can achieve following a particular family of rules. We perform a robustness exercise to understand how the effectiveness of these rules depends on the structure of the economy.

5.1.1 Peso Debt

We report the results of the simulations for debt in pesos in tables 2-4. We report the standard deviation of key variables and the welfare, measured as a fraction of steady state consumption that agents are willing to give up to achieve the steady-state welfare level. Table 2 shows the highest welfare achieved by each family the above-mentioned rules when all shocks are considered. In this case, the rule that reacts to portfolio shocks achieves the highest welfare, closely followed by the leaning against the wind strategy. Notice from tables 4 and 3 that the central bank can easily offset shocks through FXI rules when the economy is hit by only one type of shock. Thus, the welfare ranking of rules when all shocks are present will be a function of the frequeny of shocks. The leaning-against-the-wind and risk premium rules seems to a better job stabilizing the economy when risk premium shocks are more prevalent.

5.1.2 Dollar Debt

Tables 5-7 present the results of the OSR analysis with dollarized debt. Once again FXI can improve welfare. For our baseline parametrization, the best strategy is to lean-against-the-wind, which absorbs portfolio shocks efficiently and allows for a higher level of consumption during risk premia shocks.

6 Conclusions

In this paper, we present a model to analyse analyze the interactions of investment and capital after the economy is hit by negative external financial shocks in presence of segmented international financial markets and a financial accelerator in domestic markets. We also study the role of dollarization in these dynamics.
We show that in presence of segmented financial markets, the question of 'which agent bears the currency risk' becomes non-trivial, which is important for the determination of a de-dollarization strategy. In case small open economies push for a de-facto de-dollarization, an episode of capital outflows/inflows will find financial intermediaries absorbing all the FX risk, which in turn deviates the exchange rate from its efficient level. In the case dollar debt is permitted, the pressure of currency mismatches will be absorbed by entrepreneurs, leading to balance sheet effects. The open position, in presence of an accelerator will amplify the business cycle reaction to external shocks. Although, an interesting channel at play is that after a depreciation, the expectation of a future appreciation creates positive dynamics for capital and investment.
Regarding FXI, our results illustrate that this tool, implemented in the form of simple rules can improve welfare by offsetting non-fundamental shocks to the economy and reducing the impact of risk shocks in international markets. As it is frequently the case, the effectiveness of the central bank will depend on the nature of the shock and its ability to identify it in a timely manner.
In future extensions of this paper we aim to explore the role of nominal frictions, the implementability of rules, and the optimality from a linear-quadratic approach.

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A Appendix

A.1 Tables and Figures

Figure 1: Response to a 1% standard deviation shock to TFP Shock

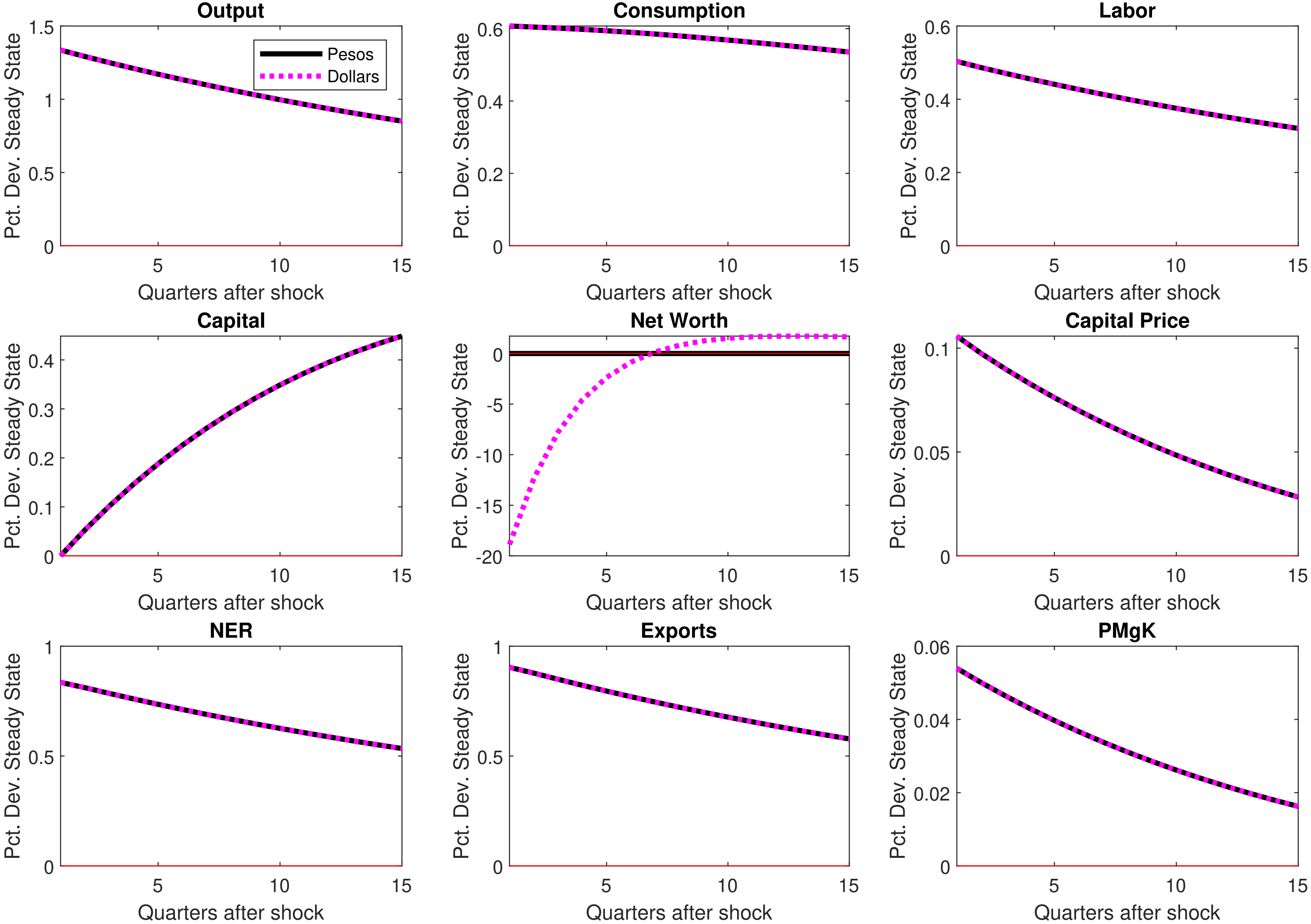


Figure 2: Response to a 1% standard deviation shock to TFP Shock

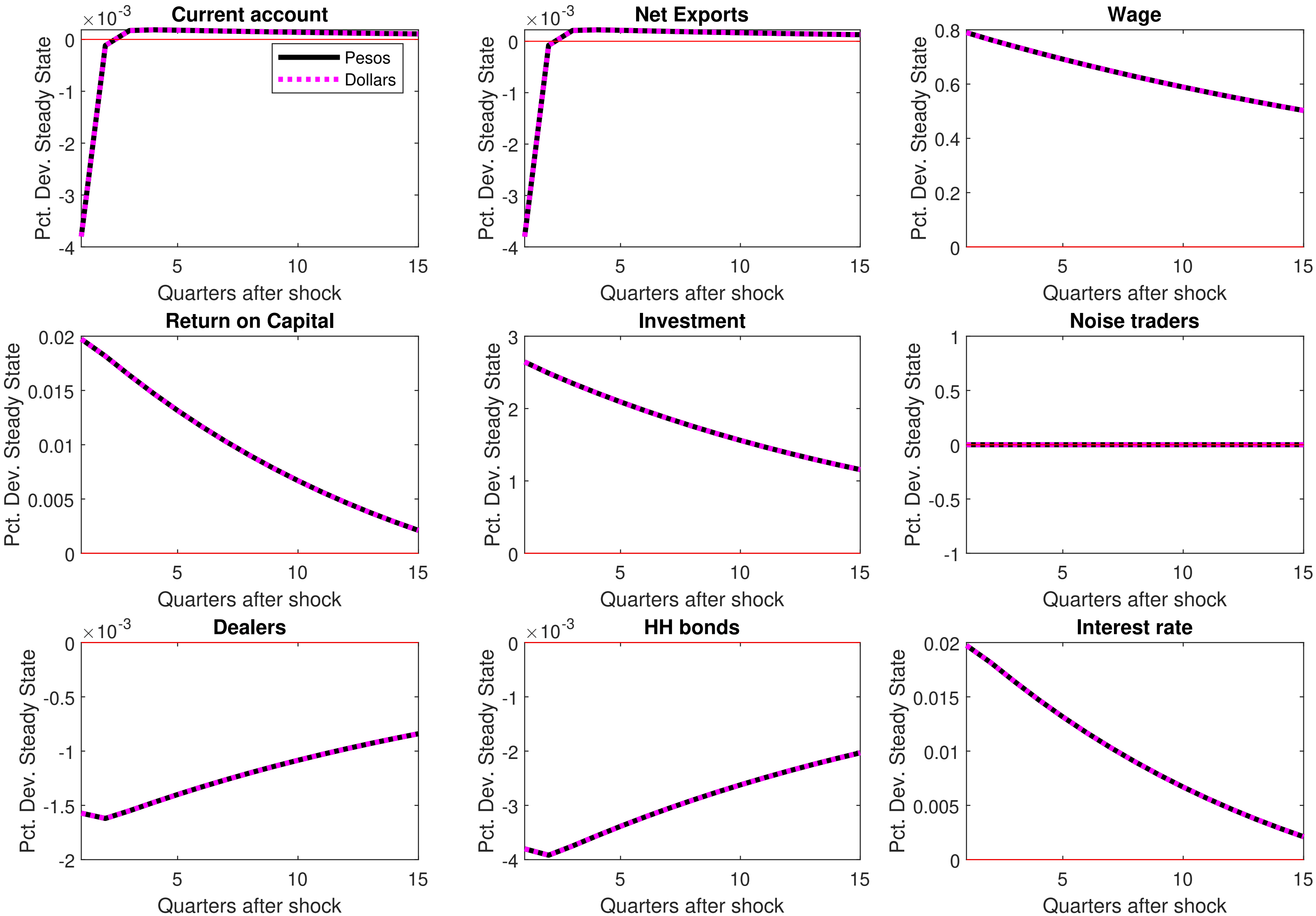


Figure 3: Response to a 1% standard deviation shock to Portfolio Shock

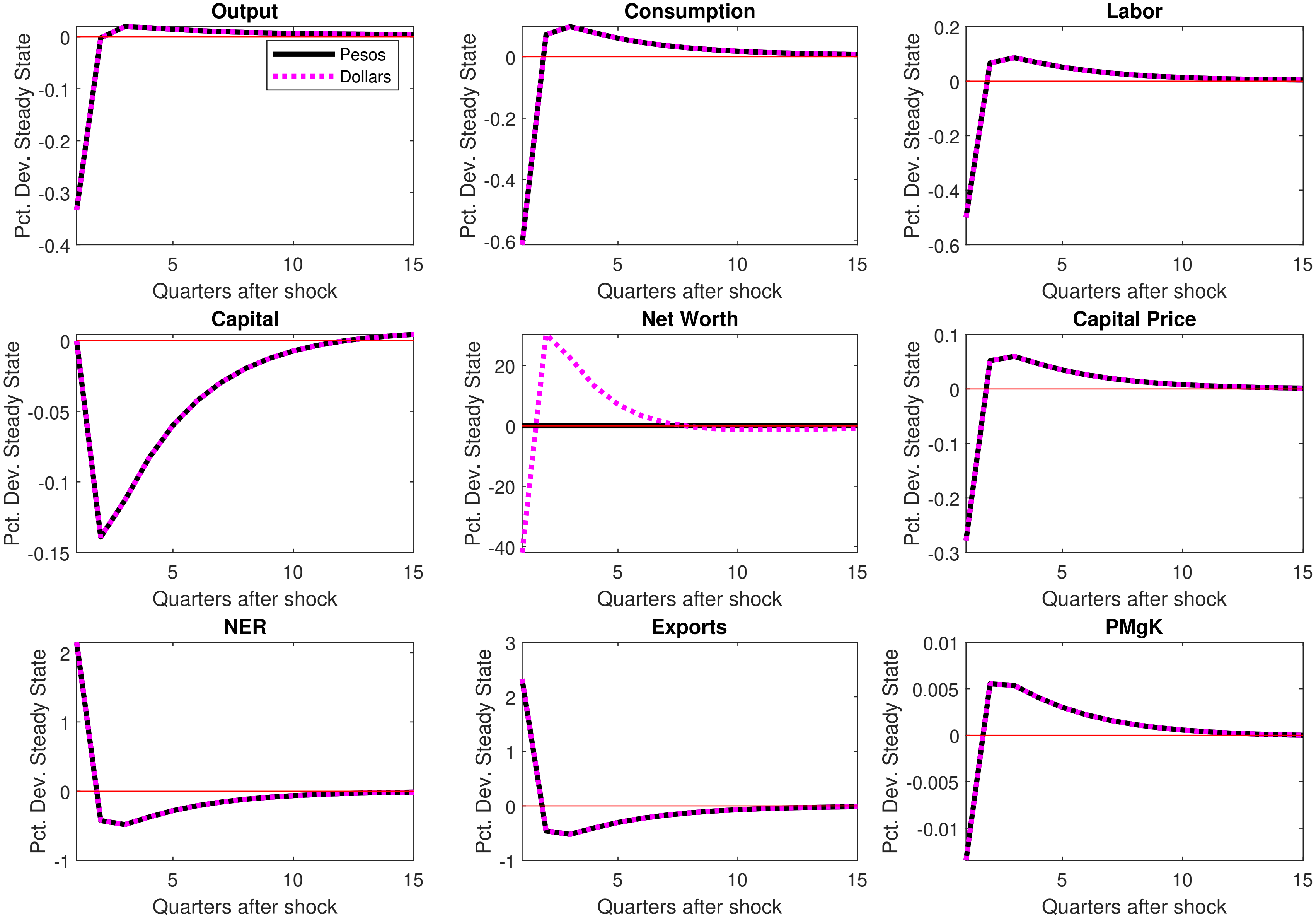


Figure 4: Response to a 1% standard deviation shock to Portfolio Shock

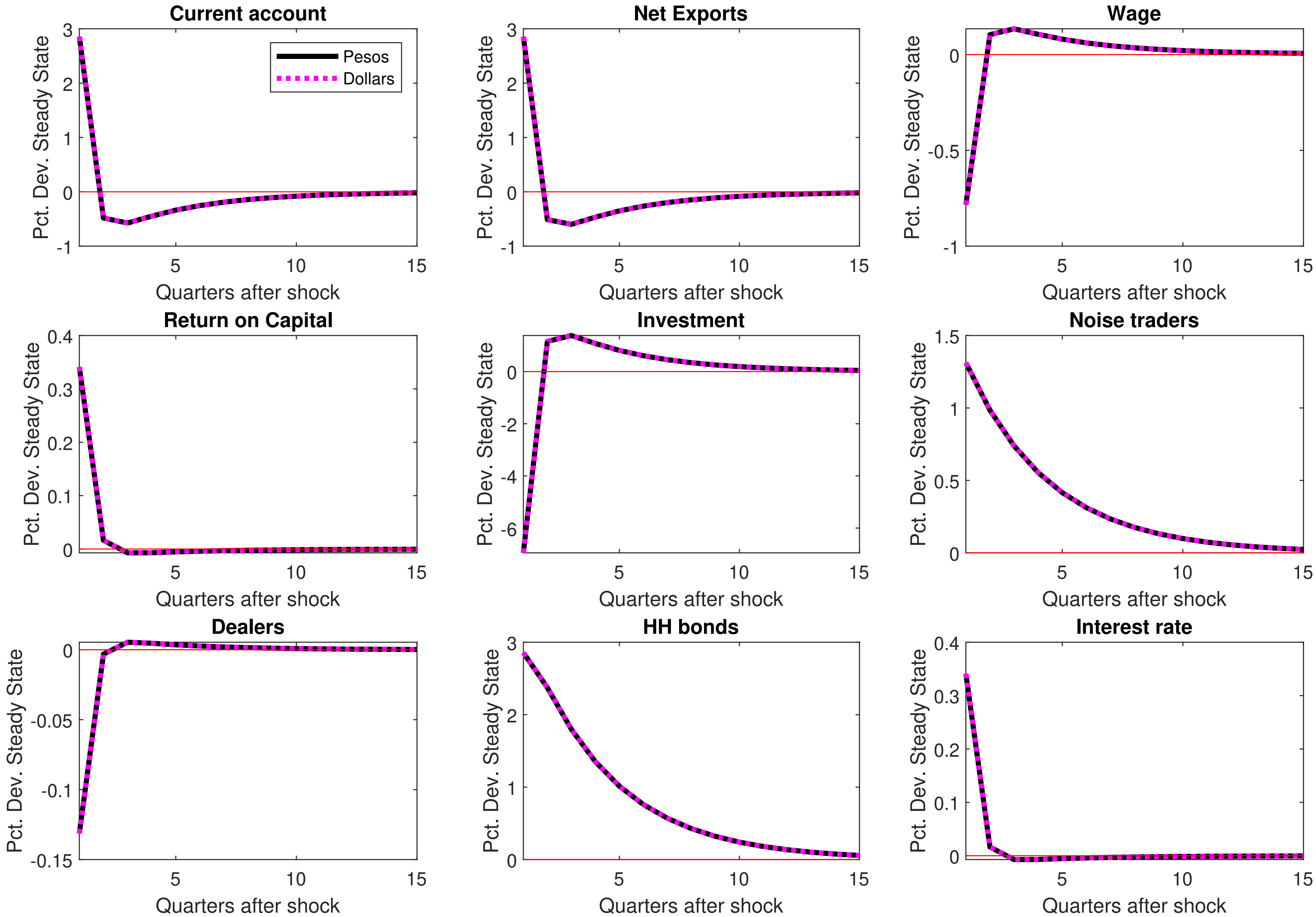


Figure 5: Response to a 1% standard deviation shock to Risk premium shock

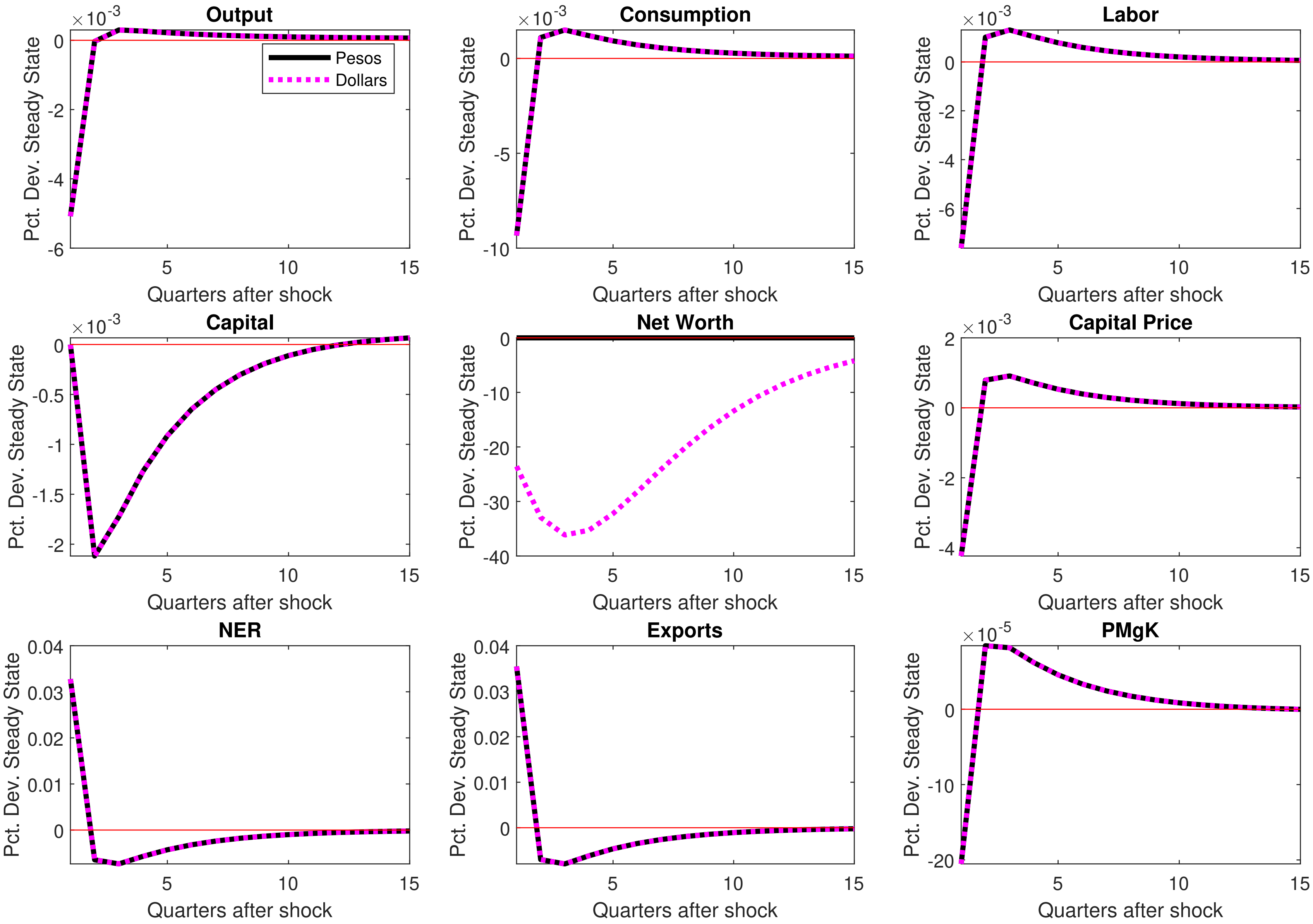


Figure 6: Response to a 1% standard deviation shock to Risk premium shock

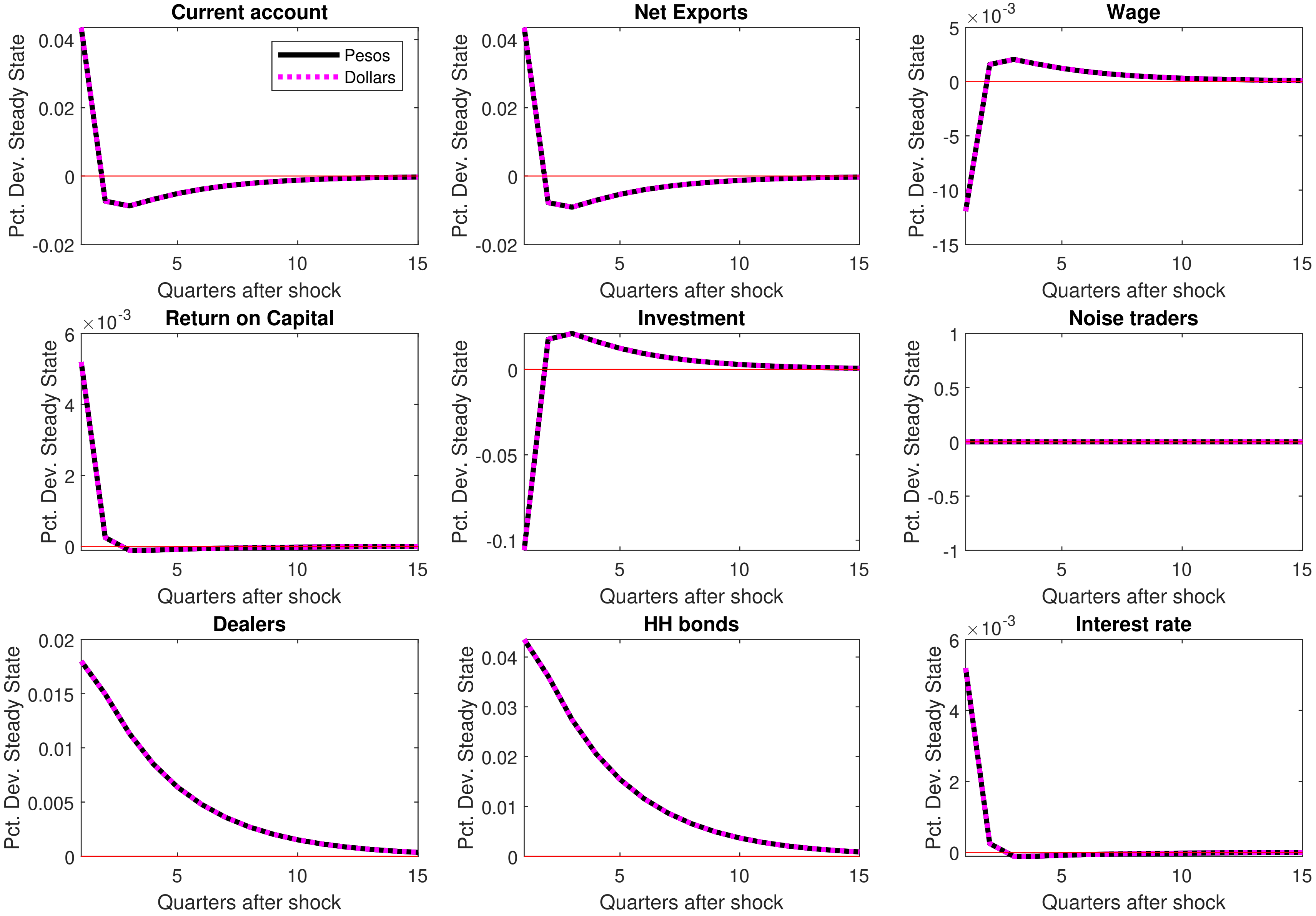


Figure 7: Response to a 1% standard deviation shock to TFP Shock: Pesos

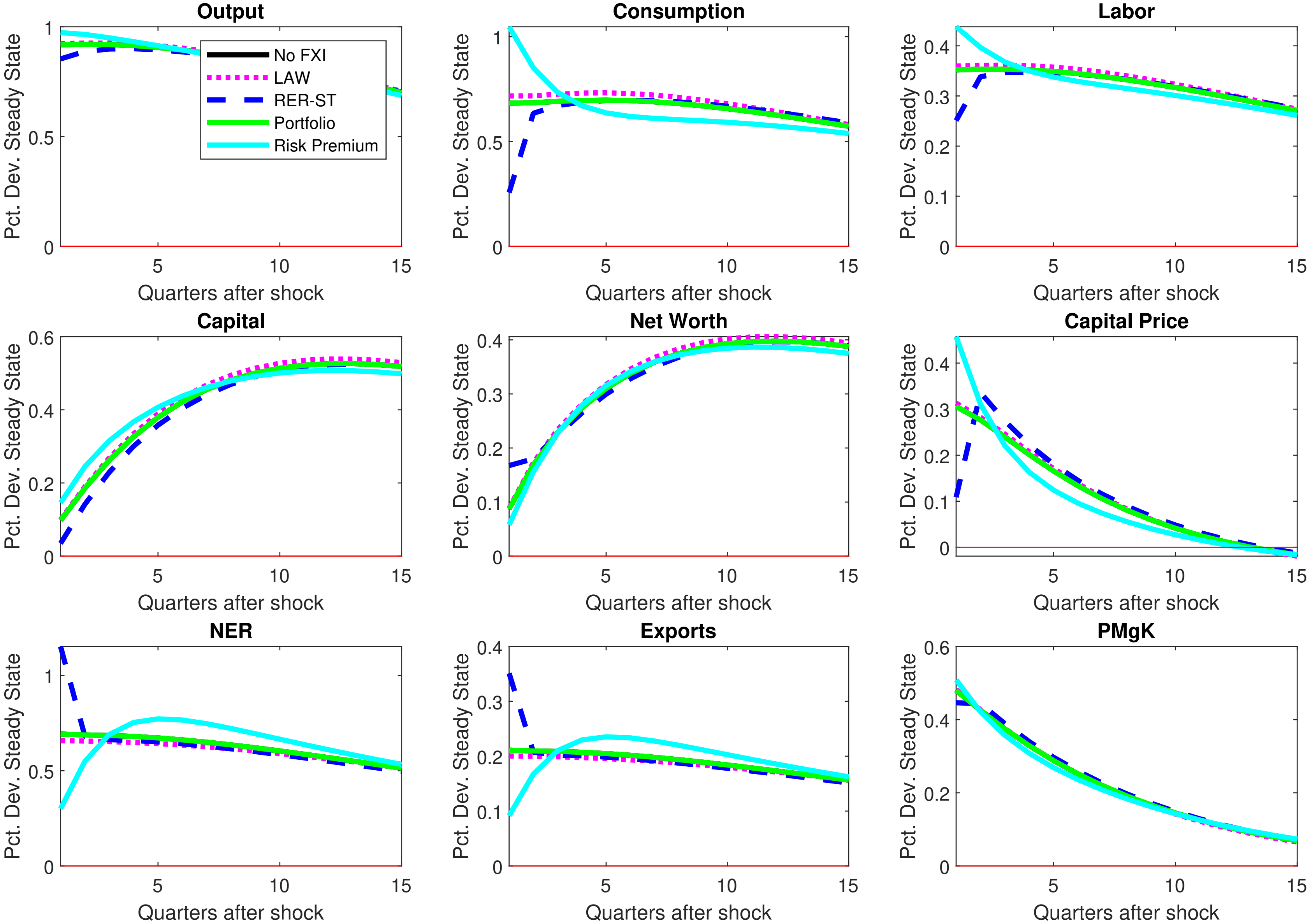


Figure 8: Response to a 1% standard deviation shock to Portfolio flows shock: Pesos

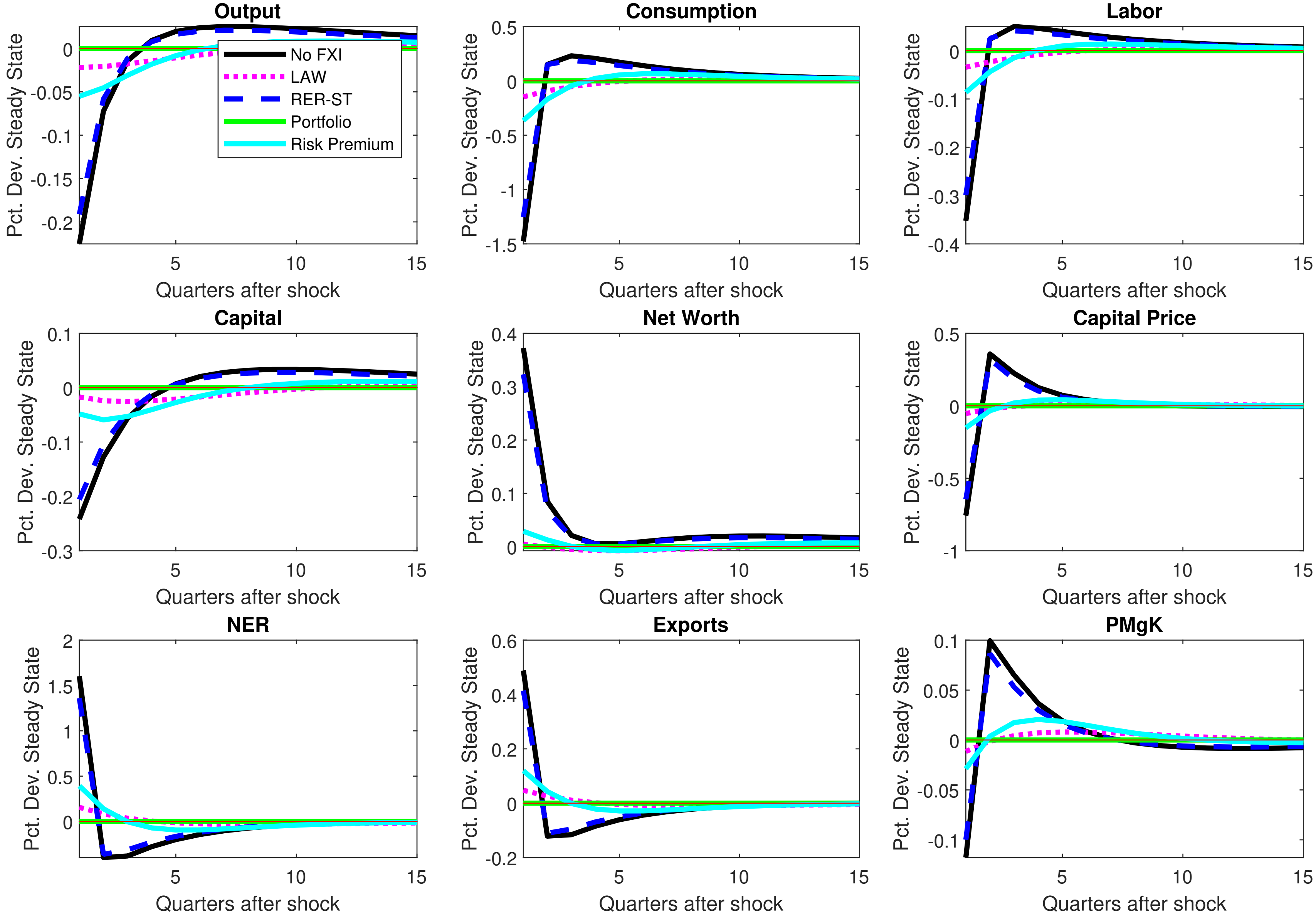


Figure 9: Response to a 1% standard deviation shock to Risk premium shock: Pesos

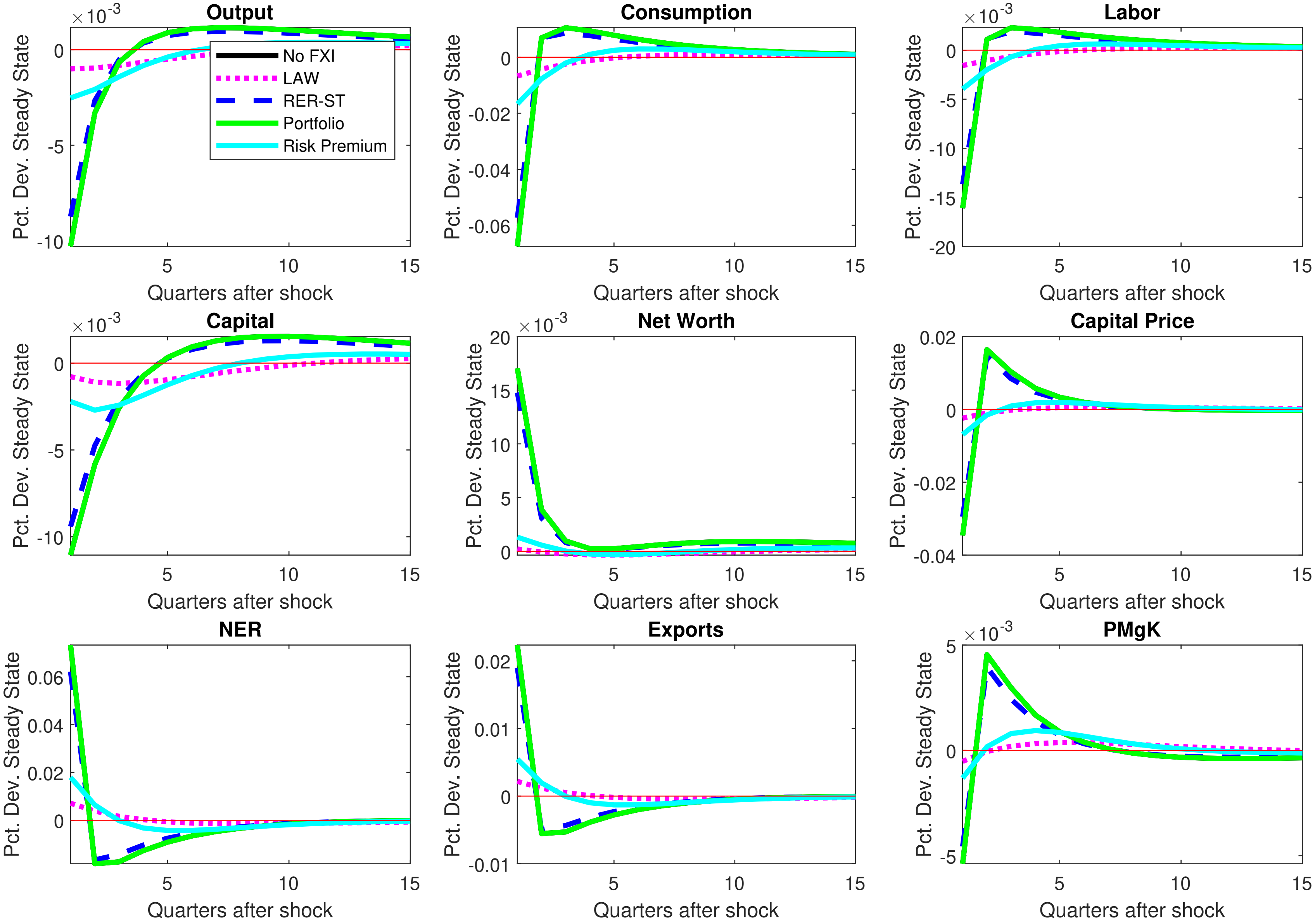


Figure 10: Response to a 1% standard deviation shock to TFP Shock: Dollar

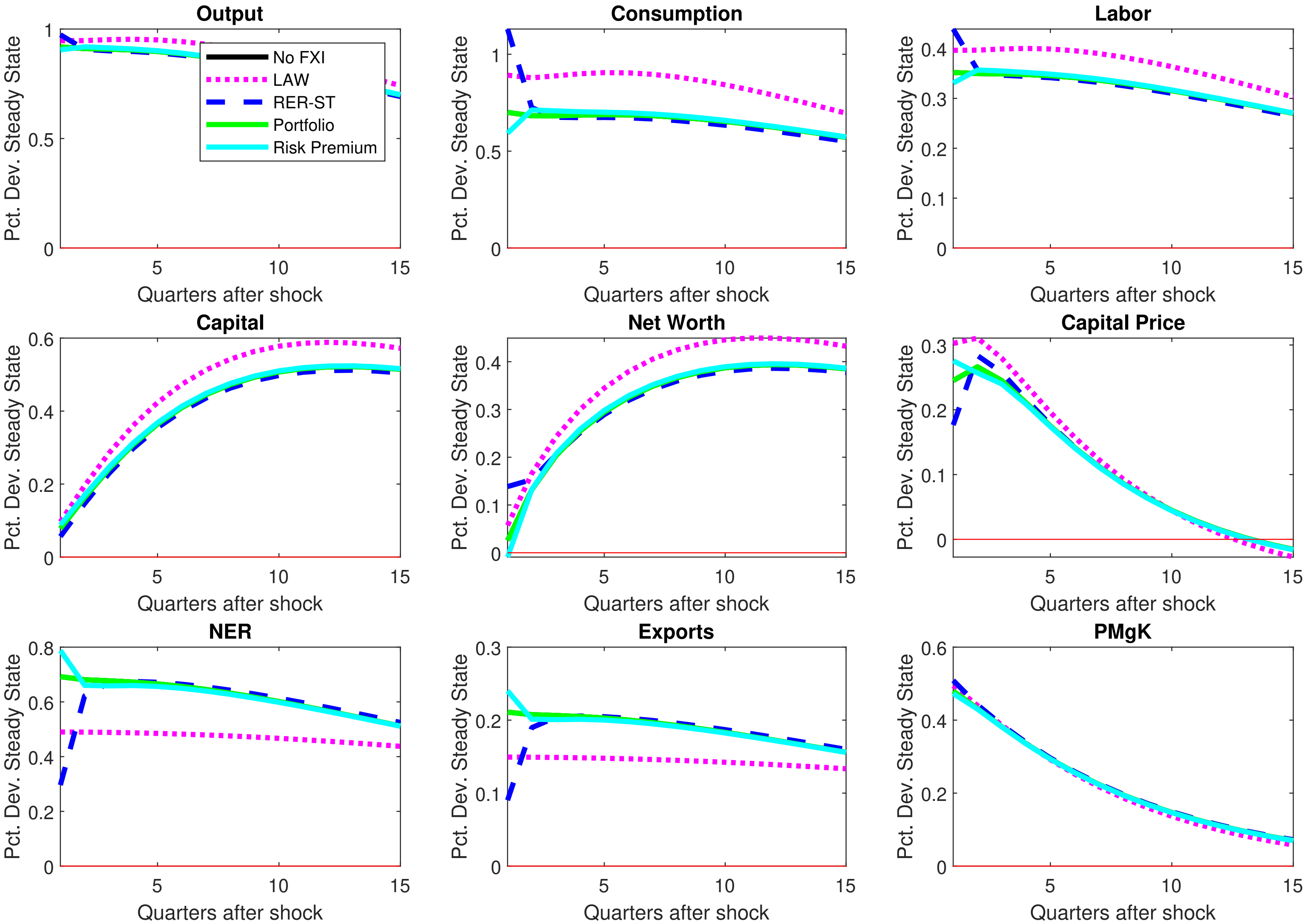


Figure 11: Response to a 1% standard deviation shock to Portfolio flows shock: Dollar

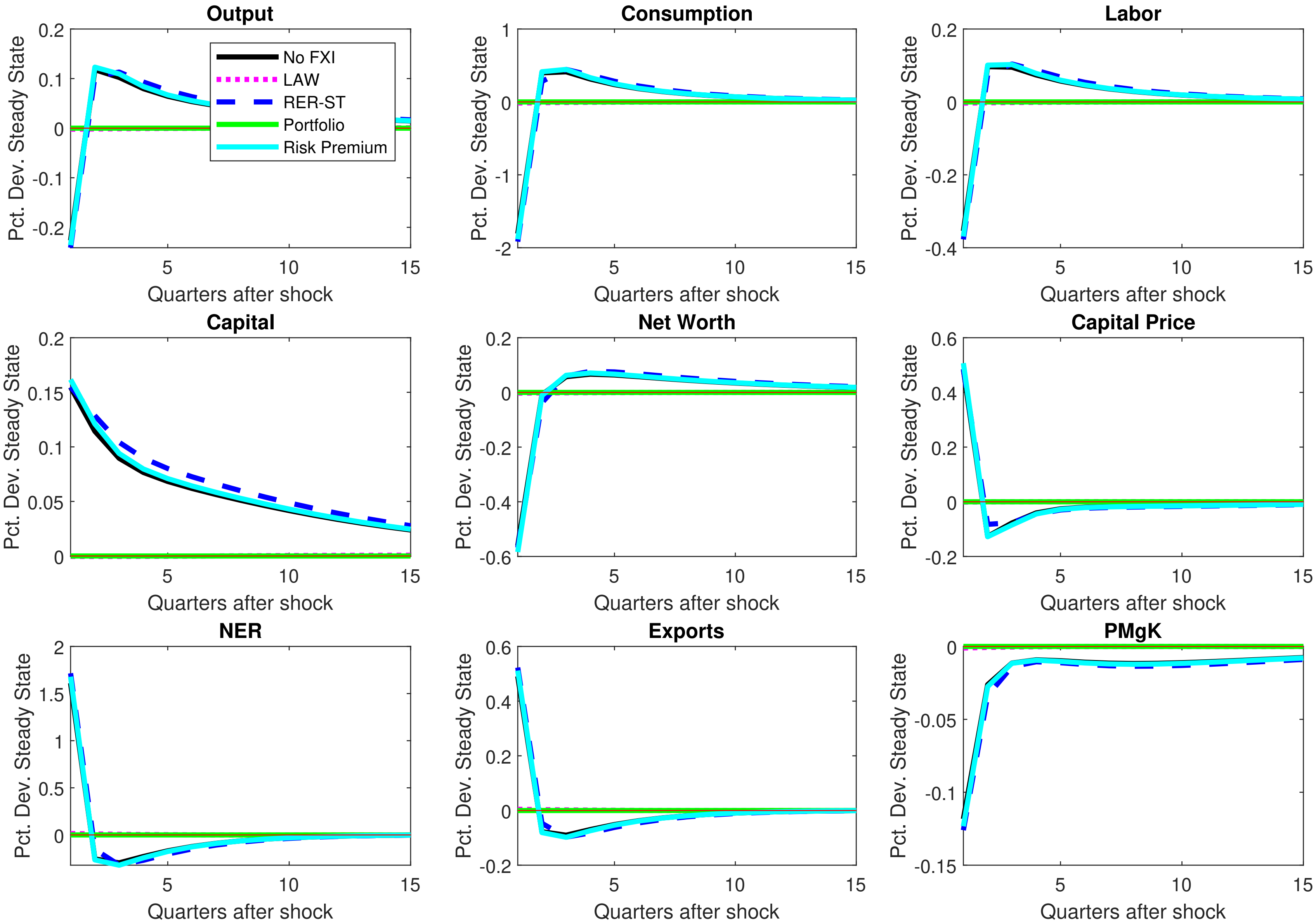
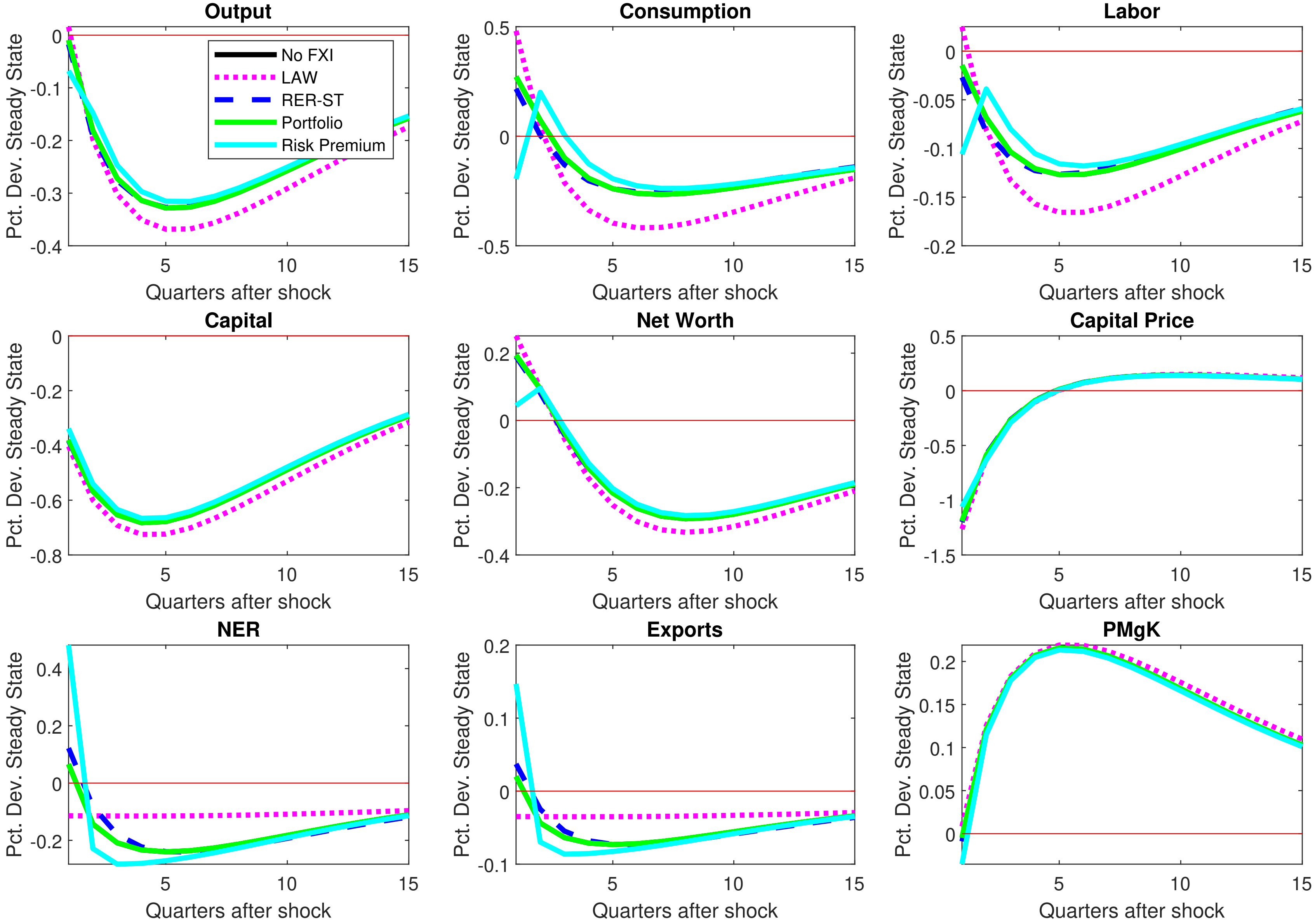


Figure 12: Response to a 1% standard deviation shock to Risk premium shock: Dollar



A.2 Tables: Results

Table 2: Standard Dev. and Welfare - Peso Debt (All shocks)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	5.82	5.83	5.78	5.80	5.81
$\sigma(W)$	2.43	2.39	2.40	2.36	2.39
$\sigma(L)$	2.21	2.17	2.18	2.15	2.17
$\sigma(C)$	5.00	4.59	4.86	4.51	4.69
$\sigma(K)$	4.10	4.11	4.09	4.07	4.07
$\sigma(Q)$	1.08	0.64	0.98	0.62	0.77
$\sigma(S)$	4.50	3.84	4.40	3.88	4.11
$\sigma(N)$	4.09	4.04	4.10	4.01	4.01
$\sigma(I)$	27.01	16.40	24.48	15.93	19.50
$\sigma(R_K)$	1.63	0.36	1.51	0.35	0.67
$\sigma(R)$	2.93	0.20	2.62	0.19	1.30
$Wunc.$	10.00	4.45	9.30	3.91	4.76
$Wcond$	9.44	3.97	8.73	3.35	4.31

Table 3: Standard Dev. and Welfare - Peso Debt (Portfolio shocks only)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	0.44	0.00	0.00	0.00	0.30
$\sigma(W)$	0.66	0.00	0.00	0.00	0.40
$\sigma(L)$	0.60	0.00	0.00	0.00	0.36
$\sigma(C)$	2.16	0.00	0.00	0.00	1.31
$\sigma(K)$	0.66	0.00	0.00	0.00	0.46
$\sigma(Q)$	0.80	0.00	0.00	0.00	0.37
$\sigma(S)$	2.73	0.00	0.00	0.00	1.57
$\sigma(N)$	0.82	0.00	0.00	0.00	0.32
$\sigma(I)$	32.85	0.00	0.00	0.00	16.75
$\sigma(R_K)$	1.60	0.00	0.00	0.00	0.58
$\sigma(R)$	2.80	0.00	0.00	0.00	1.20
$Wunc.$	8.63	-0.00	-0.00	0.00	-0.00
$Wcond$	8.49	0.00	0.00	0.00	0.00

Table 4: Standard Dev. and Welfare - Peso Debt (Risk premium shocks only)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	0.00	0.00	0.00	0.00	0.00
$\sigma(W)$	0.00	0.01	0.00	0.00	0.00
$\sigma(L)$	0.00	0.01	0.00	0.00	0.00
$\sigma(C)$	0.01	0.03	0.01	0.01	0.01
$\sigma(K)$	0.00	0.01	0.00	0.00	0.00
$\sigma(Q)$	0.00	0.02	0.00	0.00	0.00
$\sigma(S)$	0.01	0.04	0.01	0.01	0.01
$\sigma(N)$	0.00	0.02	0.00	0.00	0.00
$\sigma(I)$	0.15	0.64	0.18	0.15	0.08
$\sigma(R_K)$	0.01	0.05	0.01	0.01	0.00
$\sigma(R)$	0.01	0.07	0.02	0.01	0.01
$W unc.$	-0.08	-0.10	-0.10	-0.08	-0.09
$W cond$	-0.08	-0.09	-0.09	-0.08	-0.09

Table 5: Standard Dev. and Welfare - Dollar Debt (All shocks)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	5.97	6.20	5.94	5.96	5.97
$\sigma(W)$	2.50	2.67	2.51	2.43	2.51
$\sigma(L)$	2.27	2.43	2.28	2.21	2.28
$\sigma(C)$	5.40	5.62	5.51	4.65	5.45
$\sigma(K)$	5.23	5.52	5.15	5.21	5.18
$\sigma(Q)$	1.63	1.67	1.63	1.55	1.57
$\sigma(S)$	4.55	3.53	4.59	3.98	4.67
$\sigma(N)$	4.57	4.76	4.51	4.41	4.56
$\sigma(I)$	40.75	41.78	40.68	38.73	39.22
$\sigma(R_K)$	1.93	1.81	1.94	1.75	1.84
$\sigma(R)$	4.09	0.99	4.14	0.53	4.32
$W unc.$	4.93	-3.68	4.49	-2.76	3.03
$W cond$	5.45	-2.28	4.98	-2.25	3.52

Table 6: Standard Dev. and Welfare - Dollar Debt (Portfolio shocks only)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	0.96	0.00	0.00	0.00	0.00
$\sigma(W)$	1.35	0.00	0.00	0.00	0.00
$\sigma(L)$	1.23	0.00	0.00	0.00	0.00
$\sigma(C)$	5.89	0.00	0.00	0.00	0.00
$\sigma(K)$	0.81	0.00	0.00	0.00	0.00
$\sigma(Q)$	2.87	0.00	0.00	0.00	0.00
$\sigma(S)$	5.02	0.00	0.00	0.00	0.00
$\sigma(N)$	5.00	0.00	0.00	0.00	0.00
$\sigma(I)$	47.53	0.00	0.00	0.00	0.01
$\sigma(R_K)$	5.04	0.00	0.00	0.00	0.00
$\sigma(R)$	10.44	0.00	0.00	0.00	0.00
$Wunc.$	5.41	-0.00	-0.00	0.00	-0.00
$Wcond$	10.33	0.00	0.00	0.00	0.00

Table 7: Standard Dev. and Welfare - Dollar Debt (Risk premium shocks only)
$\sigma_c = 1, \varepsilon_H = \varepsilon_F = 1.2, \sigma_\psi = 0.01$

	No FXI	*OSR LAW*	*OSR RER*	*OSR PF*	*OSR RP*
$\sigma(Y)$	0.75	0.82	0.75	0.75	0.75
$\sigma(W)$	0.29	0.43	0.29	0.29	0.29
$\sigma(L)$	0.27	0.39	0.26	0.27	0.26
$\sigma(C)$	0.77	1.30	0.70	0.77	0.64
$\sigma(K)$	1.73	1.70	1.72	1.73	1.74
$\sigma(Q)$	1.13	1.17	1.10	1.13	1.06
$\sigma(S)$	0.58	0.59	0.59	0.58	0.69
$\sigma(N)$	0.94	1.20	0.89	0.94	0.83
$\sigma(I)$	28.30	28.93	27.95	28.30	27.28
$\sigma(R_K)$	1.50	1.53	1.46	1.50	1.36
$\sigma(R)$	0.70	0.96	0.64	0.70	0.43
$Wunc.$	-3.78	-4.38	-4.05	-3.78	-3.76
$Wcond$	-3.12	-3.79	-3.44	-3.12	-3.22

A.3 Summary of the Model

1. Home Goods Market Clearing

$$Y_t^H = C_t^H + C_t^{eH} + I_t^H + C_t^{H,*} + \mu \int_0^{\bar{\omega}_t} \omega \mathrm{d}F(\omega) R_t^k Q_{t-1} K_t \tag{51}$$

2. Euler Equation

$$C_t^{-\gamma_c} = \beta R_t \mathbb{E}_t \left[C_{t+1}^{-\gamma_c} \frac{P_t}{P_{t+1}} \right] \tag{52}$$

3. Capital law of motion

$$K_{t+1} - K_t = \Phi \left(\frac{I_t - \delta K_t}{K_t} \right) K_t \tag{53}$$

4. Capital Rental Rate

$$R_{t+1}^k = \frac{1}{P_{t+1}} \left[P_{W,t+1} \alpha \frac{Y_{t+1}^H}{K_{t+1}} - \frac{P_{I,t}\delta}{Q_t} \right] + \frac{Q_{t+1}}{Q_t} \tag{54}$$

5. Law of one price

$$P_t^F = S_t P_t^{F,*} \tag{55}$$

6. Modified UIP

$$\mathbb{E}_t \log S_{t+1} - \log S_t = \log R_t - \log R_t^* - \frac{1}{2}\sigma^2 - \frac{\gamma_f}{m}\sigma^2 \left(B_{t+1}^{f,*} - B_{ss}^{f,*} \right) \tag{56}$$

7. Demand for Capital

$$\mathbb{E}_t \left[R_{t+1}^k \right] = \chi \left(\frac{Q_t K_{t+1}}{N_{t+1}} \right) R_t^* \mathbb{E}_t \left[\frac{S_{t+1}}{P_{t+1}} \right] \frac{P_t}{S_t} \tag{57}$$

8A. Initial point for V

$$V_t = \left[\left(1 - \mu \int_0^{\bar{\omega}_t} \omega dF(\omega) \right) R_t^k - R_t^* \frac{S_t}{S_{t-1}} \frac{P_{t-1}}{P_t} \right] Q_{t-1} K_t + R_t^* \frac{S_t}{S_{t-1}} \frac{P_{t-1}}{P_t} N_t \tag{58}$$

8B. Net worth law of motion

$$N_{t+1} = \phi V_t + \frac{P_{W,t}}{P_t} (1-\alpha) \Omega Y_t^H \tag{59}$$

9. Consumption composite C

$$C_t = \left[\gamma^{\frac{1}{\rho}} \left(C_t^H \right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}} \left(C_t^F \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{60}$$

10. Household consumption relative demand

$$\frac{C_t^H}{C_t^F} = \frac{\gamma}{(1-\gamma)} \left(\frac{P_t^H}{P_t^F} \right)^{-\rho} \tag{61}$$

11. Investment composite

$$I_t = \left[\gamma_i^{\frac{1}{\rho_i}} \left(I_t^H \right)^{\frac{\rho_i-1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}} \left(I_t^F \right)^{\frac{\rho_i-1}{\rho_i}} \right]^{\frac{\rho_i}{\rho_i-1}} \tag{62}$$

12. Investment relative demand

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{(1-\gamma_i)} \left(\frac{P_t^H}{P_t^F} \right)^{-\rho_i} \tag{63}$$

13. Foreign demand for consumption goods

$$C_t^{H,*} = \left[\left(\frac{P_t^H / S_t}{P_t^*} \right)^{-\zeta} Y_t^* \right]^{v} \left(C_{t-1}^{H,*} \right)^{1-v} \tag{64}$$

14. Budget identity

$$S_t B_{t+1}^{t,*} + S_t B_{t+1}^{f,*} + S_t B_{t+1}^{cb,*} - S_t D_{t+1}^{e,*} = \\ = NX_t + R_{t-1} S_{t-1} B_t^{t,*} + R_{t-1}^* S_t B_t^{f,*} + R_{t-1}^* S_t B_t^{cb,*} - S_t R_{t-1}^* D_t^{e,*} \tag{65}$$

15. CPI

$$P_t = \left[\gamma \left(P_t^H\right)^{1-\rho} + (1-\gamma)\left(P_t^F\right)^{1-\rho}\right] \tag{66}$$

16. Productivity process

$$\log A_t = (1-\rho_A) + \rho_A \log A_{t-1} + \varepsilon_t^A \tag{67}$$

17. Foreign interest rate

$$R_t^* = \rho_{R^*} R_{t-1}^* + \varepsilon_t^{*,mon} \tag{68}$$

18. Asset Pricing

$$\mathrm{E}_{t-1} Q_t \Phi' \left(\frac{I_t - \delta K_t}{K_t}\right) = \mathrm{E}_{t-1} \frac{P_{I,t}}{P_t} \tag{69}$$

19. IPI

$$P_{I,t} = \left[\gamma_i \left(P_t^H\right)^{1-\rho_i} + (1-\gamma_i)\left(P_t^F\right)^{1-\rho_i}\right] \tag{70}$$

20. Labour Demand

$$W_t = P_{W,t}(1-\alpha)(1-\Omega)\frac{Y_t}{H_t} \tag{71}$$

21. Labour Supply

$$H_t^{\upsilon} = C_t^{-\gamma_c} \frac{W_t}{P_t} \tag{72}$$

22. Noise traders process

$$\psi_t = \rho_\psi \psi_{t-1} + \sigma_\psi \varepsilon_t^\psi \tag{73}$$

23. Noise traders zero capital position

$$B_{t+1}^t = -S_t B_{t+1}^{t*} \tag{74}$$

24. Pesos bond market clearing

$$B_{t+1} + B_{t+1}^t + B_{t+1}^f + B_{t+1}^{cb} = 0 \tag{75}$$

25. Technology

$$Y_t^H = A_t K_t^\alpha H_t^{(1-\alpha)(1-\Omega)} \tag{76}$$

26. Entrepreneurial consumption

$$C_t^e = (1-\phi) V_t \tag{77}$$

27. Lease rate

$$\mathrm{E}_{t-1} Q_t \left[\Phi\left(\frac{I_t - \delta K_t}{K_t}\right) - \Phi'\left(\frac{I_t - \delta K_t}{K_t}\right)\left(\frac{I_t - \delta K_t}{K_t}\right)\right] = r_t^l \tag{78}$$

28. Capital Producer Profits

$$\Gamma_t^K = Q_t K_{t+1} - Q_t K_t + \frac{P_{I,t}}{P_t}\left(I_t - \delta K_t\right) + r_t^l K_t \tag{79}$$

29. Foreign price process

$$P_t^{F,*} = \bar{P}^{F,*} \tag{80}$$

30. Consumption composite C^e

$$C_t^e = \left[\gamma^{\frac{1}{\rho}}\left(C_t^{e,H}\right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}}\left(C_t^{e,F}\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{81}$$

31. Enterpreneurs' consumption relative demand

$$\frac{C_t^{e,H}}{C_t^{e,F}} = \frac{\gamma}{(1-\gamma)}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho} \tag{82}$$

A.4 Steady State

1. $Y_{ss}^{H} = A_{ss}K_{ss}^{\alpha}H_{ss}^{(1-\alpha)(1-\Omega)}$ technology Y

2. $W_{ss} = P_{Wss}(1-\alpha)(1-\Omega)\dfrac{Y_{ss}}{H_{ss}}$ labor demand P_W

3. $R_{ss}^{k} = \dfrac{1}{P_{ss}}\left[P_{Wss}\alpha\dfrac{Y_{ss}}{K_{ss}} - \dfrac{P_{Iss}\delta}{Q_{ss}}\right] + 1 + \dfrac{r_{ss}^{l}}{Q_{ss}}$ return on capital K

$$R_{ss}^{k} = \frac{1}{P_{ss}}\left[P_{Wss}\alpha\frac{K_{ss}^{\alpha}H_{ss}^{(1-\alpha)(1-\Omega)}}{K_{ss}} - \frac{P_{Iss}\delta}{Q_{ss}}\right] + 1 + \frac{r_{ss}^{l}}{Q_{ss}} \text{ return on capital } K$$

$$R_{ss}^{k} = \frac{P_{Wss}}{P_{ss}}\alpha K_{ss}^{\alpha-1}H_{ss}^{(1-\alpha)(1-\Omega)} - \frac{P_{Iss}/P_{ss}}{Q_{ss}}\delta + 1 + \frac{r_{ss}^{l}}{Q_{ss}}$$

$$K_{ss} = H_{ss}^{(1-\Omega)}\left\{\frac{1}{\alpha}\frac{P_{ss}}{P_{W,ss}}\left[R_{ss}^{k} + \frac{P_{Iss}/P_{ss}}{Q_{ss}}\delta - 1 - \frac{r_{ss}^{l}}{Q_{ss}}\right]\right\}^{-\frac{1}{1-\alpha}}$$

4. $H_{ss}^{\upsilon} = C_{ss}^{-\gamma_c}\dfrac{W_{ss}}{P_{ss}}$ labor supply H

$$H_{ss} = \left\{C_{ss}^{-\gamma_c}\left(\frac{P_{Wss}}{P_{ss}}\right)^{\frac{1}{1-\alpha}}(1-\alpha)(1-\Omega)\left\{\frac{1}{\alpha}\left[R_{ss}^{k} + \delta - 1\right]\right\}^{-\frac{\alpha}{1-\alpha}}\right\}^{\frac{1}{(\Omega+\upsilon)}}$$

5. $1 = \beta R_{ss}$euler equationB_{t+1}

7. $R_{ss}^{k} = R_{ss}^{*}\chi(\ell_{ss}, \bar{\omega}_{ss})$ demand for capital R^{k}

8. $V_{ss} = \left[(1 - \mu F(\bar{\omega}_{ss})\mathbb{E}(\omega|\,\omega < \bar{\omega}_{ss}))R_{ss}^{k} - R_{ss}^{*}\right]Q_{ss}K_{ss} + R_{ss}^{*}N_{ss}$ start of period N V

9. $N_{ss} = \phi V_{ss} + \dfrac{P_{W,ss}}{P_{ss}}(1-\alpha)\Omega Y_{ss}^{H}$ net worth law of motion N

$$N_{ss} = \frac{1}{1-\phi R^{*}}\left\{\phi\left[(1-\mu VD)R_{ss}^{k} - R_{ss}^{*}\right]Q_{ss}K_{ss} + \frac{P_{W,ss}}{P_{ss}}(1-\alpha)\Omega Y_{ss}^{H}\right\}$$

10. $C_{ss}^{e} = (1-\phi)V_{ss}$ entrepreneurial consumption C^{e}

11. $I_{ss} = \delta K_{ss}$ capital law of motion I

12. $Q_{ss}\Phi'(0) = \dfrac{P_{I,ss}}{P_{ss}}$ asset pricing

13. $r_{ss}^{l} = 0$ lease rate r^{l}

14. $R_{ss}^{*} = \beta^{-1}$ foreign interest rate R^{*}

15. $Y_{ss}^{*} = Y_{ss}^{*}$ foreign output process Y^{*}

16. $S_{ss}D_{ss}^{e,*} = P_{ss}(Q_{ss}K_{ss} - N_{ss})$ entrepreneurs balance sheet $D_{t}^{e,*}$

17. $B_{ss} + B_{ss}^{f} = 0$ pesos bond market clearing B

19. $B_{ss}^{f} + S_{ss}B_{ss}^{f,*} = 0$ intermediaries zero capital position B^{f}

20. $P_{ss}^{F} = S_{ss}P_{ss}^{F,*}$ LOP P^{F}

21. $P_{ss}^{H} = P_{W,ss}$ no staggered pricing P_{t}^{H}

22. $P_{ss} = \gamma\left(P_{ss}^{H}\right)^{1-\rho} + (1-\gamma)\left(P_{ss}^{F}\right)^{1-\rho}$ CPI P_t

23. $P_{I,ss} = \gamma_i\left(P_{ss}^{H}\right)^{1-\rho_i} + (1-\gamma_i)\left(P_{ss}^{F}\right)^{1-\rho_i}$ IPI $P_{I,t}$

24. $I_{ss}^{F} = \left(\dfrac{1}{(1-\gamma_i)^{\frac{1}{\rho_i}}}\left(I_{ss}^{\frac{\rho_i-1}{\rho_i}} - \gamma_i^{\frac{1}{\rho_i}}\left(I_{ss}^{H}\right)^{\frac{\rho_i-1}{\rho_i}}\right)\right)^{\frac{\rho_i}{\rho_i-1}}$ investment composite I_{t}^{F}

25. $C_{ss}^{\frac{\rho_i-1}{\rho_i}} = \gamma^{\frac{1}{\rho}}\left(C_{ss}^H\right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}}\left(C_{ss}^F\right)^{\frac{\rho-1}{\rho}}$ consumption composite C_t^F

26. $\left(C_{ss}^e\right)^{\frac{\rho_i-1}{\rho_i}} = \gamma^{\frac{1}{\rho}}\left(C_{ss}^{e,H}\right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}}\left(C_{ss}^{e,F}\right)^{\frac{\rho-1}{\rho}}$ consumption composite $C_t^{e,F}$

$$\left(\frac{C_{ss}^e}{C_{ss}^{e,F}}\right)^{\frac{\rho_i-1}{\rho_i}} = \gamma^{\frac{1}{\rho}}\left(\frac{C_{ss}^{e,H}}{C_{ss}^{e,F}}\right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}}$$

$$\left(\frac{C_{ss}^e}{C_{ss}^{e,F}}\right)^{\frac{\rho-1}{\rho}} = \gamma^{\frac{1}{\rho}}\left(\frac{\gamma}{(1-\gamma)}\right)^{\frac{\rho-1}{\rho}}\left(\frac{P_{ss}^H}{P_{ss}^F}\right)^{1-\rho} + (1-\gamma)^{\frac{1}{\rho}}$$

$$\left(C_{ss}^{e,F}\right)^{\frac{1-\rho}{\rho}} = \left(C_{ss}^e\right)^{\frac{1-\rho}{\rho}}\left[\gamma^{\frac{1}{\rho}}\left(\frac{\gamma}{(1-\gamma)}\right)^{\frac{\rho-1}{\rho}}\left(\frac{P_{ss}^H}{P_{ss}^F}\right)^{1-\rho} + (1-\gamma)^{\frac{1}{\rho}}\right]$$

$$\left(C_{ss}^{e,F}\right) = \left(C_{ss}^e\right)\left[\gamma^{\frac{1}{\rho}}\left(\frac{\gamma}{(1-\gamma)}\right)^{\frac{\rho-1}{\rho}}\left(\frac{P_{ss}^H}{P_{ss}^F}\right)^{1-\rho} + (1-\gamma)^{\frac{1}{\rho}}\right]^{\frac{\rho}{1-\rho}}$$

27. $\dfrac{C_{ss}^{e,H}}{C_{ss}^{e,F}} = \dfrac{\gamma}{(1-\gamma)}\left(\dfrac{P_{ss}^H}{P_{ss}^F}\right)^{-\rho}$ consumption relative demand $C_t^{e,H}$

28. $\dfrac{C_{ss}^H}{C_{ss}^F} = \dfrac{\gamma}{(1-\gamma)}\left(\dfrac{P_{ss}^H}{P_{ss}^F}\right)^{-\rho}$ consumption relative demand C_t^H

29. $\dfrac{I_{ss}^H}{I_{ss}^F} = \dfrac{\gamma_i}{(1-\gamma_i)}\left(\dfrac{P_{ss}^H}{P_{ss}^F}\right)^{-\rho_i}$ investment consumption relative demand I_t^H

30. $P_{ss}^* = \gamma\left(P_{ss}^H/S_{ss}\right)^{1-\rho} + (1-\gamma)\left(P_{ss}^{F,*}\right)^{1-\rho}$ Foreign CPI P^*

31. $C_{ss}^{H,*} = \left(\dfrac{P_{ss}^H/S_{ss}}{P_{ss}^*}\right)^{-\zeta} Y_{ss}^*$ foreign consumption of domestic good $C^{H,*}$

32. $Y_{ss}^H = C_{ss}^H + C_{ss}^{eH} + I_{ss}^H + C_{ss}^{H,*} + \mu\displaystyle\int_0^{\bar{\omega}_{ss}} \omega \mathrm{d}F(\omega)\, R_{ss}^k Q_{ss} K_{ss}$ goods market clearing *

33. $NX_{ss} = P_{W,ss}Y_{ss}^H - P_{ss}C_{ss} - P_{I,ss}I_{ss} - P_{ss}C_{ss}^e - \mu P_{ss}\displaystyle\int_0^{\bar{\omega}_{ss}} \omega dF(\omega)\, R_{ss}^k Q_{ss} K_{ss}$

34. $\dfrac{-NX_{ss}}{(R_{ss}-1)\,S_{ss}} = B_{ss}^{f,*} - D_{ss}^{e,*}$

35. $\mathcal{A}_{ss} = S_{ss}B_{ss}^{f,*} + S_{ss}B_{ss}^{cb,*} + S_{ss}B_{ss}^{t,*} - S_{ss}D_{ss}^{e,*}$ NFA definition $\mathcal{A}$

36. $CA = 0$

B SOE RBC Model with Capital and no Financial Accelerator no other frictions - OC

1. Home Goods Market Clearing

$$Y_t^H = C_t^H + I_t^H + C_t^{H,*} \tag{83}$$

2. Euler Equation

$$\frac{1}{C_t} = \beta R_t \mathbb{E}_t \left[\frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}} \right] \tag{84}$$

3. Capital law of motion

$$K_{t+1} = (1-\delta) K_t + I_t \tag{85}$$

4. Capital Market Eq.

$$Q_t = \beta E_t \left(\frac{C_t}{C_{t+1}} \left(R_{t+1}^k + (1-\delta) Q_{t+1} \right) \right) \tag{86}$$

5. Law of one price

$$P_t^F = S_t P_t^{F,*} \tag{87}$$

6. Modified UIP

$$\mathbb{E}_t \log S_{t+1} - \log S_t = \log R_t - \log R_t^* - \frac{1}{2}\sigma^2 - \frac{\gamma_f}{m}\sigma^2 \left(B_{t+1}^{f,*} - B_{ss}^{f,*} \right) \tag{88}$$

7. Consumption composite C

$$C_t = \left(C_t^H \right)^{\gamma} \left(C_t^F \right)^{1-\gamma} \tag{89}$$

8. Household Consumption Relative Demand

$$\frac{C_t^H}{C_t^F} = \frac{\gamma}{(1-\gamma)} \left(\frac{P_t^F}{P_t^H} \right) \tag{90}$$

9. Investment composite

$$I_t = \left(I_t^H \right)^{\gamma_i} \left(I_t^F \right)^{1-\gamma_i} \tag{91}$$

10. Investment relative demand

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{(1-\gamma_i)} \left(\frac{P_t^F}{P_t^H} \right) \tag{92}$$

11. Foreign demand for consumption goods

$$C_t^{H,*} = (1-\gamma^*) \left(\frac{P_t^H}{S_t P_t^*} \right)^{-\varepsilon_F} Y_t^* \tag{93}$$

12. Budget identity

$$\begin{aligned} &S_t B_{t+1}^{t,*} + S_t B_{t+1}^{f,*} + S_t B_{t+1}^{cb,*} = \\ &= N X_t + R_{t-1} S_{t-1} B_t^{t,*} + R_{t-1}^* S_t B_t^{f,*} + R_{t-1}^* S_t B_t^{cb,*} \end{aligned} \tag{94}$$

13. CPI

$$P_t = \left(P_t^H \right)^{\gamma} \left(P_t^F \right)^{1-\gamma} \tag{95}$$

14. Productivity Process

$$\log A_t = (1 - \rho_A) + \rho_A \log A_{t-1} + \varepsilon_t^A \tag{96}$$

15. Foreign interest rate

$$R_t^* = \rho_{R^*} R_{t-1}^* + \varepsilon_t^{*,mon} \tag{97}$$

16. Asset Pricing

$$Q_t = \frac{P_{I,t}}{P_t} \tag{98}$$

17. IPI

$$P_{I,t} = \left(P_t^H\right)^{\gamma_i} \left(P_t^F\right)^{1-\gamma_i} \tag{99}$$

18. Labour Demand

$$\frac{K_t}{H_t} = \frac{W_t}{R_t^k} \frac{\alpha}{1-\alpha} \tag{100}$$

19. Labour Supply

$$H_t^{\nu} = C_t^{-1} W_t \tag{101}$$

20. Real Marginal Cost

$$MC_t = \frac{1}{Z_t^{1-\alpha}} \left(\frac{W_t}{1-\alpha}\right)^{1-\alpha} \frac{R_t^{k\,\alpha}}{\alpha} \tag{102}$$

21. Noise traders process

$$\psi_t = \rho_\psi \psi_{t-1} + \sigma_\psi \varepsilon_t^\psi \tag{103}$$

22. Noise traders zero capital position

$$B_{t+1}^t = -S_t B_{t+1}^{t*} \tag{104}$$

23. Clearance of the pesos bond market

$$B_{t+1} + B_{t+1}^t + B_{t+1}^f + B_{t+1}^{cb} = 0 \tag{105}$$

24. Technology

$$Y_t^H = K_t^\alpha \left(Z_t H_t\right)^{(1-\alpha)} \tag{106}$$

25. Process for foreign price

$$P_t^{F,*} = \bar{P}^{F,*} \tag{107}$$

26. Good H Price

$$P_t^H = P_t MC_t \tag{108}$$

27. Period utility

$$U_t = \log C_t - \frac{H_t^{1+\nu}}{1+\nu} \tag{109}$$

28. Net Exports

$$NX_t = P_t^H Y_t^H - P_t C_t - P_{I,t} I_t \tag{110}$$