Limited Asset Market Participation and Capital Controls in a Small Open Economy *

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May, 2015

Abstract

This paper sets up a canonical new Keynesian small open economy model with limited asset market participation to financial markets. Households who cannot have access to financial markets have difficulty in adjusting their consumption profiles to the terms of trade change, resulting in unncessary fluctuations of trade balance. The paper shows that there is room for government to improve welfare by controlling international capital movement to productivity shocks in a flexible price equilibrium with unitary elasticities of substitution, i.e. for the Cole-Obstfeld preference, contrasting with Fahri and Werning (2013). This result reflects the fact that the existence of limited asset market particiaption to financial markets entails the unnecessary fluctuations of the economy to exogenous shocks by aggravating the externality of the terms of trade. The paper also finds that the domestic price stability is not optimal monetary policy in open economy with limited asset market participation, contrasting to the result of Bilbiie (2008) in a closed economy where the price stability is optimal monetary policy. Finally, it shows that the optimal capital control tax leans against the wind. Moreover, the resource allocations associated with optimal time-varying capital control and monetary policy is more stabilized than the ones without capital controls.

JEL classification: E52, F41

Keywords: Capital Control, Limited Asset Market Participation, Price Stability, Welfare Loss

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* I thank seminar participants at Kobe University and Tohoku University for their helpful comments. All errors are my own.

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1 Introduction

Recent economic crises show that economies can be adversely affected by volatile capital flows, which have been blamed for booms and busts. The question of whether monetary authority should intervene to deal with these economic fluctuations is at the heart of the policy debate in open macroeconomics. Mundell's famous trilemma that provides a useful framework to analyze this question states shows how economies should cope with the macroeconomic shocks.

In a small open economy context, Fahri and Werning (2012) extend Galí and Monacelli (2005)'s canonical new Keynesian framework by incorporating incomplete market. They show that there is a case for capital control to stabilize the economy and to regain monetary autonomy in a fixed exchange rate regime. Fahri and Werning (2013) go one step further to show that capital controls can be desirable in a flexible exchange rate regime, contrasting to the Mundellian view.

This paper extends the existing literature on optimal capital controls in a small economy framework by incorporating limited asset market participation (LAMP hereafter) into otherwise standard model. Along the line of Campbell and Mankiw (1989), Gali, Lopez-Salido and Valles (2004 hereafter Gali et al.), and Bilbiie (2008), it is assumed that a fraction of households, called the rule of thumb households have zero assets and just consume their current disposable income, while other fraction of households have all assets to smooth their consumption profile.

In this paper, we address the effect of LAMP in designing the optimal capital control and monetary policy in otherwise a canonical new Keynesian small open economy. In particular, we investigate the following questions. First, we explore whether it is necessary for the government to control international capital movement to improve upon the welfare of the domestic resident in the Cole-Obstfeld case, i.e. in the unitary inter- and intra-temporal elasticity of substitution case with productivity shocks only. Second, we discuss whether price stability is optimal in the presence of the LAMP in the otherwise canonical new Keynesian model with productivity shocks only, irrespective of the presence of optimal capital control. Finally, we discuss the properties of optimal capital control and the welfare gain from the optimal capital controls in small open economy with LAMP.

Since the net export is exactly balanced in the flexible price equilibrium with a Cole-Obstfeld preference, and monetary policy is independent under a flexible exchange rate regime, any theoretical basis for the capital controls does not exist in international finance at first glance. The rule of thumb households who cannot have access to the financial markets generates a wedge between production and expenditures in the Cole-Obstfeld case because they must spend all of their current income to purchase current consumption goods, generating unnecessary capital movements to the international relative price change. Hence, in the presence of the rule of thumb households, there is room for government to intervene to improve the welfare by stabilizing these economic fluctuations with capital control.

The main findings of this paper can be summarized as follows.

Firstly, we show that there is room for government to improve welfare in the presence of LAMP by controlling international capital movement in the flexible price equilibrium with a unitary intertemporal and intratemporal elasticity of substitution, i.e. in the Cole-Obstfeld preference and efficient productivity shocks. The difference between the welfare associated with the optimal capital controls and the welfare associated with no capital control increases with the fraction of the rule of thumb households in the economy. This result contrasts with Fahri and Werning (2013) who find no room for capital controls in flexible exchange rate regime with the Cole-Obstfeld preference and productivity shocks, but without LAMP. The existence of LAMP entails the unnecessary fluctuations of the economy to technology shocks by preventing the rule of thumb households from smoothing their consumption profiles to the international relative price changes induced by the macroeconomic shocks. Hence, the capital controls to smooth out capital flows can dampen down the unnecessary swings of the economy by alleviating the terms of trade externality compounded with LAMP.

Secondly, the domestic price stability is not optimal monetary policy, even if the fiscal authority implements an optimal capital control to dampen the volatile capital movement across the border and the terms of trade fluctuations. Monetary authority should deviate from price stability to improve the welfare in a small open economy for unitary elasticity of substitution with LAMP and productivity shocks only.

Finally, the difference between the welfare associated with optimal capital control and the welfare without any capital control is much larger than the difference between the welfare associated with optimal monetary policy and the welfare associated with alternative monetary policy such as domestic price index inflation targeting rule.

The remainder of the paper is organized as follows. Section 2 presents a canonical small open economy model with habit persistence and nominal price rigidities and discusses equilibrium conditions. Section 3 and 4 address the Ramsey (constrained-efficient) optimal capital control and monetary policy in a small open economy with habit persistence both under time-varying tax and time-invariant tax regime, respectively. Section 4 presents a numerical analysis of the welfare ranking of alternative monetary policy rules. Section 5 concludes.

2 The Model

This section sets up a variant of new Keynesian model with habit persistence applied to an open-economy. The world is composed of two countries, home (H) and foreign (F) with population size n and $1-n$ respectively. In this paper, the small open economy is characterized as a limiting-case approach as in Faia and Monacelli (2008) and Galí and Monacelli (2005). It is assumed that the relative size of domestic economy is negligible relative to the rest of the world, i.e. $n \longrightarrow 0$.

2.1 Households

2.1.1 Asset Holders Problem

Households who can have access to asset market, called asset holding households choose their consumption, asset holdings, and labor supply maximizes its expected lifetime utility function ($\mathcal{W}_{A_t}$) subject to sequence of budget constraints:

$$\mathcal{W}_{A_t} \equiv E_t \left[\sum_{k=0}^{\infty} \beta^k u(C_{A,t+k}, N_{A,t+k}) \right], \ 0 < \beta < 1, \quad (1)$$

where $u(C_{A,t+k}, N_{A,t+k}) = \frac{C_{A,t+k}^{1-\sigma}-1}{1-\sigma} - \frac{N_{A,t+k}^{1+\nu}}{1+\nu}$ for $\sigma \neq 1$, and $u(C_{A,t+k}, N_{A,t+k}) = \ln(C_{A,t+k}) - \frac{N_{A,t+k}^{1+\nu}}{1+\nu}$ for $\sigma = 1$. β is the household's discount factor, and E_t denotes the mathematical expectation operator over all possible states of nature on history x^t.[1] $C_{A,t+k}$, $N_{A,t+k}$ represent the asset holding household's consumption and working hours in period $t+k$, respectively. $C_{A,t}$ is a composite consumption index defined by

$$C_{A,t} = [\theta^{\frac{1}{\eta}} C_{A_H,t}{}^{\frac{\eta-1}{\eta}} + (1-\theta)^{\frac{1}{\eta}} C_{A_F,t}{}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}, \ \eta > 0. \quad (2)$$

Here $C_{A_H,t}$ and $C_{A_F,t}$ are indices of domestic and foreign consumption goods consumed by domestic asset holding households, and θ and $1-\theta$ represent the share of domestic consumption allocated to domestic goods, and imported goods. The indices are given by the following CES aggregator of the quantities consumed of each variety of good:

$$C_{A_H,t} = [\int_0^1 C_{A_H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj]^{\frac{\epsilon}{\epsilon-1}}, \ \ C_{F,t} = [\int_0^1 C_{Ft}(j)^{\frac{\epsilon-1}{\epsilon}} dj]^{\frac{\epsilon}{\epsilon-1}}, \ \ \epsilon > 1. \quad (3)$$

Here η and ϵ measure the elasticity of substitution between domestic and foreign goods, and the elasticity of substitution among goods within each category.

Assume that only Ricardian households have access to the asset market. There is a domestic currency-denominated bond market. It is assumed that domestic households can trade only one-period nominal riskless bonds

[1] Here $x^t = \{x_0, ...x_t\}$ denotes the history of events up to period t.

denominated in home and foreign currency, while foreign households trade one-period nominal riskless bonds denominated in foreign currency. It is also assumed that the international trade of foreign currency denominated bonds are subject to intermediation costs as in Benigno (2008) and Turnovsky (1985).[2] Then the domestic asset holding household's budget constraint can be written as

$$\begin{aligned} P_t C_{A,t} + B_{A,t} + \mathcal{E}_t B_{F,t} \quad &\leq \quad R_{t-1} B_{A,t-1} + W_t(1-\tau_{A,t}) N_{A,t} + TR \\ &+\mathcal{E}_t \Psi_{t-1} R^*_{t-1}(1+\tau_{B,t-1}) \Xi(\frac{\mathcal{E}_{t-1} B_{F,t-1}}{P_{t-1}}) B_{F,t-1A,t}. \end{aligned} \tag{4}$$

Here $B_{A,t}$ and $B_{F,t}$ denote domestic and foreign currency denominated nominal bonds, while R_t and R^*_t are the interest rate corresponding to the bonds, respectively. W_t, $TR_{A,t}$,and $\tau_{A,t}$ denote nominal wages, government lump-sum tax/ transfers given to the domestic household, the tax rate on labor income in period t. Capital controls are modeled as follows: $\tau_{B,t}$ is a subsidy on capital outflows and a tax on capital inflows in the domestic economy. We assume that the rest of the world does not impose capital controls. Ψ_t is the risk premium shock at time t. We assume that the risk premium shock follows an $AR(1)$ process as $\ln \Psi_t = \rho_\psi \ln \Psi_{t-1} + \xi_{\Psi,t}, \quad -1 < \rho_\psi < 1$, where $E(\xi_{\Psi,t}) = 0$ and $\xi_{\Psi,t}$ is i.i.d. over time.

The function $\Xi(\frac{\mathcal{E}_t B_{F,t}}{P_t})$ incorporates the cost or the risk premium from international borrowings. The risk premium or $\Xi(\frac{\mathcal{E}_t B_{F,t}}{P_t}) - 1$ is increasing with the country's foreign debt, i.e. $\Xi^{'}(.) < 0$, and it is equals to zero when the economy is in the steady state, i.e. $\Xi(\mathcal{B}_F) = 1$ in the steady state where $\mathcal{B}_{F,t} \equiv \frac{\mathcal{E}_t B_{F,t}}{P_t}$.

$$C_{A,t}^{-\sigma} = \beta R_t E_t[C_{A,t+1}^{-\sigma} \frac{P_t}{P_{t+1}}], \tag{5}$$

$$C_{A,t}^{-\sigma} = \beta R^*_t (1+\tau_{B,t}) \Psi_t \Xi(\mathcal{B}_{F,t}) E_t[C_{A,t+1}^{-\sigma} \frac{\mathcal{E}_{t+1} P_t}{\mathcal{E}_t P_{t+1}}], \tag{6}$$

$$N_{A,t}^{\nu} = (1-\tau_{A,t}) w_t C_{A,t}^{-\sigma}, \tag{7}$$

where w_t is the real wage in period t.

Similarly, the foreign household's intertemporal decision of bond holdings is given by

$$C_t^{*-\sigma} = \beta R^*_{t+1} E_t[C_{t+1}^{*-\sigma} \frac{P^*_t}{P^*_{t+1}}]. \tag{8}$$

[2] This intermediation cost assumption is made for technical reasons. See Schmitt-Grohé and Uribe (2001) for alternative assumptions to overcome the stationary problem in a small open economy model.

(6) and (8) imply that the equilibrium nominal exchange rate is determined by

$$E_t[\left[\left(\frac{C^*_{t+1}}{C^*_t}\right)^{-\sigma}\frac{P^*_t}{P^*_{t+1}}\right]] = \Xi(\mathcal{B}_{F,t})\Psi_t(1+\tau_{B,t})E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\frac{\mathcal{E}_{t+1}P_t}{\mathcal{E}_tP_{t+1}}\right]. \quad (9)$$

2.1.2 Non-Asset Holders

The non-asset holding households or a rule of thumb consumers who cannot have access to the financial market just supply labor $N_{R,t}$ and consumes their whole wage income determined in each period:

$$P_tC_{R,t} = (1-\tau_{R,t})W_tN_{R,t} + TR_{R,t}, \quad (10)$$

where $\tau_{R,t}$ is the tax rate on labor income and $TR_{R,t}$ is the lump-sum tax or transfer to the non-asset holding households' in period t.

Rule of thumb households who cannot have access to asset market choose their consumption and labor supply maximizes its expected lifetime utility function ($\mathcal{W}_{R_t}$) subject to sequence of budget constraint (10):

$$\mathcal{W}_{R_t} \equiv E_t\left[\sum_{i=0}^{\infty}\beta^i u(C_{R,t+k}, N_{R,t+k})\right],\ 0<\beta<1, \quad (11)$$

where $u(C_{R,t+k}, N_{R,t+k}) = \frac{C^{1-\sigma}_{R,t+k}-1}{1-\sigma} - \frac{N^{1+\nu}_{R,t+k}}{1+\nu}$ for $\sigma \neq 1$, and $u(C_{R,t+k}, N_{R,t+k}) = \ln(C_{R,t+k}) - \frac{N^{1+\nu}_{R,t+k}}{1+\nu}$ for $\sigma = 1$.

Rule-of thumb household's optimization conditions are given by

$$C^{\sigma}_{R,t}N^{\nu}_{R,t} = w_t, \quad (12)$$

and the budget constraint (10).

2.2 Aggregation

The aggregate level of any household-specific variable X_t is given by $X_t \equiv \int_0^1 X_t(j)dj = (1-\gamma)X_{A,t} + \gamma X_{R,t}$. Hence, aggregate consumption and aggregate hours are given by

$$C_t = (1-\gamma)C_{A,t} + \gamma C_{R,t} \quad (13)$$

and

$$N_t = (1-\gamma)N_{A,t} + \gamma N_{R,t}. \quad (14)$$

Finally, aggregate lump-sum taxes or transfers are also given by

$$T_t = \gamma T_{A,t} + (1-\gamma) T_{R,t}. \tag{15}$$

2.3 Domestic Firms

Differentiated goods and monopolistic competition are introduced along the lines of Dixit and Stiglitz (1977). Suppose that there is a continuum of firms producing differentiated goods, and each firm indexed by i, $0 \le i \le 1$, produces its product with a linear technology $Y_t(i) = Z_t N_t(i) - \overline{\mathbf{F}}$, where Z_t is a technology process in home country at period t, and $Y_t(i)$, $N_t(i)$, and $\overline{\mathbf{F}}$ are output, total labor input of the ith firm, and fixed cost, respectively. We assume that the productivity shock follows an $AR(1)$ process as $\ln Z_t = (1-\rho_Z)\ln Z + \rho_Z \ln Z_{t-1} + \xi_{A,t}, \quad 0 < \rho_Z < 1$, where $E(\xi_{Z,t}) = 0$ and $\xi_{Z,t}$ is i.i.d. over time.

Each domestic firm i takes $P_{H,t}$ and the aggregate demand as given, and chooses its own product price $P_{H,t}(i)$. In this economy, the distortion occurs due to the existence of monopolistic competition in the goods market and habit persistence. The firm sets, on average, its price above marginal cost. In equilibrium, this makes the marginal rate of substitution between consumption and labor different from their corresponding marginal rate of transformation.

Since the input markets are perfectly competitive, the firm $j^{'}$s demand for labor is determined by its cost minimization as follows:

$$w_t = \mathrm{mc}_t Z_t \frac{P_{H,t}}{P_t}, \tag{16}$$

where $\mathrm{mc}_t \equiv \frac{MC_t}{P_{H,t}}$ is a domestic firm's markup in period t. Next, the CPI-DPI ratio $\frac{P_t}{P_{H,t}}$ can be expressed in terms of the terms of trade $\mathcal{T}_t \equiv \frac{P_{F,t}}{P_{H,t}}$ as follows:

$$\frac{P_t}{P_{H,t}} = [(1-\theta) + \theta \mathcal{T}_t^{1-\eta}]^{\frac{1}{1-\eta}} \equiv \mathcal{K}(\mathcal{T}_t) \tag{17}$$

or

$$\frac{1+\pi_t}{1+\pi_{H,t}} = \frac{\mathcal{K}(\mathcal{T}_t)}{\mathcal{K}(\mathcal{T}_{t-1})}\ , \tag{18}$$

where $\pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}} - 1$ and $\pi_t \equiv \frac{P_t}{P_{t-1}} - 1$ represent the domestic price index inflation rate and the consumer price index inflation rate at time t, respectively.

Hence, the labor market equilibrium condition can be rewritten in terms of the terms of trade

$$\frac{N_{i,t}^{\nu}}{MU_{C_i,t}} = \mathrm{mc}_t (1-\tau_{it}) Z_t \mathcal{K}(\mathcal{T}_t), \tag{19}$$

for $i = A$ and R. The real exchange rate is also linked to the terms of trade through the following expression:

$$\mathcal{E}_t \equiv \frac{\mathcal{S}_t P_t^*}{P_t} = \mathcal{T}_t[(1-\theta) + \theta \mathcal{T}_t^{1-\eta}]^{\frac{1}{\eta-1}} \equiv \mathcal{H}(\mathcal{T}_t). \tag{20}$$

Next, consider a staggered-price model a la Calvo (1983) and Yun (1996). Each firm resets its optimal price $\widetilde{P}_{H,t}(j)$ with probability $(1-\alpha)$ in any given period, independent of the time elapsed since the last adjustment firms sets the new price. Other fraction of firms, α, sets its current price at its previous price level. The firm j's problem that maximizes the current market value of the profits generated while that price remains effective can be written as follows.

$$\max_{\widetilde{P}_{Ht}(j)} \ E_t\{\sum_{k=0}^{\infty} \alpha^k Q_{t,t+k} \left(\frac{P_t}{P_{t+k}}\right) [\widetilde{P}_{H,t}(j) Y_{Ht,t+k}(j) - MC_{t+k} Y_{Ht,t+k}(j)]\}, \tag{21}$$

subject to the sequence of demand constraints

$$Y_{Ht,t+k}(j) \leq \left(\frac{\widetilde{P}_{H,t}(j)}{P_{H,t+k}}\right)^{-\epsilon} Y_{H,t+k},$$

where $Q_{t,t+k} \equiv \beta^k \frac{U_C(C_{A,t})}{U_C(C_{A,t+k})}$, $\widetilde{P}_{H,t+k}(j) = \widetilde{P}_{H,t}(j)$ with a probability α^k and $k = 0, 1, 2 ... \infty$.

The optimal price setting equation can be expressed as a recursive form as in Schmitt-Grohé and Uribe (2004) and Yun (2005):

$$\frac{\epsilon}{\epsilon-1}\mathcal{X}_t = \mathcal{Y}_t, \tag{22}$$

where

$$\mathcal{X}_t = \widetilde{p}_{H,t}^{-1-\epsilon} \frac{Z_t N_t}{\Delta_{H,t}} \mathrm{mc}_t + \alpha E_t[(1+\pi_{H,t+1})^{1+\epsilon}(1+\pi_{t+1})^{-1} Q_{t,t+1} \left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-1-\epsilon} \mathcal{X}_{t+1}], \tag{23}$$

$$\mathcal{Y}_t = \widetilde{p}_{H,t}^{-\epsilon} \frac{Z_t N_t}{\Delta_{H,t}} + \alpha E_t[Q_{t,t+1}(1+\pi_{H,t+1})^{\epsilon}(1+\pi_{t+1})^{-1} \left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-\epsilon} \mathcal{Y}_{t+1}]. \tag{24}$$

Here $\widetilde{p}_{H,t} \equiv \frac{\widetilde{P}_{H,t}}{P_{H,t}}$ is the relative price of any domestic good whose price was adjusted in period t. (22) is a short-run nonlinear aggregate supply relation between inflation and output, given expectations regarding future inflation, output and disturbances. The domestic price aggregator implies that the relative price $\widetilde{p}_{H,t}$ satisfies the relationship:

$$1 = (1-\alpha)\widetilde{p}_{H,t}^{1-\epsilon} + \alpha(1+\pi_{H,t})^{\epsilon-1}. \tag{25}$$

2.4 Importing Firms

To focus the effect of habit on the welfare ranking of alternative monetary policy rules, we consider only the case of a perfect exchange rate pass-through, a case in which foreign companies do not have any role in setting price as in Galí and Monacelli (2005) and De Paoli (2009, 2010).

Assume that the Law of One Price holds, such that the price of foreign good j in domestic currency, $P_{F,t}(j)$, equals its price denominated in foreign currency, $P^*_{F,t}(j)$, multiplied by the nominal exchange rate, $\mathcal{S}_t$:

$$P_{F,t}(j) = \mathcal{S}_t P^*_{F,t}(j). \tag{26}$$

In the rest of the world, a representative household faces a problem identical to the one outlined above. The only difference is that a negligible weight is assigned to consumption goods produced in a small economy ($\theta^* = 1$). Therefore, $P^*_t = P^*_{Ft}$ and $C^*_t = C^*_{Ft}$ for all t.

2.5 Equilibrium

Aggregating individual output across firms, one finds a wedge between the aggregate output Y_t and aggregate labor hours N_t

$$Y_t = \frac{Z_t N_t}{\Delta_{H,t}}, \tag{27}$$

where $\Delta_{H,t} = \int_0^1 \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon} dj$ is the relative price dispersion in period t. The relative price distortion $\Delta_{H,t}$ that results from the firms' staggered price setting practice in the Calvo-type model can be rewritten as a recursive form:

$$\Delta_{H,t} = (1-\alpha)\widetilde{p}_{H,t}^{-\epsilon} + \alpha(1+\pi_{H,t})^{\epsilon}\Delta_{H,t-1}, \tag{28}$$

with $\Delta_{H,-1}$ given. Also (18) can be rewritten in terms of the CPI inflation rate and DPI inflation rate:

$$\frac{1+\pi_t}{1+\pi_{H,t}} = \frac{\mathcal{K}(\mathcal{T}_t)}{\mathcal{K}(\mathcal{T}_{t-1})} \tag{29}$$

Assuming symmetric degree of home bias across countries with the negligible relative size of home country, goods market clearing in home and foreign countries requires that

$$Y_t = (1-\theta)\mathcal{K}(\mathcal{T}_t)^{\eta}((1-\gamma)C_{A,t} + \gamma C_{R,t}) + \theta \mathcal{T}_t^{\eta} C_t^*, \tag{30}$$

$$Y_t^* = C_t^*. \tag{31}$$

Also, the resource constraint relating production and expenditures can be written as

$$((1-\gamma)C_{A,t}+\gamma C_{R,t})+\mathcal{B}_{F,t} \leq R_{t-1}^*\Psi_{t-1}\digamma(\mathcal{B}_{Ft-1})\mathcal{B}_{Ft-1}\frac{\mathcal{J}(\mathcal{T}_t)}{\mathcal{J}(\mathcal{T}_{t-1})}\frac{P_{t-1}^*}{P_t^*}+\mathcal{H}(\mathcal{T}_t)^{-1}\frac{Z_t N_t}{\Delta_{H,t}}. \tag{32}$$

Note that (27) and (30) can be simplified as

$$\frac{Z_t N_t}{\Delta_{H,t}} - \overline{\mathbf{F}} = (1-\theta)\mathcal{K}(\mathcal{T}_t)^{\eta}((1-\gamma)C_{A,t} + \gamma C_{R,t}) + \theta \mathcal{T}_t^{\eta} C_t^*. \tag{33}$$

Net supply of bonds must satisfy

$$B_{H,t} + B_t^* = 0. \tag{34}$$

The competitive equilibrium conditions consist of the efficiency conditions and the budget constraint of the households and firms, and the market clearing conditions of each goods market, labor market, money, and bond market under each asset market regime. Then, the symmetric equilibrium is an allocation of $\{C_{A,t}, C_{R,t},\ C_t^*, N_{A,t}, N_{R,t}, N_t^*, Y_t, Y_t^*\}_{t=0}^{\infty}$, a sequence of prices and costate variables for the home and foreign country $\{P_{H,t}, P_{F,t}, P_{F,t}^*, P_{H,t}^*, P_t, P_t^*, B_{H,t}, B_t^*, \text{mc}_t,$
$\text{mc}_t^*, \Delta_{H,t}, \Delta_{Ft}^*\}_{t=0}^{\infty}$ and a sequence of the real exchange rate $\{\mathcal{E}_t\}_{t=0}^{\infty}$ such that (1) the asset holding and rule of thumb households decision rules solve their optimization problem given the states and the prices; (2) the demands for labor solves each firm's cost minimization problem and price setting rules solve its present value maximization problem given the states and the prices; (3) each goods market, labor market, and bond market are cleared at the corresponding prices, given the initial conditions for the state variables ($\Delta_{H,-1},\ \Delta_{F,-1}^*$), and the exogenous productivity shock processes $\{\ Z_t, Z_t^*\}_{t=0}^{\infty}$ as well as the monetary and fiscal policies $\{\tau_{B,t}, \tau_{B,t}^*, R_t, R_t^*\}_{t=0}^{\infty}$.

3 Optimal Capital Controls and Monetary Policy

In this section, we will discuss the optimal capital control under the assumption that the fiscal authority does not implement any tax to deal with distortions associated with monopolistic competition in goods market. Given distortions associated with monopoly power in goods market, the Ramsey planner who internalizes both the terms of trade externality and LAMP chooses optimal capital control tax and monetary policy prescriptions for $\{\tau_{B,t}, R_t\}_{t=0}^{\infty}$ as well as plans for $\{C_{A,t},\ N_{A,t}, C_{R,t},\ N_{R,t}, \mathcal{B}_{F,t}, \pi_{H,t},\ \mathsf{mc}_t, \pi_t, \mathcal{T}_t, \widetilde{p}_{H,t},\ \mathcal{X}_t, \mathcal{Y}_t, \Delta_{H,t}\}_{t=0}^{\infty}$ to maximize the weighted average of the asset holder and rule of thumb households

$$\mathcal{W}_t \equiv (1-\gamma)\mathcal{W}_{A_t} + \gamma \mathcal{W}_{R_t} \tag{35}$$

subject to 13 equations of private sector optimization and market clearing conditions: (4), (9), (12), (19), (22), (23), (24), (25), (28), (29), (30), (33), taking the initial conditions for the variables for $\Delta_{H,-1}$, and the exogenous technology and risk premium shock processes $\{Z_t,\ Z_t^*,\ \Psi_t\}_{t=0}^{\infty}$, and foreign variables as given.

Before turning discussing the properties of optimal capital control and monetary policy in a small open economy with nominal price rigidities, we will look at the optimal capital controls in the economy with the flexible prices.

3.1 Optimal Capital Control in the Flexible Price Equilibrium

We first turn to optimal capital controls in a flexible price model, where firms set their optimal price as $P_{H,t} = \mathcal{M}MC_t$. Let $\mathrm{V}(Z_t, \mathcal{F}_t)$ represent the value function in the Bellman equation for the optimal policy problem in period t, where $\mathcal{F}_t$ represents the given variables of foreign country and exogenous shocks in period t. To have some intuitions of capital controls in the presence of the LAMP, we will focus on the Cole-Obstfeld preferences, i.e. unitary elasticities of substitution ($\sigma = \eta = 1$) and discuss the implications by comparing the results with the findings of Fahri and Werning (2012, 2013), where capital control is not necessary in the small open economy with efficient productivity shocks.

The Ramsey problem for unitary elasticities of substitution can be simplified as follows:

$$\begin{aligned}\mathrm{V}(Z_t,\mathcal{F}_t) \quad = \quad & \max_{\{\tau_{B,t}, C_{A,t}, N_{A,t}, C_{R,t}, N_{R,t},\ \mathcal{B}_{Ft},, \mathcal{T}_t\}} .[(1-\gamma)\left(\log C_{A,t} - \frac{N_{A,t}^{1+\nu}}{1+\nu}\right) \qquad (36)\\ & +\gamma\left(\log C_{R,t} - \frac{N_{R,t}^{1+\nu}}{1+\nu}\right) + \beta E_t \mathrm{V}(Z_{t+1},, \mathcal{F}_{t+1})],\end{aligned}$$

subject to

$$Z_t((1-\gamma)N_{A,t} + \gamma N_{R,t}) - F = (1-\theta)\mathcal{T}_t^{\theta}((1-\gamma)C_{A,t} + \gamma C_{R,t}) + \theta \mathcal{T}_t C_t^*, \tag{37}$$

$$C_{A,t}N_{A,t}^{\nu}\mathcal{T}_t^{\theta} = Z_t\mathcal{M}^{-1} \tag{38}$$

$$C_{R,t}N_{R,t}^{\nu}\mathcal{T}_t^{\theta} = Z_t\mathcal{M}^{-1}, \tag{39}$$

$$C_{R,t} = \mathcal{M}Z_t\mathcal{T}_t^{-\theta}N_{R,t}, \tag{40}$$

$$\Xi(\mathcal{B}_{F,t})\Psi_t(1+\tau_{B,t})E_t[\frac{C_{A,t}}{C_{A+1,t}}\left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t}\right)^{1-\theta}] = E_t[\frac{C_t^*}{C_{t+1}^*}], \tag{41}$$

$$\mathcal{T}_t^{-\theta}Z_t((1-\gamma)N_{A,t}+\gamma N_{R,t}) = ((1-\gamma)C_{A,t}+\gamma C_{R,t})-\left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}}\right)^{1-\theta}\Psi_{t-1}\Xi(\mathcal{B}_{F,t-1})R_{t-1}^*\mathcal{B}_{F,t-1}+\mathcal{B}_{F,t}. \tag{42}$$

The income effect and substitution effect arising from the international relative price changes just cancel out and the net export is always balanced in the Cole-Obstfeld case, if households can have access to the financial market (Cole and Obstfeld (1991) and Fahri and Werning (2012, 2013)). However, if there are some households who cannot have access to the financial markets, then their inability to optimally adjust consumption to the terms of trade change results in unnecessary fluctuations of trade balance even in the Cole-Obstfeld case, calling for capital controls to stabilize capital movements across the borders.

Proposition 1

Suppose that all prices in both domestic economy with limited asset market participation and the rest of the world described in Section 2.1 are flexible. Then the net export cannot be always balanced for the Cole-Obstfeld case, i.e. $\sigma = \eta = 1$, *even if there are only domestic and foreign productivity shocks.*

Proof: Please refer to the Appendix.

Proposition 1 shows that the net export cannot be balanced in the Cole-Obstfeld case, leaving room for government intervene the international capital market to stabilize the economy contrary to Fahri and Werning (2012, 2013). To improve the social welfare by minimizing the unnecessary fluctuations of trade balance associated with terms of trade externality in the presence of LAMP, the government needs to control international capital movement.

Proposition 2

In the presence of the rule of thumb households who cannot have access to the financial markets described in Section 2.1, the optimal capital controls should respond to domestic and foreign productivity shocks for $\sigma = \eta = 1$ *in the flexible price equilibrium.*

Proof: Please refer to the Appendix.

The rule of thumb households who do not have financial assets to smooth out their consumption have to spend all their current income to finance current consumption, entailing undesirable fluctuations of terms of trade and trade balance to the exogenous shocks. The efficient productivity shock is no exception in the economy with LAMP. Hence, the government has an incentive to control international capital movement in the presence of limited asset market participation. In response to productivity shocks, capital controls can mitigate variations in domestic nominal interest rate in the economy, where the interest rate channel is partially muted by the presence of LAMP. This result contrasts with existing literature such as Fahri and Werning (2012, 2013), where there is no room for capital controls in a flexible price equilibrium with productivity shocks for the unitary elasticity of substitution, but without any limit to financial market participation.

Proposition 3

In the presence of the rule of thumb households who cannot have access to the financial markets described in Section 2.1, the domestic price stability is not optimal in the economy with productivity shocks for $\sigma = \eta = 1$.

Proof: Please refer to the Appendix**.**

In the presence of LAMP, the monetary authority should optimally try to undo the time-varying distortions associated with LAMP and monopoly power in goods market by deviating from price stability even if households have the unitary elasticity of intertemporal and intratemporal elasticity of substitution.

4 Quantitative Analysis

In this section, we will explore the effect of habit persistence on the dynamic properties of resource allocations under alternative capital tax and labor income tax regimes in a small open economy. Specifically, the effect of capital control on welfare and resource allocations is explored in depth by employing the second-order approximation methods along the line of Schmitt-Grohé and Uribe (2006).

4.1 Parameter Values

All parameter values used in this paper are reported in Table 1 which are taken from De Paoli (2009), Faia and Monacelli (2008), and Galí and Monacelli (2005). First, we set both the intertemporal and intratemporal elasticities of substitution, i.e. σ^{-1} and η to 1, and the Frisch labor supply elasticity of labor supply ν^{-1} to 1 in the benchmark model. Because these parameter values play a key role in the welfare ranking of simple monetary policy rules, we also consider other values of them as in Table 1. In particular, the intratemporal elasticity between home and foreign goods η which plays a key role in the dynamic properties of the selected macroeconomic variables in the model is set to values in $[1, 5]$. We set the subjective discount factor to $1.04^{-1/4}$, which is consistent with an annual real rate of interest of 4 percent as in Prescott (1986). Next, we set the elasticity of substitution among varieties ϵ to 6, implying the average size of markup, μ to be 1.2 as in Galí and Monacelli (2005). The value of the nominal rigidity parameter α is set to 2/3 to match the value of Bils and Knelow (2004).

Finally, the exogenous driving process, i.e. the (log) productivity, $a_t(\equiv \log A_t)$ and $y_t^*(\equiv \log Y_t^*)$ is assumed to follow an AR(1) process as in De Paoli (2009), Faia and Monacelli (2008), and Galí and Monacelli (2005).

$$\begin{aligned} z_t &= 0.95 z_{t-1} + \varepsilon_t^z, \quad \sigma_z = 0.007, \\ y_t^* &= 0.95 y_{t-1}^* + \varepsilon_t^*, \quad \sigma_{y^*} = 0.007. \end{aligned} \tag{43}$$

The (log) risk premium shock, $\psi_t(\equiv \log \Psi_t)$ is also assumed to follow an AR(1) process:

$$\psi_t = 0.9\psi_{t-1} + \varepsilon_{\psi t}, \ \sigma_\psi = 0.007.$$

4.2 Some Intuitions on Capital Controls

Suppose that both domestic and the rest of the world monetary authorities implement domestic price index inflation targeting rules, i.e. $\pi_{H,t} = \pi_t^* = 0$ for all time t. Then, the log-linearization of (9) around the steady-state in the Cole-Obstfeld case leads to

$$\widehat{\tau}_{Bt} = -\widehat{\psi}_t + \eta \widehat{\mathcal{B}}_{Ft} - E_t[\widehat{C}_{A,t} - \widehat{C}_{A,t+1}] + E_t[\widehat{C}_t^* - \widehat{C}_{t+1}^*] - (1-\theta)E_t[\widehat{\mathcal{T}}_{t+1} - \widehat{\mathcal{T}}_t]. \tag{44}$$

First, consider the response of capital controls to the domestic productivity shock in the flexible price equilibrium. As shown in Proposition 2, the flexible price does not guarantee the balance of net export to the productivity shocks because the rule of thumb households cannot smooth consumption with assets. To see the effect of exogenous shocks on the capital controls, rewrite equation (44) in terms of the interest rate differential between home and foreign countries and the expected depreciation of the real exchange rate:

$$\tau_{B,t} = \chi \mathcal{B}_{Ft} - E_t[\Delta \widehat{\mathcal{T}}_{t+1}] - \nu E_t[\widehat{N}_{A,t+1}] - (1-\rho_A)a_t - \widehat{R}_t^*,$$

$$\widehat{\tau}_{Bt} = -\widehat{\psi}_t + \eta \widehat{\mathcal{B}}_{F,t} + (\widehat{r}_t - \widehat{r}_t^*) - E_t[\widehat{\mathcal{E}}_{t+1} - \widehat{\mathcal{E}}_t)]. \tag{45}$$

A positive domestic productivity shock leads to an expansion of domestic output and a decrease of domestic price, depreciating the terms of trade. The monetary authority decreases its interest rate to stabilize the price level. The asset holders who can use financial assets to smooth consumption end up with a substantial increase in consumption, but without any effect on net export, because the income effect and substitution effect just cancel out to the depreciation of the terms of trade as in Fahri and Werning (2013). However, the rule of thumb households who do not have any asset to buffer their consumption profile from the shocks end up with increasing less their consumption to the depreciation of the terms of trade than the asset holders. Hence, the presence of the rule of thumb households generates a wedge between production and expenditure even in the Cole-Obstfeld case. To moderate the terms of trade depreciation and trade balance fluctuation to the favorable domestic productivity shock, lower domestic interest rate and a depreciation of the real exchange rate are accommodated by a tax to the capital outflows, i.e. a negative value of $\widehat{\tau}_{Bt}$ to the the positive domestic productivity shock.

Next, consider the response of the optimal capital controls to the risk premium shock. The positive risk premium shock generates capital outflows and a depreciation of the terms of trade. It is optimal for the monetary authority to increase the interest rate to reverse the capital flow across borders. The contractionary monetary policy results in a decrease of domestic household's demand for consumption and a current account surplus. A positive control tax on capital outflow accommodates a lower domestic interest rate and a depreciation of the real exchange rate to stabilize the trade balance to the unfavorable risk premium.

4.3 Dynamics in Flexible Price Equilibrium

4.3.1 Impulse Response to Productivity Shocks

No intervention is required in the flexible price equilibrium with unitary elasticity of substitution, if every house can have access to financial market. However, the presence of the rule of thumb households generates undesirable fluctuation of the trade balance in the economy with flexible prices and a unitary elasticity of substitution preference. The rule of thumb households who cannot have access to financial markets cannot adjust their consumption profiles, resulting a wedge between production and expenditure in a small open economy. Hence, the government can improve upon the welfare by using capital controls in response to productivity shocks in the small open economy with the rule of thumb households in the Cole-Obstfeld case.

Figure 1 shows the response of some selected variables to the positive domestic productivity shock without LAMP and with substantial degree of LAMP, i.e. for $\gamma = 0$ and 0.5 when prices are flexible and there is no capital controls. Trade account which is balanced in the absence of LAMP turns into a marginal surplus in the presence of LAMP because the non-asset holders cannot optimally increase their consumption to the favorable productivity shocks. This temporary capital inflow is harmful once these flows are reversed, calling for capital controls to mitigate the capital flows as in Figure 1.

Figure 2 presents the response of some selected variables to the positive domestic productivity shock for various degree of LAMP, i.e. for $\gamma \in [0, 0.5]$ in the presence of optimal capital control policy. Inspection of Figure 1 and 2 shows that huge capital inflows are mitigated with capital controls. A positive domestic productivity shock expands domestic output with domestic price decrease, which leads to a depreciation of terms of trade. As the relative price of domestic goods decreases, the demand for domestic goods increases, yielding a surge in trade surplus. The wealth effect and substitution effect from the terms of trade change just cancel out to the asset holders. However, the rule of thumb households who cannot have access to financial market cannot optimally adjust their consumption profiles to the favorable domestic productivity shock, and end up consuming less than the asset holders, resulting in the domestic expenditure less than output, i.e. a trade surplus. To reduce output gap and stabilize price, the monetary authority increases the interest rate, which also contributes to the trade account surplus. Under this circumstance, the government needs to implement a tax to capital outflow to maintain a trade account surplus. Higher the degree of the limited asset market participation, higher trade surplus and capital control tax rate.

4.3.2 Impulse Response to Risk Premium Shock

Next, consider the response of the optimal capital control tax to the risk premium shock $(\widehat{\psi}_t)$.

Figure 3 shows the impulse response of some selected variables to the positive risk premium shock in the flexible price model for different degree of LAMP, i.e. $\gamma \in [0, 0.5]$.

The risk premium shock leads to a large depreciation of the exchange rate and th terms of trade, resulting in a trade surplus. To direct more international capital toward domestic country, the domestic monetary authority raises its policy rate and the government also levies the capital control tax on capital outflow to the risk premium shock. Asset holders optimally responds to the risk premium shock and the subsequent interest rate increase by decreasing their spending and increasing net saving, while non-asset holders just spend all their current income. Capital control moderates excessive capital inflows to buffer the impact of the risk premium shock on the economy. As a result, the purchasing power of the domestic households is less hurt. Resource allocations such as output, consumption, and the trade account as well as the prices and the terms of trade are stabilized. As the degree of the limited asset market participation increases, interest rate directly affects less portion of households, requiring higher the interest rate to stabilize resource allocations and prices. As a result, the burden of capital control to stabilize international capital movement decreases as in Figure 2.

4.4 Dynamic Response in Sticky Price Equilibrium

4.4.1 Impulse Response to Productivity Shocks

Figure 4 shows the response of some selected variables to the positive domestic productivity shock when half of the households cannot have access to financial markets. Trade balance as well as the terms of trade are stabilized with both optimal capital controls and monetary policy in place.

The monetary authority decreases its interest rate to expand output consistent with the flexible price equilibrium allocation. Given the domestic expenditure increases with nominal interest rate decrease, the government needs to implement capital control tax to stabilize the international capital flows. Optimal capital controls mutes mildly the terms of trade depreciation and trade balance. As the degree of intratemporal elasticity of substitution between home and foreign goods (η), i.e. trade elasticity increases, households are more willing to substitute home goods with foreign goods to the international relative price change. Figure shows that the terms of trade depreciates less, but the trade balance improves more to the domestic productivity shock for higher trade elasticity ($\eta = 5$) than lower trade elasticity ($\eta = 2$).

4.4.2 Impulse Response to Risk Premium Shock

Next, consider the response of the optimal capital control tax to the risk premium shock ($\widehat{\psi}_t$).

Figure 5 shows the impulse response of some selected variables to the positive risk premium shock in the sticky price equilibrium for $\gamma = 0.5$.

The risk premium shock leads to a large depreciation of the exchange rate and th terms of trade, resulting in a trade surplus. To direct more international capital toward domestic country, the domestic monetary authority raises its policy rate and the government also levies the capital control tax on capital outflow to the risk premium shock. Capital control moderates excessive capital inflows to buffer the impact of the risk premium shock and the subsequent interest rate increase on the economy. As a result, the purchasing power of the domestic households is less hurt, decreasing consumption less, but output expands less in economies with capital controls in place than in economies without capital controls in place.

4.5 Welfare and Resource Allocations

In this subsection, we will discuss the effect of LAMP on resource allocations and the optimal capital tax by employing the second-order approximation methods along the line of Schmitt-Grohé and Uribe (2006).

Table 2 presents the welfare and resource allocations with productivity shocks only for the Cole-Obstfeld case when prices are flexible. In Table 2, $\mathcal{W}_{C_1}$ and $\mathcal{W}_{C_2}$ represent the welfare under only efficient domestic and foreign productivity shocks and the welfare under a risk premium shock as well as domestic and foreign productivity shocks.

First, the difference between the welfare associated with the optimal capital controls and the welfare associated with no capital control is 0.0085% of the steady-state consumption under efficient productivity shocks, while it equals 0.2319% of steady-state consumption under three exogenous shocks.

Second, the welfare associated with the optimal time-varying labor income taxation and capital controls in the internal habit equals the welfare with the optimal time-varying labor income taxation and capital controls in the external habit. The time-varying optimal taxation completely eliminates distortions associated with habit, irrespective of internality or externality.

Third, the optimal labor income taxation moves procyclically over business cycles as expected. However, the capital controls are marginally countercyclical.

5 Conclusion

In the present paper, we have extended the existing literature on optimal capitals in a small economy framework by incorporating limited asset market participation into the model. We have shown that there is room for government to improve welfare by controlling international capital movement to a productivity shock even in the flexible price equilibrium with unitary elasticities of substitution, i.e. in the Cole-Obstfeld case. The difference between the welfare associated with capital controls and the welfare associated without capital controls is substantial in the Cole-Obstfeld case with efficient productivity shocks only.

Moreover, the monetary authority should deviate from price stability to improve the welfare in the small open economy with a Cole-Obstfeld preference with productivity shocks only if there exists households who cannot have access to the financial market. Finally, we have shown that the optimal capital control tax leans against the wind less under an optimal time-varying labor income tax regime than under a time-invariant labor income tax regime.

Table 1:The Calibrated Parameters

Parameter	Values	Description and definitions
γ	0.3	Fraction of rule of thumb households
ϵ	6	Elasticity of demand for a good with respect to its own price
σ	1, 2	Relative risk aversion parameter
α	0, 2/3	Fraction of firms that do not change their prices in a given period
η	1, 2, 4, 5	Elasticity of substitution between home and foreign goods
ν	0.5, 1, 3	Inverse of elasticity of labor supply
r	0.016	Steady state real interest rate

Appendix

Proof of Proposition 1

Consider the resource constraint

$$
\begin{aligned}
Y_t &= (1-\theta)\mathcal{T}_t^{\theta} C_t + \theta \mathcal{T}_t C_t^* \\
&= \mathcal{T}_t^{\theta} C_t + \theta(\mathcal{T}_t C_t^* - \mathcal{T}_t^{\theta} C_t).
\end{aligned}
$$

$$(1+\tau_{B,t})\Psi_t \Xi(\mathcal{B}_{F,t}) E_t \left[\frac{C_{A,t}}{C_{A,t+1}} \left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t} \right)^{1-\theta} \right] = E_t \left[\frac{C_t^*}{C_{t+1}^*} \right]$$

$$Y_t = \mathcal{T}_t^{\theta} C_t - \Psi_{t-1} \left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}} \right)^{1-\theta} \Xi(\mathcal{B}_{F,t-1}) R_{t-1}^* \mathcal{B}_{F,t-1} + \mathcal{B}_{F,t}]$$

Since $\tau_{B,t} = 0$, and $\Psi_t = 1$,

$$\Xi(\mathcal{B}_{F,t}) E_t \left[\frac{C_{A,t}}{C_{A,t+1}} \left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t} \right)^{1-\theta} \right] = E_t \left[\frac{C_t^*}{C_{t+1}^*} \right] \tag{A1}$$

$$Y_t = \mathcal{T}_t^{\theta} C_t - \left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}} \right)^{1-\theta} \Xi(\mathcal{B}_{F,t-1}) R_{t-1}^* \mathcal{B}_{F,t-1} + \mathcal{B}_{F,t}].$$

Note that

$$\theta(\mathcal{T}_t C_t^* - \mathcal{T}_t^{\theta} C_t) = -\left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}} \right)^{1-\theta} \Xi(\mathcal{B}_{F,t-1}) R_{t-1}^* \mathcal{B}_{F,t-1} + \mathcal{B}_{F,t}]. \tag{A2}$$

To show that $\mathcal{B}_{F,t} = 0$ cannot be a solution of equations of (A1) and (A2), suppose that $\mathcal{B}_{F,t} = 0$ for all time t. Then $\Xi(\mathcal{B}_{F,t}) = 1$ and (A2) implies that $\mathcal{T}_t^{1-\theta} = \frac{C_t}{C_t^*}$. The LHS of (A1) equals $E_t \left[\frac{C_{A,t}}{C_{A,t+1}} \left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t} \right)^{1-\theta} \right] = E_t \left[\frac{C_{A,t}}{C_{A,t+1}} \frac{(1-\gamma)C_{A,t+1}+\gamma C_{R,t+1}}{(1-\gamma)C_{A,t}+\gamma C_{R,t}} \frac{C_t^*}{C_{t+1}^*} \right]$. Hence, only if $\gamma = 0$, then the LHS of equation (A1) equals the RHS of equation (A1), implying $\mathcal{B}_{F,t} = 0$. Otherwise, $E_t \left[\frac{C_{A,t}}{C_{A,t+1}} \left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t} \right)^{1-\theta} \right] \neq E_t \left[\frac{C_t^*}{C_{t+1}^*} \right]$.

Therefore, $\mathcal{B}_{F,t} \neq 0$.■

Proof of Proposition 2

Under the assumption that $\Psi_t = 1$, the domestic social planner's problem can be written as follows:

$$\begin{aligned} \mathrm{V}(Z_t,\mathcal{F}_t) &= \max_{\{\tau_{B,t}C_{A,t},\, N_{A,t},C_{R,t},\, N_{R,t},\ \mathcal{B}_{Ft},\mathcal{T}_t\}} .[(1-\gamma)\left(\log C_{A,t} - \frac{N_{A,t}^{1+\nu}}{1+\nu}\right) \quad \text{(A3)} \\ &+\gamma\left(\log C_{R,t} - \frac{N_{R,t}^{1+\nu}}{1+\nu}\right) + \beta E_t \mathrm{V}(Z_{t+1},,\mathcal{F}_{t+1})], \end{aligned}$$

subject to

$$Z_t((1-\gamma)N_{A,t}+\gamma N_{R,t})-\overline{\mathbf{F}} = (1-\theta)\mathcal{T}_t^{\theta}((1-\gamma)C_{A,t}+\gamma C_{R,t})+\theta\mathcal{T}_t C_t^*, \quad \text{(A4)}$$

$$C_{A,t}N_{A,t}^{\nu} = \mathcal{T}_t^{-\theta}Z_t\mathcal{M}^{-1} \quad \text{(A5)}$$

$$C_{R,t}N_{R,t}^{\nu} = \mathcal{T}_t^{-\theta}Z_t\mathcal{M}^{-1}, \quad \text{(A6)}$$

$$C_{R,t} = \mathcal{M}Z_t\mathcal{T}_t^{-\theta}N_{R,t}, \quad \text{(A7)}$$

$$\Xi(\mathcal{B}_{F,t})\Psi_t(1+\tau_{B,t})E_t[\frac{C_{A,t}}{C_{A+1,t}}\left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t}\right)^{1-\theta}] = E_t[\frac{C_t^*}{C_{t+1}^*}], \quad \text{(A8)}$$

$$\mathcal{T}_t^{-\theta}[Z_t((1-\gamma)N_{A,t}+\gamma N_{R,t})-\overline{\mathbf{F}}] = ((1-\gamma)C_{A,t}+\gamma C_{R,t})-\left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}}\right)^{1-\theta}\Psi_{t-1}\Xi(\mathcal{B}_{F,t-1})R_{t-1}^*\mathcal{B}_{F,t-1}+\mathcal{B}_{F,t}. \quad \text{(A9)}$$

From (A4) and (A9), $\left(\frac{\mathcal{T}_t}{\mathcal{T}_{t-1}}\right)^{1-\theta}\Psi_{t-1}\Xi(\mathcal{B}_{F,t-1})R_{t-1}^*\mathcal{B}_{F,t-1}+\mathcal{B}_{F,t} = \theta[\mathcal{T}_t^{1-\theta}C_t^* - (1-\gamma)C_{A,t} - \gamma C_{R,t}]$. Hence, (A8) implies that

$$\begin{aligned} &\Xi(\mathcal{B}_{F,t})\Psi_t(1+\tau_{B,t})E_t[\frac{C_{A,t}}{C_{A+1,t}}\frac{\theta[\mathcal{T}_{t+1}^{1-\theta}C_{t+1}^* - (1-\gamma)C_{A,t+1} - \gamma C_{R,t+1}]}{\Psi_t\Xi(\mathcal{B}_{F,t})R_t^*\mathcal{B}_{F,t} + \mathcal{B}_{F,t+1}}] \\ =\ & E_t[\frac{C_t^*}{C_{t+1}^*}] \end{aligned}$$

Log-linearization leads to

$$\begin{aligned} & -\eta\mathcal{B}_{F,t} + \varphi_t + \tau_{B,t} - E_t[\Delta\widehat{c}_{A,t+1} - \Delta\widehat{c}_{t+1}^*] \\ =\ & (1-\theta)E_t[\widehat{\mathcal{T}}_{t+1} + \widehat{c}_{t+1}^* - (1-\gamma)\widehat{c}_{A,t+1} - \gamma\widehat{c}_{R,t+1}] - \beta^{-1}\mathcal{B}_{F,t} \end{aligned}$$

$\Xi(\mathcal{B}_{F,t})\Psi_t(1+\tau_{B,t})E_t[\frac{C_{A,t}}{C_{A+1,t}}\left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t}\right)^{1-\theta}] = E_t[\frac{C_t^*}{C_{t+1}^*}]$

If $\mathcal{B}_{F,t} = 0$, i.e. for all time, then no capital control is necessary, i.e. τ_{Bt} is zero for all time. (A4) and (A9) show that $\tau_{B,t} = 0$ iff $(1-\gamma)C_{A,t} + \gamma C_{R,t} = \mathcal{T}_t C_t^*$ for all t. With $\tau_{Bt} = 0$ and $(1-\gamma)C_{A,t} + \gamma C_{R,t} = \mathcal{T}_t C_t^*$ in (A8), it follows that

$$E_t[\frac{C_{A,t}}{C_{A+1,t}}\left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t}\right)^{1-\theta}] = E_t[\left(\frac{\mathcal{T}_{t+1}}{\mathcal{T}_t}\right)\frac{(1-\gamma)C_{A,t} + \gamma C_{R,t}}{(1-\gamma)C_{A,t+1} + \gamma C_{R,t+1}}]$$

which is contradiction. However, (A8) shows that the optimal capital control tax rate cannot be zero. The capital control should respond to the productivity shocks in the presence of the rule of thumb households for the Cole-Obstfeld case.

■

Proof of Proposition 3

The Ramsey problem for unitary elasticity of substitution, i.e. for $\sigma = \eta = 1$, can be simplified as

$$\begin{aligned}
\mathcal{L} \quad = \quad & E_t \sum_{i=0}^{\infty} \beta^{t+i}\{\left((1-\gamma)(\log C_{A,t+i} - \frac{N_{A,t+i}^{1+v}}{1+v}) + \gamma(\log C_{R,t+i} - \frac{1}{1+v})\right) \\
& +\lambda_{1,t+i}[\frac{Z_{t+i}((1-\gamma)N_{A,t+i} + \gamma)}{\Delta_{H,t+i}} - F - (1-\theta)\mathcal{T}_{t+i}^{\theta}((1-\gamma)C_{A,t+i} + \gamma C_{R,t+i}) - \theta\mathcal{T}_{t+i}C_{t+i}^*] \\
& +\lambda_{2,t+i}[1 - (1-\alpha)\widetilde{p}_{H,t+i}^{1-\epsilon} - \alpha(1+\pi_{H,t+i})^{\epsilon-1}] \\
& +\lambda_{3,t+i}[\Delta_{H,t+i} - (1-\alpha)\widetilde{p}_{H,t+i}^{-\epsilon} - \alpha(1+\pi_{H,t+i})^{\epsilon}\Delta_{H,t+i-1}] \\
& +\lambda_{4,t+i}[Z_{t+i}(1-\tau)\mathrm{mc}_{t+i} - \mathcal{T}_{t+i}^{\theta}N_{A,t+i}^{\nu}C_{A,t+i}] \\
& +\lambda_{5,t+i}[\frac{\epsilon}{\epsilon-1}\mathcal{X}_{t+i} - \mathcal{Y}_{t+i}] + \lambda_{6,t+i}[\mathcal{X}_{t+i} - \widetilde{p}_{H,t+i}^{-1-\epsilon}\frac{Z_{t+i}((1-\gamma)N_{A,t+i} + \gamma)}{\Delta_{H,t+i}}\mathrm{mc}_{t+i} \\
& -\alpha\beta[(1+\pi_{H,t+i+1})^{\epsilon}\frac{\mathcal{T}_{t+i}^{\theta}}{\mathcal{T}_{t+i+1}^{\theta}}(\frac{C_{A,t+i+1}}{C_{A,t+i}})^{-1}\left(\frac{\widetilde{p}_{H,t+i}}{\widetilde{p}_{H,t+i+1}}\right)^{-1-\epsilon}\mathcal{X}_{t+i+1}] \\
& +\lambda_{7,t+i}[\mathcal{Y}_{t+i} - \widetilde{p}_{H,t+i}^{-\epsilon}\frac{Z_{t+i}((1-\gamma)N_{A,t+i} + \gamma)}{\Delta_{H,t+i}} \\
& -\alpha\beta(\frac{C_{A,t+i+1}}{C_{A,t+i}})^{-1}(1+\pi_{H,t+i+1})^{\epsilon-1}\frac{\mathcal{T}_{t+i}^{\theta}}{\mathcal{T}_{t+i+1}^{\theta}}\left(\frac{\widetilde{p}_{H,t+i}}{\widetilde{p}_{H,t+i+1}}\right)^{-\epsilon}\mathcal{Y}_{t+i+1}]\}
\end{aligned}$$

Then, the first order conditions are given by

$$
\begin{aligned}
C_{A,t} \quad : \quad & (1-\gamma)C_{A,t}^{-1} + \alpha\epsilon(1+\pi_{H,t})^{\epsilon-1}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}C_{A,t}^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}\mathcal{X}_t\lambda_{6,t} \\
& +\alpha(\epsilon-1)(1+\pi_{H,t+1})^{\epsilon-2}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}C_{A,t}^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}\mathcal{Y}_t\lambda_{7,t} \\
= \quad & (1-\theta)(1-\gamma)\mathcal{T}_t^{\theta}\lambda_{1,t} + \mathcal{T}_t^{\theta}N_{A,t}^{\nu}\lambda_{4,t} \qquad \text{(A10)} \\
& -\alpha\beta E_t[\epsilon(1+\pi_{H,t+1})^{\epsilon-1}\frac{\mathcal{T}_t^{\theta}}{\mathcal{T}_{t+1}^{\theta}}C_{A,t+1}^{-1}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-1-\epsilon}\mathcal{X}_{t+1}\lambda_{6,t+1} \\
& +(\epsilon-1)(1+\pi_{H,t+1})^{\epsilon-2}\frac{\mathcal{T}_t^{\theta}}{\mathcal{T}_{t+1}^{\theta}}C_{A,t+1}^{-1}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-\epsilon}\mathcal{Y}_{t+1}\lambda_{7,t+1}],
\end{aligned}
$$

$$
\begin{aligned}
N_{A,t} \quad : \quad & (1-\gamma)N_{A,t}^{\nu} + (1-\gamma)Z_t\Delta_{H,t}^{-1}(\mathrm{mc}_t\widetilde{p}_{H,t}^{-1-\epsilon}\lambda_{6,t} + \widetilde{p}_{H,t}^{-\epsilon}\lambda_{7,t}) \qquad \text{(A11)} \\
= \quad & (1-\theta)(1-\gamma)Z_t\cdot_{H,t}^{-1}\lambda_{1,t} + \nu\mathcal{T}_t^{\theta}N_{A,t}^{\nu}C_{A,t}\lambda_{4,t},
\end{aligned}
$$

$$
C_{R,t} : \gamma C_{R,t}^{-1} = (1-\theta)\gamma\mathcal{T}_t^{\theta}\lambda_{1,t}, \qquad \text{(A12)}
$$

$$
\mathrm{mc}_t : Z_t(1-\widetilde{\tau})\lambda_{4,t} = \widetilde{p}_{H,t}^{-1-\epsilon}\frac{Z_t((1-\gamma)N_{A,t}+\gamma)}{\Delta_{H,t}}\lambda_{6,t} \qquad \text{(A13)}
$$

$$
\begin{aligned}
\pi_{H,t} \quad : \quad & 0 = \alpha(\epsilon-1)(1+\pi_{H,t})^{\epsilon-2}\lambda_{2,t} + \alpha\epsilon(1+\pi_{H,t})^{\epsilon-1}\lambda_{3,t} \qquad \text{(A14)} \\
& +\alpha\epsilon(1+\pi_{H,t})^{\epsilon-1}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-\sigma}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}\mathcal{X}_t\lambda_{6,t} \\
& +\alpha(\epsilon-1)(1+\pi_{H,t})^{\epsilon-2}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-\sigma}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}\mathcal{Y}_t\lambda_{7,t}
\end{aligned}
$$

$$
\begin{aligned}
\Delta_{H,t} \quad : \quad & Z_t((1-\gamma)N_{A,t}+\gamma)\Delta_{H,t}^{-2}\lambda_{1,t} + \alpha(1+\pi_{H,t+i})^{\epsilon}\lambda_{3,t} \qquad \text{(A15)} \\
= \quad & Z_t((1-\gamma)N_{A,t}+\gamma)\Delta_{H,t}^{-2}(\widetilde{p}_{H,t}^{-1-\epsilon}\mathrm{mc}_t\lambda_{6,t} + \widetilde{p}_{H,t}^{-\epsilon}\lambda_{7,t})
\end{aligned}
$$

$$\begin{aligned}
\widetilde{p}_{H,t} \quad : \quad & (1-\alpha)(1-\epsilon)\widetilde{p}_{H,t}^{-\epsilon}\lambda_{2,t} - (1-\alpha)\epsilon\widetilde{p}_{H,t}^{-\epsilon-1}\lambda_{3,t} \qquad \text{(A16)} \\
& -(1+\epsilon)\widetilde{p}_{H,t}^{-2-\epsilon}\frac{Z_t((1-\gamma)N_{A,t}+\gamma)}{\Delta_{H,t}}\mathrm{mc}_t\lambda_{6,t} - \epsilon\widetilde{p}_{H,t}^{-\epsilon-1}\frac{Z_t((1-\gamma)N_{A,t}+\gamma)}{\Delta_{H,t}}\lambda_{7,t} \\
& +\alpha\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}[(1+\epsilon)(1+\pi_{H,t})^{\epsilon-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}\widetilde{p}_{H,t}^{-1}\mathcal{X}_t\lambda_{6,t} \\
& +\epsilon(1+\pi_{H,t})^{\epsilon}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}\widetilde{p}_{H,t}^{-1}\mathcal{Y}_t\lambda_{7.t}] \\
= \quad & \alpha\beta\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}E_t[(1+\epsilon)[(1+\pi_{H,t+1})^{\epsilon-1}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-1-\epsilon}\widetilde{p}_{H,t}^{-1}\mathcal{X}_{t+1}\lambda_{6,t+1} \\
& +\epsilon[(1+\pi_{H,t+1})^{\epsilon}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-\epsilon}\widetilde{p}_{H,t}^{-1}\mathcal{Y}_{t+1}\lambda_{7,t+1}],
\end{aligned}$$

$$\begin{aligned}
\mathcal{T}_t \quad : \quad & \theta[(1-\theta)\mathcal{T}_t^{\theta-1}((1-\gamma)C_{A,t}+\gamma C_{R,t})+C_t^*]\lambda_{1,t} + \theta\mathcal{T}_t^{\theta-1}N_{A,t}^{\nu}C_{A,t}\lambda_{4,t} \\
& +\theta\alpha\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}\mathcal{T}_t^{-1}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}[(1+\pi_{H,t})^{\epsilon-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}\mathcal{X}_t\lambda_{6,t} \\
& +(1+\pi_{H,t})^{\epsilon}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}\mathcal{Y}_t\lambda_{7,t}] \qquad (46) \\
= \quad & \theta\alpha\beta E_t[\frac{\mathcal{T}_t^{\theta-1}}{\mathcal{T}_{t+1}^{\theta}}(\frac{C_{A,t+1}}{C_{A,t}})^{-1}[(1+\pi_{H,t+1})^{\epsilon-1}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-1-\epsilon}\mathcal{X}_{t+1}\lambda_{6,t+1} \\
& +(1+\pi_{H,t+1})^{\epsilon}\left(\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t+1}}\right)^{-\epsilon}\mathcal{Y}_{t+1}\lambda_{7,t+1}]
\end{aligned}$$

$$\mathcal{X}_t : \frac{\epsilon}{\epsilon-1}\lambda_{5,t} + \lambda_{6,t} = \alpha[(1+\pi_{H,t})^{\epsilon}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}]\lambda_{6,t}, \qquad \text{(A17)}$$

$$\mathcal{Y}_t : \lambda_{7,t} = \lambda_{5,t} + \alpha[(1+\pi_{H,t})^{\epsilon-1}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}]\lambda_{7,t}. \qquad \text{(A18)}$$

Equations (A17) and (A18) imply that

$$\begin{aligned}
& \lambda_{7,t}[1-\alpha[(1+\pi_{H,t})^{\epsilon-1}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-\epsilon}]] \qquad \text{(A19)} \\
= \quad & \frac{\epsilon-1}{\epsilon}[1-\alpha[(1+\pi_{H,t})^{\epsilon}\frac{\mathcal{T}_{t-1}^{\theta}}{\mathcal{T}_t^{\theta}}(\frac{C_{A,t}}{C_{A,t-1}})^{-1}\left(\frac{\widetilde{p}_{H,t-1}}{\widetilde{p}_{H,t}}\right)^{-1-\epsilon}]]\lambda_{6,t}.
\end{aligned}$$

$\lambda_{6,t}$ and $\lambda_{7,t}$ can be expressed in terms of the endogenous variables such as $C_{A,t}$, $C_{R,t}$, $N_{A,t}$, Z_t, $\mathcal{T}_t$, $\widetilde{p}_{H,t}$, $\Delta_{H,t}$, $\pi_{H,t}$ from (A11), (A12), (A13), and (A19). Plugging $\lambda_{6,t}$ and $\lambda_{7,t}$ into (A15), (A14), and (A13), $\lambda_{2,t}$, $\lambda_{3,t}$, and $\lambda_{4,t}$ are also expressed in terms of these endogenous variables. Hence, $\pi_{H,t}$ depends on the path of $C_{A,t}$, $C_{R,t}$, $N_{A,t}$, Z_t, $\mathcal{T}_t$, $\widetilde{p}_{H,t}$, and $\Delta_{H,t}$.

■

Table 1: Parameter Values

Parameter	Values	Description and definitions
b	0, 0.5, 0.7	Degree of externality in consumption
ϵ	6	Elasticity of demand for a good with respect to its own price
σ	1, 2	Relative risk aversion parameter
α	0, 2/3	Fraction of firms that do not change their prices in a given period
η	1, 2, 4, 5	Elasticity of substitution between home and foreign goods
ν	0.5, 1, 3	Inverse of elasticity of labor supply
r	0.016	Steady state real interest rate

Table 2 : Dynamic Properties of the Resource Allocations in a Flexible Price Equilibrium with productivity shocks only ($\sigma = \eta = 1, \ \gamma = 0.3$)

Variable	Mean	Std. Dev.	Auto. Corr	$Corr(x, y)$
Optimal	Capital	Control	Policy	
$\mathcal{W}_{C1} = 0$				
τ_B	0.0000	0.0605	0.9003	0.0464
$\mathcal{T}$	1.0000	2.7881	0.9324	0.6926
TB	0.0000	0.0730	0.7965	0.0386
c	1.0000	1.3035	0.9327	0.8055
y	1.0000	1.8556	0.9256	1
No	Capital	Control		
$\mathcal{W}_{C1} = -0.0085$				
τ_B	0	0	-	-
$\mathcal{T}$	1.0013	2.7774	0.9260	0.6882
TB	0.0001	0.0348	0.9284	-0.1588
c	1.0002	1.3147	0.9261	0.8044
y	1.0007	1.8450	0.9250	1

Note: τ and τ_B are expressed in percentage points and $y, \ n, \ \mathcal{T}, TB$ and c in levels and $\mathcal{W}_C$ represents the difference between the welfare associated with the optimal time-varying labor income and capital controls and the welfare associated with the corresponding policy rules. The parameter values are $\beta = (1.04)^{-1/4}, \ T = 200$, and $J = 1000$.

Table 3 : Dynamic Properties of the Resource Allocations in a Flexible Price Equilibrium with productivity and risk premium shocks ($\sigma = \ \eta = \ 1, \ \gamma = 0.3$)

Variable	Mean	Std. Dev.	Auto. Corr	$Corr(x, y)$
Optimal	Capital	Control	Policy	
$\mathcal{W}_{C1} = 0$				
τ_B	0.0100	0.7763	0.9614	-0.1240
$\mathcal{T}$	1.0000	4.0420	0.8605	0.7229
TB	0.0000	1.3699	0.7969	0.3847
c	1.0000	2.1990	0.8455	0.1274
y	1.0000	2.0181	0.9063	1
No	Capital	Control		
$\mathcal{W}_{C2} = -0.2319$				
τ_B	0	0	-	-
$\mathcal{T}$	1.0086	3.2836	0.9285	0.6973
TB	0.0036	0.8070	0.9313	0.2095
c	0.9957	1.6903	0.9316	0.4737
y	1.0026	1.9184	0.9270	1

Note: τ and τ_B are expressed in percentage points and $y, \ n, \ \mathcal{T}, TB$ and c in levels and $\mathcal{W}_C$ represents the difference between the welfare associated with the optimal time-varying labor income and capital controls and the welfare associated with the corresponding policy rules. The parameter values are $\beta = (1.04)^{-1/4}, \ T = 200$, and $J = 1000$.

Table 4 : Dynamic Properties of the Resource Allocations in a Flexible Price Equilibrium with Productivity Shocks only ($\sigma = \eta = 1,\ \gamma = 0.5$)

Variable	Mean	Std. Dev.	Auto. Corr	$Corr(x, y)$
Optimal	Capital	Control	Policy	
$\mathcal{W}_C = 0$				
τ_B	0.0200	0.0606	0.8927	0.0534
$\mathcal{T}$	1.0000	2.8421	0.9321	0.7024
TB	0.0000	0.0729	0.7978	0.0453
c	1.0000	1.2874	0.9318	0.7940
y	1.0000	1.8552	0.9254	1
No	Capital	Control		
$\mathcal{W}_C = -0.0148$				
τ_B	0	0	-	-
$\mathcal{T}$	1.0004	2.8012	0.9262	0.6958
TB	0.0002	0.0592	0.9295	-0.0131
c	0.9998	1.3029	0.9277	0.8145
y	1.0001	1.8701	0.9271	1

Note: τ and τ_B are expressed in percentage points and $y,\ n,\ \mathcal{T}, TB$ and c in levels and $\mathcal{W}_C$ represents the difference between the welfare associated with the optimal time-varying labor income and capital controls and the welfare associated with the corresponding policy rules. The parameter values are $\beta = (1.04)^{-1/4},\ T = 200$, and $J = 1000$.

Table 5 : Dynamic Properties of the Resource Allocations in a Flexible Price Equilibrium with Productivity and Risk Premium Shocks ($\sigma = \eta = 1, \ \gamma = 0.5$)

Variable	Mean	Std. Dev.	Auto. Corr	$Corr(x, y)$
Optimal	Capital	Control	Policy	
$\mathcal{W}_{C1} = 0$				
τ_B	0.0300	0.7364	0.9679	-0.1053
$\mathcal{T}$	1.0000	4.0509	0.8631	0.7246
TB	0.0000	1.3186	0.7981	0.3749
c	1.0000	2.1498	0.8474	0.1347
y	1.0000	1.9962	0.9062	1
No	Capital	Control		
$\mathcal{W}_{C2} = -0.2321$				
τ_B	0	0	-	-
$\mathcal{T}$	1.0077	3.2336	0.9291	0.6942
TB	0.0032	0.7224	0.9322	0.1902
c	0.9960	1.6324	0.9321	0.5185
y	1.0021	1.8994	0.9268	1

Note: τ and τ_B are expressed in percentage points and $y, \ n, \ \mathcal{T}, TB$ and c in levels and $\mathcal{W}_C$ represents the difference between the welfare associated with the optimal time-varying labor income and capital controls and the welfare associated with the corresponding policy rules. The parameter values are $\beta = (1.04)^{-1/4}, \ T = 200$, and $J = 1000$.

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Figure 1 : Impulse Response to a Positive Domestic Technology Shock without Capital Control in Flexible Price Equilibrium($\sigma = \eta = 1$)

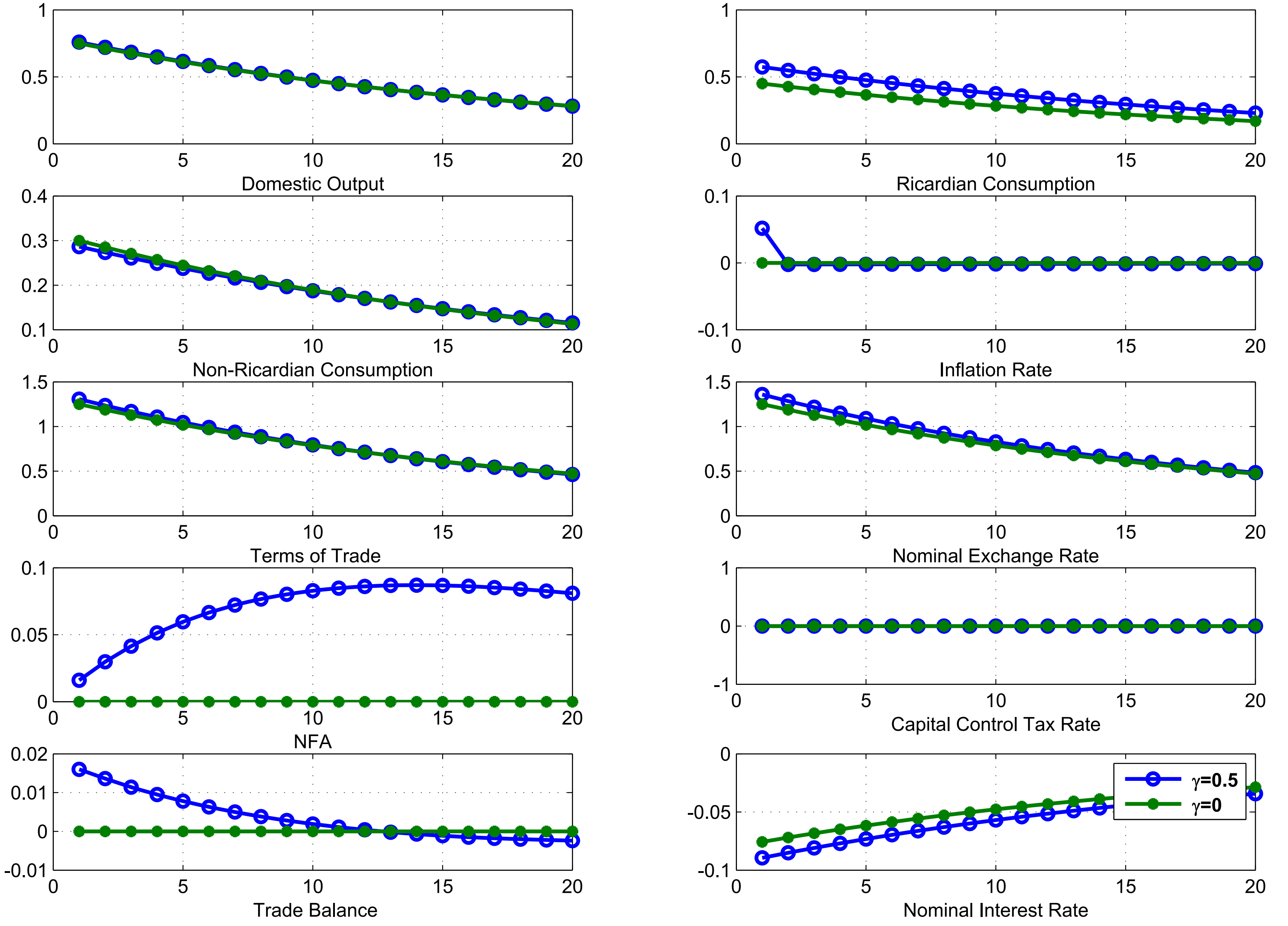

Figure 2 : Impulse Response to a Positive Domestic Technology Shock in Flexible Price Model: (σ=1, η=1)

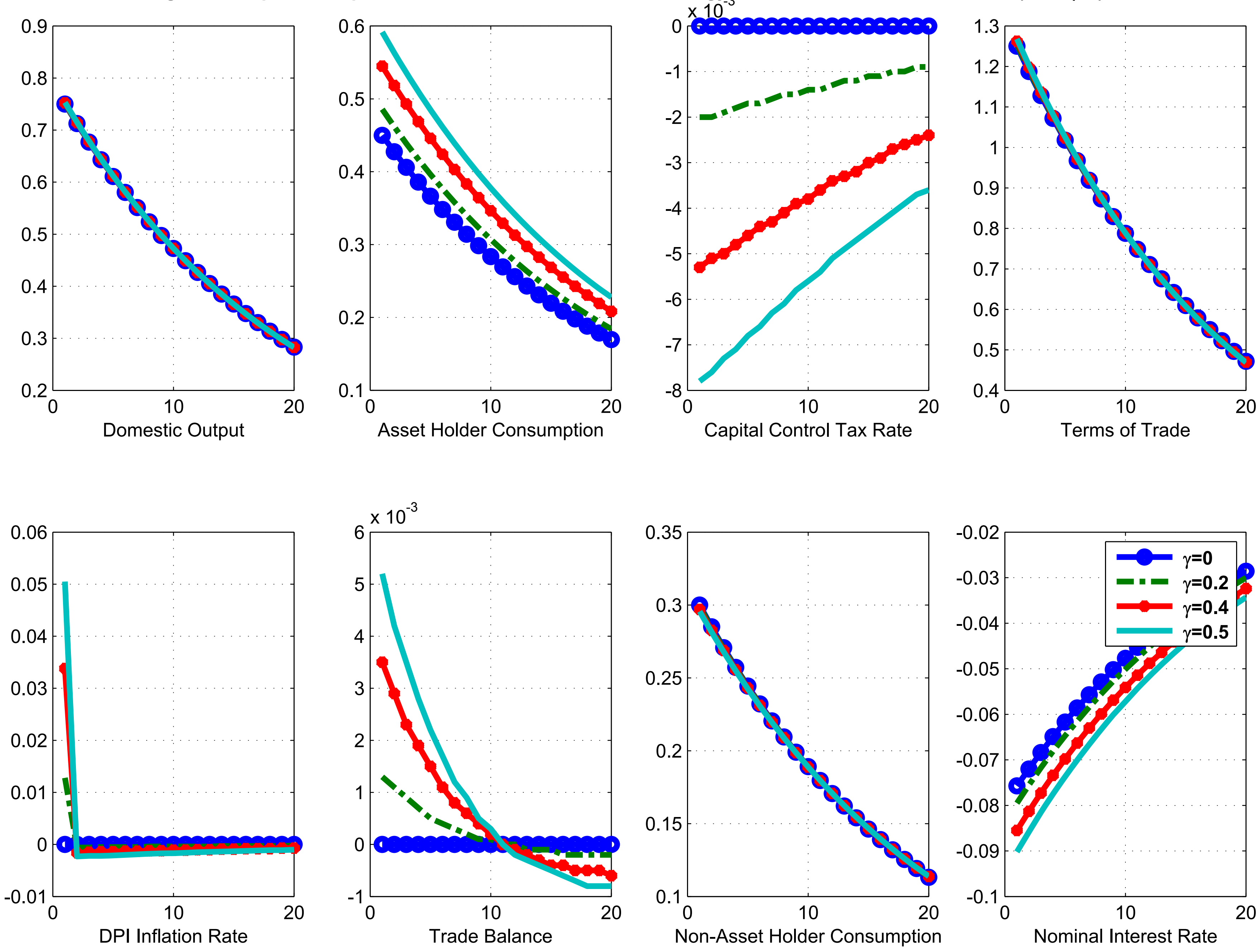

Figure 3 : Impulse Response to a Positive Risk Premium Shock in Flexible Price Model: (σ=1, η=1)

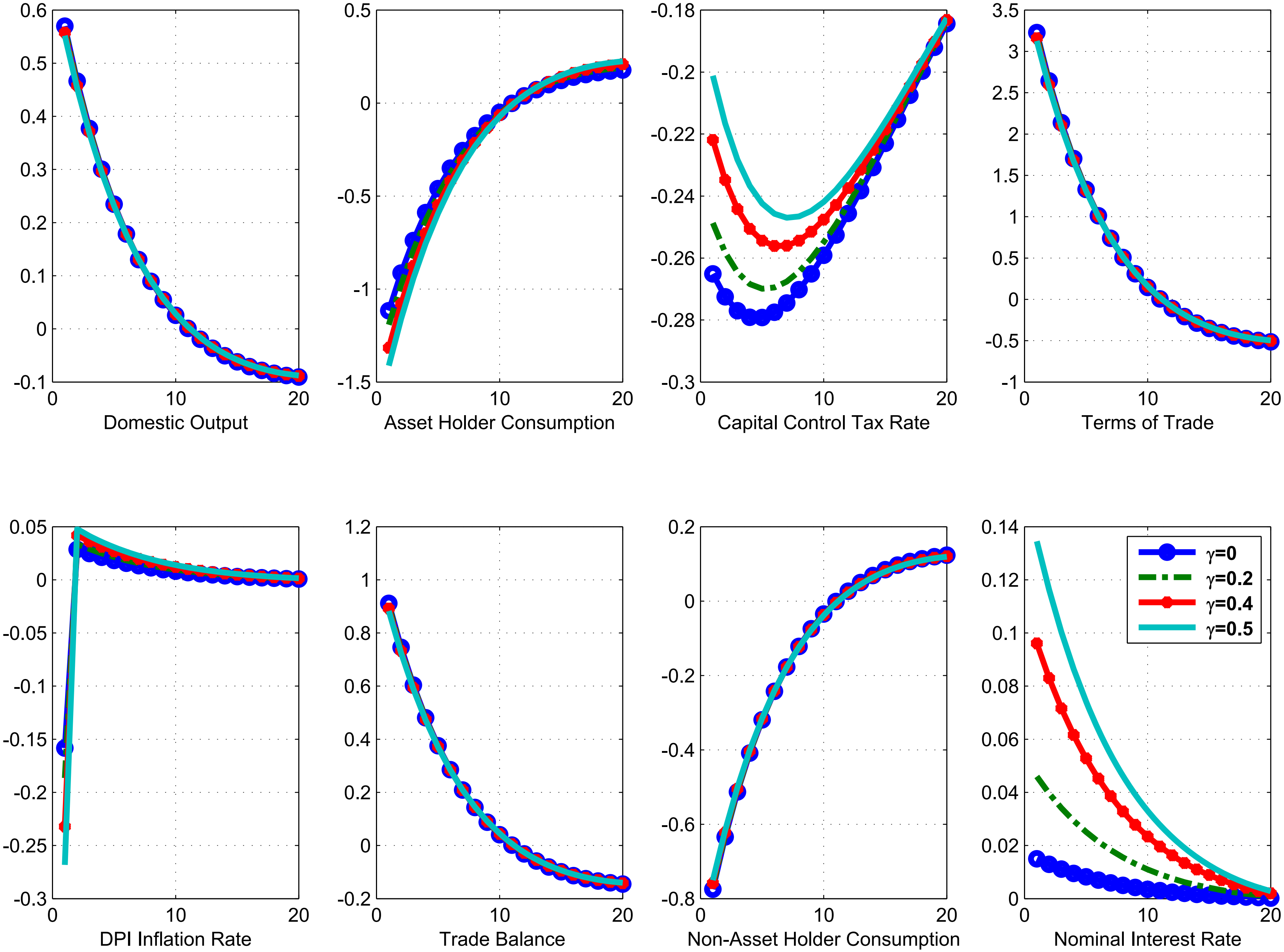

Figure 4 : Impulse Response to a Positive Domestic Technology Shock in Sticky Price Equilibrium (σ=1, γ=0.5)

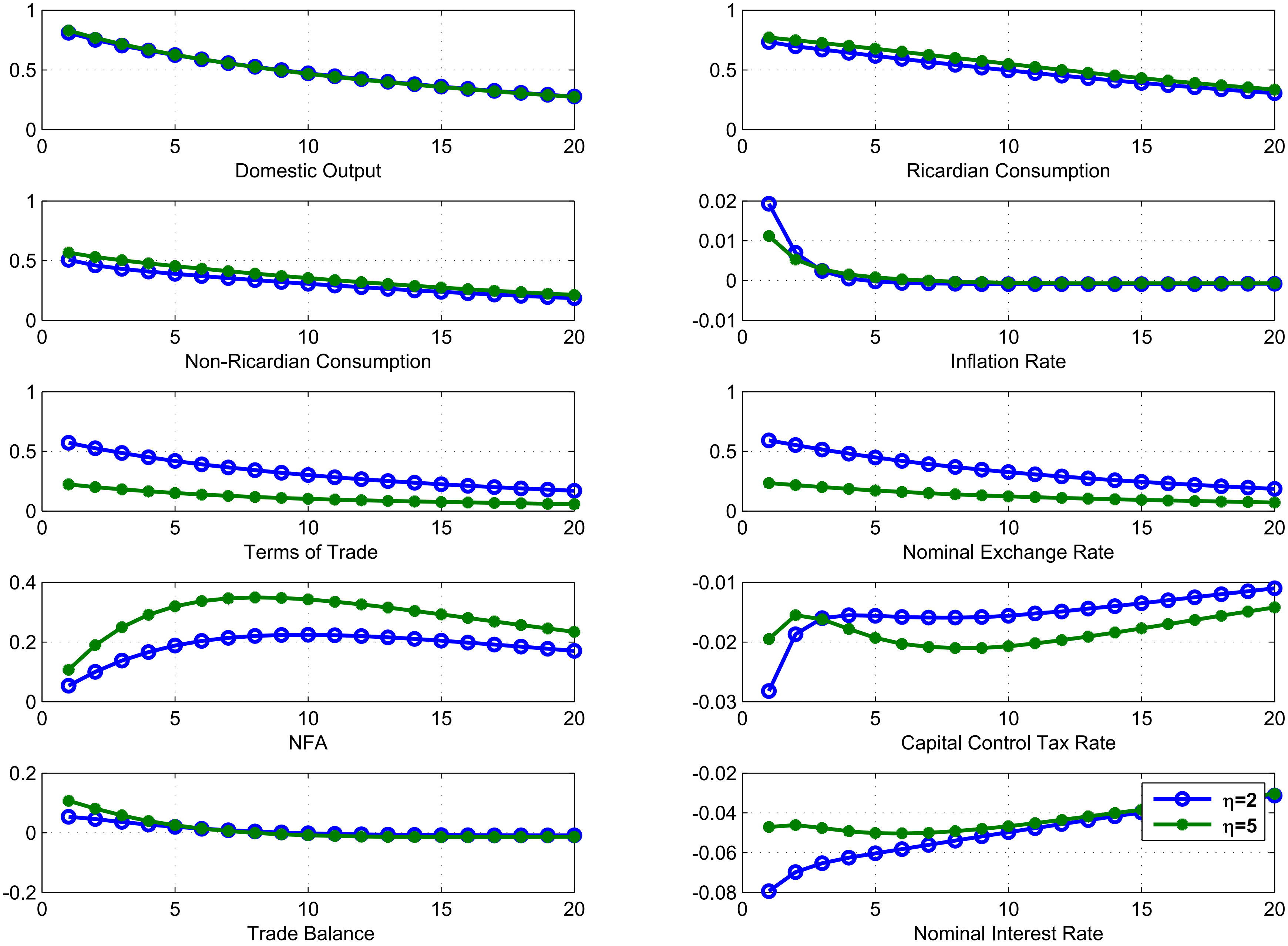

Figure 5 : Impulse Response to a Positive Risk Premium Shock in Sticky Price Equilibrium (σ=1, γ=0.5)