Financial Globalization, Financial Frictions and Monetary Policy*

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Abstract

Should monetary policy change in an environment with high degrees of financial globalization? To answer this question we lay down an open economy model where net lending toward the rest of the world is constrained by a borrowing limit motivated by limited enforcement. Borrowing is secured by collateral in the form of durable goods whose accumulation is subject to adjustment costs. We demonstrate that, although this economy can generate persistent current account deficits, it can also deliver a stationary equilibrium. The comparison between different monetary policy regimes (floating versus pegged) shows that the *impossible trinity* is reversed: a higher degree of financial globalization, by inducing more persistent and volatile current account deficits, calls for exchange rate stabilization. Finally, we study the design of optimal (Ramsey) monetary policy and find that optimality requires deviations from price stability and calls for exchange rate stabilization.

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1 Introduction

The last two decades have been characterized by an extraordinary wave of financial globalization often accompanied with persistent current account imbalances[1]. For many countries current account imbalances have been negatively related to booms in house price, mortgages and consumer credits and durable demand. Since a significant proportion of claims on consumers credit has been placed in the international markets, for many countries the boom in durable demand has been mainly financed with foreign lending[2]. Lending standards have been in general quite loose along several dimensions, but overall they have been tied to collateral values so that swings (upward or downward) in durable prices (particularly house prices) have determined the amount of lending[3].

Against this background many central bank around the world have followed, explicitly or implicitly, inflation targeting or price stability polices without putting any weight on asset or durable prices and exchange rate movements. This is remarkable given that some countries had experienced significant exchange rate depreciations and asset price growth. We therefore ask whether the prescriptions for monetary policy change in an environment as the one described above.

To this purpose we lay down a DSGE small open economy model in which agents consume durable and non-durable goods[4], supply labour services and finance consumption with foreign lending. The rest of the world is populated by infinite lived agents who behave as consumption smoothers. Total (net) lending is constrained by a borrowing limit and is secured by collateral in the form of durable stock, as the latter can be seized by lenders in the event of default. Due to imperfect monitoring only a fraction of this collateral can be pledged by lenders. The type of borrowing constraint considered is an ad hoc limit on the line of Kiyotaki and Moore [31], Kocherlacota [33], Chari, Kehoe and McGrattan [17] among others. We further assume that durable goods provide

[1] Backus, Henriksen, Lambert, Telmer [2] show that among industrialized countries the US, the UK, Spain and Australia have run persistent current account deficits.

[2] See Bernanke [11] for a discussion of the link between global imbalances and house price booms. He noticed that countries whose current accounts have moved toward deficit have generally experienced substantial housing appreciation and increases in household wealth.

[3] The collateral policy practice adopted in the last two decades were quite risky as absence of any information on future income streams the availability of lending is heavily dependent on the market swings. In many occasions banks have *renewed and replenished* mortgages whenever the house price had gone up independently from the ability of the borrower to repay.

[4] We assume only non-durable goods are tradable and are aggregated through Armington aggregator.

utility services (see Davis and Heatcote [23], Miles [46], Iacoviello [30], Campbell and Hercowitz [14] and Monacelli [47]) and that durable investment is subject to adjustment costs, an assumption which allows to reproduce persistence in response to various shocks (see Topel and Rosen [58], Erceg and Levin [26]). In this model net asset accumulation is determined by the borrowing constraint and depends on the future value of collateral. The degree of financial globalization in this economy is captured by the parameter characterizing the sensitivity of foreign lending to the value of collateral, as a higher value relaxes the constraint on foreign lending. There are two production sectors in the domestic economy: the durable good sector and the non-durable goods sector. Firms in both sectors are monopolistic competitive and face Rotemberg [56] adjustment costs: the assumptions of sticky prices is needed to compare alternative monetary policy regimes. Monetary policy is conducted by means of Taylor type rules.

Three results arise. First, we show that the net asset accumulation in this model is uniquely determined in the steady state and that it is saddle path stationary in a neighborhood of the steady state. A crucial assumption for this result is that foreign agents have higher discount rates than domestic lenders. In this case the domestic economy experiences persistent net external liabilities, as in equilibrium domestic residents behave as impatient agents and borrow from the rest of the world. Despite this, the current account deficit leads to stationary dynamics. Second, we compare alternative monetary policy regimes (floating versus pegged) under productivity, government expenditure and global liquidity shocks and for alternative degree of financial globalization. Our findings show that the *impossible trinity* is reversed in this model: higher degree of financial liberalization exacerbate the destabilizing effect of exchange rate fluctuations on foreign debt, consumption and output, hence it calls for more aggressive exchange rate targeting. Finally, we derive the optimal (Ramsey) plan and find that monetary policy should deviate from price stability and smooth exchange rate fluctuations, the more so the higher the degree of financial liberalization.

In the open economy literature other papers have studied the effects of financial globalization (see Broner and Ventura [13], Devereux and Sutherland [25]) and its link with monetary policy (Devereux and Sutherland [25]). Most papers have modelled financial globalization in the form of

international portfolio asset allocation, while we focus on collateral constrained lending.

The rest of the paper proceeds as follows. Section 2 presents the model. Section 3 demonstrates how to obtain a stationary equilibrium. Section 4 describes the transmission mechanism in this model. Section 5 shows the comparison of alternative monetary policy regimes under alternative degree of financial liberalization. Section 6 shows the results of the optimal policy plan. Section 7 concludes.

2 A Small Open Economy with Borrowing Limits

There is a small open economy (which we refer to as the domestic economy) and the rest of the world. A crucial assumption in our set-up is that residents of the small open economy have lower discount factors compared to agents populating the rest of the world. As domestic agents are impatient, in equilibrium the small open economy will have a negative asset position; we will return on this point later.

The small open economy is populated by infinitely lived agents who consume non-durable and durable goods, work, invest in domestic government claims and require loans to finance expenditures. Consumption in durable and non-durable goods is financed through foreign lending, which takes the form of non–state contingent securities and is bounded above by a fraction of the future value of the collateral - i.e. durable goods. Because of this, the net asset position, both in the long and in the short run, is linked to the future value of collateral. Demand for durable goods is justified since they enter the utility function. The assumption of a financially constrained open economy is justified by the inability of foreign lenders to implement perfect monitoring. Under those circumstances the tightness of the borrowing limit depends on the degree of information asymmetry, of financial market integration and of debt repossession ability which in turn depends upon legal and institutional arrangements. There are two production sectors in this economy: the durable good sector and the non-durable goods sector. Firms in both sectors are monopolistic competitive and face Rotemberg [56] adjustment costs.

2.1 Domestic Households

Let $s^t = \{s_0, ...s_t\}$ denote the history of events up to date t, where s_t denotes the event realization at date t. The date 0 probability of observing history s^t is given by ρ_t. The initial state s^0 is given so that $\rho(s^0) = 1$. Henceforth, and for the sake of simplifying the notation, let's define the operator $E_t\{.\} \equiv \sum_{s_{t+1}} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t.

Agents maximize the following expected discounted sum of utilities:

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t U(C_{I,t}, N_t) \right\} \tag{1}$$

where total labour hours are denoted with N_t, total aggregate consumption is denoted by:

$$C_{I,t} = \left((1-\gamma)^{\frac{1}{\theta}} C_t^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} \widetilde{D}_t^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2}$$

with non-durable consumption given by a Dixit-Stiglitz consumption aggregator of domestic and imported goods (with η being the intratemporal elasticity):

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

and durable consumption given by:

$$\widetilde{D}_t = D_{t-1} - \frac{\psi}{2} \frac{(X_t - \delta D_{t-1})^2}{D_{t-1}} \tag{4}$$

where D_{t-1} is the real value of the stock of durable goods which is held in positive amount for it generates utility, $X_t = D_t - (1-\delta)D_{t-1}$ is investment in durable goods, δ is the depreciation rate and the function $\frac{\psi}{2}(\frac{X_t - \delta D_{t-1}}{D_{t-1}})^2$ represents an adjustment cost function. Preferences are concave, bounded above and satisfy Inada conditions and β represents the discount factor of domestic agents. As domestic residents are impatient we assume that $\beta < \mu$,with μ being the discount factor of foreign residents.

After defining $P_t \equiv [(1-\alpha)P_{h,t}^{1-\eta} + \alpha P_{f,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ as the domestic price index and $S_t = \frac{P_{f,t}}{P_{h,t}}$ as the terms of trade, optimal demands for domestic and imported goods imply the following relation:

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

The household receives at the beginning of time t a labor income of $W_t N_t$, where W_t is the nominal wage. Agents can invest in domestic (nominal) government claims, B_t, which pay a gross nominal interest rate one period later. Furthermore, they can borrow in foreign currency, B_t^*. The gross nominal interest rate to be paid on foreign borrowing is given by R_t^{*n}. Agents can also buy and sell durables, D_t, in an internal competitive market[5]. Agents are also owners of the monopolistic sectors which produce durable and non-durable goods, hence they receive profits $\Pi_{d,t}$ and $\Pi_{h,t}$. The price of durable in terms of consumption goods is denoted Z_t.

The sequence of budget constraints in nominal terms reads as follows:

$$P_t C_t - R_{t-1}^n B_{t-1} + e_t R_{t-1}^{n,*} B_{t-1}^* + P_t Z_t \left(D_t - D_{t-1}(1-\delta)\right) \leq W_t N_t - B_t + e_t B_t^* + \tau_t + \Pi_{h,t} + \Pi_{d,t} \quad (6)$$

where e_t is the nominal exchange rate. It is now convenient to re-state the budget constraint in real terms:

$$C_t + R_{t-1}^{n,*} \frac{e_t}{e_{t-1}} \frac{b_{t-1}^*}{\pi_t} - R_{t-1}^n \frac{b_{t-1}}{\pi_t} + Z_t \left(D_t - D_{t-1}(1-\delta)\right) = \frac{W_t}{P_t} N_t + b_t^* - b_t + \frac{\boldsymbol{\tau}_t}{P_t} + \frac{\Pi_{h,t}}{P_t} + \frac{\Pi_{d,t}}{P_t} \quad (7)$$

The crucial assumption in this model is that agents face borrowing constraints on the world market. As the foreign lenders are not able to fully repossess their funding, debt and its services are guaranteed as repayable up to a certain fraction of the collateral value (limited liability constraint). The collateral corresponds to the future value of the durable good $P_{t+1} Z_{t+1} D_t$. To formalize this idea let´s assume that domestic households face the following *period-by-period* borrowing constraint on foreign nominal debt:

$$e_t R_t^{*n} B_t^* \leq \Omega \; E_t\{P_{t+1} Z_{t+1} D_t\} \quad (8)$$

Constraint 8 can arise in presence of limited enforcement without default[6]. In equilibrium debt repudiation never occurs as the lender would repossess the whole collateral value. Collateral is in fact used as a promise for repayment. The parameter Ω is the fraction of the future value of the

[5] As the bigger fraction of durables is represented by residential housing, non-tradability is an empirically plausible assumption.

[6] Perri [51] in the *New Palgrave Dictionary of Economics* clarifies that default occurs in equilibrium when limited enforcement is coupled with other frictions.

collateral that is guaranteed to be repaid and can be interpreted as a down payment. Hence Ω reflects the degree of information asymmetry, of financial market integration and of debt repossession ability of foreign lenders which in turn depends upon legal and institutional arrangements. In general it is assumed that it is costly for foreign lenders to repossess the entire collateral value. Since increasing Ω allows to relax the borrowing limit and to increase the availability of foreign lending, we assume that higher degree of financial liberalization is associated with higher value of Ω.

Once again it is convenient to re-state the constraint in real terms:

$$R_t^{n,*} b_t^* \leq \Omega_t E_t \{ \frac{\pi_{t+1} Z_{t+1} D_t}{\frac{e_{t+1}}{e_t}} \} \tag{9}$$

where $e_t \frac{B_t^*}{P_t} = b_t^*$ are real international bonds. From equation 9 it is clear that fluctuations in the real exchange rate influence the link between collateral and net asset accumulation: a real exchange rate depreciation can increase the value of collateral and ease the borrowing constraint. Let's assume that assume a separable utility. Households choose the set of processes $\{C_t, N_t, b_t, b_t^*, D_t\}_{t=0}^{\infty}$ taking as given the set of processes $\{P_t,\ W_t,\ R_t^n, R_t^{n*},\ Z_t\}_{t=0}^{\infty}$ and the initial wealth b_0, b_0^*, D_0 so as to maximize 1 subject to7 and 9. Let's define $U_{c,t}\xi_t$ as the Lagrange multiplier on 9. The following optimality conditions must hold:

$$U_{c,t} \frac{W_t}{P_t} = -U_{n,t} \tag{10}$$

$$U_{c,t} = \beta E_t \left\{ \frac{R_t^n}{\pi_{t+1}} U_{c,t+1} \right\} \tag{11}$$

$$U_{c,t} - U_{c,t} R_t^{n*} \xi_t = \beta E_t \left\{ U_{c,t+1} \frac{e_{t+1}}{e_t} \frac{R_t^{n*}}{\pi_{t+1}} \right\} \tag{12}$$

$$\begin{aligned} & \mathbf{Z}_t \mathbf{U}_{c,t} - \Omega U_{c,t} \xi_t E_t \left\{ \frac{\pi_{t+1} Z_{t+1}}{\frac{e_{t+1}}{e_t}} \right\} + U_{\underset{\sim}{D_t}} \psi(\frac{D_t - D_{t-1}}{D_{t-1}}) \\ = \quad & E_t \left\{ \beta U_{\underset{\sim}{D_{t+1}}} (1 + \psi(\frac{D_{t+1} - D_t}{D_t}) + \frac{\psi}{2} \frac{(D_{t+1} - D_t)^2}{D_t^2}) \right\} + (1 - \delta)\ E_t \left\{ Z_{t+1} U_{c,t+1} \right\} \end{aligned} \tag{13}$$

Equation 10 gives the optimal choice of labor supply. Note that in this context the borrowing constraint does not affect the labour supply choice. Equation 11 is the first order condition on

domestic bond holding. Equation 12 is the first order condition with respect to foreign bonds and it can be interpreted as a modified Euler condition; a binding borrowing constraint (which implies a positive ξ_t) induces a intratemporal distortion in the value of consumption between two different dates

Equation 13 is the efficiency condition for the intertemporal choice of the durable good. The intuition for this equation is as follows. The time t marginal cost of foregoing one unit of non-durable consumption (weighted by the price of the durable) is equated to its marginal gain which has three components. The first is the direct marginal utility of one additional unit of durable investment now and in the future:

$$E_t \left\{ \beta \Delta_{\tilde{D_{t+1}}} (1 + \psi(\frac{D_{t+1} - D_t}{D_t}) + \frac{\psi}{2} \frac{(D_{t+1} - D_t)^2}{D_t^2} \right\} \tag{14}$$

The second is the expected marginal utility of one unit of non-durable consumption postponed into the future:

$$\beta(1 - \delta) E_t \left\{ Z_{t+1} U_{c,t+1} \right\} \tag{15}$$

If the agent shifts today one unit of consumption from non-durable to durable goods, by acquiring more collateral, he can increase his debt availability which in turn raises future consumption demand for non-durables.

The third component of the marginal gain is given by the shadow value of relaxing the liability constraint, $\Omega U_{c,t} \xi_t E_t \left\{ \frac{\pi_{t+1} Z_{t+1}}{\frac{e_{t+1}}{e_t}} \right\}$, as an additional unit of collateral becomes available. From equation 13 it stands clear that a binding borrowing constraint induces an intertemporal *distortion* of magnitude $\Omega U_{c,t} \xi_t E_t \left\{ \frac{\pi_{t+1} Z_{t+1}}{\frac{e_{t+1}}{e_t}} \right\}$ in the value of durable consumption between two different dates. Such wedge behaves as a tax on durable goods and changes in its magnitude can shift consumption from durable to non-durable goods. An increase in the parameter Ω has both a direct and an indirect impact on this wedge. Those two effects move actually in opposite directions. The direct impact comes form the fact that the size of the wedge itself depends upon Ω. A higher value of this parameter increases credit availability therefore acting as a positive *wealth* shock that reduces the demand for collateralizable durable goods. In other words an increase in Ω increases the tax on durable good, as it reduces the marginal benefit of durable relative to non-durable at the current

date. The indirect impact comes from the fact a higher value of Ω, by relaxing the borrowing limit, reduces the size of ξ_t. As the shadow value of the borrowing limit decreases, the marginal benefit of one additional unit of collateral today increases. As ξ_t enters the durable tax component, a decrease in ξ_t will induce agents to *substitute* non-durable with durable consumption goods. Later on, our quantitative simulations will show that the second effect tends to prevail so that, in response to shocks, we observe an increase in the volatility of non-durable consumption and a decrease in the volatility of durable consumption.

2.2 Foreign Households

The rest of the world can be thought as approximating a continuum of countries whose trade balance is zero. This implies that $P^*_{f,t} = P^*_t$. Agents in the rest of the world behave as standard consumption smoother. Let´s define μ as the discount factor of foreign residents. This implies that the following consumption Euler condition holds:

$$U_{c^*,t} = \mu E_t \left\{ \frac{R^{*n}_t}{\pi^*_{t+1}} U_{c^*,t+1} \right\} \tag{16}$$

Nominal interest rate in the rest of the world are exogenously given; they can become time-varying when modeled as random shocks. Furthermore foreign households face the following optimal demand for domestic goods:

$$C^*_{h,t} = \alpha^* Y^*_t \left(\frac{P^*_{h,t}}{P^*_t} \right)^{-\eta} \tag{17}$$

2.3 Open Economy Relations

It is assumed that the law of one pice holds continuously so that $P_{h,t} = e_t P^*_{h,t}$ and $P_{f,t} = e_t P^*_{f,t}$ where e_t is the nominal exchange rate. Given the definition for the terms of trade and the CPI index, the following equation for the CPI inflation (for non-durable goods) holds:

$$\pi_t = \pi_{h,t} \frac{\left((1-\alpha) + \alpha S_t^{1-\eta} \right)^{\frac{1}{1-\eta}}}{\left((1-\alpha) + \alpha S_{t-1}^{1-\eta} \right)^{\frac{1}{1-\eta}}} \tag{18}$$

The real exchange rate is given by:

$$q_t = \left[(1-\alpha)\left(S_t\right)^{\eta-1} + \alpha\right]^{\frac{1}{1-\eta}} \tag{19}$$

2.4 Non-durable Goods Production Sector

Firms in the non-durable production sector are monopolistic competitive and face Rotemberg [56] adjustment costs. They produce different varieties of goods according to the following production function:

$$Y_t(i) = A_{h,t} N_{h,t}\left(i\right)$$

As non-durable goods are aggregated according to the following Dixit-Stiglitz aggregators $C_{H,t} \equiv \int_0^1 [C_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di]^{\frac{\varepsilon}{\varepsilon-1}}$ and $C_{F,t} \equiv \int_0^1 [C_{F,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di]^{\frac{\varepsilon}{\varepsilon-1}}$ firms face the following demand function:

$$Y_t(i) = \left(\frac{P_{h,t}(i)}{P_{h,t}}\right)^{-\varepsilon} Y_t \tag{20}$$

Firms choose the path of prices $P_{h,t}\left(i\right)$ to maximize expected discounted future profits:

$$E_0\left\{\sum_{t=0}^{\infty} \Lambda_{0,t}\left(Y_t(i)P_{h,t}\left(i\right) - W_t N_{h,t}\left(i\right) - \frac{\omega}{2}\left(\frac{P_{h,t}\left(i\right)}{P_{h,t-1}\left(i\right)} - 1\right)^2 P_{h,t}\right)\right\}$$

subject to the demand constraint in 20, with $\Lambda_{t,t+1} \equiv \frac{\Lambda_{0,t+1}}{\Lambda_{0,t}} \equiv \beta E_t\left\{\frac{1}{1-\psi_t}\frac{\lambda_{t+1}}{\lambda_t}\frac{P_t}{P_{t+1}}\right\}$ being the borrower's stochastic discount factor and with $\frac{\omega}{2}\left(\frac{P_{h,t}(i)}{P_{h,t-1}(i)} - 1\right)^2 P_{h,t}$ representing firm's costs of adjusting prices. The parameter ω represents slugginesh in price adjustment. Let´s define $mc_{h,t}$ as the Lagrange multiplier on constraint 20. After imposing symmetry and substituting for the labour market equilibrium conditions, we obtain the following optimality condition for prices:

$$\begin{aligned}\omega\left(\pi_{h,t}-1\right)\pi_{h,t} \quad = \quad & A_{h,t}N_{h,t}\varepsilon\left[\frac{(1-\varepsilon)}{\varepsilon} + \frac{1}{A_{h,t}}\frac{-U_{N,t}}{U_{c,t}}\left[(1-\alpha)+\alpha S_t^{1-\eta}\right]^{\frac{1}{1-\eta}}\right] \\ & +\omega\beta E_t\left\{\left(\frac{1}{1-\psi_t}\right)\frac{U_{c,t+1}}{U_{c,t}}\left[\frac{(1-\alpha)+\alpha S_t^{1-\eta}}{(1-\alpha)+\alpha S_{t+1}^{1-\eta}}\right]^{\frac{1}{1-\eta}}\left(\pi_{h,t+1}-1\right)\pi_{h,t+1}\right\}\end{aligned} \tag{21}$$

2.5 Durable Goods Production Sector

Firms in the durable goods production sector solve a similar maximization problem than firms in the non-durable sector. Hence optimal pricing condition reads as follows:

$$\begin{aligned}\omega_d\left(\pi_{d,t}-1\right)\pi_{d,t} &= A_{d,t}N_{d,t}\varepsilon\left[\frac{(1-\varepsilon)}{\varepsilon}+\frac{1}{Z_t}\frac{-U_{N,t}}{U_{c,t}A_{d,t}}\right] \\ &\quad +\omega_d\beta E_t\left\{\left(\frac{1}{1-\psi_t}\right)\frac{U_{c,t+1}}{U_{c,t}}\frac{Z_{t+1}}{Z_t}\left(\pi_{d,t+1}-1\right)\pi_{d,t+1}\right\}\end{aligned} \tag{22}$$

2.6 Market Clearing

Given that labor is immobile across countries, labor market clearing implies:

$$N_{d,t}+N_{h,t}=N_t \tag{23}$$

For good markets to be cleared in country h, total purchases of durable goods must equalize total domestic production:

$$A_{d,t}N_{d,t}=D_t-(1-\delta)D_{t-1}+\frac{\omega_n}{2}\left(\pi_{d,t}-1\right)^2 \tag{24}$$

As non-durables are traded market clearing requires that total production is equalized to domestic and foreign demand:

$$A_{h,t}N_{h,t}=(1-\alpha)Y_t\left(\frac{P_{h,t}}{P_t}\right)^{-\eta}+\alpha Y_t^*\left(\frac{P_{h,t}^*}{P_t^*}\right)^{-\eta}+\frac{\omega}{2}\left(\pi_{h,t}-1\right)^2+g_t \tag{25}$$

where g_t represents exogenous government spending and follows a AR(1) shock.

2.7 UIP and Asset Evolution

The arbitrage condition between domestic government claims and foreign bond holdings, equations 11 and 12, implies the following uncovered interest rate parity:

$$R_t^n=R_t^{*n}\frac{\left[\xi_t+\beta E_t\left\{\frac{e_{t+1}}{e_t}\frac{U_{c,t+1}}{\pi_{t+1}U_{c,t}}\right\}\right]}{\left[\beta E_t\left\{\frac{U_{c,t+1}}{\pi_{t+1}U_{c,t}}\right\}\right]} \tag{26}$$

The evolution of foreign debt is obtained by the aggregate budget constraint of the domestic residents:

$$C_t + Z_t\left(D_t - D_{t-1}(1-\delta)\right) + \frac{W_t N_t}{P_t} + \frac{\Pi_{h,t}}{P_t} + \frac{\Pi_{d,t}}{P_t} = b_t^* - R_{t-1}^{n*}\frac{e_t}{e_{t-1}}\frac{b_{t-1}^*}{\pi_t} \tag{27}$$

After substituting the expression for the profit functions, $\frac{\Pi_{h,t}}{P_t} + \frac{\Pi_{d,t}}{P_t}$, we obtain:

$$A_{h,t}N_{h,t} - \frac{\omega}{2}\left(\pi_{h,t}-1\right)^2 - g_t + Z_t(A_{d,t}N_{d,t} - \frac{\omega_n}{2}\left(\pi_{d,t}-1\right)^2) + \frac{U_{n,t}}{U_{c,t}}N_t = b_t^* - R_{t-1}^{n*}\frac{e_t}{e_{t-1}}\frac{b_{t-1}^*}{\pi_t} \tag{28}$$

Equations 9 and 28 together clarify the link between durable prices and net asset accumulation. The level of net asset accumulation depends on the value of collateral as from equation 9, while its accumulation is linked to current account deficits by equation 28. Notice that the dependence of net asset accumulation on the stock of durable, which is a state variable, amplifies the persistence of fluctuations in the current account.

3 Uniqueness and Stationarity of Long Run Asset Position

Proposition 1. Under the following assumptions:

Assumption 1 (preferences) The Hessian of the utility function is semi-definite negative and Inada conditions for consumption hold.

Assumption 2 (discounting) $\beta,\ \mu \in (0,1)\,;\beta < \mu$.

Assumption 3 (technology): The production function, $F(N)$, is homogeneous of degree 1 with $F \in C^2, F_N > 0, F_{NN} \leq 0$. Moreover $F\left(0\right) = 0$, $\lim_{N\to 0} F'\left(N\right) = +\infty$, $\lim_{N\to\infty} F'\left(N\right) = 0$.

and in a close neighborhood of the steady state, the collateral constraint:

$$R_t^{n,*}b_t^* \leq \Omega_t E_t\{\frac{\pi_{t+1}Z_{t+1}D_t}{\frac{e_{t+1}}{e_t}}\} \tag{29}$$

is binding at any date and any state and determines uniquely the net asset position.

Proof. Following Becker [6] and Becker and Foias [7], [8] we can show that the constraint 29 binds if there exist a *dominant consumer,* namely a patient household willing to lend. Consider

the Euler condition of domestic residents with respect to foreign lending:

$$1 - R_t^{n*}\xi_t = \beta E_t \left\{ \frac{U_{c,t+1}}{U_{c,t}} \frac{e_{t+1}}{e_t} \frac{R_t^{n*}}{\pi_{t+1}} \right\} \tag{30}$$

By evaluating equation 30 at the steady state and substituting the steady-state relation $R^{n*} = \frac{1}{\mu}$ (which is obtained by the steady state version of equation 16)[7], we obtain:

$$\mu - \beta = \xi > 0 \tag{31}$$

As the Lagrange multiplier is positive, the constraint is binding at the steady state. Hence the net asset position of the small open economy is uniquely determined by the borrowing constraint.

Corollary. The net asset position does not posses unit roots.

As the Euler condition in the steady state, 31, does not depend on initial conditions but solely on model parameters, the net asset position does not posses unit roots.

The above results move a step forward in understanding the conditions for stationarity of the current account. In a seminal work, Obstfeld and Rogoff [48] have shown that under market incompleteness the steady state of an open economy model is characterized by unit roots. This implies that the steady state depends on initial values and transient shocks have long run effects. In subsequent works several methods have been proposed to recover stationarity: parameter and functional form restrictions (see Cole and Obstfeld [20], Corsetti and Pesenti [21]), endogenous discount factor (Uzawa-type preferences), debt-elastic interest-rate premium, convex portfolio adjustment costs (see Schmitt-Grohe and Uribe [57]) or the assumption of finitely lived agents (see Ghironi [29]). Here we show that the present model is also characterized by a stationary dynamic due to the presence of a binding collateral constraint. Moreover our stationarity inducing method has the advantage of allowing an endogenous determination of the net asset position. Indeed, while the methods proposed in Schmitt-Grohe and Uribe [57] require an exogenously imposed long run level of external assets, collateral constraints allow to determine the net asset position endogenously.

[7] **More generically, notice that the Lagrange multiplier is positive also when inflation targets differ from one.**

4 The Transmission of Shocks

Before turning to the evaluation of different exchange rate regimes and to the optimal policy design, it is instructive to characterize the transmission mechanism in our model under floating exchange rates. We do that by looking at impulse response analysis under two shocks: productivity and global liquidity shocks. We have chosen to consider a productivity shock as this is the main source of business cycle fluctuations. We have chosen to consider a global liquidity shock as empirical evidence has shown that this shock has had a significant role in explaining house price movements and in accounting for global imbalances[8]. Furthermore in a model with sticky prices, an interest rate shock plays also the role of a demand shock.

4.1 Calibration

In this section we analyze the response of the economy to shocks with the goal of comparing alternative monetary policy regimes under different degrees of financial globalization. Calibration is set as follows.

Preferences. Time is measured in quarters. We assume that $\beta < \mu$, $\beta = 0.98$ (see Krusell and Smith [36]) and $\mu = 0.99$. The structure of the model implies that the real interest rate of the rest of the world is pinned down by the patient consumers, hence it is equal to $\frac{1}{\mu}$. Utility is separable in aggregate consumption, $C_{I,t}$ and labour, N_t, and takes the following form: $\frac{C_{I,t}^{1-\sigma}}{1-\sigma} + \upsilon \frac{N_t^{1+\tau}}{1+\tau}$.The parameter σ is set equal to 1 as in most of the RBC literature. The parameter τ is set equal to 1 and the parameter υ is chosen so as to generate a steady state employment of 0.3 in the non-durable sector.

Production. The elasticity of substitution for different varieties, ε, is set to 8. This implies a mark-up of about 15 percent. In order to parameterize the degree of price stickiness ω, we observe that, by log-linearizing equation 21 we can obtain an elasticity of inflation to real marginal cost (normalized by the steady-state level of output)[9] that takes the form $\frac{\varepsilon-1}{\omega}$. This allows a

[8] See for instance Sousa and Zaghini 2006, Räffer and Stracca 2006, Belke, Orth and Setzer 2008.

[9] To produce a slope coefficient directly comparable to the empirical literature on the New Keynesian Phillips curve this elasticity needs to be normalized by the level of output when the price adjustment cost factor is not explicitly proportional to output, as assumed here.

direct comparison with empirical studies on the New Keynesian Phillips curve such as Galí and Gertler [27] and Sbordone [54] using a Calvo-Yun approach. In those studies, the slope coefficient of the log-linear Phillips curve can be expressed as $\frac{(1-\widehat{\vartheta})(1-\beta\widehat{\vartheta})}{\widehat{\vartheta}}$, where $\widehat{\vartheta}$ is the probability of not resetting the price in any given period in the Calvo-Yun model. For any given values of ε, which entails a choice on the steady-state level of the markup, we can thus build a mapping between the frequency of price adjustment in the Calvo-Yun model $\frac{1}{1-\widehat{\vartheta}}$ and the degree of price stickiness ϑ in the Rotemberg setup. The recent New Keynesian literature has usually considered a frequency of price adjustment of four quarters as realistic. Recently, Bils and Klenow [12] have argued that the observed frequency of price adjustment in the U.S. is higher, and in the order of two quarters. As a benchmark, we parameterize $\frac{1}{1-\widehat{\vartheta}} = 4$, which implies $\widehat{\vartheta} = 0.75$. Given $\varepsilon = 8$, the resulting stickiness parameter satisfies $\vartheta = \frac{Y\ \widehat{\vartheta}\ (\varepsilon-1)}{(1-\widehat{\vartheta})(1-\beta\widehat{\vartheta})} \approx 27$, where Y is steady-state output.

The elasticity of substitution between home and foreign consumption, η, is set to 3. Empirical studies assign values to this parameter that range from 2 to 5. The share of home consumption goods in the domestic country, α, is set to 0.7, which implies, compatibly with empirical evidence for industrialized countries, a degree of openness of 0.3.

Durables. The elasticity of substitution between durable and non-durable goods is set equal to 1, while the share of durable spending is set to 0.2, a value consistent with industrialized countries. Consistently with Erceg and Levin [26] the parameter ψ in the adjustment cost function is set to 300. This value allows to obtain a volatility for durable goods higher than the one for non-durable, as suggested by empirical evidence. The quarterly depreciation rate of the durable stock is set to $\delta = 0.39764$; this value is consistent with a specification of the durable investment which includes both consumer durables and residential investment. The baseline parameter that defines the tightness of the endogenous borrowing limit is set consistently with loan to value ratios for the industrialized countries over the period 1952-2005[10] which is 0.25. This parameter is varied in the simulations in order to assess the role of financial globalization.

Stochastic processes. Following Prescott [52] and McCallum and Nelson [41] the standard deviation of the productivity shock is set to 0.007 and its persistence is set to 0.95. Log-government

[10] See IMF Report 2008.

consumption evolves according to the following exogenous process, $\ln\left(\frac{g_t}{g}\right) = \rho_g \ln\left(\frac{g_{t-1}}{g}\right) + \varepsilon_t^g$, where the steady-state share of government consumption, g, is set so that $\frac{g}{y} = 0.25$ and ε_t^g is an i.i.d. shock with standard deviation σ_g. Empirical evidence in Perotti [50] suggests $\sigma_g = 0.008$ and $\rho_g = 0.9$. We also introduce a global liquidity shock and interpret it as a shock to the aggregate process of money supply in the rest of the world. As such we formalize it as an AR(1) shock to foreign interest rate with $\sigma_g = 0.00623$ and $\rho_g = 0.6$.

Monetary Policy regimes. There is an active monetary policy. The monetary authority sets the short term nominal interest rate by reacting to endogenous variables as in the general class of the Taylor rules:

$$R_t^n = (\frac{\pi_t}{\bar{\pi}})^{\varpi_\pi}(\frac{e_t}{e_{t-1}})^{\frac{\varpi^e}{1-\varpi_e}} \tag{32}$$

where $R_t^n = R_t \frac{P_{t+1}}{P_t}$, ϖ_π is the weight the monetary authority puts on the deviation of inflation from the target $\bar{\pi}, \varpi_e$ is the weight that the monetary authority puts on the deviation of the exchange rate between two subsequent periods. We assign a value of 2 to the parameter ϖ_π. We have chosen to target the change in the exchange rate, $\frac{e_t}{e_{t-1}}$, as this allows to achieve determinacy as shown by Benigno, Benigno and Ghironi [10]. A regime of pure floating exchange rate is identified by the case $\varpi^e = 0$. Pegged exchange rate regimes are identified by a Taylor rule of the form 32 in which $\varpi^e > 0$. This parameter will be varied in the simulations from a low value of 0 to a high value of 0.9. A direct quantification of this parameter is not possible as the classification between floating and pegged exchange rate regimes is only done at a qualitative level.

4.2 Dynamic Responses to Shocks

Figure 1 shows the dynamic response of selected variables to a 1% productivity shock in the non-durable sector of the domestic economy. As it is standard in sticky prices models, output increases while inflation decreases. As technology has improved and since prices are sticky, firms save on labour demand, hence employment falls. The increase in output brings about an increase in non-durable and durable consumption demand. The response of durables shows an hump-shaped dynamic due to the presence of adjustment costs. The increase in durables is accompanied by a fall in its price. Overall, however, the future value of durables (the value of collateral) increases.

The increase in the value of collateral allows to relax the borrowing constraint and to increase the supply of foreign debt, as it is shown by the fact that the Lagrange multiplier deviates from zero. As consumption demand is higher than output, domestic residents increase their demand for foreign debt. In equilibrium foreign lending increases. The ensuing current account deficit induces a real exchange rate depreciation. Importantly the current account deficit (which is the counterpart of the foreign debt accumulation) shows a persistent dynamic. This is the sense in which our model can generate persistent global imbalances, despite the long run stationarity featured by the current account dynamic.

Figure 2 shows impulse response of selected variables to 1% global liquidity shocks. Several empirical studies have shown a link between housing demand (or durable demand) and the increase in global liquidity. We therefore analyze the property of an increase in global liquidity, interpreted as a fall in foreign interest rate. The availability of foreign lending increases in this case. This relaxes the borrowing constraint, therefore increasing the demand for both, durable and non-durable consumption. Such an increase is accompanied by an increase in domestic prices, $P_{h,t}$, which renders domestic goods less attractive. The ensuing switching expenditure effect implies a fall in foreign prices, $P_{f,t}$, and an exchange rate appreciation. Overall the CPI price index falls, as exports fall by more than the increase in domestic demand. The fall in aggregate demand induces a fall in employment and output.

5 Exchange Rate Regimes and Financial Globalization

We now turn to the evaluation of the stabilization properties of exchange rate pegs under different degrees of financial globalization. A first step in this direction consists in analyzing the impact of an increase in the degree of financial globalization for the dynamic of our economy. Recall that we interpret financial globalization as an increase in the parameter Ω. As debt in this economy is denominated in foreign currency, exchange rate fluctuations will have an impact on the value of collateral and through this on the dynamic of foreign debt and of other macro variables. The higher is the degree of financial globalization, the higher is the destabilizing effect that exchange

rate fluctuations have on foreign debt and the macro-economy. The combined effect of financial globalization and exchange rate fluctuations on foreign debt can be analyzed through the lenses of the following two effects:

1) *Wedge/substitution effect.* Consider an expected exchange rate appreciation. A fall in the exchange rate should increase the future value of collateral relative to the value of debt services, as shown by the collateral constraint, $R_t^{n,*} b_t^* \leq \Omega_t E_t \{ \frac{\pi_{t+1} Z_{t+1} D_t}{\frac{e_{t+1}}{e_t}} \}$. As it stands clear from equation 13, when an additional unit of collateral becomes available the shadow value of relaxing the liability constraint, $\Omega U_{c,t} \xi_t E_t \left\{ \frac{\pi_{t+1} Z_{t+1}}{\frac{e_{t+1}}{e_t}} \right\}$, changes. This shadow value represents an intertemporal *distortion* in the value of durable consumption between two different dates. Such wedge behaves as a tax on durable goods and changes in its magnitude can shift consumption from durable to non-durable goods at the current date. An increase in the parameter Ω has both a direct and an indirect impact on this wedge. Those two effects move actually in opposite directions. The direct impact comes form the fact that the size of the wedge itself depends upon Ω. A higher value of this parameter increases credit availability therefore acting as a positive *wealth* shock that reduces the demand for collateralizable durable goods. In other words an increase in Ω increases the tax on durable good, $\Omega U_{c,t} \xi_t E_t \left\{ \frac{\pi_{t+1} Z_{t+1}}{\frac{e_{t+1}}{e_t}} \right\}$, as it reduces the marginal benefit of durable relative to non-durable at the current date. The indirect impact comes from the fact that a higher value of Ω, by relaxing the borrowing limit, reduces the size of ξ_t. As the shadow value of the borrowing limit decreases the marginal benefit of one additional unit of collateral today increases. As ξ_t enter the durable tax component, a decrease in the Lagrange multiplier will induce agents to *substitute* non-durable with durable consumption goods. Quantitatively the first effect seems to prevail, as, while the sensitivity of non-durable consumption increases when Ω increases, the contrary is true for the demand in durable goods. The increase in consumption volatility feeds into output and inflation, therefore destabilizing the whole economy.

3) *Valuation effect.* An exchange rate appreciation, by increasing the real value of collateral, increases the borrowing capability at the extensive margin. Such *valuation effect* works in the same direction as the *wealth effect,* hence overall it tends to increase non-durable consumption volatility.

This in turn increases the volatility of output and inflation as discussed previously.

Overall, it seems that increasing financial globalization tends to exacerbate the effects of exchange rate fluctuations and to destabilize the whole economy. Having established such link, the policy maker in our economy faces a trade-off in terms of inflation versus exchange rate targeting. On the one side, an exchange rate peg, accompanied to an increase in capital flows, tends to reduce the ability of the monetary authority to stabilize output and inflation. Such an effect, first formalized in the Mundell-Fleming model, is known as the *impossible trinity.* On the other side, higher financial globalization tends to exacerbate the destabilizing effects of exchange rate fluctuations on the whole economy and, because of this, calls for more aggressive exchange rate target. In our model the second effect tends to prevail as shown in Figure 3, 4 and 5. The three figures show the volatility (in percentage values) of output, inflation and (non-durable) consumption for different degrees of financial globalization and exchange rate target. To compute volatility we consider all three shocks (productivity, government expenditure and foreign interest rate). The figures show that the volatility of the three variables considered increases whenever the degree of financial globalization increases and decreases whenever the monetary authority increases the weight on exchange rates. The monetary authority can minimize the volatility of all three variables by applying an exchange rate target around 0.8.

6 Ramsey (Optimal) Monetary Policy

Given that higher financial globalization tends to exacerbate the destabilizing effects of exchange rate fluctuations, should the monetary authority optimally stabilize the exchange rate? In models with sticky prices, the main distortion faced by the monetary authority is given by the cost of inflation fluctuations. Nominal frictions call for pure inflation targeting, with no weight assigned to either output fluctuations or to exchange rate fluctuations. This is the prescription advanced both in closed[11] and open economy model[12]. However in our model the planner faces a trade-off between stabilizing inflation and stabilizing the exchange rate, as, in presence of high financial

[11] See Woodford [59], Clarida, Gali and Gertler [18] among others.

[12] See for instance Obsteld and Rogoff [49], Benigno and Benigno [9], McCallum and Nelson [42], Corsetti and Pesenti [21] and [22], Kollman [34], Devereux and Engel [24], Clarida, Galí, and Gertler [19], Galí and Monacelli [28].

globalization, the latter brings about stabilization of the overall economy. Hence the planner might want to deviate from full price stability and allow for some degree of inflation volatility in order to buy some degree of exchange rate stabilization.

We analyze the design of optimal monetary policy following the Ramsey approach[13]. The optimal policy plan for the domestic economy is determined by a monetary authority that maximizes the discounted sum of utilities of all domestic residents:

$$Min_{\{\Lambda_t^n\}_{t=0}^{\infty}} \; Max_{\{\Xi_t^n\}_{t=0}^{\infty}} \; E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(C_{I,t}, N_t) \right\} \tag{33}$$

given the constraints of the competitive economy represented by equations 5, 9, 10, 11, 12, 13, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26.

As constraints 9, 11, 12, 13, 16, 21, 22, 26 exhibit future expectations of control variables, the maximization problem of the Ramsey planner is intrinsically non-recursive. As first emphasized in Kydland and Prescott [35], and then developed by Marcet and Marimon [40], a formal way to rewrite the same problem in a recursive stationary form is to enlarge the planner's state space with additional (pseudo) co-state variables. Such variables bear the crucial meaning of tracking, along the dynamics, the value to the planner of committing to the pre-announced policy plan.

To analyze the trade-off between inflation and exchange rate stabilization we simulate the Ramsey plan under the three shocks considered and compute the implied optimal volatility of real exchange rate and inflation.

Figure 6 shows results by plotting the optimal volatility (in percentage values) of real exchange rate and of (annual) inflation for different values of the degree of financial globalization. While the volatility of the real exchange rate is largely stabilized for increasing values of the financial openness, the volatility of inflation is instead increasing significantly. Hence, when the economy becomes more financially globalized the trade-off between inflation and exchange rate stabilization moves in favor of the latter.

[13] See Ramsey [53], Atkinson and Stiglitz [1], Lucas and Stokey [39], Chari and Kehoe [**?**], Khan et al.[32], Schmitt-Grohe and Uribe [55] among many others.

7 Conclusions

We have analyzed an economy in which consumption is financed through foreign lending. Net lending toward the rest of the world is constrained by a borrowing limit motivated by limited enforcement and borrowing is secured by collateral in the form of durable goods. We demonstrate that although this economy can generate persistent current account deficit it can still deliver a stationary equilibrium. As financial globalization tends to exacerbate the destabilizing effects of exchange rate fluctuations, the monetary authority can achieve higher stabilization and welfare by stabilizing the exchange rate. This implies that pure inflation targeting strategies might not be fully optimal for economies with large exposure to foreign debt and significant global imbalances, a condition which characterized several industrialized countries in the last decade.

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Figure 1: impulse responses to domestic productivity shock in the non-durable sector

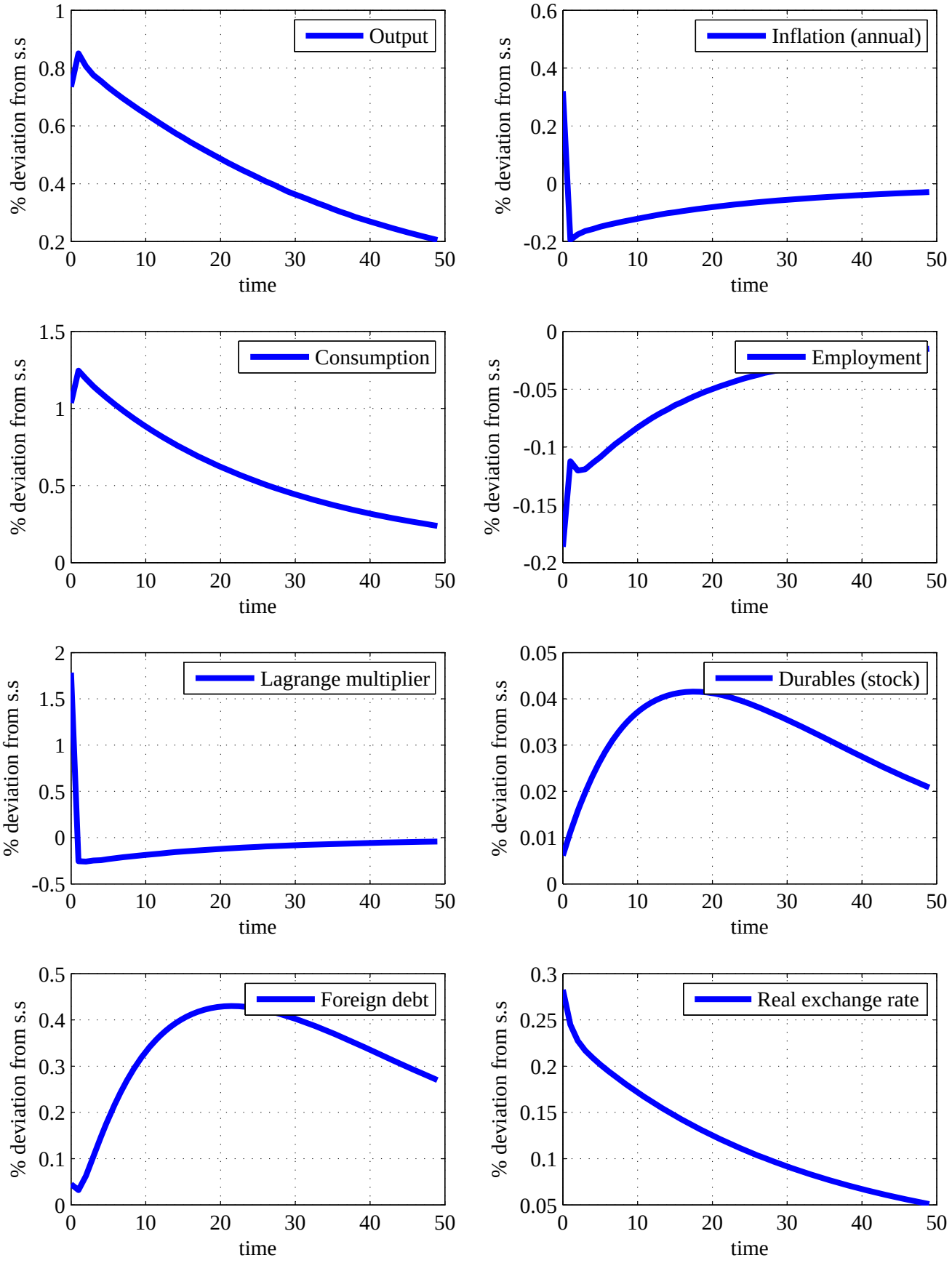


Figure 2: impulse responses to global liquidity shock (a fall in foreign interest rates)

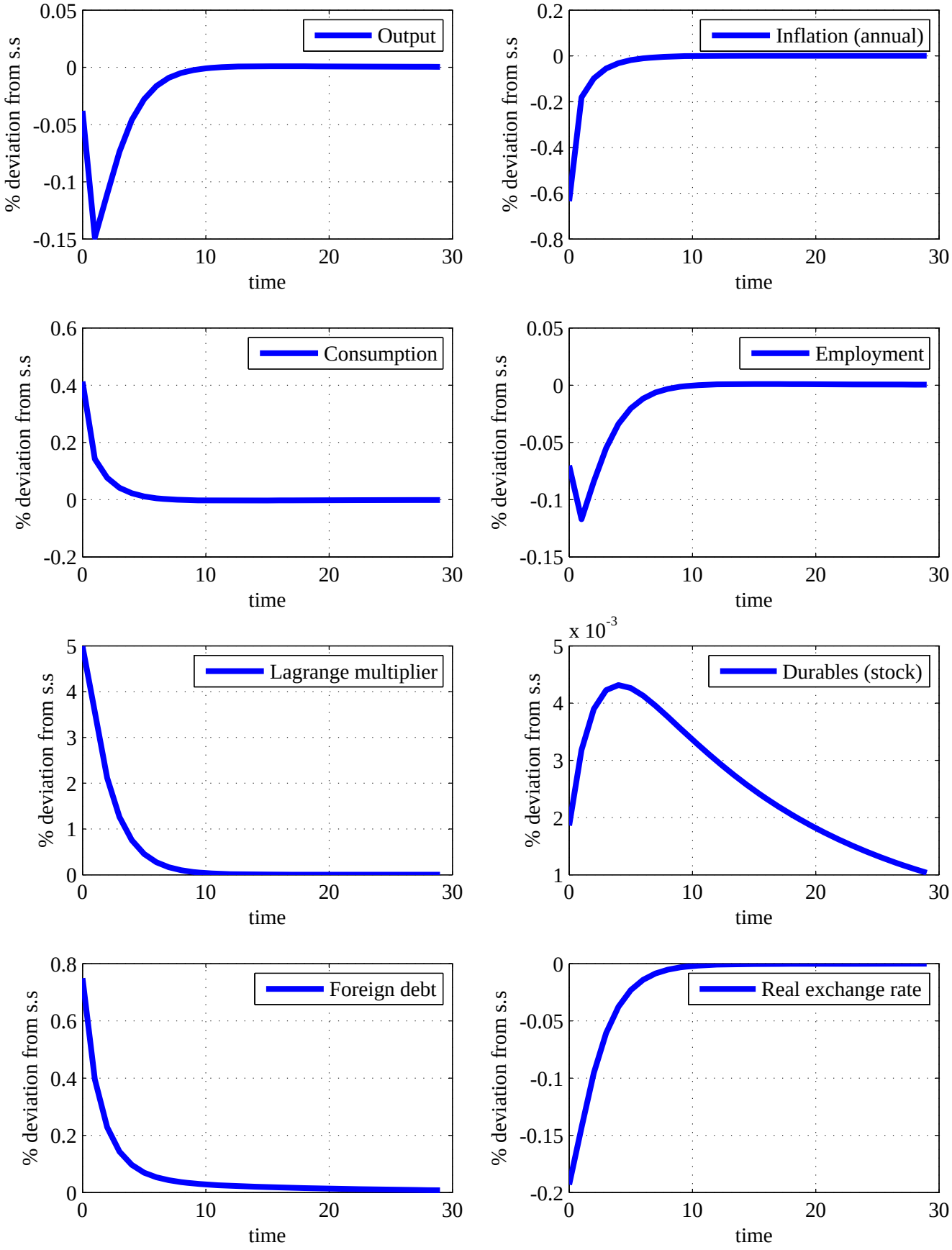


Figure 3: Volatitlity of output for different degrees of financial globalization and exchange rate target

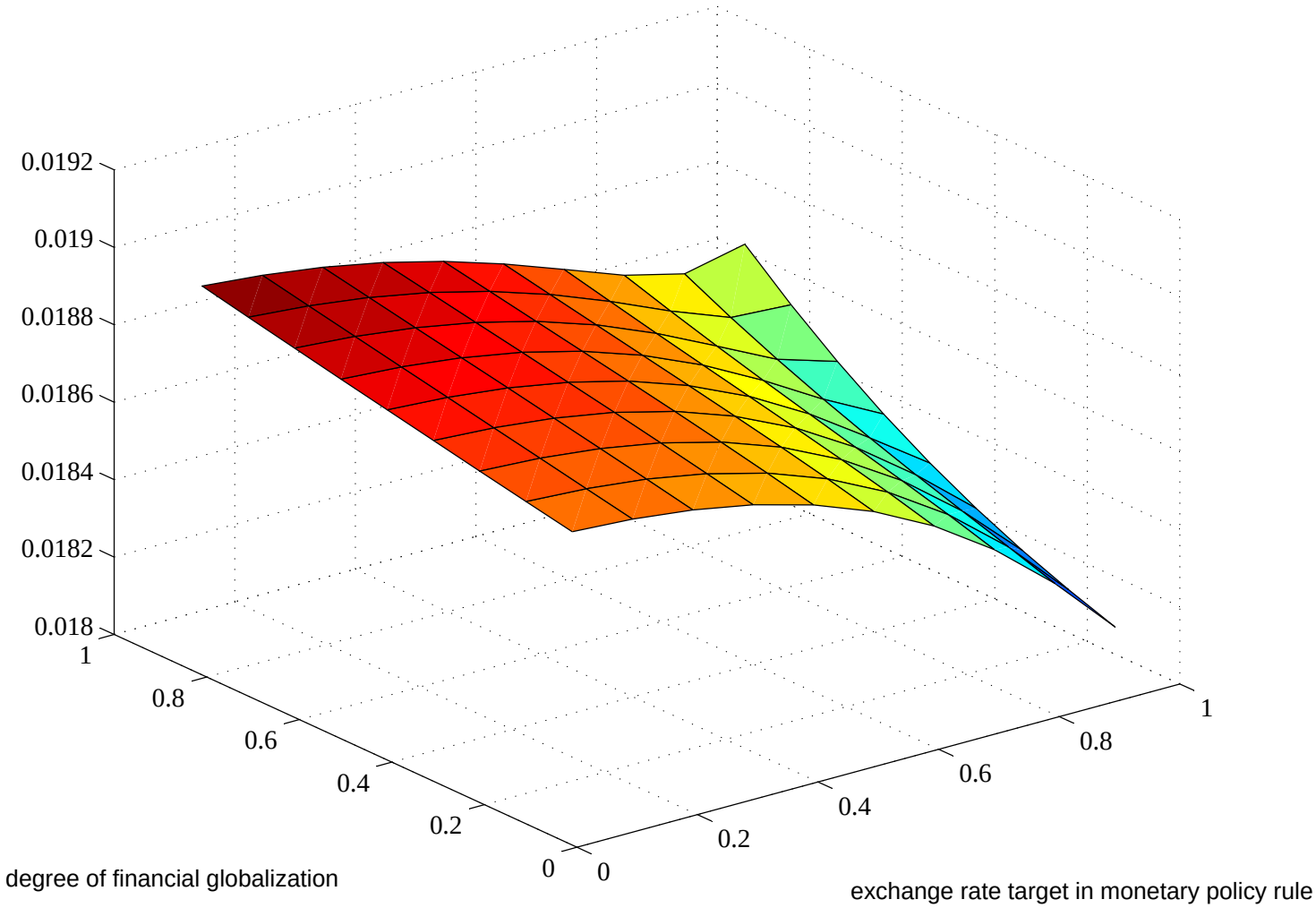


Figure 4: volatility of consumption for different degrees of financial globalization and exchange rate target

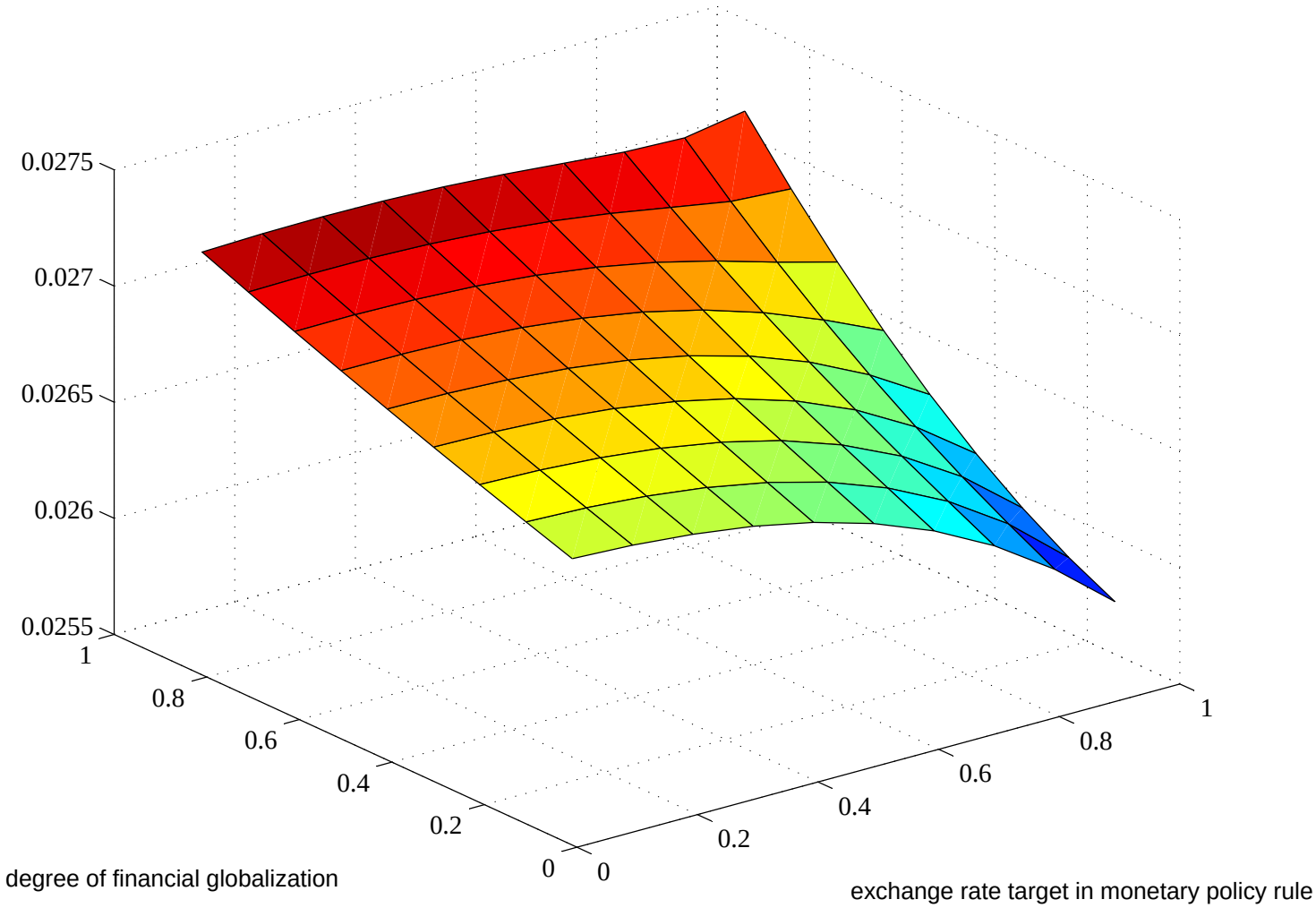
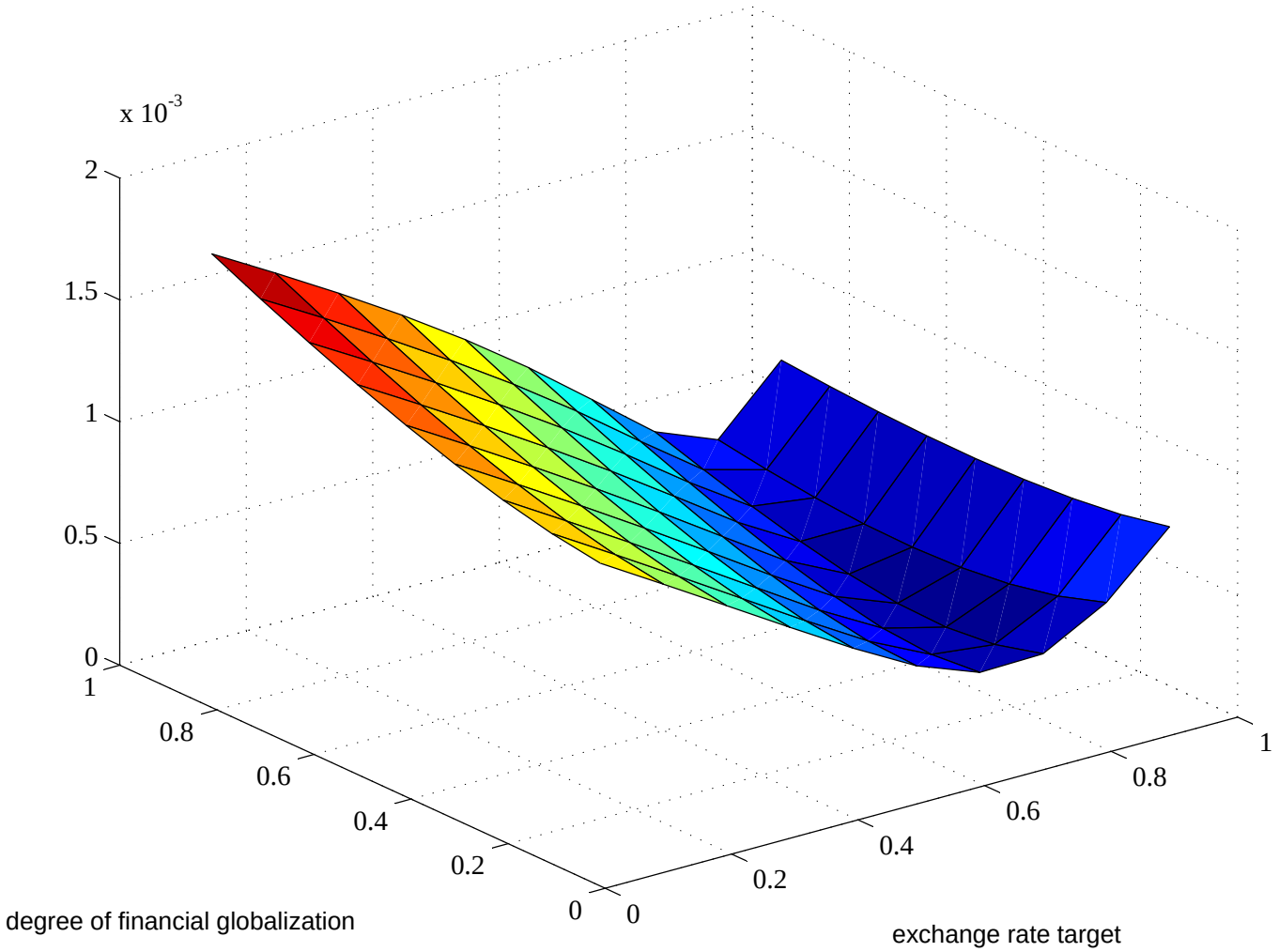
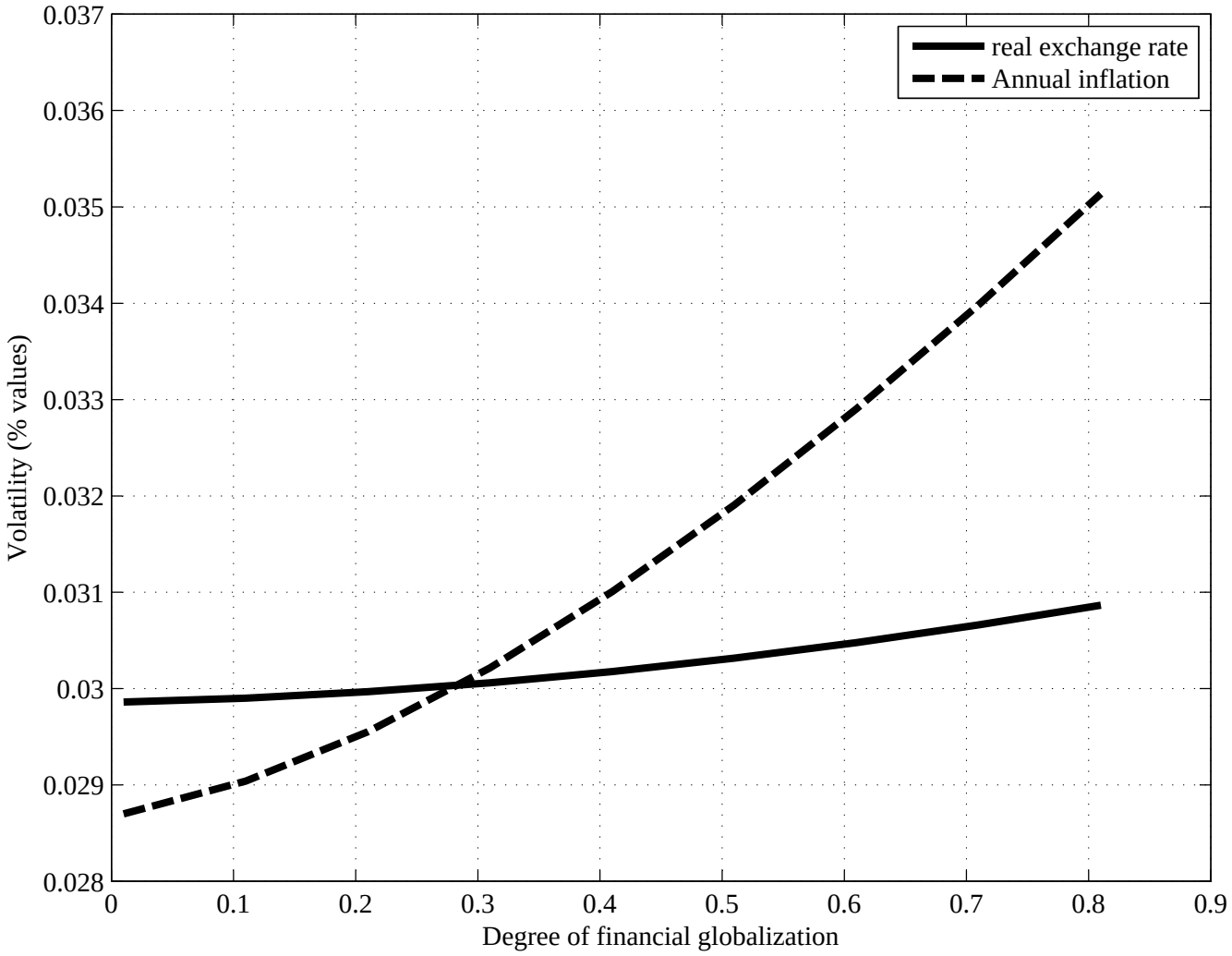


Figure 5:volatitlity of (quarterly) CPI inflation for different degrees of exchange rate target and financial globalization




real exchange rate
Annual inflation
Volatility (% values)
Degree of financial globalization
0.037
0.036
0.035
0.034
0.033
0.032
0.031
0.03
0.029
0.028
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9