Need Singapore Fear Floating? A DSGE-VAR Approach

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Abstract

This paper uses a DSGE-VAR model to examine the managed exchange-rate system at work in Singapore and asks if the country has any reason to fear floating the exchange rate with a Taylor rule inflation-targeting mechanism that uses the short term interest rate instead of the exchange rate as the benchmark monetary policy instrument. Our results show that the use of a more flexible exchange rate system will slightly reduce consumption volatility, will not appreciably improve welfare, but will significantly increase interest rate and investment volatility.

JEL Classificaltion: E52, E62,F41

1 Introduction

Should Singapore fear floating its exchange rate with a Taylor rule inflation-targeting mechanism? Calvo and Reinhart (2002) noted that many emerging markets retain a preference for a managed float with much less flexibility than is commonly assumed by official exchange-rate classification schemes. Lack of credibility of the monetary authority or liability dollarization, they note, are major reasons emerging market countries would avoid floating. However, there are other reasons which may be more relevant for a small, highly open and fast growing economy such as Singapore.

Reflecting the small open nature of its economy, Singapore has adopted an exchange rate centered monetary policy framework since 1981. Given the open-economy trilemma, monetary policy can only achieve fully two of the following three dimensions: monetary policy independence, fixed exchange rates, and open capital accounts. As a major financial centre, Singapore has chosen free capital mobility. Hence, it can only choose to target either the exchange rate or one monetary variable, but not both. The Monetary Authority of Singapore (MAS) has chosen to use the exchange rate as opposed to the more conventional benchmark policy interest rate as its policy operating tool since the early 1980s (MAS, 2000).

This is not surprising as the highly open and trade-dependent nature of the economy implies that the exchange rate is the most effective tool for controlling inflation. Singapore is highly dependent on external demand which constitutes three quarters of aggregate demand. Moreover, domestic consumption has a high import content — out of every Singapore dollar spent in Singapore, about fifty cents go to imports. Being a price-taker in international markets, it follows that Singapore is highly susceptible to imported inflation. As a result of the exchange rate-centered monetary policy framework and free capital mobility in Singapore, domestic short-term interest rates are significantly determined by foreign interest rates.

The Monetary Authority of Singapore (MAS) adopts an intermediate exchange rate regime by targeting the Singapore dollar under a basket-band-crawl (BBC) system (Khor et al, 2004; Williamson, 1999). Under this managed float system, the Singapore dollar is related to a trade-weighted basket (termed TWI) of currencies of its major trading partners and competitors.[1] The prescribed policy band is centered at the target exchange rate for the TWI which is reflective of the long-run equilibrium exchange rate and the band is allowed to crawl over time to keep it in line with Singapore's long-term economic fundamentals.[2] The Singapore dollar is allowed to float within the band. The MAS avoids intervening within the band except to prevent unwarranted volatility in the TWI. However, when the TWI approaches or exceeds the boundaries of the policy band, the MAS may carry out intervention operations in order to "lean against the wind" and defend the band.

In its semiannual monetary policy cycle, the MAS would announce the exchange rate policy stance through a Monetary Policy Statement. Apart from changes to the crawl in the central parity, there could be a re-centering of the policy band. Another form of adjustment is through changing the width of the band of fluctuations. Essentially, the exchange rate is used as an intermediate monetary policy instrument to achieve the primary objective of non-inflationary growth. In a sense, monetary policy is operated in Singapore as sort of a hybrid between the BBC and inflation targeting. In practice, an adjustable band is used to track the movement of its instrument, while setting its instrument in a way to hit intermediate targets as a means to control inflation and achieve non-inflationary growth (Khor et al. 2004). In this way, the BBC system can be operated to achieve the same objectives as inflation targeting.

The managed float system had served Singapore well. With the exception of the Asian crisis period, the MAS has successfully deterred speculators from attacking the domestic currency over the past three decades. Even during the Asian crisis period, the flexibility accorded by the managed float system aided Singapore in escaping from the crisis relatively unscathed. Nevertheless, it can be argued that it is Singapore's acceptance of market driven depreciations at the

[1] Neither the component currencies, their assigned weights in the basket, the central rate, nor the band limits are disclosed by the MAS.

[2] The TWI has historically exhibited an upward trend reflecting the strong and improving fundamentals of the Singapore economy over the past decades. However, Singapore's competitiveness does not seem to have been compromised by the strong dollar policy which has the advantageous effect of pushing the Singapore companies to move up the value chain to focus on higher value-added industries.

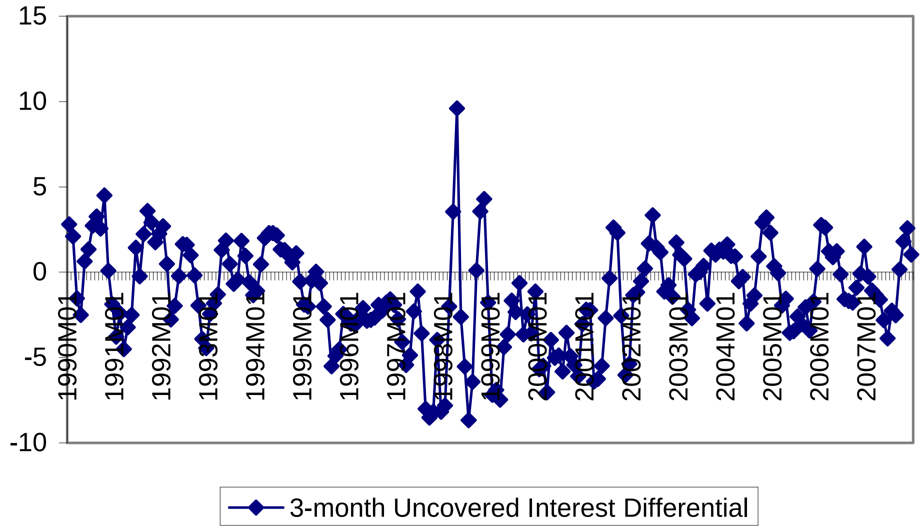
wake of and amid the deepening of the crisis that could have deterred currency speculators from engineering over-depreciation in the domestic currency (Yip, 2005). In other words, it is as if the Singapore dollar was on a free float during this period. Of course, Singapore's substantial amount of foreign reserves played a critical role in deterring speculative attacks. Further, strong economic fundamentals such as consistent fiscal surplus, large current account surplus, maintenance of stable and consistent macroeconomic policies, and a robust financial system are important explanations why Singapore was relatively less affected by the Asian crisis.

In comparison, the Asian crisis has prompted the central banks in East Asia to shift their focus from exchange rate stability to price stability. In particular, the crisis-hit countries like Indonesia, (South) Korea, Philippines and Thailand announced the explicit adoption of inflation targeting and the move towards using interest rates as the key monetary policy instrument. After all, the near pegged exchange rates and its attendant insurance effect exacerbated the boom-bust cycles associated with capital flows, thereby contributing to the crisis (Cossetti et al., 1999). However, unless capital controls are imposed, the open economy trilemma dictates that those countries that adopt inflation targeting would tend to have a freely floating exchange rate regime as well. Should Singapore follow suit? [3]

A key consideration in use of the interest rate variable in its conduct of monetary policy is whether the Singapore economy is interest rate-sensitive. Singapore's extensive network of international financial and trade linkages with the attendant huge and rapid capital flows and a very liberal policy towards foreign direct investment could result in an economy that is not so responsive to interest rate changes. However, the MAS is still able to exert a degree of control over domestic interest rates by varying the amount of liquidity injections. Figure 1, which depicts the ex post three-month uncovered interest differential between the US and Singapore, reveals that the differentials are quite different from zero and as pointed out by Yip (2003) they are substantially larger in magnitude compared with corresponding figures from Hong Kong. Hence, the fluctuations in the differentials are indicative of some autonomy in the interest rate policy, albeit to a rather limited extent as the exchange rate is managed within a prescribed policy band.

[3] Some market participants have advocated a move to greater flexibility in the exchange rate to guard against the risk of policymakers misjudging the level of Singapore's equilibrium exchange rate. However, others have pointed out that increasing flexibility in the TWI would increase the risk of the Singapore dollar overshooting and is thus, destabilizing.

Figure 1



In a monetary VAR analysis of Singapore's monetary transmission mechanism, Chow (2005) found that the exchange rate is more influential than the interest rate as a source of macroeconomic fluctuations. Nonetheless, the analyses in this study are performed on historical data and therefore reflect past monetary policy actions, in particular the use of the effective exchange rate as the monetary policy instrument. To determine if the conduct of monetary policy would have been more welfare enhancing had the interest rate been used as the policy operating instrument in place of the exchange rate would require counter-factual experiments and simulation analysis which is what we aim to do in this paper.

In the next section we lay out a two sector open economy for Singapore with its current exchange-rate regime, with sticky prices and financial frictions. We then discuss the results of Bayesian estimation in the DSGE and DSGE/VAR framework and contrast the results with variance decomposition analysis. Finally we undertake counterfactual simulations with a floating exchange rate system with a Taylor rule for the interest rate. We also examine the dynamic response of key variables to a fiscal spending impulse under the two monetary regimes.

2 The Model

2.1 Household Preferences and Endowments

Households own capital, for rental to export-goods producing firms, and supply labor both to both these export and home-goods firms. Capital for rental to the firms depreciates at the rate δ_1 for the export-goods firms. When households accumulate capital or decumulate capital beyond the steady state level, they pay adjustment costs. The following law of motion is specified for capital, while adjustment costs are given by AC_t^x. The parameters ϕ_h, ϕ_x are the adjustment cost parameters.

$$K_t^x = (1-\delta_1)K_{t-1}^x + I_t^x \tag{1}$$

$$AC_t^x = \left(\frac{\phi_x \left(I_t^x - \delta_1 \overline{K}^x \right)^2}{2K_t^x} \right) + Z_t^{AC} \tag{2}$$

The variable Z_t^{AC} is a stochastic shock to adjustment costs of investment in the export sector. It evolves according to the following autoregressive process:

$$\ln(Z_t^{AC}) = \rho_{AC} \ln(Z_{t-1}^{AC}) + (1-\rho_{AC}) \ln(\overline{Z}^{AC}) + \epsilon_{Z^{AC},t} \tag{3}$$

$$\epsilon_{Z^{AC},t} \sim N(0, \sigma^2_{\epsilon_{Z^{AC}}}) \tag{4}$$

We assume that all of investment goods are imported from abroad, and that the price P^f is the relevant price for these goods. The variable $\overline{K}^x$ is the steady state level of the capital stock for export-goods producing firms.

The household consumption at time t, C_t, is a CES bundle of both domestic consumption goods, C_t^d and imported goods, C_t^f.

$$C_t = \left[(1-\gamma_1)^{\frac{1}{\theta_1}} \left(C_t^d \right)^{\frac{\theta_1 - 1}{\theta_1}} + (\gamma_1)^{\frac{1}{\theta_1}} \left(C_t^f \right)^{\frac{\theta_1 - 1}{\theta_1}} \right]^{\frac{\theta_1}{\theta_1 - 1}} \tag{5}$$

The demand for each component of consumption is a function of the overall consumption index and the price of the respective component relative to the general price level, P :

$$C_t^d = (1-\gamma_1) \left(\frac{P_t^d}{P_t} \right)^{-\theta_1} C_t \tag{6}$$

$$C_t^f = \gamma_1 \left(\frac{P_t^f}{P_t} \right)^{-\theta_1} C_t \tag{7}$$

The parameters γ_1 and $(1-\gamma_1)$ are the relative shares of foreign and domestic goods in the overall consumption index, while θ_1 is the price elasticity of demand for each consumption component.

Domestically-produced goods are both non-traded home goods and export goods (some of which are consumed domestically). The following CES aggregator is used for domestically-produced consumption goods:

$$C_t^d = \left[(1-\gamma_2)^{\frac{1}{\theta_2}} \left(C_t^h \right)^{\frac{\theta_2 - 1}{\theta_2}} + (\gamma_2)^{\frac{1}{\theta_2}} \left(C_t^x \right)^{\frac{\theta_2 - 1}{\theta_2}} \right]^{\frac{\theta_2}{\theta_2 - 1}} \tag{8}$$

The relative demands for the home non-traded goods and the export goods are given by the following equations:

$$C_t^h = (1-\gamma_2)\left(\frac{P_t^h}{P_t^d}\right)^{-\theta_2} C_t^d \tag{9}$$

$$C_t^x = \gamma_2\left(\frac{P_t^x}{P_t^d}\right)^{-\theta_2} C_t^d \tag{10}$$

where the parameters γ_2 and $(1-\gamma_2)$ are the shares of the export and non-traded goods in domestic production of consumption goods, and θ_2 is the price elasticity of demand.

The domestically-produced price index is given by the following CES aggregator:

$$P_t^d = \left[(1-\gamma_2)\left(P_t^h\right)^{1-\theta_2} + \gamma_2\left(P_t^x\right)^{1-\theta_2}\right]^{\frac{1}{1-\theta_2}} \tag{11}$$

In the same manner, the overall price index, of course, is a CES function of the price of foreign and domestic consumption goods:

$$P_t = \left[(1-\gamma_1)\left(P_t^d\right)^{1-\theta_1} + \gamma_1\left(P_t^f\right)^{1-\theta_1}\right]^{\frac{1}{1-\theta_1}} \tag{12}$$

In addition to buying consumption goods, households put deposits M_t in the bank and receive dividends from the export and non-traded or home-goods producing firms. Total dividends is given by Π_t, with $\Pi_t = \Pi_t^x + \Pi_t^h$. The household pays taxes on labor income $\tau W_t L_t$ and on consumption $\tau_c C_t$. The following equation gives the household budget constraint (P_t^f is the price of imported goods):

$$\begin{aligned} & W_t L_t + (1+R_{t-1}^m)M_{t-1} + \Pi_t + P_t^{k^x} K_t^x \\ = \; & P_t C_t(1+\tau_c) + M_t + \tau W_t L_t + P_t^f I_t^x \\ & + P_t^f\left(\frac{\phi_x\left(I_t^x - \delta_2 \overline{K}^x\right)^2}{2K_t^x}\right) \end{aligned} \tag{13}$$

We assume that government spending G is bundled with consumption for utility in CES aggregator. We do this to indicate that there is a reason for government spending to take place, that such spending creates externalities for consumption, in the form of infrastructure, public utilities and other services which enhance household utility:

$$\widetilde{C}_t = \left[\phi C_t^{-\varkappa} + (1-\phi)G_{t-1}^{-\varkappa}\right]^{-\frac{1}{\varkappa}} \tag{14}$$

However, household utility does not simply come from the current consumption bundle. Rather, habit persistence applies to this consumption index when it enters the specific utility function, so that the relevant consumption index is deflated by the Habit Stock, H_t. The Habit Stock is a function of the lagged average consumption bundle, raised to the power ρ, the habit persistence parameter:

$$H_t = \overline{\widetilde{C}}_{t-1}^{\varrho} \tag{15}$$

Overall utility is a positive function of the consumption bundle and the habit stock and a negative function of labor:

$$U(\widetilde{C}_t/H_{t+\iota}, L_t) = Z_t^C \frac{\left(\widetilde{C}_t/H_t\right)^{1-\eta}}{1-\eta} - \gamma \frac{L_t^{1+\varpi}}{1+\varpi} \tag{16}$$

The parameter η is the relative risk aversion coefficient, while γ is the disutility of labor, and ϖ the Frisch labor supply elasticity. The variable Z_t^C is a shock to the utility of consumption and evolves according to the following process:

$$\ln(Z_t^C) = \rho_C \ln(Z_{t-1}^C) + (1-\rho_C)\ln(\overline{Z}^C) + \epsilon_{Z^C,t} \tag{17}$$

$$\epsilon_{Z^C,t} \sim N(0, \sigma^2_{\epsilon_{Z^C}}) \tag{18}$$

The household chooses the paths of consumption, labor, deposits, investment and capital, to maximize the present value of its utility function subject to the budget constraint and the law of motion for capital. Thus, the objective function of the household is given by the following expression:

$$\underset{\{C_t, L_t, M_t, I_t^h, K_t^h, I_t^x, K_t^x\}}{Max} \sum_{\iota=0}^{\infty} \beta^{\iota} U(\widetilde{C}_{t+\iota}/H_{t+\iota}, L_{t+\iota}) \tag{19}$$

where the parameter β represents the constant, exogenous discount factor. This optimization is subject to the three constraints:

$$\begin{aligned} & W_t L_t + (1+R_{t-1}^m)M_{t-1} + \Pi_t + P_t^{k^x} K_t^x \\ = \; & P_t C_t (1+\tau_c) + M_t + \tau W_t L_t + P_t^f I_t^x \\ & + P_t^f \left(\frac{\phi_x \left(I_t^x - \delta_2 \overline{K}^x\right)^2}{2K_t^x} \right) \end{aligned} \tag{20}$$

$$K_t^x = (1-\delta_2)K_{t-1}^x + I_t^x \tag{21}$$

The variable $P_t^{k^x}$ the return to the export-goods producing firm,while W_t is the nominal wage rate.

The household optimization is represented by the intertemporal Lagrangean:

$$\underset{\{C_t,L_t,M_t,I_t^h,K_t^h,I_t^x,K_t^x\}}{Max}\mathcal{L} = \sum_{\iota=0}^{\infty}\beta^{\iota}\left\{\begin{array}{c} U(\widetilde{C}_{t+\iota}/H_{t+\iota},L_{t+\iota}) \\ -\Lambda_{t+\iota}\left[\begin{array}{c} P_{t+\iota}C_{t+\iota}(1+\tau^C)+M_{t+\iota} \\ -(1+R^m_{t-1+\iota})M_{t-1+\iota} \\ +P^f_{t+i}I^x_{t+i}+ \\ P^f_{t+i}\frac{\phi_x\left(I^x_{t+i}-\delta_1\overline{K}^x\right)^2}{2K^x_{t+i}} \\ +(\tau-1)W_{t+\iota}L_{t+\iota}-\Pi_{t+i} \\ -P^k_{t+i}K^x_{t+i} \end{array}\right] \\ -Q^x_{t+i}\left(K^x_{t+i}-I^x_{t+i}-(1-\delta_2)K^x_{t-1+i}\right) \end{array}\right\} \tag{22}$$

Note that there are three Lagrange multipliers, one, $\Lambda_{t+\iota}$, is the familiar marginal utility of income or wealth, while Q^s_{t+i}, known as Tobin's Q, is the shadow price of capital for the export-goods sector.

Optimizing the Bellman equation with respect to the decision variables $C_t, L_t, M_t, I_t^h, K_t^h$ yields the following set of First-Order Conditions for the representative household:

$$\Lambda_t P_t = \left[\widetilde{C}_t/H_t\right]^{-\eta}\frac{1}{H_t}\left(\widetilde{C}_t\right)^{1-\varkappa}\phi\left(C_t\right)^{-\varkappa-1}Z_t^C \tag{23}$$

$$\gamma L_t^{\varpi} = \Lambda_t(1-\tau^w)W_t \tag{24}$$

$$\Lambda_t = \beta\Lambda_{t+1}(1+R_t^m) \tag{25}$$

$$Q_t^x = \beta\Lambda_{t+1}P_{t+1}^{k^x}+\beta\Lambda_{t+1}P_{t+1}^f\frac{\left(\phi_x\left[I_{t+1}^x-\delta_1\overline{K}^x\right]\right)^2}{2\left(K_t^x\right)^2}+\beta Q_{t+1}^x(1-\delta_2) \tag{26}$$

$$I_t^x = \delta_1\overline{K}^x+\frac{K_t^x}{\phi_x}\left(\frac{Q_t^x}{\Lambda_t}-P_t^f\right) \tag{27}$$

The first equation, 23, simply tells us that the marginal utility of wealth is equal to the marginal utility of consumption divided by the price level. The second equation, 24, states that the marginal disutility of labor is equal to the after tax marginal utility of consumption provided by the after-tax wage. The third equation is the Keynes-Ramsey rule for optimal saving: the marginal utility of wealth today should be equal to the discounted marginal utility tomorrow, multiplied by the gross rate of return on saving (in the form of deposits).

The equation for Tobin's Q tells us that the value of capital today is the discounted marginal utility of capital tomorrow, multiplied by the return to capital, in addition to the reduced value of adjustment costs in the future (due to the higher level of capital) and the discounted value of capital tomorrow, net of depreciation.

Finally, the investment equation tells us that investment will be equal to the steady state investment, $\delta_1\overline{K}^x$, when $\frac{Q_t^x}{\Lambda_t}=P_t^f$. Any increase in Tobin's Q_t^x, relative to the marginal utility of income and the price of investment goods, will trigger increases in investment.

3 Production and Technology

3.1 Home-Goods Firms

The home-good producing firms use the following CES technology:

$$Y_t^h = A^h \left[(1-\alpha_1) \left(L_t^h \right)^{-\kappa_1} \right]^{-\frac{1}{\kappa_1}} \tag{28}$$

The parameter $(1-\alpha_1)$ are the shares of labor in the CES production function, while the coefficient κ_1 is the CES aggregator. The technology shock is given by Z_t^h.

The demand for the home good can be both for domestic consumption, as well for government consumption spending:

$$Y_t^h = C_t^h + G_t \tag{29}$$

We assume that the firm faces a liquidity constraint, it must borrow an amount N_t^x from banks each quarter to pay a fraction μ_1 of its wage bill, at the borrowing rate R_t^n. We also assume that the amount of borrowing is subject to a collateral constraint proportional by a factor υ_1 to the total returns on capital:

$$N_t^h = \mu_1 W_t L_t^h, \tag{30}$$

The total profits (or dividends) of the export firm is given by the following identity:

$$\Pi_t^h = P_t^h Y_t^h - (1 + \mu_1 R_t^n) W_t L_t^h \tag{31}$$

Maximizing profits with respect to the use of capital and labor, we have the following first-order conditions for the firm:

$$\frac{\partial Y_t^h}{\partial L_t^h} = (1 + \mu_1 R_t^n) \frac{W_t}{P_t^h} \tag{32}$$

In the CES technology, we have the following expressions:

$$\frac{\partial Y_t^h}{\partial L_t^x} = \left(A^h Z_t^h \right)^{\kappa_1} (1-\alpha_1) \left(\frac{Y_t^h}{L_t^h} \right)^{1+\kappa_1} \tag{33}$$

You can see that with $\kappa_1 = 0$, the first order conditions reduce to the Cobb-Douglas marginal productivity conditions.

3.2 Export Goods

The firm producing export goods faces a similar production function:

$$Y_t^x = A^x \left[(1-\alpha_2) \left(L_t^x \right)^{-\kappa_2} + \alpha_2 \left(K_t^x \right)^{-\kappa_1} \right]^{-\frac{1}{\kappa_2}} \tag{34}$$

We assume that foreign demand responds to the relative price of this export good, in the sense that if the real exchange rate depreciates (relative to steady-state level $\left(\frac{\overline{S}}{\overline{P}}\right)$, foreign demand rises by a factor χ^x. Export demand is also subject to a stochastic shock, $\epsilon_{C^*,t}$ at time t.

$$C_t^* = \rho_{C^*} C_{t-1}^* + (1-\rho_{C^*})\overline{C^*} + (1-\rho_{C^*})\chi^x[\left(\frac{S_{t-1}}{P_{t-1}}\right) / \left(\frac{\overline{S}}{\overline{P}}\right)] + \epsilon_{C^*,t} \quad (35)$$

$$\epsilon_{C^*,t} \sim N(0, \sigma^2_{\epsilon_{C^*}}) \quad (36)$$

Under a small open economy setting we also assume that the price of the export good in domestic currency is simply equal to the exchange rate S_t multiplied by the world export price, $P_t^{x^*}$. We assume that the world export price follows the following exogenous stochastic process:

$$\ln(P_t^{x^*}) = \rho_{P^{x^*}} \ln(P_{t-1}^{x^*}) + (1-\rho_{P^{x^*}})\ln(\overline{P}_t^{x^*}) + \epsilon_{P^{x^*},t} \quad (37)$$

$$\epsilon_{P^{x^*},t} \sim N(0, \sigma^2_{\epsilon_{P^{x^*}}}) \quad (38)$$

Total demand for the export good is composed of the local demand (for consumption purposes) as well as the foreign demand:

$$Y_t^x = C_t^x + C_t^*$$

These firms also facing a liquidity constraint for meeting their wage bill:

$$N_t^x = \mu_2 W_t L_t^x \quad (39)$$

The profits of the export-goods firms are given by the following relation:

$$\Pi_t^x = P_t^x Y_t^x - (1+\mu_2 R_t^n) W_t L_t^x - -P_t^{k^x} K_t^x \quad (40)$$

Optimizing profits implies the following first-order condition for cost minimization:

$$\frac{\partial Y_t^x}{\partial L_t^x} = (1+\mu_2 R_t^n)\frac{W_t}{P_t^x} \quad (41)$$

$$\frac{\partial Y_t^x}{\partial K_t^x} = \frac{P_t^{k^x}}{P_t^x} \quad (42)$$

3.3 Labor Mobility and Capital Immobility

We assume that labor can move between the home-goods and export sectors. This implies the following equality for real labor productivity in each sector:

$$\frac{\partial Y_t^x}{\partial L_t^x}\frac{P_t^x}{(1+\mu_2 R_t^n)} = \frac{\partial Y_t^h}{\partial L_t^h}\frac{P_t^h}{(1+\mu_1 R_t^n)}$$

However, once installed, capital cannot be moved from one sector to the other. This means that the capital stocks in each sector, K_t^x, K_t^h are determined by date $t-1$ state variables and current-period investment decisions.

3.4 Calvo Pricing for Home Goods

The pricing for home-goods firms is different from that of export firms. We assume sticky monopolistically competitive firms in the home-goods market.

Let the marginal cost at time t be given by the following expression:

$$A_t = \frac{(1+\mu_1 R_t^n)W_t}{\left(A^h Z_t^h\right)^{\kappa_1}(1-\alpha_1)\left(\frac{Y_t^h}{L_t^h}\right)^{1+\kappa_1}} \tag{43}$$

In the Calvo price setting world, there are forward-looking price setters and backward looking setters. Assuming at time t a probability of persistence of the price at ξ , with demand for the product from firm j given by $Y_t^h\left(P_t^h\right)^{\zeta}$, the expected marginal cost, in recursive formulation, is presented by the expression for A_t^{num}. The expected demand, for the given price, is given by the variable A_t^{den}. The forward-looking price setting sets the optimal price, P_t^o, so that expected marginal revenue is equal to expected marginal costs. The optimal price also includes an autoregressive markup shock, $Z_t^{P^o}$.

$$\begin{aligned}
A_t^{num} &= Y_t^h\left(P_t^h\right)^{\zeta} A_t + \beta\xi A_{t+1}^{num} && (44)\\
A_t^{den} &= Y_t^h\left(P_t^h\right)^{\zeta} + \beta\xi A_{t+1}^{den} && (45)\\
P_t^o &= \frac{A_t^{num}}{A_t^{den}} + Z_t^{P^o} && (46)\\
\ln(Z_t^{P^o}) &= \rho_{P^o}\ln(Z_{t-1}^{P^o}) + (1-\rho_{P^o})\ln(\overline{Z}^{P^o}) + \epsilon_{Z^{P^o},t} && (47)\\
\epsilon_{Z^{P^o},t} &\sim N(0,\sigma^2_{\epsilon_{Z^{P^o}}}) && (48)\\
P_t^{h,b} &= P_{t-1}^h\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\kappa^i}(1+\widetilde{\pi}_t)^{\kappa^\pi} && (49)\\
P_t^h &= \left[\xi\left(P_t^{h,b}\right)^{1-\zeta} + (1-\xi)\left(P_t^o\right)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} && (50)
\end{aligned}$$

The backward looking price setters do not keep the price fixed. They will set their price equal to the price at the previous period, P_{t-1}^h multiplied by the previous period's inflation, $\left(\frac{P_{t-1}}{P_{t-2}}\right)$ raised to an indexation parameter κ^i, and by the gross inflation target announced by the central bank, $(1+\widetilde{\pi}_t)$, representing monetary policy statements, relative to inflation targets, raised to a parameter κ^π.

3.5 Importing Firms

Imported goodsY^f are used for both consumption C^f and for investment in the home-goods I^h and I^x respectively.

$$Y^f = C^f + I^h \tag{51}$$

The importing firms do not produce these goods. However, they have to borrow a fraction μ_3 of the cost of these imported goods in order to bring them to the home market for domestic consumers and investors:

$$N_t^f = \mu_3 (S_t P_t^{f^*} Y_t^f) \tag{52}$$

where P_t^{f*} is the world rice of the import goods and S_t is the exchange rate. The domestic cost of the imported goods is given by:

$$\begin{aligned} P^f &= [\mu_3(1 + R_t^n) + (1 - \mu_3)]\,(S_t P_t^*) \\ &= [1 + \mu_3 R_t^n] S_t P_t^* \end{aligned} \tag{53}$$

4 The Financial Sector

Banks lend to all three types of firms:

$$N_t = N_t^x + N_t^h + N_t^f \tag{54}$$

In addition to these firms, the banks lend to the government B_t^g and receive a risk-free interest rate $R_{t.}$

They borrow from foreign financial centers the amount B^f and pay a risk premium above the domestic interest rate when such foreign debt exceeds a steady-state level $\overline{B^f}$:

$$\Phi_t = \max\left\{0, \varphi\left[e^{\left(\left|B_{t-1}^f - \overline{B^f}\right|\right)} - 1\right] B_{t-1}^f\right\} \tag{55}$$

The banks thus pay a gross interest rate $R_t^* + \Phi_t$ on their outstanding dollar-denominated debt B_{t-1}^f to foreign financial centers,

In addition to paying deposits the interest rate R_t^m we assume that banks are also required to set aside a required ratio of reserves on outstanding deposits, $\phi_4 M_t$. The relevant opportunity cost of holding these reserves is of course the amount the banks can earn by holding risk-free government bonds, $\phi_4 R_t M_{t.}$ In addition banks are required to set aside a fraction of capital against their outstanding loans, $\phi_5 N_{t.}$. As in the case of the require reserves against deposits, the opportunity cost is given by $\phi_5 R_t N_{t.}$

The gross profit of the banking sector is given by the following balance-sheet identity:

$$
\begin{aligned}
\Pi_t^B \quad = \quad & (1+R_{t-1})B_{t-1}^g \\
& +(1+R_{t-1}^n)N_{t-1} \\
& -(1+R_{t-1}^* + \Phi_{t-1})B_{t-1}^f S_t \\
& -(1+R_{t-1}^m)M_{t-1} \\
& -B_t^g - N_t + S_t B_t^f + M_t \\
& -\phi_4 R_{t-1} M_{t-1} - \phi_5 R_{t-1} N_{t-1} \qquad (56)
\end{aligned}
$$

The bank maximizes its the present discounted value of its profits, given by V_t^B, with respect to its its portfolio of assets (loans to the government and firms, B_t^g and N_t) and liabilities (deposits from households and borrowing from foreign financial centers M_t and B_t^f).

$$
\underset{\{B_t^g, N_t, M_t, B,_t^f\}}{Max} V_t^B = \Pi_t^B + \beta V_{t+1}^B
$$

This optimization leads to the following set of first-order conditions for financial sector profit maximization:

$$
\begin{aligned}
1 &= \beta(1+R_t) && (57) \\
1 &= \beta(1+R_t^n) - \beta\phi_5 R_t^n && (58) \\
1 &= \beta(1+R_t^m) + \beta\phi_4 R_t && (59) \\
S_t &= \beta(1+R_t^* + \Phi_t)S_{t+1} + \beta\Phi_t' B_t^f S_{t+1} && (60)
\end{aligned}
$$

This set of first-order conditions leads to the familiar set of spreads for interest rates, as well as the interest-parity equation:

$$
\begin{aligned}
R_t &= R_t^n - \phi_5 && (61) \\
R_t &= R_t^m + \phi_4 && (62) \\
(1+R_t)S_t &= (1+R_t^* + \Phi_t + \Phi_t' B_t^f)S_{t+1} && (63)
\end{aligned}
$$

The foreign interest rate evolves according to the following law of motion:

$$
\begin{aligned}
R_t^* &= \rho_{R^*} R_{t-1}^* + (1-\rho_{R^*})\overline{R}^* + \epsilon_{R^*,t} \\
& \epsilon_{R^*} \tilde{} N(0, \sigma_{\epsilon_{R^*}}^2)
\end{aligned}
$$

For Singapore, we allow some flexibility in the exchange rate. Following McCallum (2006), we assume that the Monetary Authority of Singapore following an exchange rate rule:

$$
\begin{aligned}
[\ln(S_{t+1}) - \ln(S_t)] &= \rho_S[\ln(S_t) - \ln(S_{t-1})] + (1-\rho_s)[\ln(P_{t+1}) - \ln(P_t)] \quad (64)\\
&\quad -(1-\rho_s)\rho_\pi[\ln(P_{t+1}) - \ln(P_t) - \widetilde{\pi}]] + \epsilon_{E,t} \quad (65)\\
&\quad \epsilon_E \tilde{} N(0, \sigma^2_{\epsilon_E}) \quad (66)
\end{aligned}
$$

where $\widetilde{\pi}$ is the target rate of inflation, . ρ_S is the depreciation persistence parameter and ρ_π is the inflation coefficient. This rule implies that in the absence of deviations of inflation from the target rate, the monetary authority will follow a purchasing power parity approach to exchange rate depreciation or appreciation. However if inflation exceeds its target, there will real appreciation. We also allow a stochastic term in the exchange rate depreciation rule.

Given that the exchange rates and the interest rates are determined by the monetary regime, the change in the reserve position of the financial sector evolve according to the following balance-sheet constraint of the financial sector:

$$
\begin{aligned}
\Delta RES_t &= -N_t - B_t \quad (67)\\
&\quad +(1 + R^n_{t-1} - \phi_5 R_{t-1})N_{t-1}\\
&\quad -(1 + R^m_{t-1} + \phi_4 R_{t-1})M_{t-1} + M_t\\
&\quad +(1 + R_{t-1})B_{t-1}\\
&\quad -(1 + R^*_{t-1} + \Phi_{t-1})B^f_{t-1}S_{t-1} + B^f_t S_t
\end{aligned}
$$

4.1 Fiscal Policy

The government takes in taxes from the households and engages. in spending on traded goods. We assume that spending may be either pro-cyclical or counter-cyclical, depending on the value of ρ_{GY}, that there is smoothing in government consumption, and there is a stochastic component to spending:

$$
\begin{aligned}
G_t &= (1-\rho_G)\overline{G} + \rho_G G_{t-1} + (1-\rho_G)\rho_{GY}(Y_{t-1} - \overline{Y}) + \epsilon_{G,t} \quad (68)\\
&\quad \epsilon_{G,t} \tilde{} N(0, \sigma^2_{\epsilon_G}) \quad (69)
\end{aligned}
$$

Given its source of labor and consumption tax revenue, the fiscal borrowing requirement is given by the following identities:

$$
\begin{aligned}
TAX_t &= \tau W_t L_t + \tau_c P_t C_t \quad (70)\\
B^g_t &= (1 + R_{t-1})B^g_{t-1} + P^h_t G_t - TAX_t \quad (71)
\end{aligned}
$$

5 Foreign Assets and Interest Rates

The aggregate foreign borrowing or asset accumulation evolves through the following identity:

$$S_t B_t^f = [1 + R_{t-1}^* + \Phi_{t-1}] S_t B_{t-1}^f + P_t^f (C_t^f + I_t^h + I_t^x) - P_t^x (C_t^*) \quad (72)$$

It should be noted that the risk premium embedded in the accumulation of foreign debt effected closes this open economy model, so that the domestic consumption and foreign debt levels do not become indeterminate. There are other ways to close the open economy model, such as adjustment costs on foreign debt accumulation, or an endogenous discount factor [see Schmitt-Grohé and Uribe (2003)] We feel that the incorporation of a time-varying endogenous risk premium is a more intuitive way to close this model.

6 Calibrated Parameters and Bayesian Priors

Before turning to Bayesian estimation, we first calibrate the parameters which determine the steady state. Following Christiano, Motto and Rostagno (2007), we calibrate parameters that control the steady state, and estimate with Bayesian methods those parameters which affect the dynamics and stochastic properties of the model. The reason we simply calibrate and do not estimate the first set of parameters is that computation of the steady-state is very time intensive.

The parameters are set for a quarterly model. The discount parameter β is similar to most other models for quarterly data. The habit persistence parameter ϱ is within range of most models, such as Smets and Wouters (2003). The depreciation rate for capital δ_1 is relatively high. We assume that the capital in our model is specific to the non-traded sector. Since investment goods in this sector are imported goods, we assume that the depreciation is high, while the adjustment cost parameter ϕ_K would be relatively low.

The ratios of consumption of foreign goods in total consumption basket, γ_1 the the share of export-goods consumption in the total domestic consumption basket, γ_2, the tax parameters for labor income and consumption, τ,τ_C all come from national income accounts. The relative risk aversion coefficient, η, the labor supply elasticity, ϖ, and the disutility of labor γ_L are commonly used. We assume a higher intratemporal elasticity between consumption of home and foreign goods in the total consumption index than the elasticity of intratemporal substitution between consumption of export and home goods in the domestic consumption index. Hence, $\theta_1 > \theta_2.\mu$

The financial friction parameters μ_i, $i = 1, ..3$,representing the borrowing needs of the export, home-goods and importing firms, were all set equal at a value of 1. We assume in such a financially developed economy as Singapore that firms in any of the sectors would have easy access to short term credit. The capital coefficient in the export production function, α_1, is set to to replicate the shares of capital and labor in the economy. Finally the banking reserve and lending cost parameters ϕ_M, ϕ_N, are set to replicate observed low spreads in the financial sector.

The habit persistence coefficient h is .5. While this value is usually somewhat higher for studies in the United States, we assume that consumers in emerging market countries are less habitual. The reason we make this assumption is that Hong Kong has a higher proportion of lower-income households, who would not have scope for habit persistence. The labor supply elasticity, ϖ, is .25, similar to that of other studies, while the disutility of labor is set at 1. We have found that variations of this parameter had little effect on the steady state values.

Table 1:
Calibrated Parameters

Symbol	Definition	Values
β	discount factor	.99
ϱ	habit parameter	.8
δ_1	capital depreciation	.02
ϕ_{K^h}	adjustment cost	.005
γ_1	foreign cons. in total cons. index	.5
γ_2	con of export good in dom.cons. index	.3
η	relative risk aversion parameter	3
ϖ	labor supply elasticity	.5
γ_L	disutility of labor	1
ϕ_C	consumption in CES utility	.95
$\varkappa$	CES utility coefficient	-.1
θ_1	intratemporal substitution elasticity, total cons	2.5
θ_2	intratemporal substitution elasticity, domestic cons	1.5
τ, τ_C	tax rates on labor income and consumption	.1,0.07
μ_1, μ_2, μ_3	financial friction parameters	1,1,1
ζ	substitution elasticity for differentiated goods	
κ	CES substitution parameter in production	-0.1
α_1	capital coefficient in non-traded goods	.3
ϕ_M, ϕ_N	deposit and lending costs for banks	.1, .15

Table 2 shows the prior distributions with the means and standard errors as well as values for the infima and suprema of the distributions. We make use of relatively flat priors for the standard deviations for the volatilities of the shocks in the model. The coefficients we estimate relate to stochastic process for government spending, and the persistence coefficient for exports, export prices ,mark-up pricing shocks. We allow the government spending coefficient with respect to output to be positive or negative, thus allowing the data to determine if spending is pro or counter-cyclical. Similarly for the coefficient of exports with respect to the real exchange rate. The coefficients for the volatility of the exchange rate rule, depreciation lag and the inflation coefficient, of course, only apply to Singapore

Table 2:
Bayesian Priors: Parameters and Distributions

Volatility	Name	Distribution	Mean	Std Dev	Inf	Sup
$\sigma_{\epsilon G}$	Gov. Spending	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon Z_{P^o}}$	Mark-Ups	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon P^{X*}}$	Terms of Trade	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon R^*}$	For. Interest	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon C^*}$	Exports	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon C}$	Consumption	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon E}$	Ex. Rate Rule	Inv. Gamma	.001	2	.005	.5
$\sigma_{\epsilon A}$	Adj Cost	Inv. Gamma	.001	2	.005	.5
Coefficient						
ρ_S	Depreciation Lag	Beta	.5	.2	.1	.9
ρ_π	Inf Coeff	Normal	1	.2	.5	2
ρ_G	Gov. Spending	Beta	.5	.2	.01	.95
ρ_{GY}	Gov. Spending	Normal	0	.1	-.3	.3
$\rho_{P^{X*}}$	Terms of Trade	Beta	.5	.2	.01	.95
ρ_{R^*}	For.Interest	Beta	.5	.2	.01	.95
ρ_{Z_P}	Markup	Beta	.5	.2	.01	.95
ρ_{C^*}	Export	Beta	.5	.2	.01	.95
ρ_{C^*R}	Export-Ex.Rate	Normal	0	.2	.01	1.5
ρ_C	Consumption	Beta	.5	.2	.01	.95
ρ_A	Adj Costs	Beta	.5	.2	.01	.95
ξ	Calvo Pricing	Beta	.5	.2	.01	.95

We use eight observables for Bayesian estimation: $\widehat{c}, \widehat{p}, \widehat{i^x}, \widehat{R^*}, \widehat{p}^X, \widehat{g}, \widehat{c^*}, \widehat{R^n}$, representing consumption, prices, investment, foreign interest rates, terms of trade, government spending, exports and the domestic lending rate, . Lower case letters with the circumflex represent the percentage deviations from the steady state. For real variables, $\widehat{c}, \widehat{i^x}, \widehat{g}, \widehat{c^*}$, we used the Hodrik-Prescott filter. For the nominal variables $\widehat{p}, \widehat{R^*}, \widehat{R^n}$, we simply used a linear detrending filter.

7 Bayesian Estimation Results

We first discuss the Bayesian estimates for each country. We estimated the models for the period 1984-2008 for the following observables: output, consumption, foreign interest rate, terms of trade, exports, inflation, and for Singapore, the exchange rate. Except for the interest rate, the data are log first differenced. Then we take up the results of posterior simulations for impulse response analysis..

We estimate the model for Singapore in pure DSGE framework as well as in a DSGE/VAR framework, following Del Negro, Marco and Frank Schorfheide (2004), Adjemian, Stephane, Matthiew Darracq, and Stephane Moyen (2008), and An, Sungbae and Heedon Kang (2009). We contrast the parameter estimates and volatilities under both frameworks for each country.

7.1 Relative Fit of DSGE and DSGE/VAR Framework

Table 3 pictures the relative fit of the DSGE models relative to the VAR framework. The parameter λ governs the relative weight of the pure DSGE model relative to the hybrid or pure VAR model. We see that the best fit for Singapore is $\lambda = .8$, by both the Laplace and Harmonic Mean measurements of the Marginal Likelihood.

Table 3:
Fit of DSGE Models

		Marginal Likelihood	
Specification	λ	Laplace	Harmonic Mean
DSGE		637.275	632.852
DSGE/VAR	Inf	1080.018	1077.471
	2.5	1134.400	1129.889
	2	1116.999	1113.476
	1.5	1131.459	1125.393
	1	1147.363	1138.677
	0.8	1180.985	1173.139
	0.75	1152.232	1148.979
	0.6	1160.498	1155.781
	0.5	1150.348	1145.880

7.2 Volatility and Parameter Estimates

Table 4 pictures the results for Singapore under the pure DSGE and the DSGE/VAR framework for $\lambda = .8$. The table contains the mean of the Bayesian estimates for 200,000 simulations in four blocks. We also show the infimum and supremum of each estimate for a 95% confidence interval.

We see that the highest persistence is in the markup pricing behavior under both methods. The major difference in the estimates given by the two methods is in the persistence coefficient for the shock to adjustment costs, ρ_A. The pure DSGE method gives a relatively low value while the DSGE/VAR a relatively high one. Under both methods, government spending can be either counter or procyclical. The effect of the real exchange rate on exports, given by χ^x, can be positive or negative in the DSGE but is always positive in the DSGE/VAR method. The Calvo price stickiness coefficient, ξ, is also small, relative to commonly accepted specifications of .75 or .8, under both methods. The estimated volatilites are all relatively small, but somewhat larger in the pure DSGE than in the DSGE/VAR, with government spending and the markup pricing shocks having the largest standard deviations under both methods.

Table 4:
Bayesian Estimates

	DSGE			DSGE/VAR: $\lambda = .8$		
Coefficient	Mean	Inf	Sup	Mean	Inf	Sup
ρ_A	0.219	0.088	0.349	0.713	0.617	0.844
ρ_C	0.752	0.657	0.867	0.589	0.302	0.924
ρ_G	0.182	0.048	0.307	0.282	0.099	0.479
ρ_{GY}	0.037	-0.07	0.139	-0.013	-0.153	0.133
ρ_{PX^*}	0.69	0.572	0.793	0.794	0.700	0.895
ρ_{R^*}	0.696	0.627	0.772	0.560	0.441	0.715
$\rho_{Z_{P^o}}$	0.88	0.84	0.91	0.861	0.782	0.912
ρ_{C^*}	0.715	0.591	0.824	0.468	0.396	0.528
χ^x	0.063	-0.04	0.161	0.155	0.036	0.259
ξ	0.361	0.289	0.421	0.380	0.276	0.461
ρ_π	1.191	0.975	1.422	1.352	1.026	1.622
ρ_s	0.917	0.907	0.926	0.828	0.779	0.892
Volatility						
$\sigma_{\epsilon G}$	0.028	0.024	0.034	0.018	0.014	0.022
$\sigma_{\epsilon Z_P}$	0.032	0.027	0.037	0.014	0.007	0.022
$\sigma_{\epsilon R^*}$	0.002	0.002	0.002	0.002	0.002	0.002
$\sigma_{\epsilon C^*}$	0.009	0.008	0.01	0.004	0.003	0.005
$\sigma_{\epsilon A}$	0.013	0.01	0.016	0.005	0.003	0.007
$\sigma_{\epsilon C}$	0.08	0.065	0.093	0.012	0.002	0.023
$\sigma_{\epsilon PX^*}$	0.018	0.016	0.021	0.005	0.004	0.007
$\sigma_{\epsilon M}$	0.019	0.016	0.022	0.004	0.003	0.005

Of course, these estimates tell us nothing about the relative importance of each of the exogenous shocks for key endogenous variables of the model. Table 5 gives the mean variance decomposition of the Bayesian estimation. We see a number of expected results, for example, that the shock to consumption explains ore than 40 percent of the variance in consumption, the shock to adjustment costs more than 35 percent of the variance of investment (in the DSGE/VAR), and the shock to export demand more than 45 percent of export volatility in the DSGE/VAR and more than 60 percent in the pure DSGE model. The shock to the monetary exchange rate rule accounts for more than 40 percent of the variance of inflation in the DSGE/VAR and more than 60 percent in the DSGE. However, we see that the shock to markup pricing accounts for more than 40% of consumption volatility in both methods, and more than 35% of the volatility in the lending rate in the DSGE/VAR. While its own standard deviation is large, the shock to government spending plays a small role in the behavior of consumption or investment under both methods. Government spending shocks crowd out very little domestic spending.

Table 5:
Variance Decomposition

DSGE								Shock
Variable	$\sigma_{\epsilon G}$	$\sigma_{\epsilon R^*}$	$\sigma_{\epsilon Z_P}$	$\sigma_{\epsilon P^{X^*}}$	$\sigma_{\epsilon C^*}$	$\sigma_{\epsilon A}$	$\sigma_{\epsilon C}$	$\sigma_{\epsilon M}$
$\widehat{c}$	0.001	0.000	0.423	0.006	0.009	0.005	0.480	0.075
$\widehat{i^x}$	0.017	0.002	0.159	0.215	0.109	0.129	0.067	0.302
$\widehat{c^*}$	0.003	0.001	0.162	0.094	0.699	0.027	0.000	0.014
$\widehat{p}$	0.005	0.001	0.030	0.245	0.069	0.035	0.001	0.613
$\widehat{R^n}$	0.002	0.100	0.681	0.078	0.053	0.022	0.003	0.061
DSGE/VAR:$\lambda = .8$								
$\widehat{c}$	0.005	0.003	0.477	0.013	0.027	0.045	0.417	0.013
$\widehat{i^x}$	0.052	0.016	0.149	0.095	0.079	0.369	0.080	0.161
$\widehat{c^*}$	0.010	0.006	0.169	0.112	0.470	0.229	0.000	0.005
$\widehat{p}$	0.019	0.009	0.031	0.244	0.153	0.128	0.001	0.415
$\widehat{R^n}$	0.008	0.202	0.357	0.086	0.071	0.204	0.001	0.070

8 Counterfactual Simulation

What if Singapore followed a monetary policy with the interest rate as its benchmark policy instrument? In particular, the following alternative is proposed:

$$R_t = \rho_r R_{t-1} + +(1-\rho_r)\rho_\pi \widehat{\pi}_t + (1-\rho_r)R + \epsilon_{R,t} \quad (73)$$

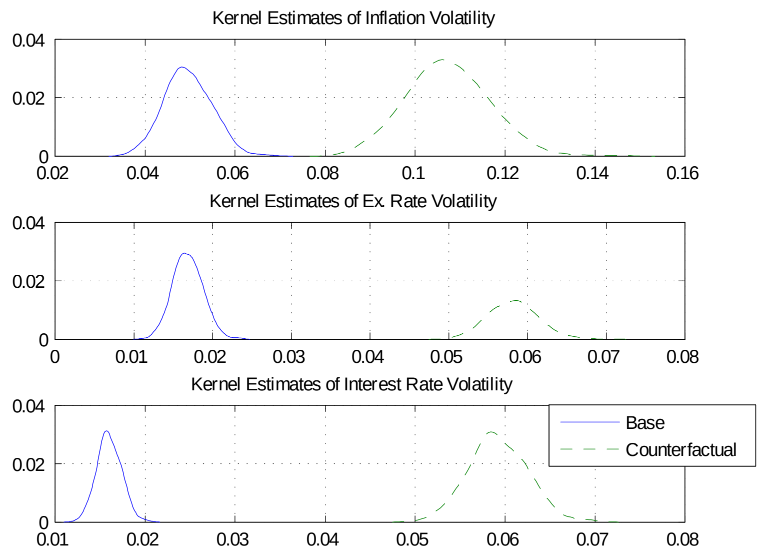
$$\epsilon_R \tilde{} N(0, \sigma^2_{\epsilon_R}) \quad (74)$$

We simulate the counterfactual model with the policy rule parameters for the Taylor rule taking on the same values as those estimated for the exchange-rate rule, since, of course, we cannot estimate a Taylor rule for Singapore. Our rationale is that the monetary authority would behave with the same desire for smoothing of the interest rate as it would for the exchange rate, and adjust the interest rate at least with the same response to inflation as they did with the exchange rate.

We simulated each model 1000 times for a sample of 500, and obtained the standard deviations of nominal and real macro variables. We examine the distribution of these variables in order to assess any significant differences in the distribution of these variables.

8.1 Stochastic Simulations

Figure 2 pictures the kernel estimates of the volatility measures of inflation, the exchange rate and the interest rate under the base scenario of exchange-rate instruments and the counterfactual Taylor rule inflation targeting. We see that abandoning the exchange rate rule in favor of the interest rate rule leads to increases in volatility of large orders of magnitude. Clearly a preference for



low inflation, exchange rate, and interest rate volatility favors the exchange-rate rule.

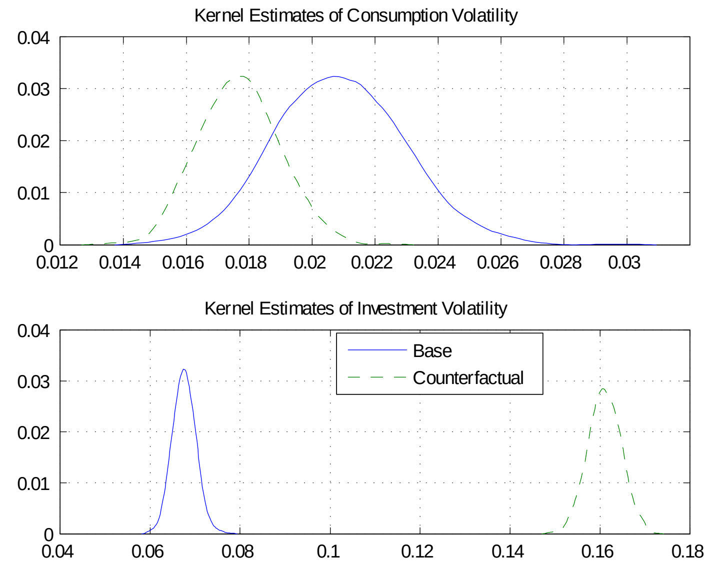
Figure 3 pictures the kernel estimates of consumption and investment volatility. We see a reduction in the volatility of consumption and an increase in the volatility of investment. However the increase in investment volatility is almost threefold, while the reduction in the mean of consumption volatility is much less, about 30 percent.

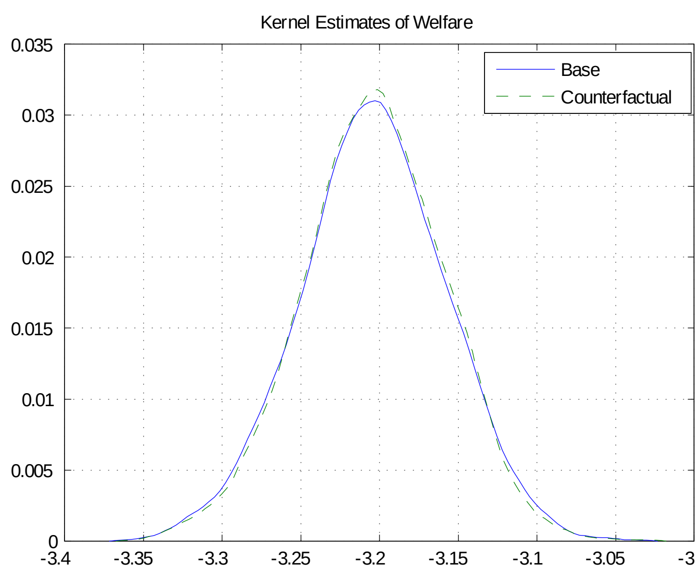
Figure 4 pictures the distribution of welfare. We see practically no difference. While the reduction in consumption volatility would favor the counterfactual regime, the increased investment volatility feeds back into increased employment volatility, which reduces welfare. So the two effects cancel each other out.

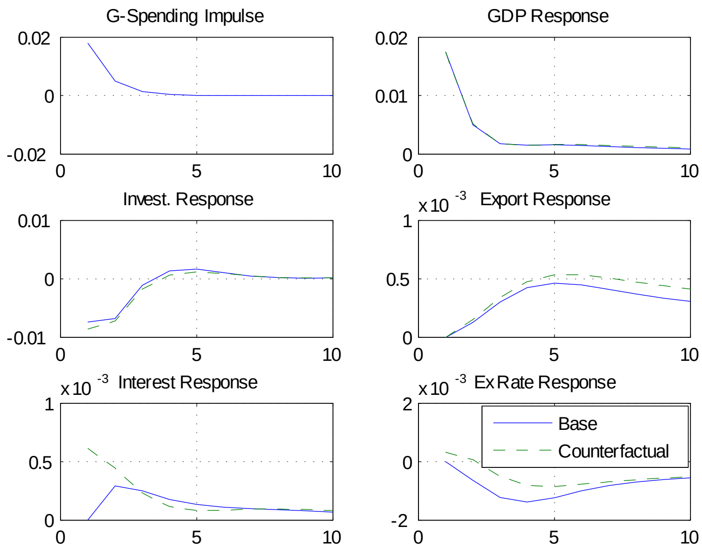
8.2 Response of Fiscal Impulse

Figure 5 pictures the response of GDP, investment, exports, domestic interest rate and the exchange rate to an two percent shock to government spending, which declines gradually over ten quarters. The solid curves give the response of each variable under the exchange-rate rule while the broken curves show the response under the counter-factual Taylor rule with inflation targeting.

We see that the response of GDP is practically the same under both policy setting, with a multiplier close to but not above unity. For investment we see crowding of about 50% of the initial stimulus under both regimes. There is also little difference in the positive response of exports: under both regimes, the peak response is equal to about 25% of the spending increase. Interest rates rise more in the Taylor regime, as expected, while the while the exchange rate


Kernel Estimates of Consumption Volatility
0.04
0.03
0.02
0.01
0
0.012 0.014 0.016 0.018 0.02 0.022 0.024 0.026 0.028 0.03
Kernel Estimates of Investment Volatility
Base
Counterfactual
0.04
0.03
0.02
0.01
0
0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18


Kernel Estimates of Welfare
Base
Counterfactual
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-3.4 -3.35 -3.3 -3.25 -3.2 -3.15 -3.1 -3.05 -3



remains failty stable in both scenarios.

The main advantage of the current system appears to be in the form of damped interest rate response to fiscal stimulus packages. The response of the other macroeconomic variables are almost identical.

9 Conclusion

Our Bayesian analysis Singapore suggests some reasons for the Singaporeans to fear floating. As a highly open economy, greater volatility in the exchange rate and interest rate, through a Taylor rule policy, would lead to much greater volatility in inflation and investment (and employment), with a payoff of somewhat reduced volatility in consumption. The overall welfare gain would be trivial.

If the policy preference is for lower investment and interest rate volatility, then there is no reason to abandon the present monetary regime. Staying with the current regime better insulates interest rates, exports and investment from government spending and other demand shocks in the non-traded sector.

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