Monetary-Fiscal Interaction in Indonesia

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Abstract

There has been a trend toward using monetary policy as the main stabilisation instrument, while fiscal policy has often been seen as either ineffective as a stabilisation instrument or unable to respond in a timely manner. There has, however, been renewed interest in fiscal policy as a stabilisation instrucment due to monetary union in teh Euro area, and due to low and stable inflation accompanied by substantial internal (UK) or external (New Zealand) imbalances. Moreover, in emerging economies, less complete markets potentially break Ricardian equivalence, creating a larger stabilisation role for fiscal policy. This paper explores the stabilisation role of fiscal policy in Indonesia. We use an estimated open economy DSGE model that features sticky prices and wages, nonRicardian agents and tax distoritions to explore the potential role for fiscal policy in stabilisation. The results suggest that fiscal policy can and does contribute meanuingfully to macroeconomic stabilisation in Indonesia, leading to better outcomes than monetary policy alone. A large estimated share of nonRicardians (62 to 67%) is important in creating a role for fiscal policy. With a risk premium that is linear in debt, the fiscal debt plays an important shock absorber role, allowing active fiscal stabilisation and absorption of exchange rate valuation effects on the stocks of debt and reserves. Even in the absence of a direct effect on the exchange rate in the model, reserves accumulation is contractionary, leading to a small depreciation of the exchange rate.

1 Introduction

The role of monetary policy in macroeconomic stabilisation is well accepted. The role of fiscal policy is less well understood. In a classical world there is little scope for stabilising fiscal policy; while in a Keynesian world fiscal policy may play a substantial role.

From a classical perspective, business cycles are seen as optimal responses to shocks, to a first approximation, and rigidities and distortions are not central. If there were inefficiencies that created a role for fiscal policy, fiscal policy would still be largely impotent since infinitely lived Ricardian households would smooth through the effects of a rise in government spending by saving and borrowing. If anything, a rise in government spending would have a small wealth effect, leading to a small fall in consumption.

From a Keynesian perspective, rigidities and distortions are central to business cycle dynamics and business cycles are associated with allocative inefficiencies. In such a world fiscal policy can be used to reduce such inefficiencies. The effectiveness of fiscal policy, however, depends on the existence of distortions and rigidities such as limited access to credit that leads to non-Ricardian behaviour (e.g., consumption out of current income rather than lifetime income, as in the ISLM model). In the presence of such rigidities, a rise in Government spending would lead to an increase in income and therefore consumption.

The empirical evidence, based on VARs, tends to support the Keynesian perspective: a rise in government spending is associated with a rise in consumption in some studies, and a small and insignificant effect in others, but rarely with a fall in consumption (Gali and Perrotti 2003).

From a practical perspective most economists support the use of automatic fiscal stabilisers, suggesting a role for fiscal policy. Gali and Perrotti (2003) present evidence that fiscal policy in OECD countries has become more countercyclical over time, which he interprets as evidence of an active role for fiscal policy. There has been renewed interest in fiscal policy in the Euro area due to the limits of monetary policy at the country level. There has also been renewed interest in inflation targeting countries have found that low and stable inflation outcomes can be accompanied by substantial internal imbalances (see Wren Lewis 2002 on the UK) or external imbalances (see Buckle and Drew 2006 for a discussion of New Zealand). Such imbalances suggest that monetary policy alone may not effectively stabilise the economy and a potential role for fiscal policy.

While monetary policy is generally associated with a single instrument, fiscal policy has many potential instruments on both the expenditure side and revenue side, which will have different effects. For example, a temporary increase in VAT is more likely to affect private consumption decisions as it directly affects prices (Wren Lewis 2002). Moreover there is a broad set of rigidities and distortions that create a potential role for fiscal policy. The possible combinations of rigidities and fiscal instruments has led to a large and growing model-based literature that explores the stabilising role of fiscal policies in the presence of various rigidities (see Schmitt-Grohe and Uribe 2005 for a medium-sized model), non-Ricardian consumption behaviour (Gali, et al 2007), monetary union (Gali and Monacelli 2004, Benigno and Woodford 2003), the valuation of nominal government liabilities (the fiscal theory of the price level, see Leeper and Yun 2005), and economic openness (Leith and Wren Lewis 2008).

Fiscal-monetary interaction may be especially relevant where the net fiscal position is large, so that monetary policy has a larger effect on fiscal debt service costs, or where the fiscal position has a large currency mismatch[1] so that monetary policy effects on the exchange rate affect fiscal flows. If monetary policy has a large effect on fiscal flows, monetary policy may be undermined through political pressure to avoid undesirable effects on the fiscal position. Similarly, where reserves holdings are large and the carry cost and valuation effects fall on the central bank's balance sheet, monetary policy may be undermined by a desire to protect the integrity of the central bank's balance sheet.

This paper extends the analysis of fiscal monetary interaction in Coenen and Straub (2005) to an open, economy setting and to an emerging economy environment. Fiscal policy may be particularly relevant for stabilisation in emerging economies, if less developed markets are associated with allocative inefficiency, for example, if a lack of access to credit by poor households or undeveloped retail credit markets mean more widespread nonRicardian consumption behaviour. Open economy features are potentially important for macroeconomic stabilisation because of the shock absorber roles of the exchange rate and the currency account and the potential importance of foreign shocks. Open economy features may also be important in assessing the effect of monetary policy on fiscal flows via exchange rate fluctuations

[1] Even if the consolidated government position is zero, in a country with a significant domestic currency debt and offsetting foreign currency reserves holdings, the carry cost of the interest rate mismatch and the effect of exchange rate fluctations on both the net position and interest receipts may still be relevant. For example, sterilised intervention in the foreign exchange market, where accumulation of foreign currency reserves is sterilised by equivalent issuance of domestic curreny government debt, will create a mismatched position.

and the wedge between domestic and foreign interest rates, a channel has become increasingly relevant in Asia as reserves positions have increased.

We develop an open economy DSGE model that features both Ricardian and nonRicardian agents, sticky prices and wages, distortionary taxation, a capital accumulation process and open trade and financial accounts, sticky domestic prices and wages and imperfect passthrough from import costs to domestic prices. The fiscal position includes foreign currency reserves and domestic and foreign currency debt. Fiscal policy is conducted through lump sum taxes that respond to fluctuations in fiscal expenditure fluctuations and to the debt gap, and through expenditure that may be pro- or countercyclical. Monetary policy is conducted through a Taylor-type rule. The model is estimated on Indonesian data and used to explore (i) the potential stabilisation role for fiscal policy, and (ii) the interaction between fiscal and monetary policy.

Overall, we find that fiscal policy can and does play an important stabilisation role in Indonesia. A large estimated share of nonRicardian agents is important in giving fiscal policy a stabilisation role. Estimated fiscal and monetary policy parameters are sensible in terms of the variance tradeoffs in the model: fiscal expenditure is countercylical, fluctuations in fiscal expenditure are mainly financed by debt and there is a gradual tax response to the debt gap. Together these allow fiscal debt to play an important shock absorber role, while government expenditure plays a stabilisation role. In the absence of an active countercyclical fiscal policy, monetary policy would need to be less aggressive in terms of inflation but more aggressive in terms of the output gap to minimise a standard loss function, but losses would still be higher. In the model foreign reserves accumulation is contractionary and leads to a small depreciation even in the absence of a direct effect on the exchange rate. The depreciation is modest compared to the effect of an equivalent 1 standard deviation contraction in fiscal expenditure.

The rest of the paper is set out as follows. Section 2 provides a brief overview of the monetary and fiscal policy framework in Indonesia. Section 3 sets out the model. Section 4 discusses the data and estimation. Section 5 discusses the impulse response functions, emphasising the effect of monetary policy on the fiscal accounts and the effect of fiscal policy on the economy. Section 6 explores monetary-fiscal interaction through policy experiments. Section 7 concludes.

2 Monetary and Fiscal Policy Framework

Prior to 1999 monetary policy in Indonesia targeted base money. Inflation targeting was informally adopted in 1999 and formally adopted in 2005. Initially a variety of instruments were used and by 2005 an interest rate corridor had been established for effective control over the overnight interest rate.

In 2003 Indonesia passed a fiscal responsibility act (Law No 17 on State Finance, 2003), which stipulates that the fiscal debt should not exceed 60 per cent of GDP and the fiscal deficit should not exceed 3 per cent of GDP. In 1995-6 Indonesia's fiscal debt varied from about 25 per cent of GDP to 35 per cent of GDP, all of which was in foreign currency. The debt increased sharply during the Asian crisis as the Rupiah depreciated. In 1999 about half of the debt was converted to domestic currency debt, a share that has been sustained since. From a peak of almost 90 per cent of GDP in 2000, the fiscal debt has subsequently fallen sharply to less than 40 per cent of GDP through a combination of a smaller fiscal deficit, and strong nominal GDP growth.

The Indonesian Rupiah was floated in 1997 and initially depreciated sharply – by over 60 per cent in real terms – recovered about a third of that by the end of 1998 and has fluctuated around an appreciating trend since. While the central bank actively intervenes in the foreign exchange market, the scope of intervention is small compared to many Asian countries. Indonesia has a stock of foreign currency reserves of about 14 per cent of GDP which is modest compared to China (about 45 per cent), India (about 25 per cent), Korea (28 per cent) and Singapore (about 100 per cent).

Reserves are held on Bank Indonesia's balance sheet. BI issues central bank paper (SBIs) to sterilise intervention and so pays domestic interest rates, but receives lower foreign currency interest rates on reserves. Although the stock of reserves is modest, interest earnings cover only about half of interest costs, leading to stress on BI's balance sheet. Apart from balance sheet risks, this potentially undermines monetary policy as a rise in interest rates may deteriorate BI's balance sheet through upward pressure on the exchange rate which reduces the domestic currency value of both the stock of foreign reserves and the associated income. The ongoing costs also potentially undermine monetary policy by requiring ongoing government financing and creating the incentive to run an easier monetary policy. Ultimately, the cost of reserves holdings is a fiscal cost in the sense that it will eventually find its way to the fiscal accounts through lower seigniorage transfers from the central bank or through central bank recapitalisation.

The cost of reserves has been handled in a variety of ways in different countries including increasing central bank capital, setting up contingency funds to absorb gains and losses, and absorbing the carry cost through noninterest bearing fiscal deposits at the central bank. In Indonesia, the offsetting effect of exchange rate fluctuations on foreign currency fiscal debt (which is, for now, larger than reserves holdings) provides a rationale for natural transfers to reduce volatility on both BI's account and the government accounts.

In Indonesia, the carry cost of holding reserves has been handled in a variety of ways including extraordinary items and crystalising revaluation gains on the stock of FX reserves associated with currency depreciation. There is also a small FX Revaluation Reserve for absorption of FX losses. It is likely that more of the carry cost will eventually need to be borne by the budget through lower seigniorage payments or new central bank capital.

3 The Model

The model is an open economy DSGE model in the spirit of Christiano Eichenbaum and Evans (2005) and Smets and Wouters (2003). The domestic economy and fiscal setup is based on Coenen and Straub (2005) which features nonRicardian households and distortionary taxation. The model is extended to include open economy features including domestic and forreign currency denominated debt, foreign reserves holdings and open trade and financial accounts.

The economy is made up of two types of representative households – Ricardian households that smooth consumption intertemporally and rule of thumb households that consume current income, – domestic producers, importing firms, foreign exchange traders, a monetary authority and a fiscal authority. Domestic prices and wages are sticky and passthrough from import costs to domestic prices is imperfect. Capacity utilisation is variable. Investment adjustment costs are an important real rigidity in the model. The fiscal debt has a domestic currency component financed by Ricardian households and a foreign currency component financed by nonresidents. Tax is raised through distortionary income, consumption and payroll taxes and a lump sum tax that is responsive to the debt gap and the fiscal balance. Government expenditure may be pro-cyclical, countercyclical or passive.

3.1 Household Decisions

There are two types of households: Ricardian households which are *forward-looking* and have access to capital markets, where they can trade a full set of contingent securities and buy and lease physical capital. Their budget constraint is:

$$\begin{aligned} & (1+\tau^c)C_t^r + I_t^r + \frac{B_t^{d,r}}{P_t} + (1+i_{t-1}^*)\Theta\frac{\varepsilon_t B_{t-1}^{P,r}}{P_t} + \frac{T_t^r}{P_t} \\ = \quad & (1-\tau^d)\left(\frac{W_t N_t^r}{P_t(1+\tau^w)} + \frac{D_t^r}{P_t} + R_t^K U_t K_t^r\right) + \tau^d \delta K_t^r \\ & +(1+i_{t-1})\frac{B_{t-1}^{d,r}}{P_t} + \frac{\varepsilon_t B_t^{P,r}}{P_t} \end{aligned} \tag{1}$$

Ricardian households spend their income on consumption C_t^r, investment in new capital, I_t^r, purchases of domestic currency government bonds, $B_t^{d,r}$, principal and interest payments on their external foreign currency debt $\varepsilon_t B_t^{P,r}$ and on taxes. Taxes are levied on consumption at thae rate τ^c, on income at the rate τ^d, and on firms' payrolls at the rate τ^w. There is also a nondistortionary lump sum tax T_t^r that varies over time. P_t is the price level. i_t is the domestic nominal interest rate. A risk premium proportional to the ratio of the net external position to steady-state output, $\Theta = (1+\phi_{rp} \frac{IIP_t}{P_t Y_t})$ is paid on foreign currency borrowing.

Ricardian households receive income from wages, rental of productive capital, dividends from firms, and returns on domestic currency bond holdings and get funding from foreign currency borrowing. W_t, is the nominal wage, K_t^r is the capital holdings of the Ricardian household, R_t^K is the real rental cost of capital, U_t is the utilisation rate of capital, D_t^r are the dividends paid by Ricardian household-owned firms. ε_t is the nominal exchange rate and δ is the depreciation rate.

Ricardian households maximise the present value of expected utility which is derived from consumption and leisure ($= 1 - N_t^r$):

$$\max E_t \sum_{k=0}^{\infty} \beta^k \left\{ \log\left(C_{t+k}^r - hC_{t+k-1}^r\right) - \epsilon_{L,t+k} \frac{{N_{t+k}^r}^{1+\zeta}}{1+\zeta} \right\} \tag{2}$$

subject to the above budget constraint, and the law of motion of capital:

$$K_{t+1} = (1-\delta) K_t^r + \epsilon_{I,t} \Upsilon\left(\frac{I_t}{I_{t-1}}\right) I_t, \tag{3}$$

$\epsilon_{L,t}$ is an AR1 labour preference shock, ζ is the inverse elasticity of labour supply, h is a habit parameter. In the capital accumulation equation, $\Upsilon\left(\frac{I_t}{I_{t-1}}\right)$ is an investment adjustment cost function that alters the efficiency through which investment is transformed into productive capital and $\epsilon_{I,t}$ is an AR1 investment-cost shock. $\Upsilon(\cdot)$ is a convex function with properties $\Upsilon(1) = 1$, $\Upsilon'(1) = 0$ and $\Upsilon"(1) = -\upsilon < 0$.

The first order conditions for the Ricardian household's problem are:

$$E_t\left\{\Lambda_{t,t+1}\frac{P_t}{P_{t+1}}\right\} = \frac{1}{1+i_t}, \tag{4}$$

$$\frac{Q_t}{P_t} = E_t\left\{\Lambda_{t,t+1}\left[(1-\tau^d)\frac{R^K_{t+1}}{P_{t+1}} + \tau^d\delta + \frac{Q_{t+1}}{P_{t+1}}(1-\delta)\right]\right\} \tag{5}$$

$$Q_t = \frac{P_{I,t} - E_t\left\{\Lambda_{t,t+1}Q_{t+1}\epsilon_{I,t+1}\Upsilon'_{t+1}(\cdot)\left(\frac{I_{t+1}}{I_t}\right)^2\right\}}{\epsilon_{I,t}\left(1-\Upsilon_t(\cdot)-\Upsilon'_t(\cdot)\frac{I_t}{I_{t-1}}\right)} \tag{6}$$

$$(1-\tau^d)\frac{R^K_t}{P_t} = \Psi'(U_t) \tag{7}$$

$$\frac{1+i_t}{(1+i^*_t)\,\Theta_t} = \frac{E_t\left\{\Lambda_{t,t+1}\frac{P_t}{P_{t+1}}\frac{\epsilon_{t+1}}{\epsilon_t}\right\}}{E_t\left\{\Lambda_{t,t+1}\frac{P_t}{P_{t+1}}\right\}}. \tag{8}$$

where $\Lambda_{t+1} \equiv \beta\left(\frac{C^r_{t+1}-hC_t}{C^r_t-hC_{t-1}}\right)^{-1}$ is the stochastic discount factor for real one-period ahead payoffs, and Q_t is the real shadow value of capital in place in equation (5) which is equal to the replacement cost of capital in equation (6).

Equation (4) equates the marginal rate of substitution between current and delayed consumption to the discounted real interest rate. Equation (5) equates the consumption cost of an additional unit of capital with the value of installed capital. The latter is equal to the rental value plus the undepreciated stock that carries over to the next period. Equation (6) equates the shadow cost of capital to the marginal cost of the extra unit. The latter is the consumption cost, net of the reduction in future adjustment costs, both adjusted for the marginal efficiency with which investment is transformed into capital (denominator). Equation (7) implies equal rates of capital utilisation across households, and equalises the cost of increasing capacity utilisation to the production benefit. Equation (8) is the uncovered interest parity condition: which equates the expected discounted domestic currency returns on holding domestic and foreign bonds, adjusted for the debt-sensitive risk premium. Abstracting from covariance terms, this can be rewritten as:

$$\frac{1+i_t}{(1+i_t^*)\,\Theta_t} = E_t\left(\frac{\varepsilon_{t+1}}{\varepsilon_t}\right) \tag{9}$$

where i_t^* represents the unobserved foreign cost of capital that makes UIP hold, given domestic interest rate developments and the risk premium Θ_t. The foreign cost of capital, i_t^*, is assumed to follow an AR1 process subject to UIP shocks. It combines both price (an unobserved combination of foreign interest rates), risk premia and capital flow effects that are reflected in exchange rate fluctuations (e.g. carry trade).[2]

A share ω of households is assumed not to have access to capital markets and so can neither save nor borrow and does not invest in capital. As a result these nonRicardian households cannot behave in a forward-looking consumption smoothing manner. Instead, following Campbell and Mankiw (19__), they consume all of their labour income net of taxes and transfers according to the following budget constraint:

$$(1+\tau^c)C_t^{nr} = \frac{(1-\tau^d)}{(1+\tau^w)}\frac{W_t}{P_t}N_t^{nr} - \frac{T_t^{nr}}{P_t} \tag{10}$$

The taxes paid (or transfers received) by nonRicardian households, T_t^{nr}, are the same as those paid by Ricardian households. Non-Ricardian households have substantially lower incomes than Ricardian households due to the absence of capital income.

3.1.1 Labour Supply and Wage Setting

Each household provides a differentiated labour service. Following Erceg et al (2000), households set wages in a staggered fashion. Wages are renegotiated with probability (1-θ_w) each period, while a fraction θ_w of households index wages to either last period's wage inflation or the central bank's inflation target according to the following rule:

$$\Gamma_{w,t} = \Gamma_{w,t-1}\left(\frac{W_{t-1}}{W_{t-2}}\right)^{\gamma_w}(1+\bar{\pi})^{(1-\gamma_w)} \tag{11}$$

where γ_w is the share of non-optimising households indexing to last period's wage inflation.

[2] See Medina, Munro and Soto (2007).

A household resetting its wage in period t will maximise utility (2) with respect to the real wage, taking into account aggregate wage dynamics (11) and the demand for its differentiated labour service, $N_{i,t+k}$:

$$N_{i,t+k} = \left(\frac{W^*_{i,t}}{W_{t+k}}\right)^{-\lambda_w} N_{t+k}$$

where W^*_t represents the wage chosen by the optimising household at time t. and the parameter $\lambda_w = \frac{1+\mu_w}{\mu_w}$, where μ_w is the steady state wage markup. The renegotiating household solves the following problem:

$$\max E_t \left\{ \sum_{k=0}^{\infty} \theta_w^k \Lambda_{t+k} \left[\frac{(1-\tau^d)}{(1+\tau^w)} \frac{\Gamma_{t+k}}{P_{t+k}} \frac{W_t N_{i,t+k}}{C_{t+k}} - \epsilon_{L,t+k} \frac{N^{\zeta}_{i,t+k}}{1+\zeta} \right] \right\}$$

The first order condition for sets the discounted marginal utility of income from an additional unit of labour equal to the expected discounted disutility of the additional labour effort:

$$E_t \sum_{k=0}^{\infty} \theta_w^k \beta^k N_{i,t+k} \left[\frac{(1-\tau^d)}{(1+\tau^w)} \left(\frac{\Gamma_{w,t+k} W^*_{i,t}}{P_{t+k}(1+\lambda_w)} \right) - \epsilon_{L,t+k} N_{t+k}{}^{\zeta} \right] = 0 \qquad (12)$$

which lead to the following dynamics for the real wage:

$$\begin{aligned} (1+\beta) wr_t &= \beta E_t wr_{t+1} + wr_{t-1} \\ &\quad + \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w(1+\zeta\frac{1+\mu_w}{\mu_w})} (\zeta n_t - c_t + \epsilon_{L,t} - wr_t) \\ &\quad + E_t \pi_{t+1} + \gamma_w \pi_{t-1} + (1-\beta\gamma_w)\pi_t \end{aligned}$$

where wr_t is the log of the real wage.

In the limit where all households renegotiate ($\theta_w = 0$), condition (12) reduces to the condition that the real wage equals the marginal rate of substitution between consumption and leisure, inclusive of taxes:

$$\frac{(1-\tau^d)}{(1+\tau^w)} \frac{W_t}{P_t} = (1+\tau^c)\epsilon_{L,t} \frac{(N_t)^{\zeta}}{C_t}$$

3.2 Aggregation

Aggregate consumption is a weighted average of Ricardian and non-Ricardian consumption:

$$C_t = \omega C_t^{nr} + (1-\omega) C_t^r$$

Investment, capital, bonds and dividend receipts of the Ricardian household are adjusted for the Ricardian share to give aggregate per capita values:

$$\begin{aligned} I_t &= (1-\omega) I_t^r, \quad K_t = (1-\omega) K_t^r, \quad D_t = (1-\omega) D_t^r \\ B_t^d &= (1-\omega) B_t^{d,r}, \quad B_t^P = (1-\omega) B_t^{P,r,} \end{aligned}$$

Labour input is equal accross households as both Ricardian and non-Ricardian households meet demand given the wage set by Ricardian households.

$$N_t = N_t^{nr} = N_t^r$$

Lump sum taxes are assumed to be equal across households.

$$T_t = T_t^{nr} = T_t^r$$

3.3 Final Goods Firms

Differentiated intermediate goods are combined using a constant elasticity of substitution (CES) aggregator of *home* and *foreign* goods to form consumption and investment goods,

$$C_t(j) = \left[\gamma_C^{1/\psi_H} \left(C_{H,t}(j)\right)^{\frac{\psi_H - 1}{\psi_H}} + (1-\gamma_C)^{1/\psi_H} \left(C_{F,t}(j)\right)^{\frac{\psi_H - 1}{\psi_H}} \right]^{\frac{\psi_H}{\psi_H - 1}}$$

$$I_t(j) = \left[\gamma_I^{1/\psi_H} \left(C_{H,t}(j)\right)^{\frac{\psi_H - 1}{\psi_H}} + (1-\gamma_I)^{1/\psi_H} \left(I_{F,t}(j)\right)^{\frac{\psi_H - 1}{\psi_H}} \right]^{\frac{\psi_H}{\psi_H - 1}}$$

where ψ_H is the elasticity of substitution between *home* and *foreign* goods and γ_C and γ_I define their respective weights in consumption and investment (investment is much more import intensive than consumption) The optimal composition of the bundles is obtained by minimizing its cost. This minimization problem determines the demands for *home* and *foreign* goods by the household, $C_{H,t}(j)$, $C_{F,t}(j)$ $I_{H,t}(j)$, $I_{F,t}(j)$ respectively, which are given by

$$C_{H,t}(j) = \gamma_C \left(\frac{P_{H,t}}{P_t}\right)^{-\psi_H} C_t(j), \qquad C_{F,t}(j) = (1-\gamma_C) \left(\frac{P_{F,t}}{P_t}\right)^{-\psi_H} C_t(j) \tag{13}$$

$$I_{H,t}(j) = \gamma_I \left(\frac{P_{H,t}}{P_t}\right)^{-\psi_H} I_t(j), \qquad I_{F,t}(j) = (1-\gamma_I)\left(\frac{P_{F,t}}{P_t}\right)^{-\psi_H} I_t(j) \tag{14}$$

where $P_{H,t}$ and $P_{F,t}$ are the price indices of *home* and *foreign* goods, and $P_{C,t}$ and $P_{I,t}$ are the price indices of the consumption and investment bundles, defined as:

$$\begin{aligned} P_{C,t} &= \left(\gamma_C P_{H,t}^{1-\psi_H} + (1-\gamma_C) P_{F,t}^{1-\psi_H}\right)^{\frac{1}{1-\psi_H}} \\ P_{I,t} &= \left(\gamma_I P_{H,t}^{1-\psi_H} + (1-\gamma_I) P_{F,t}^{1-\psi_H}\right)^{\frac{1}{1-\psi_H}} \end{aligned}$$

Similarly, home goods are exported and used as an input into a foreign consumption good. The foreign demand for home goods is:

$$X_t = \gamma^* \left(\frac{P_{H,t}}{\varepsilon_t P_t^*}\right)^{-\psi^*} Y_t^*(j) \tag{15}$$

where ψ^* is the foreign elasticity of substitution between *home* and *foreign* goods and γ^* is the steady state share of domestic goods in foreign GDP.

3.4 Intermediate Goods Producing Firms

Intermediate goods are produced using constant returns to scale technology:

$$Y_t = \epsilon_{a,t} K_t^{\alpha} N_t^{(1-\alpha)} - \Phi \tag{16}$$

where Φ is a fixed cost of production chosen to ensure zero profits in steady state, and $\epsilon_{a,t}$ represents a transitory technology shock. Taking the rental cost of capital and real wage as fixed, cost minimisation implies the following rate of substitution between capital and labour:

$$\frac{K_t}{N_t} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{W_t}{P_t R_t^K}\right) \tag{17}$$

Real marginal cost is given by:

$$MC_t = \frac{1}{\epsilon_{a,t}}\left(\frac{R_t^K}{\alpha}\right)^{\alpha}\left(\frac{W_t}{P_t}\frac{1}{1-\alpha}\right)^{1-\alpha} = \frac{R_t^K}{\alpha(1+\phi) Y_t/K_t} \tag{18}$$

where $\phi = \Phi/Y$ is the ratio of fixed cost to steady state GDP.

Following Calvo (1983), differentiated intermediate goods firms set prices in a staggered fashion. Each firm resets prices with probability (1-θ_H) each period, while a fraction θ_H index prices to last period's inflation. Firms that do not optimise at time t index prices to a geometric average $\Gamma_{p,t}$ of last period's inflation and the inflation target:

$$\Gamma_{p,t} = \Gamma_{p,t-1} \left(1 + \pi_{t-1}\right)^{\gamma_H} \left(1 + \bar{\pi}\right)^{1-\gamma_H}$$

where $\gamma_H$is the share of nonoptimising firms that index to past inflation. A firm resetting its price in period t optimises the present value of expected profits subject to the dynamics of aggregate inflation and demand from final goods producers (equation 13).

$$\max E_t \sum_{k=0}^{\infty} \theta_p^k \Lambda_{t+k} \left[Y_{t+k} P_{i,t}^* - MC_{t+k} Y_{t+k}\right]$$

$P_{i,t}^*$ represents the price chosen by a firms that repotimises at time t. The first order condition for optimal price setting in period t is:

$$E_t \left(\sum_{k=0}^{\infty} \theta_p^k \Lambda_{t+k} Y_{i,t+k} P_{i,t}^* \Gamma_{p,t+k} - (1 + \lambda_{p,t+k}) MC_{t+k} \right) = 0$$

This setup leads to the following inflation dynamics:

$$\pi_{H,t} = \frac{\beta}{(1 + \beta\gamma_H)} E_t \pi_{H,t+1} + \frac{\gamma_H}{(1 + \beta\gamma_H)} \pi_{H,t-1} + \tag{19}$$

$$\frac{(1 - \beta\theta_H)(1 - \theta_H)}{(1 + \beta\gamma_H)\theta_H} mcr_t + \eta_{H,t} \tag{20}$$

where mcr_t is the log deviation of real marginal cost from steady state, and $\eta_{H,t}$ is an i.i.d. cost push shock.

In steady state the price is set as a markup over marginal cost. In the limit where all firms reoptimise ($\theta_H = 0$), the price is set equal to marginal cost. The domestic firm also satisfies export demand at the price $P_{H,t}$.

3.5 Importing Firms

Importing firms use CES technology to combine a continuum of differentiated imported varieties to produce a final *foreign* good Y_F. This good is consumed by households and used for assembling new capital goods. The optimal mix of imported varieties in the final *foreign* good defines the demands for each imported variety. In particular, the demand for variety z_F is given by:

$$Y_{F,t}(z_F) = \left(\frac{P_{F,t}(z_F)}{P_{F,t}} \right)^{-\epsilon_F} Y_{F,t}, \tag{21}$$

where ϵ_F is the elasticity of substitution among imported varieties, $P_{F,t}(z_F)$ is the domestic-currency price of imported variety z_F in the domestic market, and $P_{F,t}$ is the aggregate price of import goods in this market.

Each importing firm has monopoly power in the domestic retailing of a particular variety. As a result local-currency price stickiness leads to incomplete exchange rate pass-through into import prices in the short-run. Each firm resets prices with probability (1-θ_F) each period Firms that do not optimise at time t index prices to a geometric average $\Gamma_{F,t}$ of last period's inflation and the inflation target:

$$\Gamma_{F,t} = \Gamma_{F,t-1} \left(1 + \pi_{t-1}\right)^{\gamma_F} \left(1 + \bar{\pi}\right)^{1-\gamma_F}$$

where $\gamma_p$is the share of nonoptimising firms that index to past inflation. Therefore, when a generic importing firm z_F receives a signal, it chooses a new price by maximizing the present value of expected profits:

$$\max_{P_{F,t}(z_F)} E_t \left\{ \sum_{i=0}^{\infty} \Lambda_{t,t+i} \phi_F^i \frac{\Gamma_{F,t}^i P_{F,t}(z_F) - \mathcal{E}_{t+i} P_{t+i}^*(z_F)}{P_{C,t+i}} Y_{F,t+i}(z_F) \right\},$$

subject to the domestic demand for variety z_F (21) and the updating rule for prices. For simplicity, we assume that $P_t^*(z_F) = P_t^*$ for all z_F.

In this setup, the optimal path for imported inflation is given by a New Keynesian Philips curve with indexation. In its log-linear form, imported goods inflation has both a forward and backward looking component and depends on the marginal real import cost.

$$\begin{aligned} \widehat{\pi}_{F,t} &= \frac{\beta}{1+\beta\gamma_F} E_t \left\{ \widehat{\pi}_{F,t+1} \right\} + \frac{\gamma_F}{1+\beta\gamma_F} \pi_{F,t-1} \\ &+ \frac{(1-\beta\theta_F)(1-\theta_F)}{\theta_F(1+\beta\gamma_F)} \left[\widehat{rer}_t - \widehat{pr}_{F,t} \right] \end{aligned}$$

Changes in the nominal exchange rate are passed through gradually into prices of imported good sold domestically. Therefore, exchange rate pass-through will be incomplete in the short-run. In the long-run firms freely adjust their prices, so the law-of-one-price holds up to a constant.

In steady state the price is set as a markup over marginal cost (the import cost). In the limit where all importing firms reoptimise ($\theta_F = 0$), passthrough is complete and $P_{F,t} = e_t P_t^*$.

3.6 Monetary Policy

Monetary policy is assumed to follow a Taylor-type rule that is sensitive to the deviation of inflation from target and to the log deviation of output from steady state, y_t:[3]

$$i_t = \varphi_i i_{t-1} + (1 - \varphi_i) \left[\varphi_\pi \pi_{t+1} + \varphi_y \widehat{y}_t \right] + \epsilon_{r,t} \tag{22}$$

where $\eta_{r,t}$ is an AR1 process.

3.7 Fiscal Policy

The nominal net fiscal position is defined as foreign currency reserves, Z_t less domestic and foreign currency fiscal debt, B_t^d and B_t^f:

$$NFP_t \equiv \varepsilon_t Z_t - B_t^d - \varepsilon_t B_t^f \tag{23}$$

While reserves are held by the central bank, they are viewed here as a fiscal asset: ultimately the costs or benefits of reserves holdings will show up in the fiscal accounts through higher/lower seigniorage transfers, or capitalisation of the central bank. The domestic debt is assumed to be held by households and the foreign debt is assumed to be held by nonresidents. Current expenditures, debt repayment, and reserves accumulation are financed through tax revenue, new borrowing and earnings on foreign reserves according to the following budget constraint:

$$\begin{aligned} \varepsilon_t Z_t - B_t^d - \varepsilon_t B_t^f &= (1 + i_{t-1}^*) \varepsilon_t Z_{t-1} - (1 + i_{t-1}) B_{t-1}^d \\ &\quad - (1 + i_{t-1}^*) \Theta_t \varepsilon_t B_{t-1}^f + FB_t \end{aligned} \tag{24}$$

where i_t^* is the nominal interest rate on foreign bonds, and FB_t is the primary fiscal balance (tax income less expenditures).

Note that foreign currency borrowing is at a premium $\Theta(\frac{\varepsilon_t \left(B_{G,t} + B_t^P - Z_t^f \right)}{P_t Y_t})$ over the foreign interest rate, while foreign currency reserves earn the risk free foreign interest rate. In steady state, the domestic and foreign borrowing costs are equal ($i = i^* - \phi_{rp} \frac{IIP}{PY}$)[4] according to the uncovered interest

[3] Ideally this would be the deviation from the flex price equilibrium to return the economy to its efficient adjustment path rather than steady state (Gali and Gertler 2007). However, in medium sized open economy models, the flex price equilibrium is often more volatilie than the sticky price equilibrium. An alternative would be to use output growth in the reaction function.

[4] ϕ_{rp} is positive and the net international investment position is negative.

parity condition As long as the risk premium is positive, there is a carry cost on foreign currency reserves. Accumulating reserves through sterilised intervention does not affect the risk premium. To illustrate the currency valuation effects and carry cost, the fiscal budget constraint (24) can be rewritten:

$$
\begin{aligned}
NFP_t &= (1 + i_{t-1} NFP_{t-1}) + FB_t \\
&\quad + \left[-\left(i_{t-1} - i^*_{t-1}\right) + \left(\frac{\varepsilon_t}{\varepsilon_{t-1}} - 1\right) i^*_{t-1} + \left(\frac{\varepsilon_t}{\varepsilon_{t-1}} - 1\right) \right] \varepsilon_{t-1} Z_{t-1} \\
&\quad + \left(i_{t-1} - i^*_{t-1} + \phi_{rp} \frac{IIP_{t-1}}{P_{t-1} Y_{t-1}} \right) \varepsilon_{t-1} B^f_{t-1} \\
&\quad - \left(\frac{\varepsilon_t}{\varepsilon_{t-1}} - 1\right) \left(i^*_{t-1} - \phi_{rp} \frac{IIP_{t-1}}{P_{t-1} Y_{t-1}} \right) \varepsilon_{t-1} B^f_{t-1} \\
&\quad - \left(\frac{\varepsilon_t}{\varepsilon_{t-1}} - 1\right) \varepsilon_{t-1} B^f_{t-1} \qquad (25)
\end{aligned}
$$

The second line shows the carry cost and the currency valuation effects on the interest flows and stocks respectively for reserves. The third line shows the interest wedge on foreign currency debt which is zero in steady state. The last two lines show the currency valuation effects on the stock and flow of foreign currency debt. In steady state, all revaluation effects are zero, and $i = i^* - \phi_{rp} \frac{NFP}{PY}$ so that the primary fiscal balance must cover interest payments on the net fiscal position plus the steady state carry cost of reserves. In the model setup the carry cost exists in steady state because UIP works between the domestic interest rate and a foreign rate plus risk premium, whereas reserves earn the risk free foreign rate.

In a country with foreign currency debt greater than reserves (e.g. Indonesia), reserves accumulation will reduce the effects of exchange rate fluctuations on the fiscal position. Depreciation of the domestic currency deteriorates the net fiscal position, but by less than it would in the absence of reserves. While any remaining mismatch will lead to fluctuations in fiscal flows, these need not adversely affect nonRicardian consumption if the stock of debt serves as a shock absorber.

The primary fiscal balance is:

$$
\begin{aligned}
FB_t &= \tau^d \left(\frac{1}{(1+\tau^w)} W_t N_t + D_t + P_t R^K_t U_t K_t - \delta P_t K_t \right) + \tau^c P_t C_t \\
&\quad + \tau^w W_t N_t + T_t - P_{H,t} G_t \qquad (26)
\end{aligned}
$$

Fiscal policy is defined by B_t^d, B_t^f, Z_t^f, G_t and T_t so four of the five need to be defined by fiscal rules. First, the ratio of reserves to steady state GDP is assumed to follow an AR(1) process, subject to "reserve accumulation shocks". Reserves shocks are not included in the UIP equation and so do not have a direct effect on the exchange rate. Intervention can be sterilised through the interest rate rule, through a rise in domestic currency fiscal debt.

$$\frac{\varepsilon_t Z_t}{P_t Y} = \left(\frac{\varepsilon_{t-1} Z_{t-1}}{P_{t-1} Y}\right)^{\rho_z} \left(\frac{\varepsilon Z}{PY}\right)^{1-\rho_z} e^{\eta_{z,t}} \tag{27}$$

Second, we assume a portfolio rebalancing rule that keeps the share of foreign currency debt stable:

$$\frac{\varepsilon_t B_t^f}{B_t^d} = \frac{\chi}{1-\chi} \tag{28}$$

where χ is the foreign currency share of fiscal debt.

Third, the ratio of G_t to GDP is defined by a simple fiscal rule:

$$g_t = \rho_g g_{t-1} + \varphi_{gy} y_t + \eta_{g,t} \tag{29}$$

where $g_t = (G_t - G)/Y$ and y_t is the log deviation of output from steady state. The fiscal authority adjusts expenditure gradually back to the steady state level in response to expenditure shocks $\eta_{g,t}$ and may play an active stabilisation role through the output gap term If φ_{gy} is zero, fiscal expenditure follows a passive AR1 process. If φ_{gy} is negative, fiscal expenditure will be countercyclical. At φ_{gy} =-1, fiscal expenditure fully offsets the output gap.

Finally, lump sum taxes are adjusted in response to deviations of debt and government spending from their steady state levels relative to GDP:

$$t_t = \varphi_{tb} b_t + \varphi_{tg} g_t \tag{30}$$

where $\varphi_b, \varphi_g > 0$, $t_t = (T_t/P_t - T/P)/Y$ and $B_t = (\varepsilon_t B_t^f + B_t^d)/P_t Y - (B^f + B^d)/PY$.[5] Under this rule, government expenditure shocks will be financed through a combination of a taxes (as φ_g approaches unity a rise in G_t will be financed by a rise in taxes) and debt (as φ_g approaches zero a rise in G_t will be financed by debt). The coefficient φ_b ensures a feedback response to debt above steady state and must be large enough to ensure solvency.

[5] This notation simplifies the log linear representation and defines these variables as percent of steady state GDP.

The steady state level of debt/GDP will be determined by several factors including the steady state level of taxes T/PY and spending G/Y, steady state growth and inflation (in our model these are not explicit), the steady state carry on reserves.

3.8 Aggregate Equilibrium

Domestic firms satisfy demand for home goods:

$$Y_t = C_{H,t} + I_{H,t} + G_t + X_t$$

Similarly, importing firms demand for imports:

$$M_t = C_{F,t} + I_{F,t}$$

Nominal GDP is:

$$P_{Y,t}Y_t = P_tC_t + P_{H,t}G_t + P_{I,t}I_t + P_{H,t}X_t - e_tP_t^*M_t$$

3.9 External Sector

Combining the households' budget constraints, the fiscal budget constraint, the definition of profits and the resource constraints we get the nominal balance of payments identity:

$$\begin{aligned} \varepsilon_t Z_t - \varepsilon_t \left(B_t^f - B_t^P\right) &= \varepsilon_t(1+i_{t-1}^*)Z_{t-1} - \varepsilon_t(1+i_{t-1}^*)\Theta\left(B_{G,t-1}^f + B_{t-1}^P\right) \\ &\quad + P_{X,t}X_t - P_{H,t}M_t \end{aligned} \tag{31}$$

The change in the external position is equal to the current account: the investment income account (including valuation effects on last period's debt and reserves) and the trade balance.

The real exchange rate is defined as:

$$RER_t = \frac{\varepsilon_t P^*}{P_t} \tag{32}$$

4 Model Solution and Estimation

We use Dynare[6] for model solution and estimation. Posterior parameters are estimated using a Bayesian approach (see DeJong, Ingram, and Whiteman 2000). We set prior distributions $\mathbf{p}(\theta)$ for the parameters based mainly

[6] See www.cepremap.cnrs.fr/dynare/ .

on their theoretical bounds and previous studies, but including country specific circumstances where relevant. We include in the model measurement equations that relate observed variables to model variables. Data for observable variables $\mathcal{Y}^T$ is used to form a joint posterior distribution $\mathbf{p}\left(\theta \mid \mathcal{Y}^T\right)$ by updating the prior distribution based on the likelihood function $L(\theta \mid \mathcal{Y}^T)$ using Bayes' theorem.

$$\mathbf{p}\left(\boldsymbol{\vartheta} \mid \mathcal{Y}^T\right) = \frac{L(\boldsymbol{\vartheta} \mid \mathcal{Y}^T)\mathbf{p}\left(\vartheta\right)}{\int L(\boldsymbol{\vartheta} \mid \mathcal{Y}^T)\mathbf{p}\left(\boldsymbol{\vartheta}\right) d\boldsymbol{\vartheta}} \tag{33}$$

An approximated solution for the posterior distribution is computed using the Metropolis-Hastings algorithm. The posteriors are the last 50% of two chains of 160,000 draws each.

We estimate the model for three periods:

1. the whole period (June 1992 to December 2006),
2. the post float period (September 1998 - December 2006), and
3. the inflation targeting period (1999 to December 2006).

The first period has the advantage of a relatively long data series. The second potentially avoids structural change around the time of the Asian crisis (e.g. exchange rate float and shift in currency denomination of fiscal debt). The third (which includes the informal inflation targeting period) potentially avoids nonlinearities associated with the Asian crisis (e.g., large exchange rate depreciation and associated inflation episode and shift in net exports).

4.1 Calibrated Parameters

To simplify the estimation procedure, some parameters are calibrated. These are shown in Table 1. Values are chosen based on observed aggregate ratios, and tax rates, to give reasonable steady state values, and to be consistent with the DSGE literature.

4.2 Estimated Parameters: Priors

We choose priors based on regularities of Indonesian data, and the DSGE literature. These are shown in Tables 2 and 3. For the share of rule of thumb consumers and the habit parameter, we choose a fairly flat prior centred on 0.5. The prior for the risk premium parameter is chosen to be consistent with a steady state risk premium of about 4 per cent per annum. Priors for Calvo parameters are centered on 0.75 and price and wage indexation parameters on 0.5.

4.3 Estimated Parameters: Posterior Means

Posterior mean estimates are shown in Tables 4 and 5. for the three estimation periods and the distributions for the inflation target period are shown in Figure 1. The parameter estimates are reasonably robust across periods despite potential nonlinearities associated with the 1997-8 Asian crisis and changes such as the exchange rate float in 1998, adoption of inflation targeting in 1999 and the change in the foreign currency denomination of debt from 100% before the crisis to about 50% afterwards.

Posterior parameter estimates are all reasonable relative to estimated models for other countries, although in a few cases, parameters are not well identified (in Figure 1, the posteriors lie virtually on top of the prior). This includes. the risk premium parameter ϕ_{rp}, the fixed cost of production, ϕ, the capacity utilisation parameter, ψ , the Calvo parameters, and the monetary policy response to inflation φ_{π}. [Try real aggregates for estimation]. The Calvo parameters will have an important effect on the results of our monetary policy experiments.

The share of nonRicardian consumers, an important parameter for our model is estimated at 62 to 67 percent and is well identified. This compares to calibrated values of 0.5 for the Euro area (Muscatelli and Tirelli, 2005), [0.37 for the US, Gali et al (2007)], and estimates of 0.25 to 0.35 for the Euro area (Coenen and Straub, 2007). The share of nonRicardian agents falls slightly over time. This is within the range of estimated values in the literature of the weight of the rule-of-thumb behavior (see Mankiw 2000).

The habit parameter is low for the first two estimation periods and increases markedly in the latest period. The risk premium parameter is lower for more recent periods. The investment adjustment cost parameter υ which is changes the curvature of the investment adjustment cost function varies a lot over the three investment periods.

While the Calvo parameters are not well identified, indexation is estimated to be highest for imports (three quarters of non-optimising firms index to past inflation), followed by home goods (about half index to past inflation) and lowest for wages (only about a third index to past inflation). Price indexation is lower for more recent periods.

The estimated monetary policy parameters imply a fairly standard Taylor rule, although the response to inflation is not well identified in the inflation target period. [reestimate with flatter prior?]. The estimated fiscal policy parameters imply strongly countercyclical government expenditure, a small tax response to debt, and mainly debt financing of fluctuations in expenditure.

5 Impulse Response Functions

Impulse Response functions are shown in Appendix B.

A one standard deviation *monetary policy shock* implies a rise in the SBI interest rate. This depressed aggregate demand (consumption and investment). The exchange rate appreciates which reduces the cost of investment goods, in particular, somewhat offsetting the fall in investment Fiscal expenditure is countercyclical and so increases to partly offset the fall in output. The rise in expenditure is partly financed by an increase in debt (the net fiscal position worsens, despite the exchange rate appreciation which reduced the value of foreign currency debt) and partly by a rise in taxes. The rise in taxes is protracted and depresses nonRicardian consumption for a protracted period. Ricardian households reduce consumption briefly.

A one standard deviation *fiscal policy shock* implies an increase in the government spending /GDP ratio which directly increases GDP. The increase in government expenditure is partly financed by debt (the net fiscal position increases) and partly financed by a protracted rise in taxes. The latter depresses nonRicardian consumption for a considerable period. In contrast, Ricardian consumption falls briefly and then rises above trend after about 8 quarters. The fall in consumption puts downward pressure on inflation. The monetary policy response to the output gap (tightening) dominates the monetary policy response to inflation (easing), and the interest rate rises, putting upward pressure on the exchange rate.

A one standard deviation *reserves accumulation shock* implies an increase in the reserves/GDP ratio. The increase in reserves is financed partly by an increase in debt and partly by a rise in taxes. Overall the net fiscal position improves (it is not fully financed by debt) which reduces the risk premium The rise in taxes depresses nonRicardian consumption and GDP. The fall in demand puts downward pressure on inflation. The monetary authority responds to the fall in output and inflation by reducing the interest rate and the exchange rate depreciates. The fiscal authority responds to the fall in output by increasing government spending which adds to inflation.

An exogenous exchange rate depreciation is interpreted as *a rise in the cost of foreign capital*. The exchange rate depreciation leads to an improvement of the trade account – the export response is strong (ψ_F is 1.75) and final goods firms substitute away from imported goods - which dominates the fall in consumption and investment. In response to the rise in GDP, government spending falls allowing a cut in lump sum taxes. The fall in taxes leads to a rise in nonRicardian consumption While the value of the foreign currency debt increases, this is largely offset by an increase in the value of foreign currency reserves and fluctuations in the net fiscal position are dominated by the effects of expenditure and tax receipts.

We also include impulse responses for *a combined government spending and cost push shock* to domestic prices as a proxy for subsidy removal. The impulse responses are very similar to a pure price shock. This is because the fall in government expenditure is mainly absorbed in lower debt, rather than taxes, and so has a small effect. The increase in prices reduces the real wage which depresses nonRicardian consumption. The nominal interest rate rises in response to the higher inflation (and so the nominal exchange rate – not shown – appreciates). However the real interest rate does not rise because of the effect of the falls in government expenditure and nonRicardian consumption on the output gap. The exchange rate does not appreciate as was seen after the subsidy removal in 2004. In part, this is because the risk premium is based on the IIP position (which deteriorates) rather than the net fiscal position (which improves).

6 Optimal Stabilisation Policy Experiments

6.1 Can fiscal policy play a stabilisation role?

As was seen in the impulse response functions, a rise in government expenditure leads to a fall in consumption (particularly nonRicardian consumption) and downward pressure on inflation. In this section we use a standard quadratic loss function to (i) look at the optimal values for fiscal and monetary policy parameters, (ii) ask whether fiscal policy can/does play a stabilising role; (ii) if so, ask which factors (e.g. nonRicardian households, sticky prices and wages, and distortionary taxation) give fiscal policy a stabilisation role, and (iv) explore the interaction of monetary and fiscal policy parameters.

We assume a standard loss function :

$$Loss = \sum_{0}^{\infty} \pi^2 + 0.5y^2$$

where y is the percent deviation from steady state and π, and r are percentage deviations from steady state. This type of loss function approximates welfare in a small New Keynesian model as discussed in Rudebush and Svensson (1999) and Woodford (2003). There are good reasons why it may not approximate welfare in this model, including debt and capital stocks, open economy features and nonRicardian agents. Ideally, the analysis would be done in a second order model, however this was beyond the scope of this paper. We view the standard loss function as a general approximation of a policy-maker's objective function: to achieve both inflation and output stability. However, we also present figures showing the effect of the policy parameters on consumption to reflect the importance of consumption in welfare (ie. utility, in a 3 equation New Keynesian model GDP = consumption) and potential poverty considerations associated with nonRicardian agents (who have lower incomes and cannot use credit to smooth consumption intertemporally). Because exchange rate volatility is also an often cited concern for policy makers in an open economy, we present figures showing the effect of policy parameters on exchange rate volatility.

Gali and Gertler (2007) argue that the output gap term should be the deviation from the flex price equilibrium, rather than the deviation of steady state. In this model with a high estimated share of nonRicardian agents, however, flexible domestic prices and wages, in particular, imply volatility in nonRicardian consumption and therefore output. So while, in theory, we would like to push the economy toward an efficient flex price adjustment path rather than all the way to steady state in a small model with Ricardian agents, here it would mean pushing the economy to a more volatile path. Therefore we stick to the deviation from steady state.

We carry out stochastic simulations of 2250 periods and drop the first 250. For a range of values of each policy parameter we plot the loss function for each estimation period. We also plot the variances of inflation, GDP, consumption and the real exchange rate. Because of uncertainty about the form of the welfare function, the results presented should be interpreted with a good degree of caution, especially in terms of optimal parameter values. What we aim to achieve in this section is a better understanding of the types of tradeoffs faced by policy makers relative to variables of interest.

Figures 2 through 4 show the results for the *monetary policy response to inflation*, φ_π. Losses are smaller for the most recent estimation period which excludes the Asian crisis. For the two earlier periods, losses increase rapidly as the parameter approaches unity, by which point the model becomes indeterminate consistent with the Taylor Principle (the nominal interest rate should be increased at least one-for-one with inflation to prevent a drop in the real interest rate). For the final period, the Taylor principle appears to be less binding. This may reflect both a fall in price indexation and stronger countercylical fiscal policy in the final period. For the inflation targeting period, losses are not very sensitive to this parameter. Estimated values are in the range 1.7 to 1.8, (but not well identified), compared to a minimum standard loss function at 1.9 to 2.8. However, the model suggests that a policy maker concerned with consumption or real exchange rate volatility, would prefer a relatively weak response to inflation (φ_π of about 1.2) while keeping to the Taylor Principle.

The results for the *monetary policy response to the output gap* φ_y are shown in Figures 5 to 7. The results for the two earlier periods show a minimum loss at a value for φ_y of about 0.8. For the inflation targeting period the minimum loss is at a value higher than normally considered practical. The estimated values are more moderate than a standard loss function would suggest. A policy maker concerned with consumption volatility would also prefer a strong interest rate response to inflation (Figure 6). However, in an open economy, concern for exchange rate volatility would suggest a more moderate response (Figure 7).

The results for the *interest rate smoothing parameter* ρ_r are shown in Figures 8 to 10. Losses are not very sensitive to this parameter until it approaches unity at which point the nominal interest rate follows a random walk. Its effect on consumption is similar. Real exchange rate volatility is minimised at a value of about 0.8, close to the estimated values.

The results for *the tax response to debt* φ_{tb} are shown in Figures 11 to 13. The loss function is not very sensitive to this parameter except at values close to zero, at which point the debt solvency condition is not met (explosive debt). The estimated values show a weak response to debt. A policy maker concerned with consumption volatility would want to respond only weakly to deviations of the debt from steady state – enough to keep the debt in check, but effectively use it as a shock absorber (Figure 12). This is consistent with the literature which suggests that fiscal policy should respond to the debt gap to ensure solvency, but that debt should only be brought back to target gradually. However, at very small values, the debt becomes volatile, and because of its effect on the risk premium, this leads to exchange rate volatility (Figure 13). So there is a tradeoff between consumption and real exchange rate stability.

The results for *the tax response to fiscal expenditure* φ_{tg} are shown in Figures 14 to 16. This parameter determines the degree to which fluctuations in fiscal expenditure are financed by an increase in taxes. The estimated values are small, suggesting a high degree of debt financing, consistent with rising losses with tax financing. This result reflects the effect of movements in lump sum taxes of nonRicardian income and consumption. It is efficient to use the debt as a shock absorber, and vary taxes only a little. In contrast, real exchange rate volatility increases with greater debt financing because fluctuations in debt increase exchange rate volatility through the risk premium, but this is relatively weak.

The *fiscal expenditure response to the output gap* φ_{gy} is the active fiscal stabilisation instrument. The loss function (Figure 17)achieves a minimum at a value well below what might be considered practical. (At a value of -1, the output gap is fully offset by government expenditure). Estimated values are a more modest range of -0.7 to -1, but still suggesting a substantial fiscal stabilisation role. As shown in Figures 18 and 19, a policy maker concerned with consumption volatility (probably closer to a welfare measure than output volatility) or with real exchange rate volatility would prefer a more modest countercylical response with φ_{gy} in the range of -0.3 to -0.6.

In Figures 20 to 22 we consider monetary policy in the absence of active fiscal stabilisation (i.e. φ_{gy} =0). This increases estimated (mostly due to higher GDP volatility). If fiscal policy were to become solely concerned with good housekeeping, leaving stabilisation to monetary policy, monetary policy could achieve a better outcome through a less aggressive response to inflation and a more aggressive response to the output gap, and less interest rate smoothing (less aggressive policy generally). However, the outcomes are never as good as in the case where fiscal policy is active.

In Figure 23 we ask what rigidities give fiscal policy an active stabilisation role. The two red lines are the same as in figure 20. Each of the other lines shows the loss in the absence of fiscal stabilisation and in the absence of one rigidity or distortion. If that feature gives fiscal policy an active stabilisation role, the loss should fall back toward the Baseline case of no fiscal stabilisation) The main suspects are nonRicardian agents, price and wage rigidities, and distortionary taxation. If all agents were Ricardian, the losses would be lower - about half way back to the case where fiscal policy was active. So we conclude that the large share of nonRicardians is important in creating a stabilization role for fiscal policy. However, none of the others is the case. In the absence of domestic price and wage rigidities, CPI inflation volatility is substantially higher. In the absence of import price rigidities and distortionary taxes, the results are little different.

Finally, we consider the effect of the stocks of fiscal debt and foreign exchange reserves on stabilisation outcomes (Figure 24). A rise in fiscal debt increases losses, but by very little within the range of debt experienced, even post Asian crisis. That is not to say that it is not important for financial stability or in squeezing other fiscal priorities, just that is doesn't affect output and inflation volatility much. The same holds for foreign exchange reserves - even at double the current level, they would have little effect on output and inflation volatility, although they play an important financial stability role. In the model, foreign exchange valuation effects on the debt and reserves are absorbed into the fiscal debt and smoothed over time.

7 Summary of Findings

We find that fiscal policy can *and does* play a stabilising role in Indonesia.

Government expenditure is estimated to countercyclical. A tax response to variations in expenditure is undesirable because expenditure is playing an active stabilisation role and because non Ricardian income and therefore consumption is directly affected by variations in taxes. Taxes respond to debt above target, by enough to ensure solvency, but to only gradually return debt to steady state. Therefore the fiscal debt plays an important shock absorber role facilitating countercyclical policy while avoiding large fluctuations in taxes which would lead to volatility in nonRicardian consumption. Estimated fiscal and monetary policy parameters look sensible in terms of the variance tradeoffs in the model.

The features in our model that could give fiscal policy an active stabilisation role are a large estimated share of non-Ricardian households (62-67 per cent of households), price/wage rigidities and distortionary taxes. Of these, only nonRicardian agents are found to be important.

In the absence of active fiscal policy, monetary policy would give the best outcomes (in terms of a standard loss function) by being less responsive to inflation and more responsive to the output gap.

The size of the stocks of debt and reserves have little effect on macrostabilisation outcomes, within reasonable limits. Fluctuations due to exchange rate valuation effects are absorbed into the debt, which is fine as long as the tax response to debt is large enough to ensure solvency. While the size of the reserves stock has little effect on stabilisation dynamics, it is, of course, still important for financial stability considerations.

In the model foreign reserves accumulation is contractionary and leads to a depreciation even in the absence of a direct effect on the exchange rate. However fiscal expenditure is a more effective instrument for influencing the exchange rate. An increase in reserves depreciates the exchange rate by considerably less than an equivalent cut in government expenditure. Countercyclical fiscal policy helps to reduce real exchange rate volatility. A policy tango is superior to monetary policy alone.

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Table 1: Calibrated Parameters

	Description	Calibrated Value
β	subjective discount rate	0.99
α	capital share	0.38
δ	depreciation rate	0.025
μ_H	steady state markup (home goods)	0.3
μ_F	steady state markup (imports)	0.3
μ_W	steady state markup (wages)	0.3
G	steady state gov't spending/GDP	0.88
B	steady state fiscal debt/GDP	0.30
Z	steady state reserves/GDP	0.10
χ	foreign curr. share of fiscal debt	0.50
τ^c	consumption tax rate	0.10
τ^d	income tax rate	0.10
τ^w	payroll tax rate	0.075

Table 2: Priors

	Parameter	Distribution	Mean/ Mode	StdDev/ Deg. Free
ω	share of nonRicardian consumers	Beta	0.5	0.2
h	habit parameter	Beta	0.5	0.2
ϕ_{rp}	risk premium parameter	Gamma	0.008	0.003
ζ	inverse elasticity of labour supply	Gamma	2	0.75
ϕ	fixed cost of production	Beta	0.3	0.1
υ	investment adjustment costs	Gamma	3.0	1.5
ψ	cap. util. parameter	Gamma	0.2	0.075
ψ_H	home goods demand elasticity	Gamma	1	0.5
ψ_F	export demand elasticity	Gamma	1	0.5
	Price & wage parameters			
θ_H	Calvo parameter home goods	Beta	0.75	0.15
γ_H	indexation: home goods	Beta	0.5	0.2
θ_F	Calvo parameter imports	Beta	0.75	0.15
γ_F	indexation: imports	Beta	0.5	0.2
θ_w	Calvo wage parameter	Beta	0.75	0.15
γ_w	wage indexation parameter	Beta	0.5	0.2
	Policy parameters			
ρ_r	Interest smoothing parameter	Beta	0.8	0.1
φ_π	MP: inflation response	Normal	1.7	0.15
φ_y	MP output response	Normal	0.5	0.05
ρ_g	Fiscal smoothing parameter	Beta	0.85	0.1
φ_{gy}	FP: expenditure response to y	Normal	0	0.5
φ_{tb}	FP: tax response to debt	Beta	0.5	0.2
φ_{tg}	FP: tax response to expenditure	Beta	0.5	0.2

Table 3: Priors

	Parameter	Distribution	Mean/ Mode	St Dev/ Deg Free
	AR1 coefficients:			
ρ_a	technology shock	Beta	0.85	0.1
ρ_g	fiscal shock	Beta	0.85	0.1
ρ_I	investment adj	Beta	0.85	0.1
ρ_L	labour preference	Beta	0.85	0.1
ρ_{i*}	foreign cost of capital	Beta	0.85	0.1
ρ_{y*}	foreign demand	Beta	0.80	0.1
ρ_z	reserves shock	Beta	0.75	0.15
	Shock standard deviations:			
σ_a	technology shock	Inv Gamma	0.07	2
σ_g	fiscal expenditure shock	Inv Gamma	0.1	2
σ_I	investment adj shock	Inv Gamma	0.1	2
σ_L	labour pref shock	Inv Gamma	0.1	2
σ_r	monetary policy shock	Inv Gamma	0.02	2
σ_{y*}	foreign demand shock	Inv Gamma	0.1	2
σ_{i*}	foreign cost of capital shock	Inv Gamma	0.1	2
σ_p	price cost push shock	Inv Gamma	0.04	2
σ_w	wage cost push shock	Inv Gamma	0.01	2
σ_z	reserves accumulation shock	Inv Gamma	0.4	2

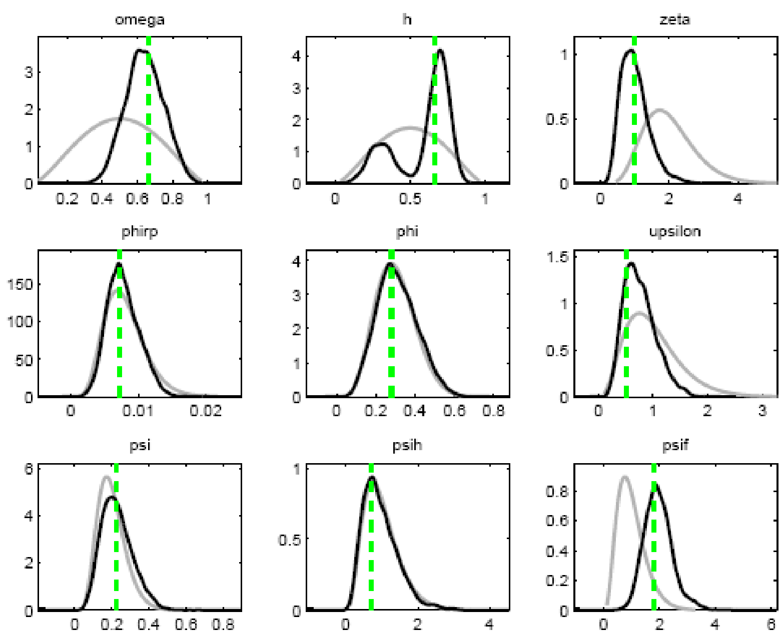
Table 4: Posterior Estimates

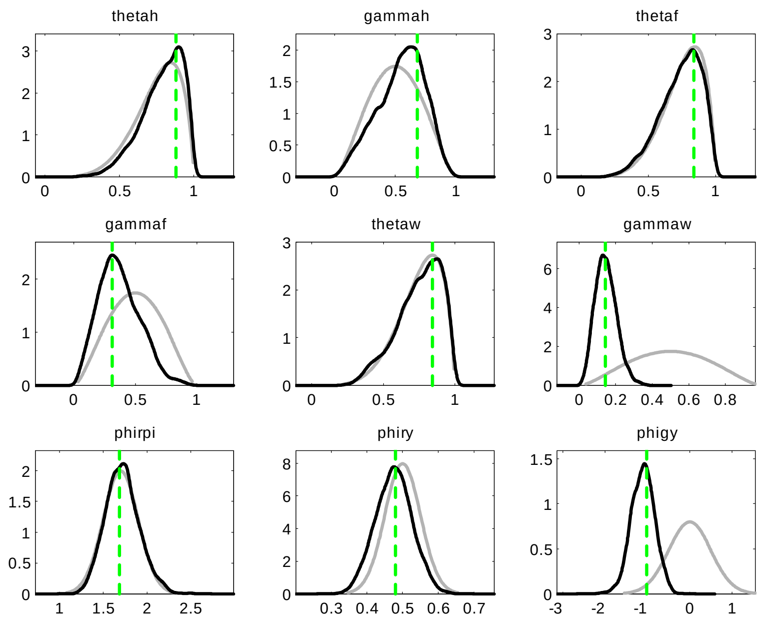
	Parameter	Whole Period Period 1991q2-2006q4	Post Float Period 1998q3-2006q4	Inflation Target Period 1999q4-2006q4
ω	share of nonRicardian consumers	0.67	0.65	0.62
h	habit parameter	0.15	0.10	0.59
ζ	inverse elasticity of labour supply	0.90	0.89	0.99
ϕ_{rp}	risk premium parameter	0.0090	0.0089	0.0077
ϕ	fixed cost of production	0.31	0.29	0.30
υ	investment adjustment costs	0.57	0.38	0.83
ψ	cap. util. parameter	0.17	0.14	0.23
ψ_H	home goods demand elasticity	0.77	0.58	0.99
ψ_F	export demand elasticity	1.90	1.86	1.92
	Price & wage parameters			
θ_H	Calvo Parameter home goods	0.83	0.90	0.78
γ_H	indexation: home goods	0.73	0.75	0.55
θ_F	Calvo parameter imports	0.71	0.81	0.74
γ_F	indexation: imports	0.49	0.48	0.36
θ_w	Calvo wage parameter	0.75	0.84	0.76
γ_w	wage indexation parameter	0.11	0.09	0.15
	Policy Parameters			
ρ_r	MP: interest smoothing	0.86	0.86	0.87
φ_π	MP: inflation response	1.87	1.80	1.68
φ_y	MP output response	0.45	0.44	0.48
ρ_g	Fiscal smoothing parameter	0.72	0.73	0.72
φ_{gy}	FP: expenditure response to y	-0.73	-0.69	-1.10
φ_{tb}	FP: tax response to debt	0.25	0.25	0.12
φ_{tg}	FP: tax response to expenditure	0.20	0.20	0.13

Table 5: Posterior Estimates

	Parameter	Whole Period 1991q2-2006q4	Post Float Period 1998q3-2006q4	Inflation Target Period 1999q4-2006q4
	AR1 coefficients:			
ρ_a	technology shock	0.59	0.62	0.52
ρ_I	investment adj	0.80	0.85	0.68
ρ_L	labour preference	0.96	0.99	0.92
ρ_{i*}	foreign cost of capital	0.86	0.86	0.65
ρ_{y*}	foreign demand	0.86	0.86	0.78
ρ_z	reserves shock	0.86	0.87	0.89
	Shock standard deviations:			
σ_a	technology shock	0.12	0.11	0.08
σ_g	fiscal expenditure shock	0.08	0.08	0.10
σ_I	investment adj shock	0.21	0.15	0.22
σ_L	labour pref shock	0.09	0.08	0.10
σ_r	monetary policy shock	0.0084	0.0081	0.0061
σ_{y*}	foreign demand shock	0.29	0.28	0.30
σ_{i*}	foreign cost of capital shock	0.029	0.028	0.032
σ_p	price cost push shock	0.023	0.022	0.020
σ_w	wage cost push shock	0.0039	0.0034	0.0036
σ_z	reserves accumulation shock	0.21	0.20	0.13

Figure 1: Prior and Posterior Distributions

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thetaf
gammaf
thetaw
gammaw
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phiry
phigy
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0 0.2 0.4 0.6 0.8
0 2 4 6
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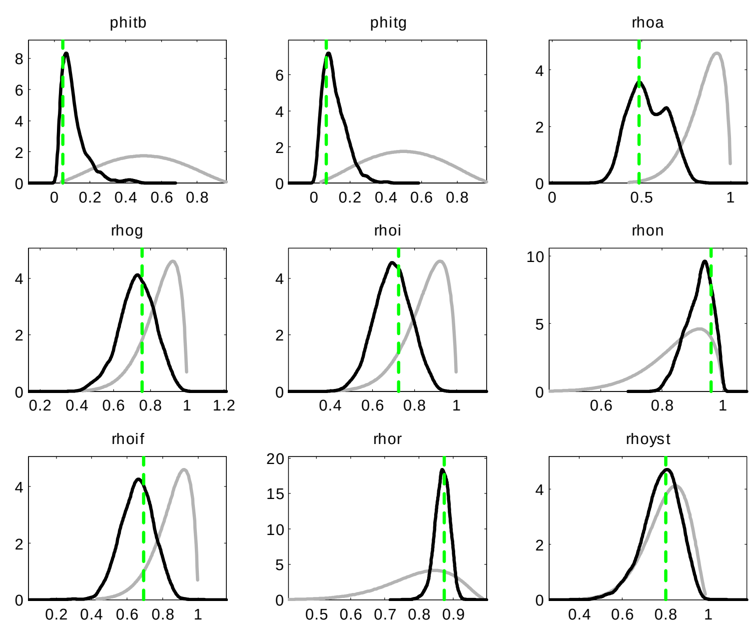
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rhog
rhoi
rhon
rhoif
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rhoyst
0 0.2 0.4 0.6 0.8
0 2 4 6 8
0 0.5 1
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0.5 0.6 0.7 0.8 0.9
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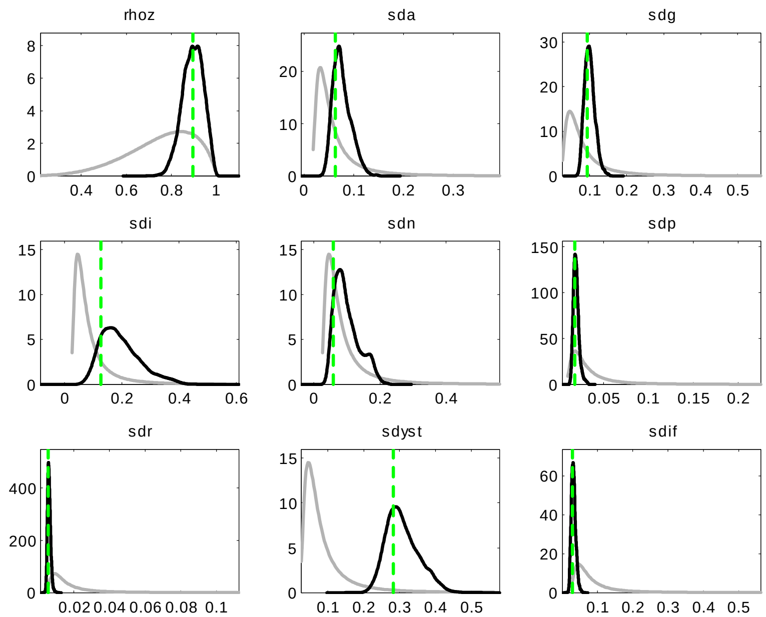
0.4 0.6 0.8 1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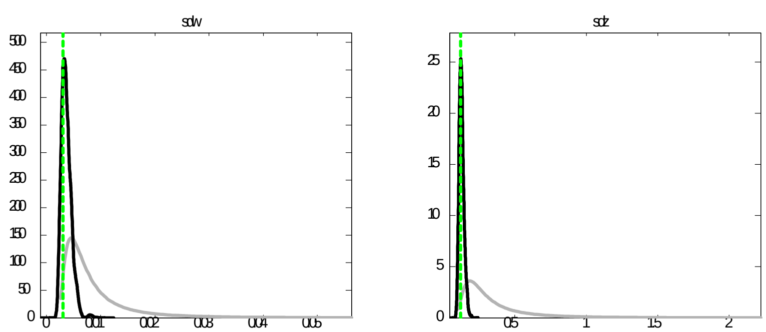
sdif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sdz

Figure 2: Monetary Policy Response to Inflation

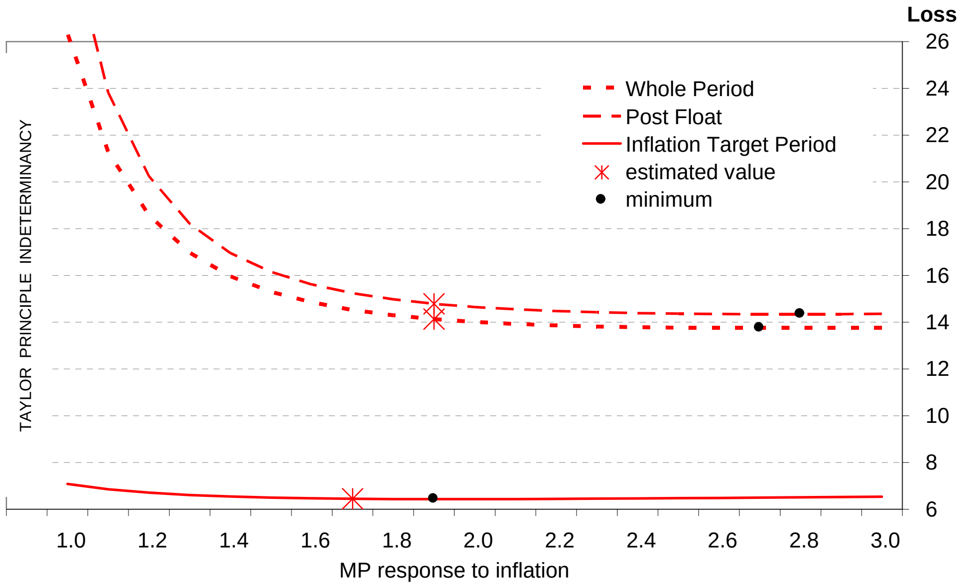


Figure 3: Variance of Inflation, the Output Gap and Consumption

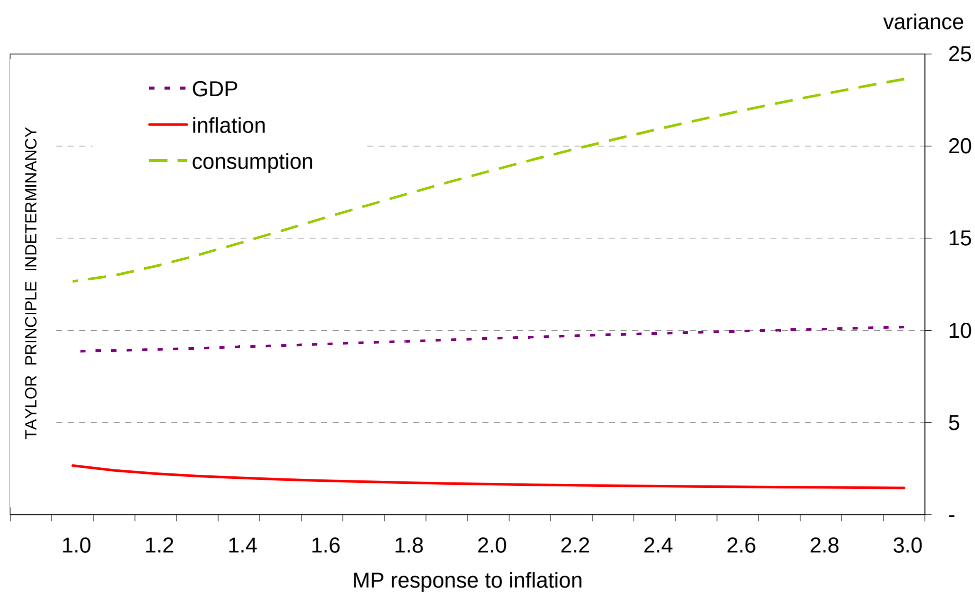


Figure 4: Variance of the Real Exchange Rate

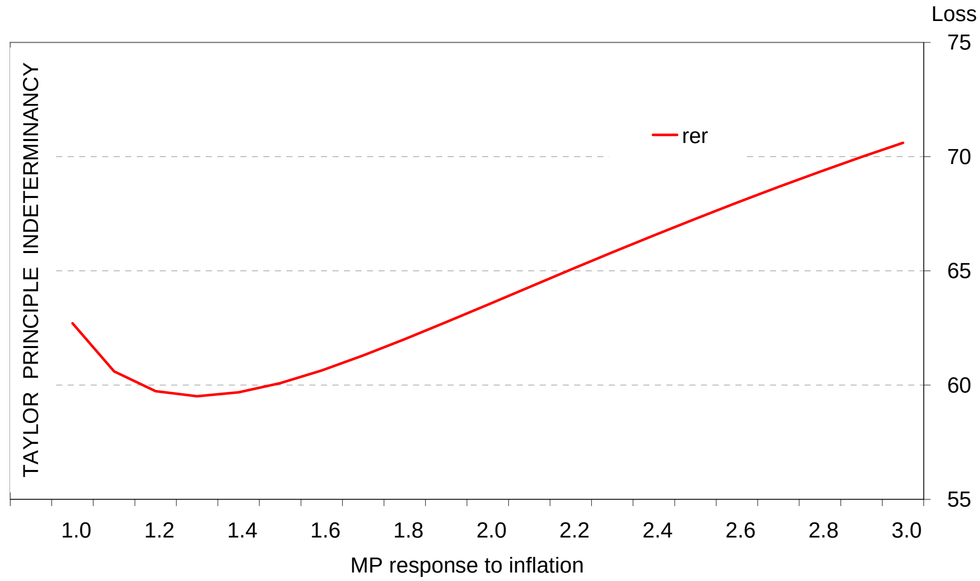


Figure 5: Monetary Policy Response to the Output Gap

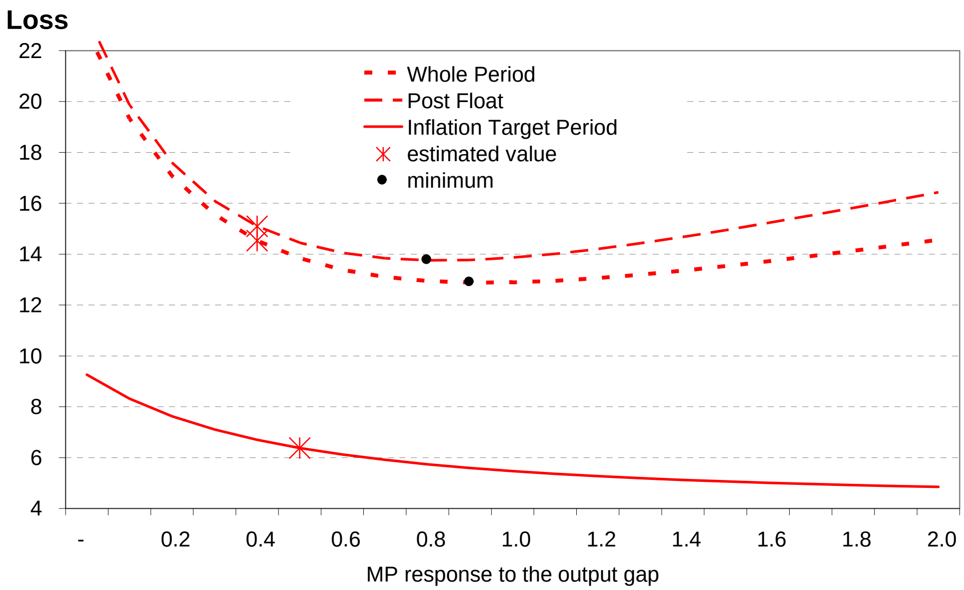


Figure 6: Variance of Inflation, GDP and Consumption

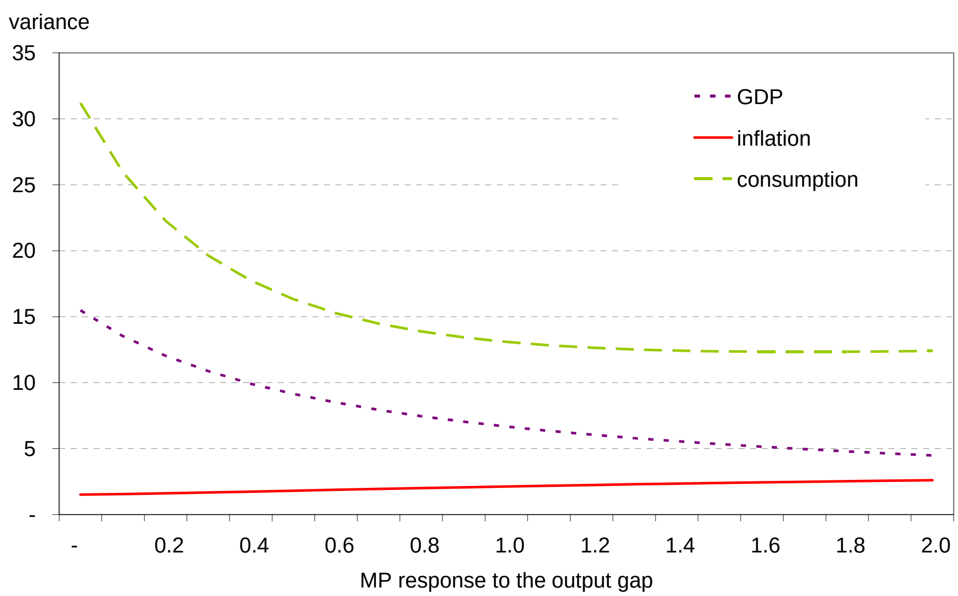


Figure 7: Variance of the Real Exchange Rate

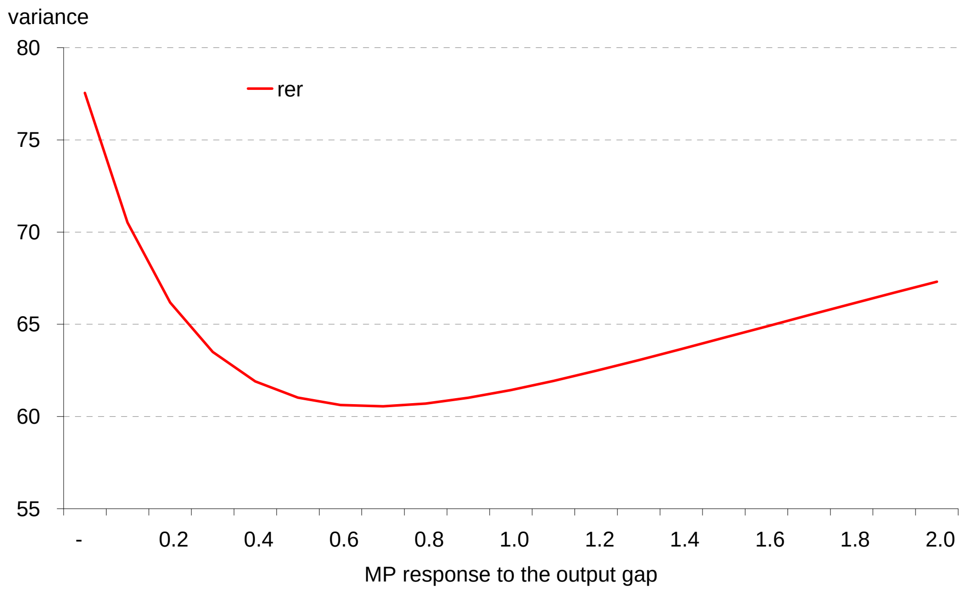


Figure 8: Interest rate Smoothing Parameter

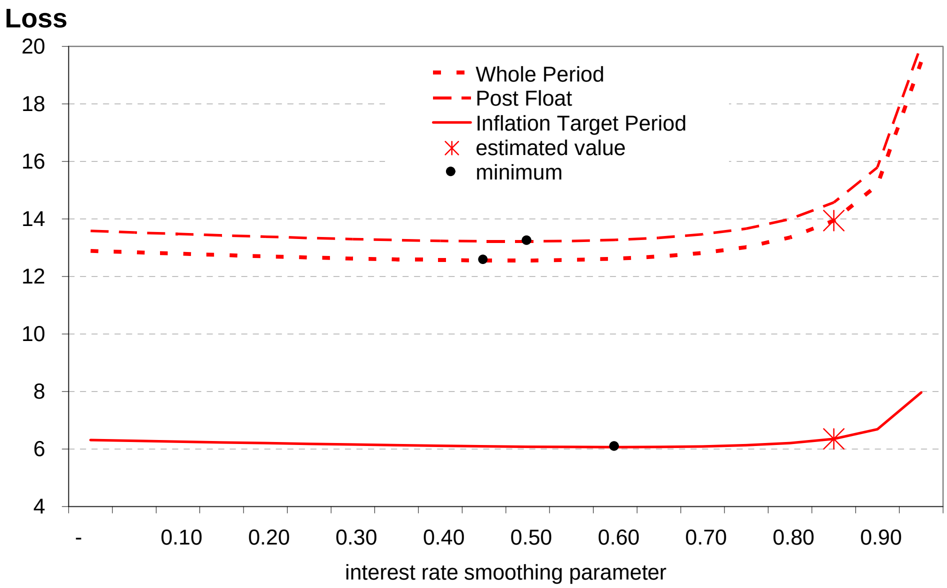


Figure 9: Variance of Inflation, GDP and Consumption

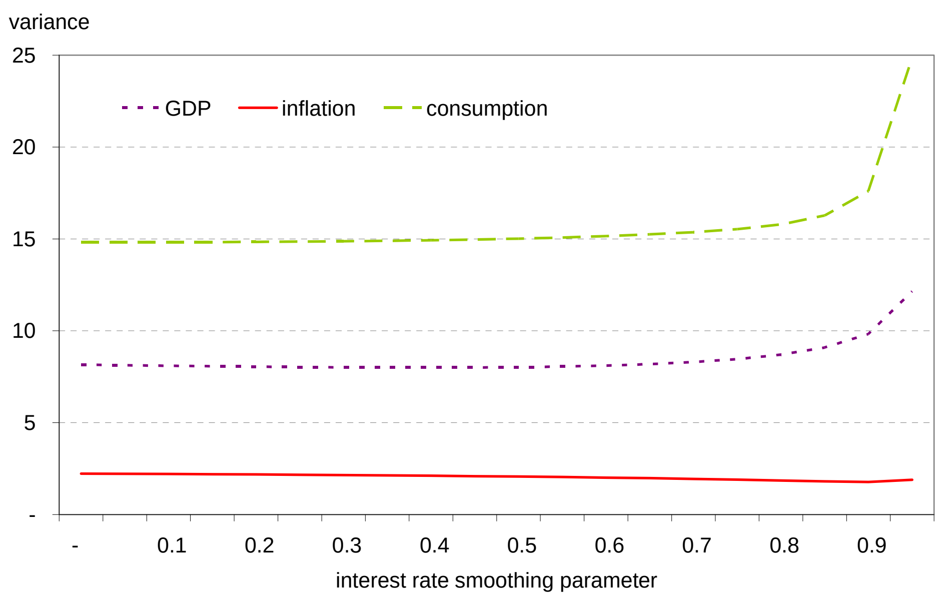


Figure 10: Variance of the Real Exchange Rate

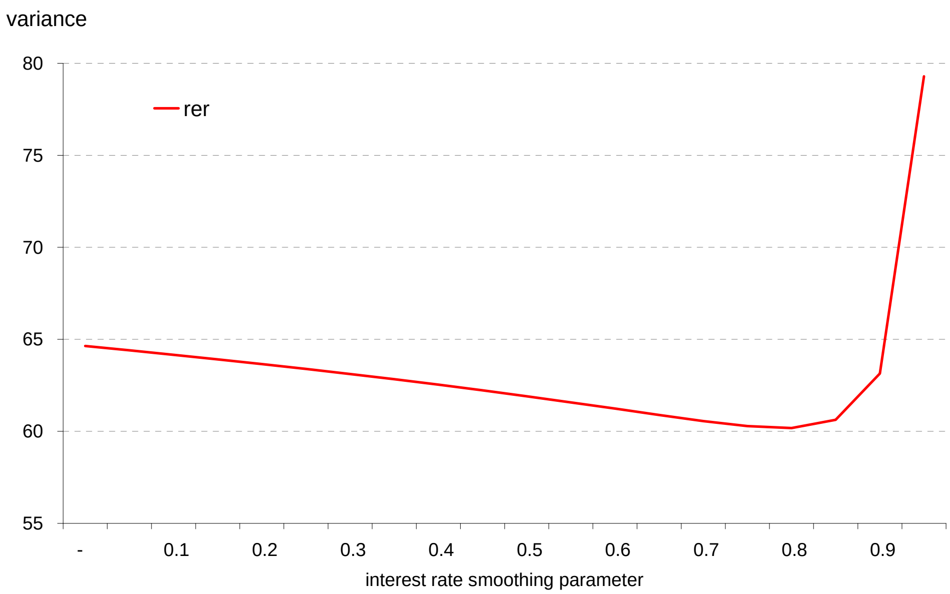


Figure 11: Tax Response to Debt

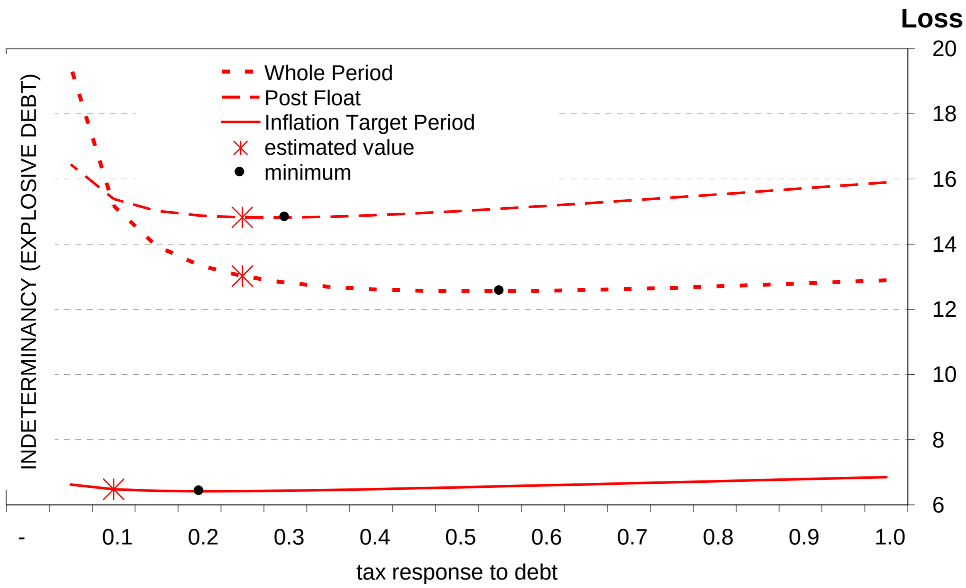


Figure 12: Variance of Inflation, GDP and Consumption

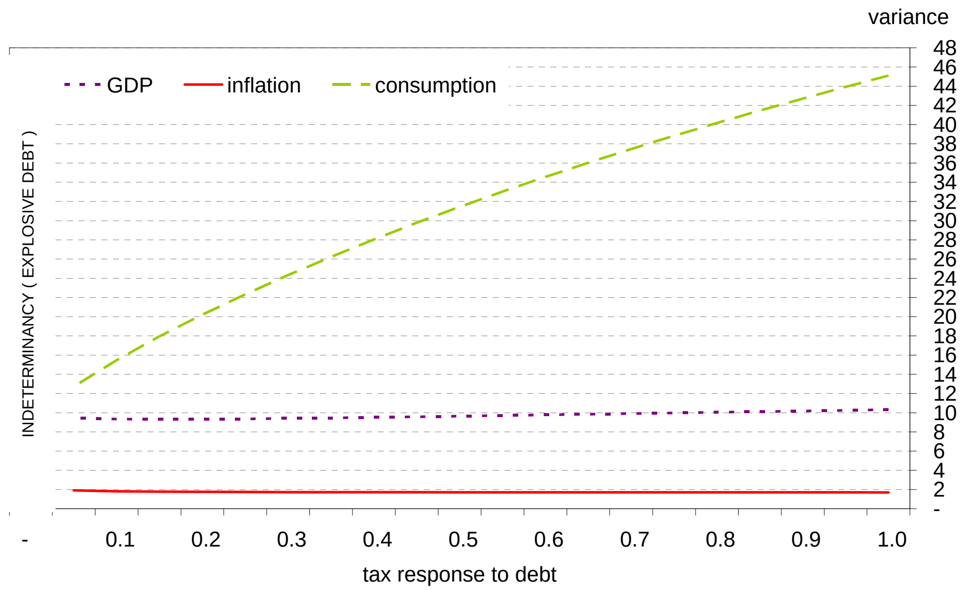


Figure 13: Variance of the Real Exchange Rate

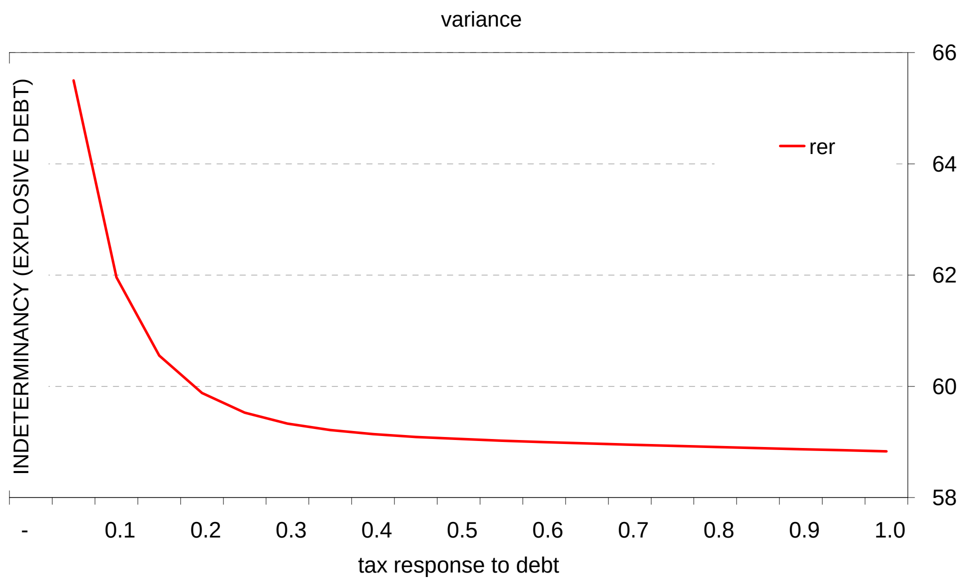


Figure 14: Tax Response to Govt Expenditure

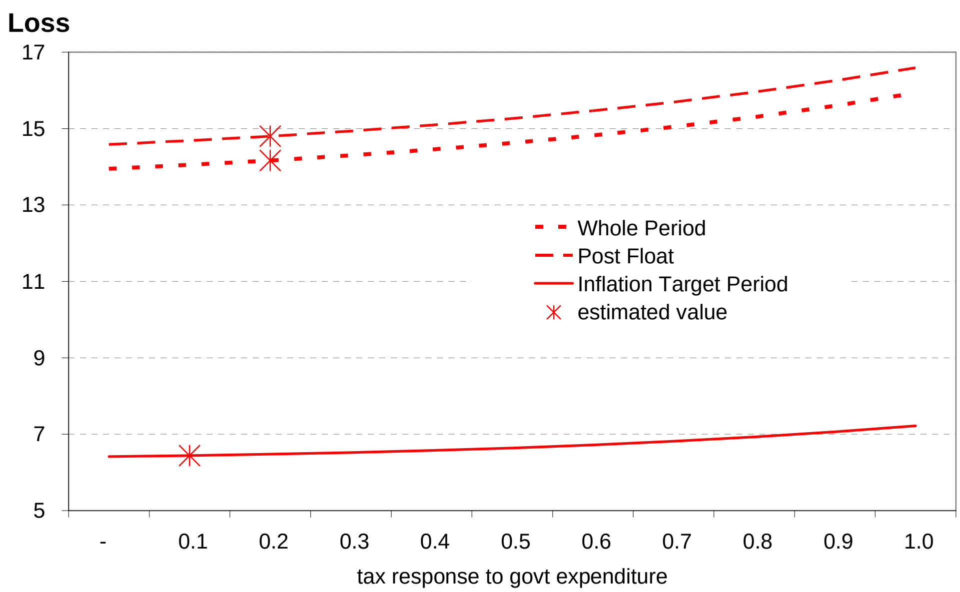


Figure 15: Variance of Inflation, GDP and Consumption

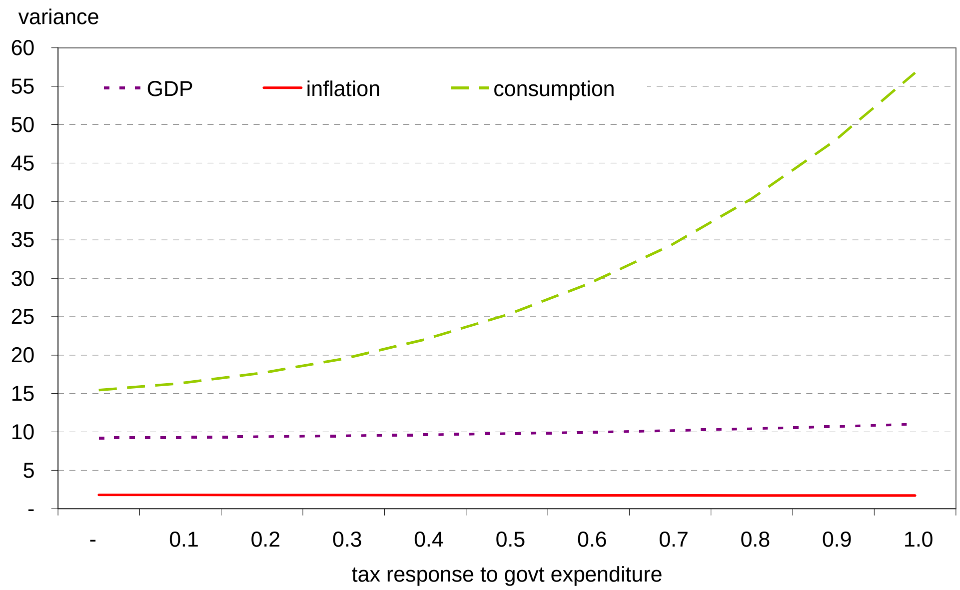


Figure 16: Variance of the Real Exchange Rate

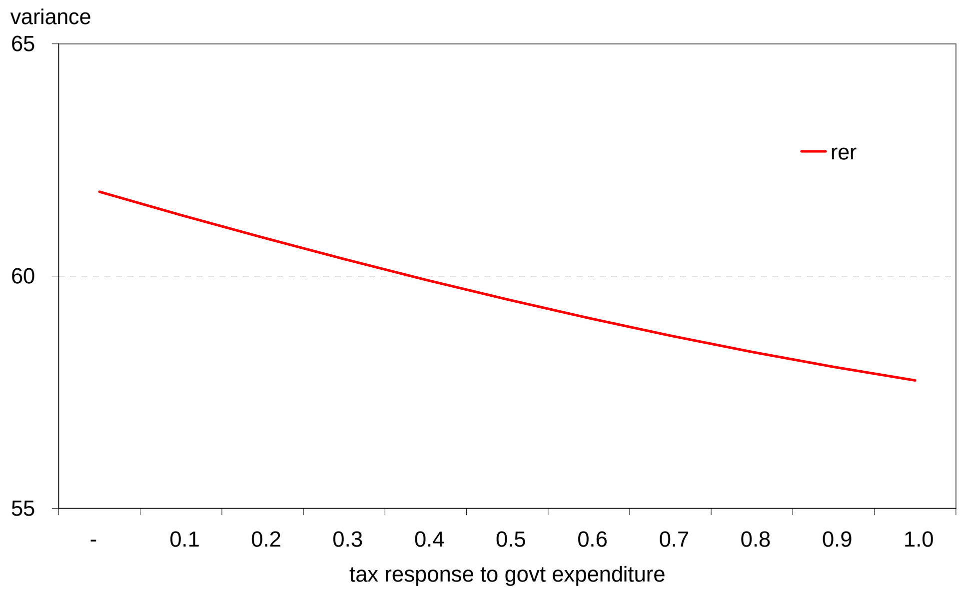


Figure 17: Government Expenditure Response to the Output Gap

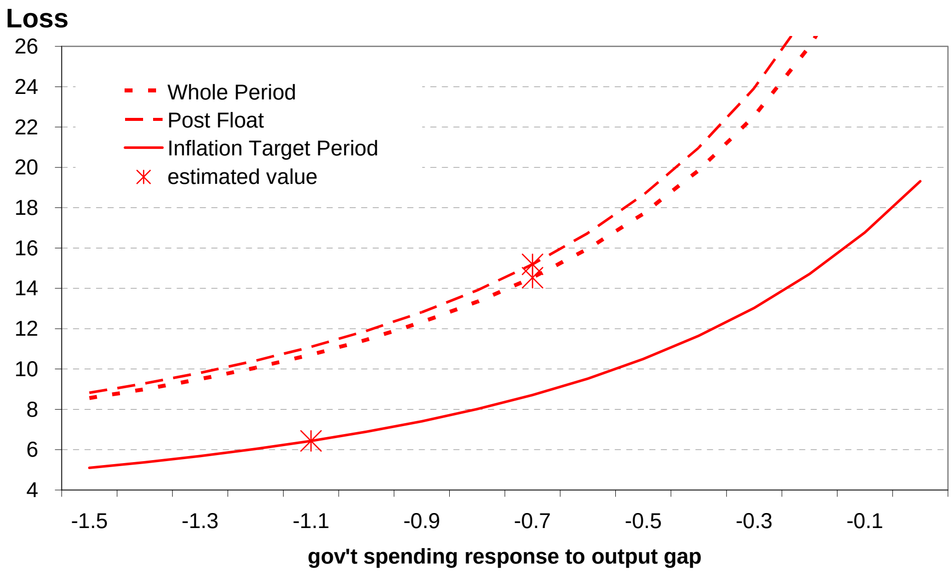


Figure 18: Variance of Inflation, GDP and Consumption

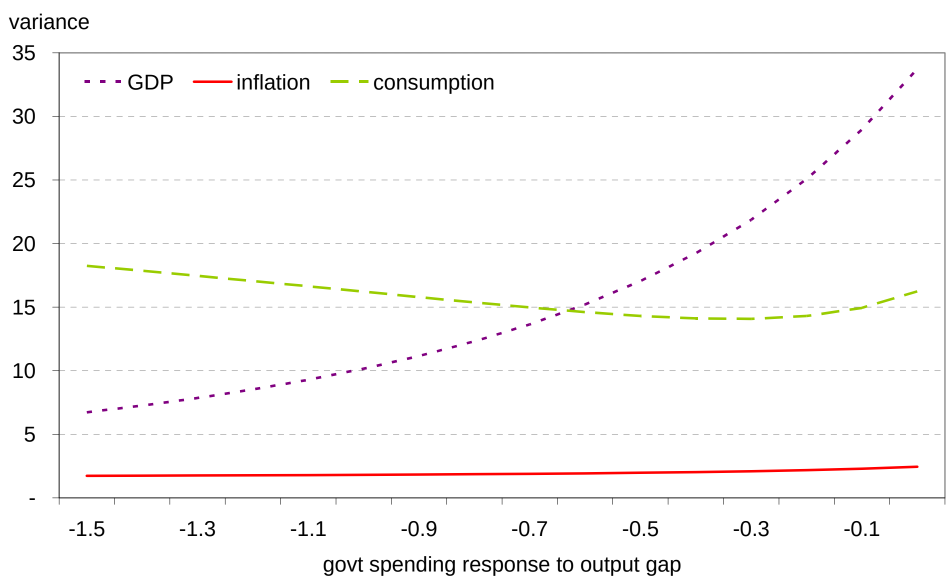


Figure 19: Variance of the Real Exchange Rate

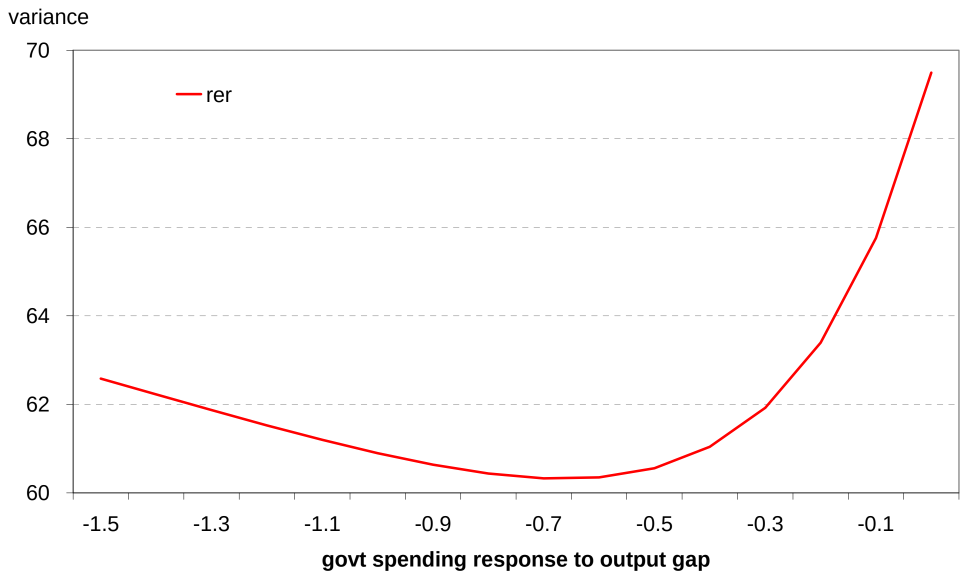


Figure 20: Shift in Loss Function in Absence of Fiscal Stabilisation ($\varphi_{gy} = 0$)

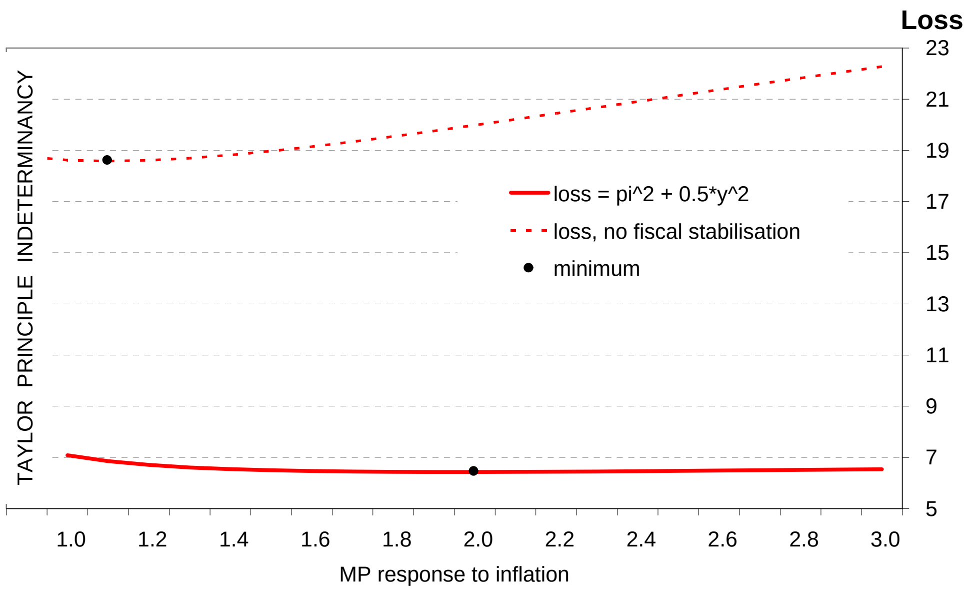


Figure 21: Shift in Loss Function in Absence of Fiscal Stabilisation ($\varphi_{gy} = 0$)

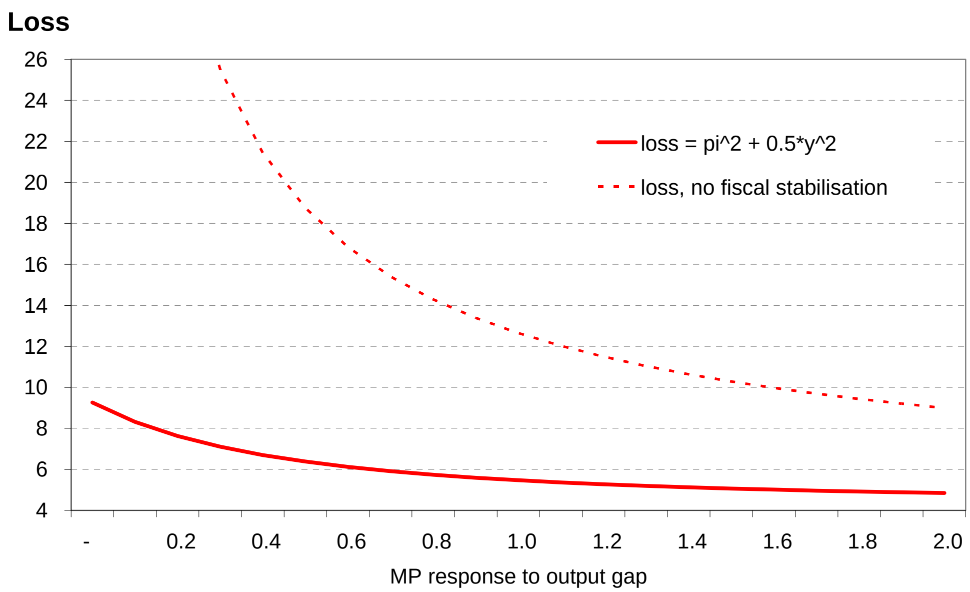


Figure 22: Shift in Loss Function in Absence of Fiscal Stabilisation ($\varphi_{gy} = 0$)

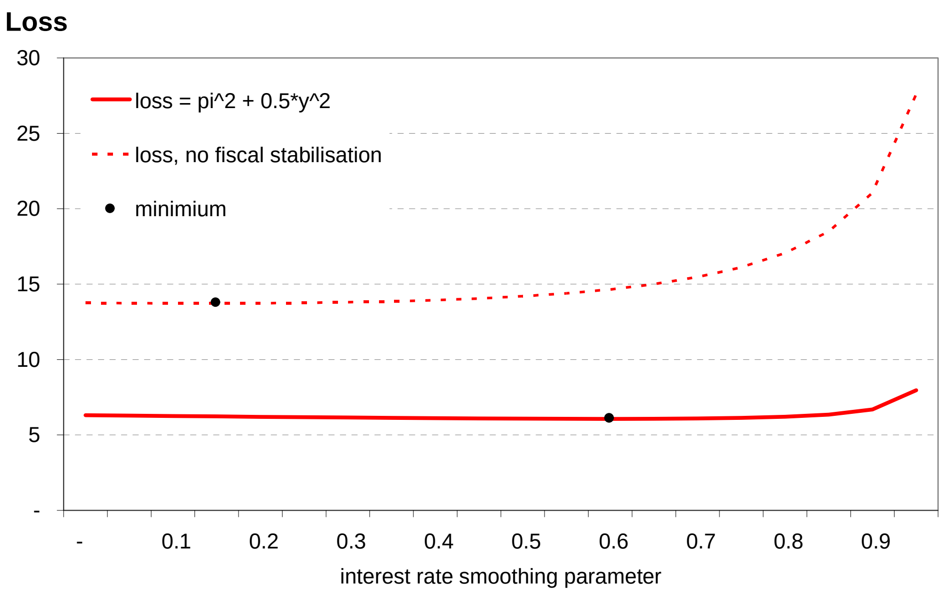


Figure 23: Rigidities and the Fiscal Stabilisation Role

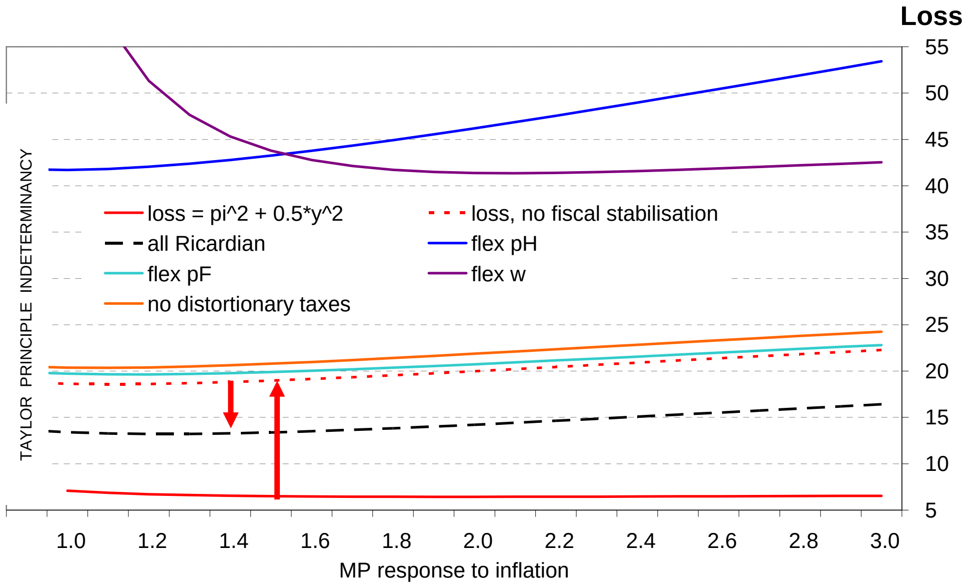
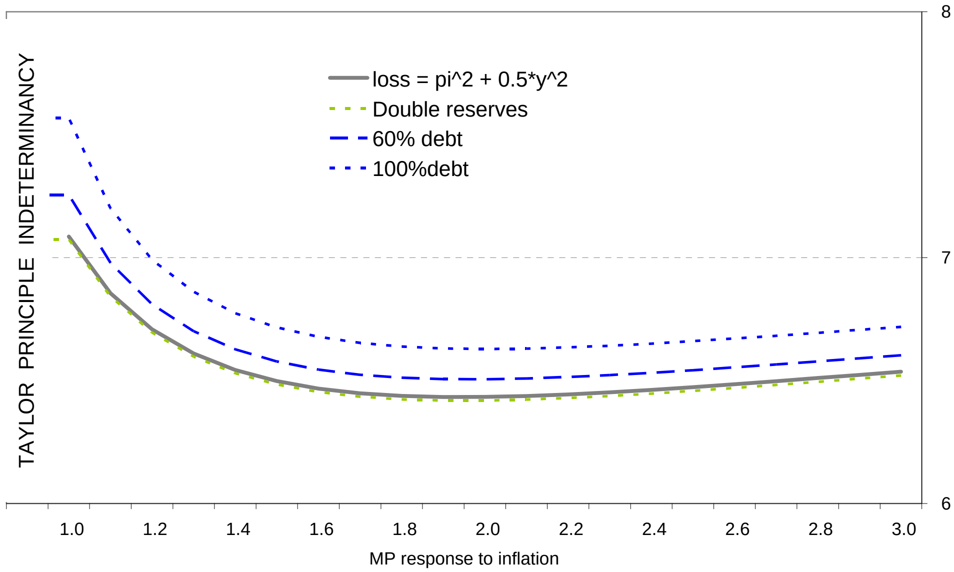


Figure 24: Effect of Debt and Reserves Stocks on Stabilisation Outcomes



8 Impulse Response Functions

Figure 25: **Response to a 1 Std Dev Productivity Shock**

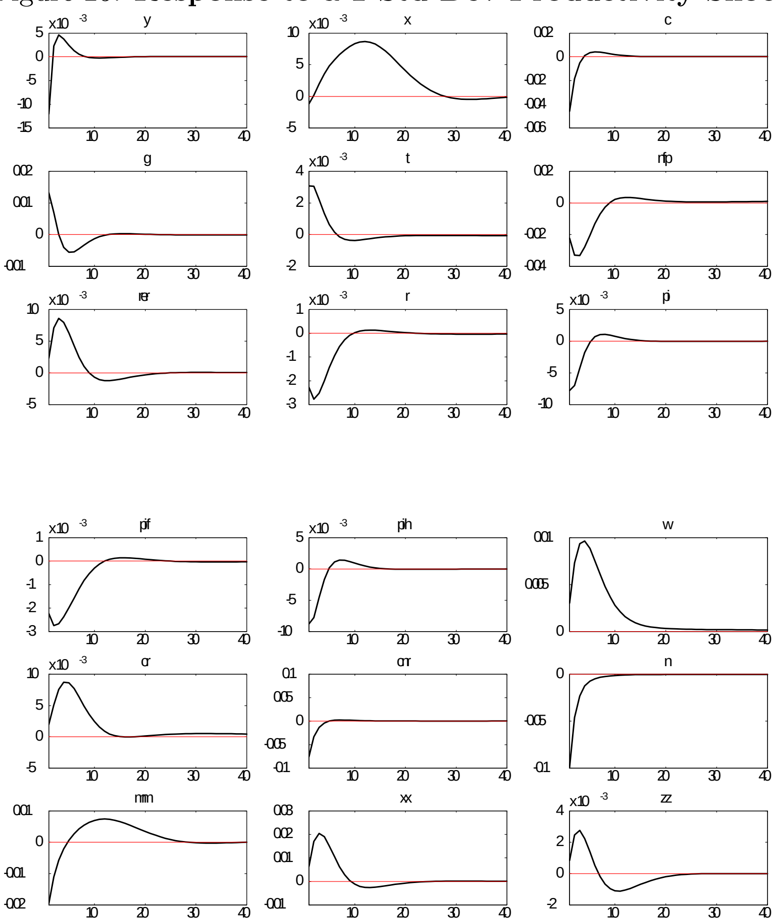


Figure 26: **Response to a 1 Std Dev Gov't Spending Shock**

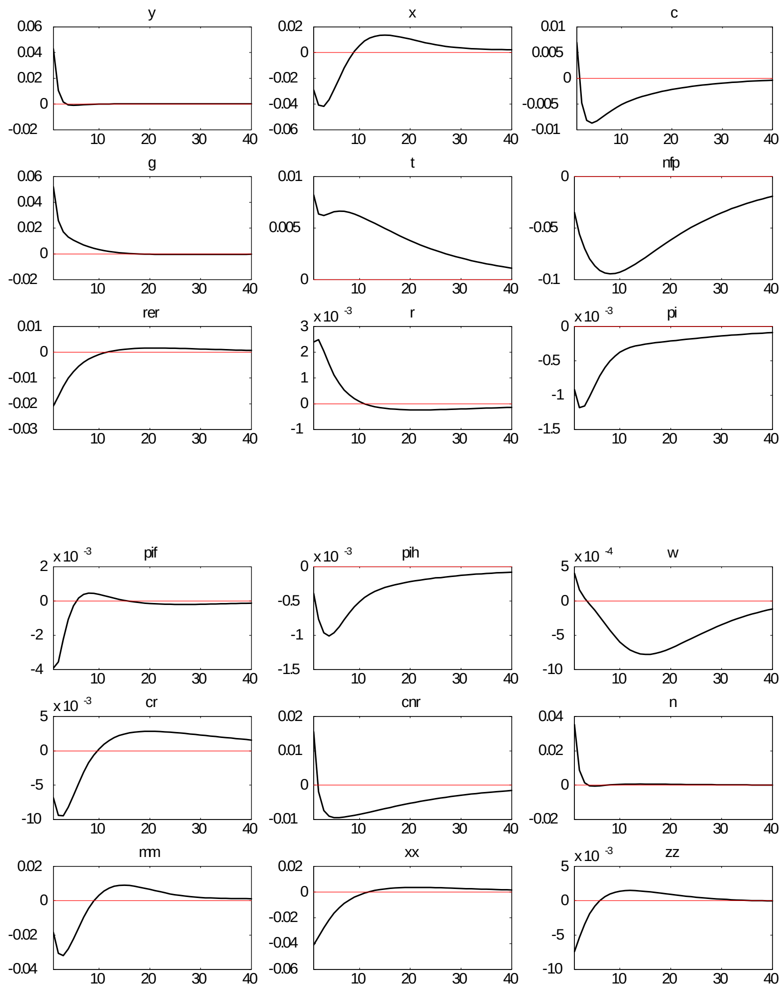


Figure 27: **Response to a 1 Std Dev Investment Cost Shock**

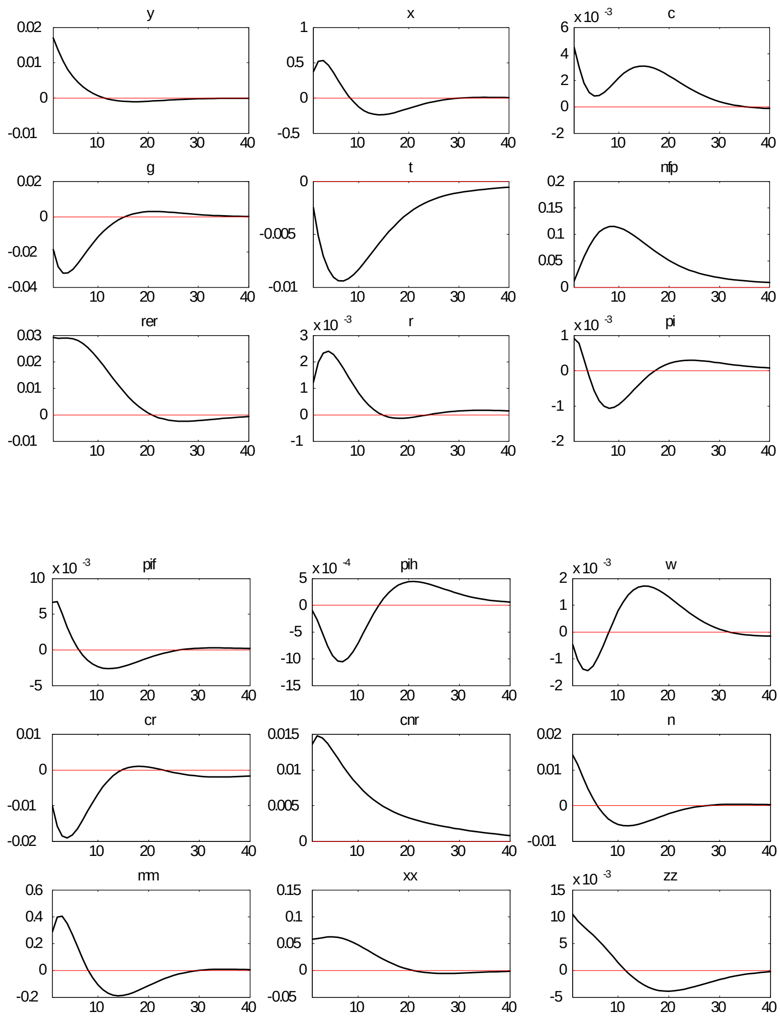


Figure 28: **Response to a 1 Std Dev Foreign Cost of Capital Shock**

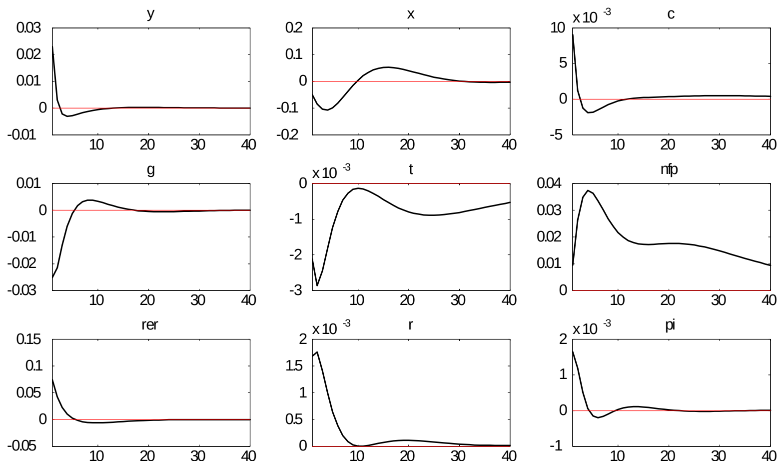


Figure 29:

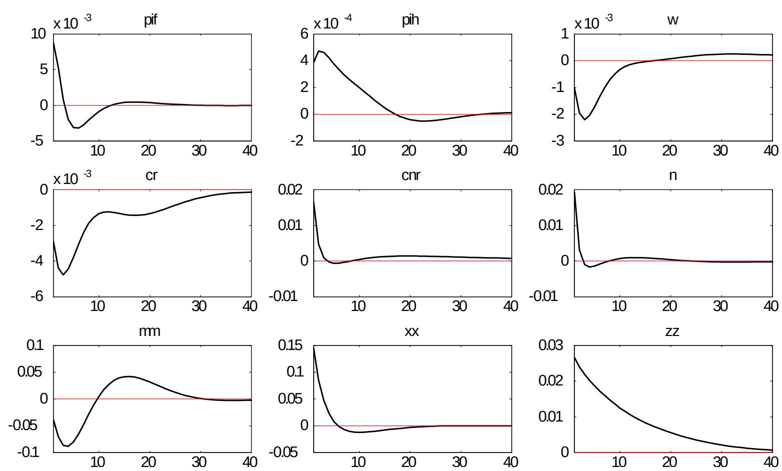

pif
x 10^-3
pih
x 10^-4
w
x 10^-3
cr
x 10^-3
cnr
n
rrm
xx
zz

Figure 30: **Response to a 1 Std Dev Labour Preference Shock**

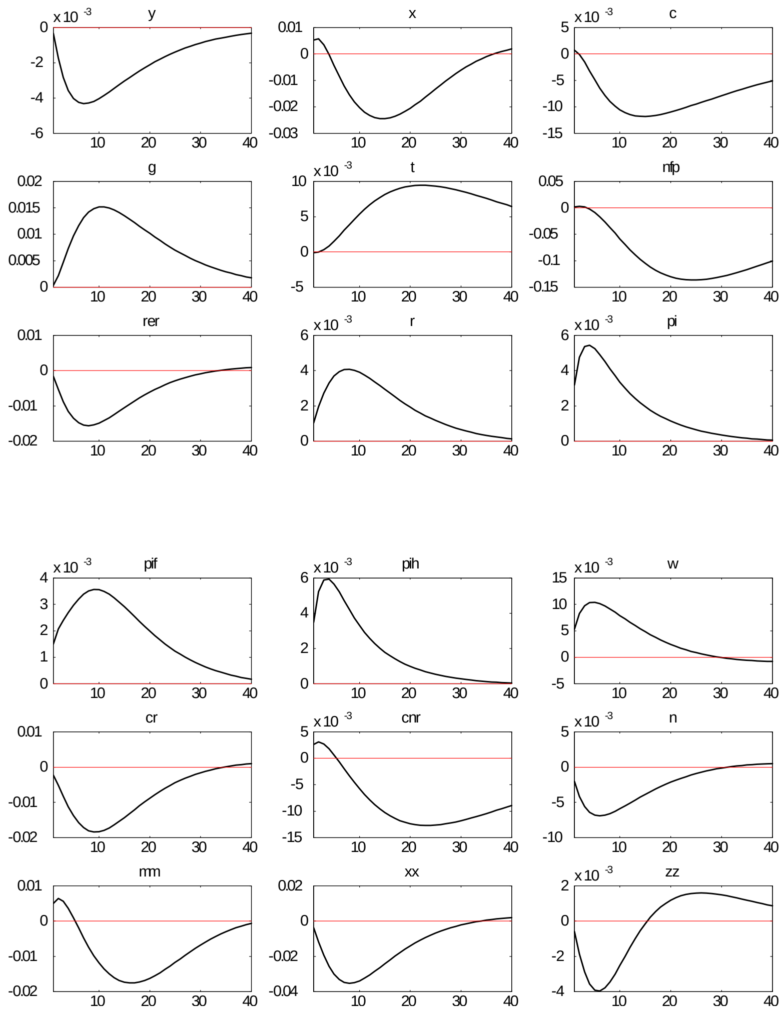


Figure 31: **Response to a 1 Std Dev Cost Push Shock**

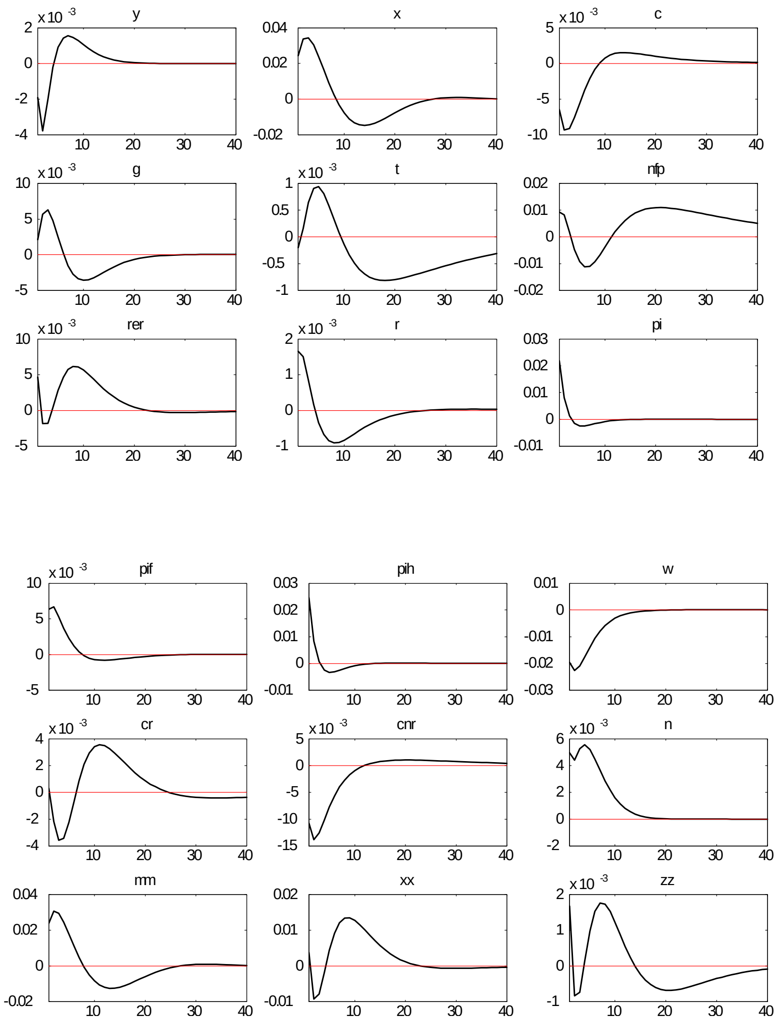


Figure 32: **Response to a 1 Std Dev Monetary Policy Shock**

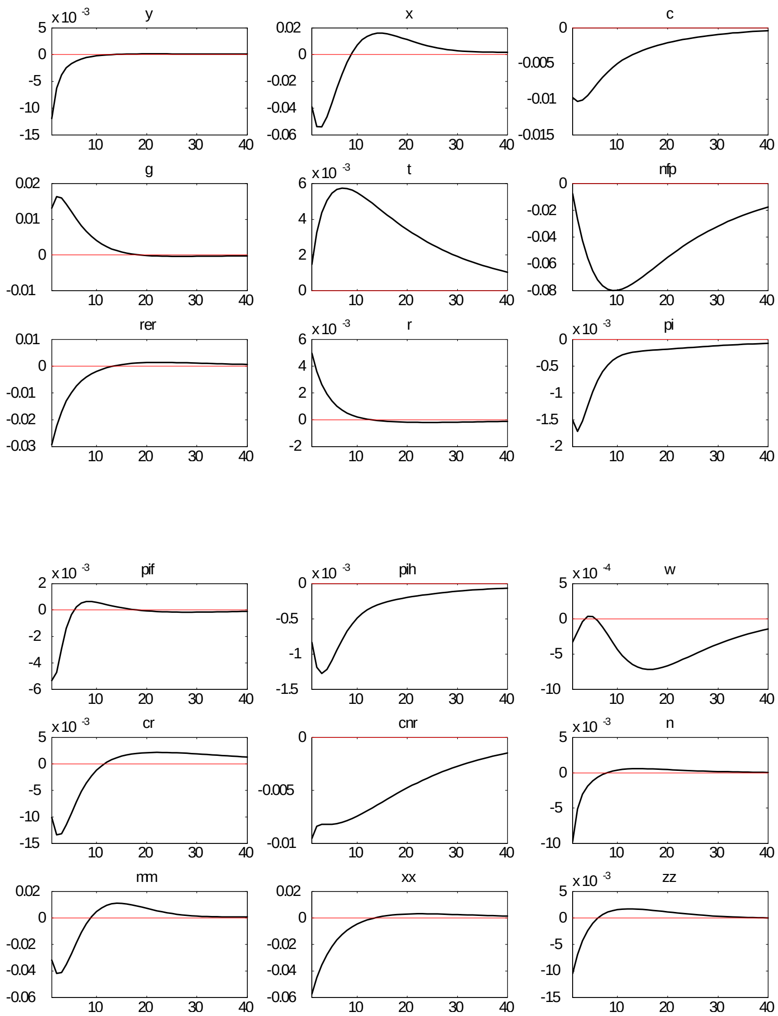


Figure 33: **Response to a 1 Std Dev Wage Shock**

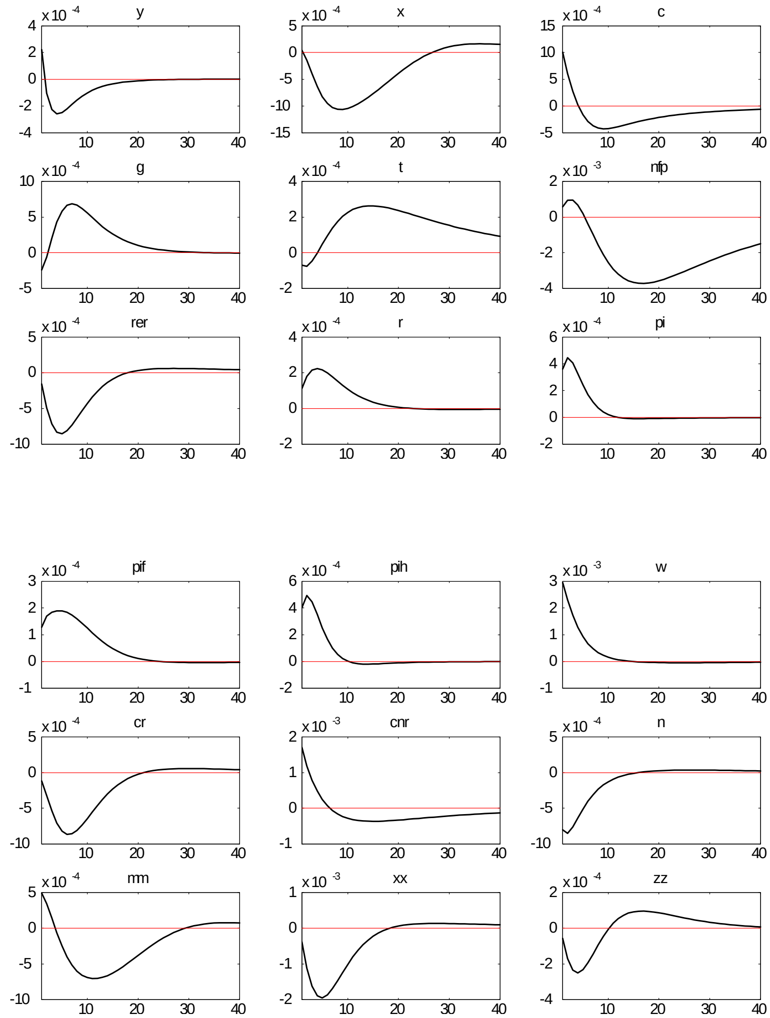


Figure 34: **Response to a 1 Std Dev Foreign Demand Shock**

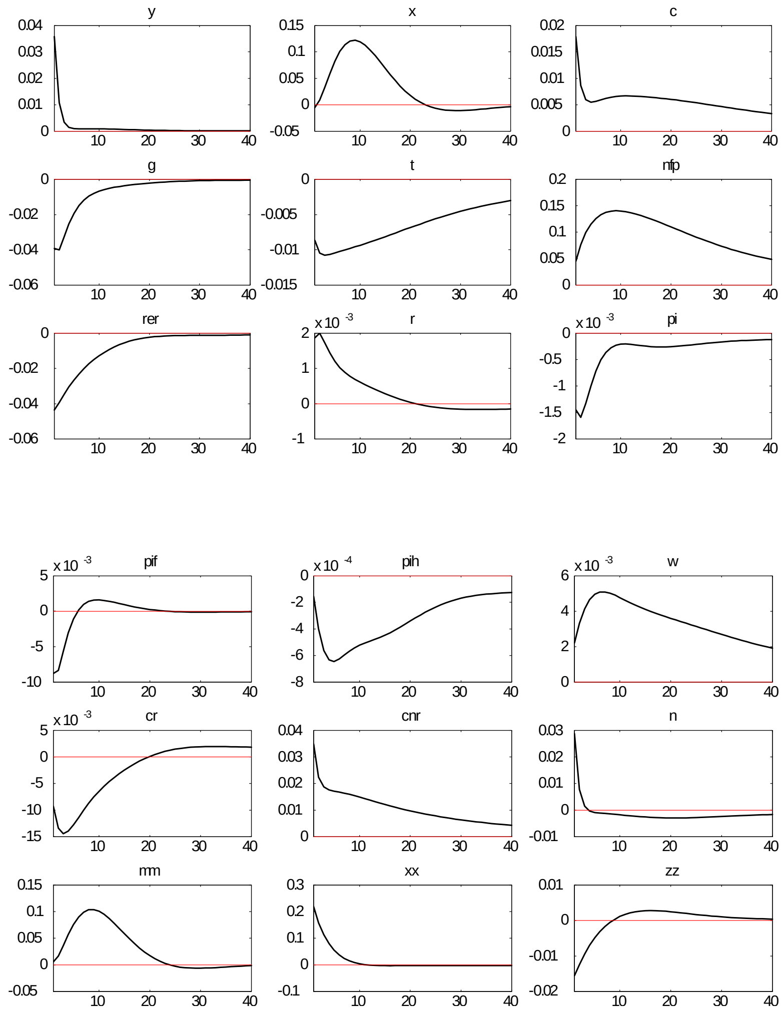


Figure 35: **Response to a 1 Std Dev Reserves Accumulation Shock**

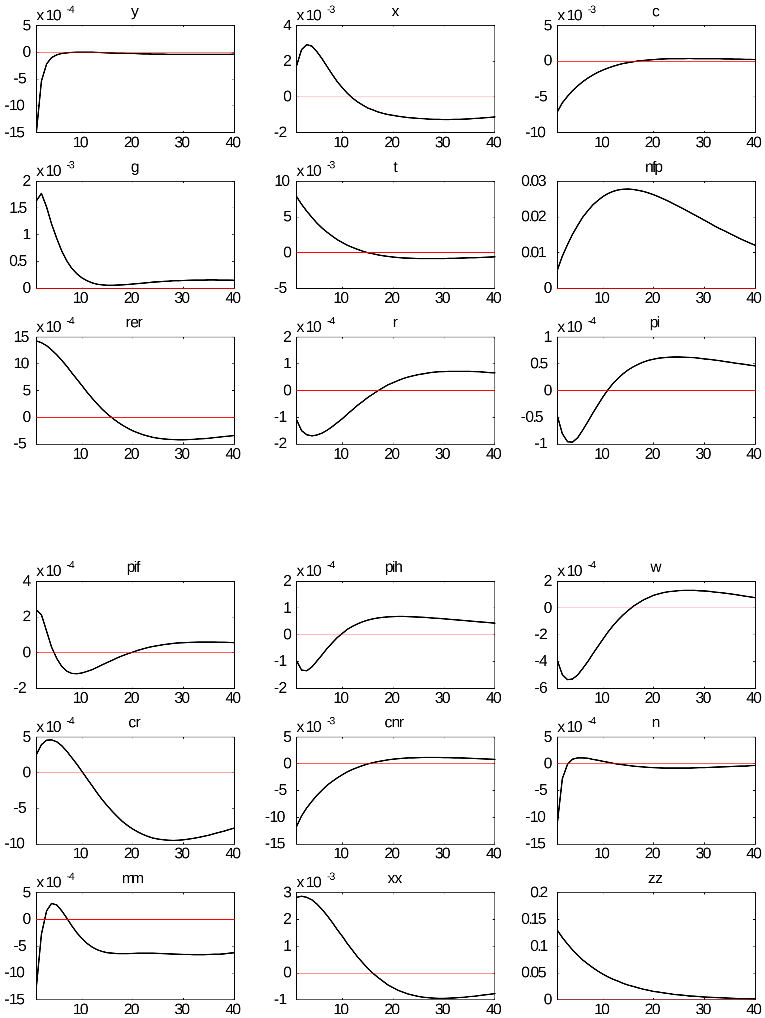
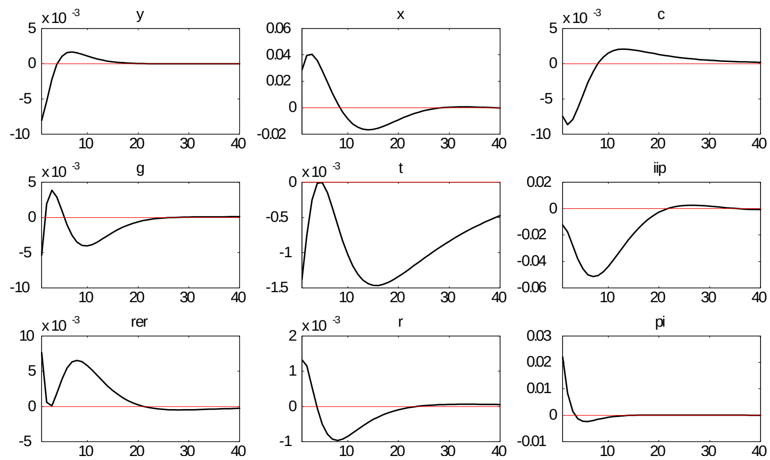
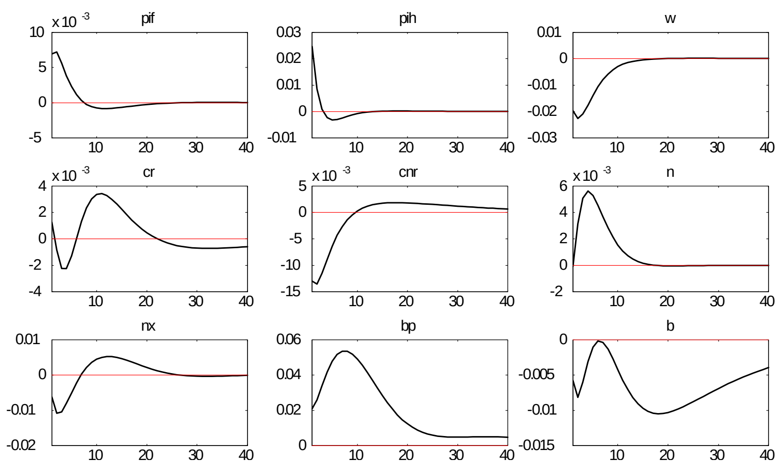


Figure 36: **Response to Subsidy Removal (Combined Cost Push and Fiscal Shock)**

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