Monetary transmission of elongated shock to the risk premium: the case of Indonesia[1]

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Abstract

This paper attempts to explain the relative importance of monetary transmission channel to inflation of passing the elongated shock to the risk premium for the case of Indonesia. How monetary policy should respond optimally to the shocks, given the distinctive monetary transmission, is another objective of the study. This paper shows that nominal exchange rate depreciation, triggered by a more persistent shock to the interest risk premium, worsens the state of the economy in short and long run. Such distinctive shocks effect is transmitted through the economy that typifies inattentiveness of consumer price disinflation to monetary policy tightening. Such insensitivity is caused by high real rigidity, strong cost channel of interest rate, strong cost channel of exchange rate pass-through, weak demand-side channel of exchange rate pass-through, and weak aggregate supply channel of interest rate. The study suggests a proper monetary policy response, which is the smallest interest rate increases within the feasible set of monetary policy responses that the model recommends, to minimize the adverse effects of the shocks.

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1 Introduction

Adverse exchange rate shocks frequently hit Indonesia. Such particular shocks might occur in terms of frequent one time shocks or in a more persistent way during a longer period. The currency crisis that badly hit the country in 1997-1998 can be considered as a severe elongated shock to the risk premium that devalued the exchange rate and altered the economy's dynamic equilibrium. Invaluable lesson should be continuously learned to pursue better monetary management in anticipating possible recurrence of such crises. Better understanding of monetary transmission mechanism and its consequence to monetary policy limitation is therefore necessary and worthwhile.

Cost channel of monetary policy has been increasingly explored for the case of developed economies. Barth and Ramey (2001) provide empirical evidence for cost channel of monetary policy based on industry level data. Ravenna and Walsh (2006)

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sho ws that, if nominal interest rate adjustment directly affect real marginal cost, then interest rate policy directly affects inflation. They also show that any shock to the economy with the presence of the channel will generate a trade-off between stabilizing inflation and stabilizing output gap. Chowdhury, et al. (2006) applied a structural approach to find that the estimated direct cost effects of short-run nominal interest rates significantly contribute to the inflation dynamics in the majority of G7 countries.

Existing empirical studies on Indonesia's monetary transmission compiled in Warjiyo and Juda Agung (2002) did not include cost channel of interest rate. However, the study, which employed VAR method, found "price puzzle" in response to monetary policy tightening. This phenomenon is usually linked to either VAR misspecification or the possible existence of a strong cost channel of monetary policy. As an emerging economy with relatively low labour productivity, it is likely that capital accumulation has been the main source of Indonesia's output growth. Hossain (2006) estimated a Cobb-Douglas production function to find that capital accumulation accounts for 60 percent source of growth in Indonesia for the last forty years. It is in the spirit of the Young (1992) paper that claimed that growth in East Asian countries was mainly driven by high rates of capital formation. Combined with higher lending rate and lower wage than those in the advanced economy, one can argue that capital share (capital owner's income as a fraction of GDP) is greater than the labour share. This argument enhances the importance of investigating cost channel of monetary policy.

This study uses a new Keynesian dynamic general equilibrium model of a small open economy involving four domestic economic players, namely the household, the firm-producer, the government, and the central bank, which interact with the foreign economy. The model characterizes the household's money-in-the-utility function and the firm's constant elasticity substitution production that employs labour, capital goods,

and domestic and imported raw material. Interest rate policy is transmitted to the new Keynesian Phillips curve type of inflation through channels of aggregate demand, exchange rate pass-through, and cost of capital. I assume that the expectation channel of monetary policy is fully credible. It corresponds to the agent's rational price expectation and perfectly credible monetary authority, which utilizes a simple interest rate policy rule contingent to the state of shock. Shock to the interest rate risk premium is applied through a covered interest rate parity determination of exchange rate. The model is adapted and developed from optimizing models with staggered wage and prices-setting, which have been widely used in the literature on inflation and monetary policy[3].

The model is employed to observe the effect of short term persistent shock to the risk premium on the performance of an economy, which is intended to be close to the structure and behaviour of Indonesia's economy. The focus of this study are the relative importance of monetary transmission channel that pass the shock and interest rate response to inflation and how monetary policy should respond optimally to the particular type and state of the shocks, given the distinctive monetary transmission.

This paper shows that nominal exchange rate depreciation triggered by more persistent shocks to the interest risk premium worsens the state of the economy in the short- and long-run. The shocks are transmitted through the economy characterizing inattentiveness of consumer price disinflation to monetary policy contraction resulted from high real rigidity, strong cost channel of interest rate, strong cost channel of exchange rate pass-through, weak demand-side channel of exchange rate pass-through, and weak aggregate supply channel of interest rate.

The study suggests a proper monetary policy response, which is the smallest interest rate increases within the feasible set of monetary policy responses that the

[3] See, for example, Ravenna and Walsh (2006), Christiano et al. (2005), Smets and Wouters (2003), Erceg and Levin (2003), Woodford (2003), and Murchison (2004). The first two incorporated interest cost channel for monetary policy.

model recommends, to minimize the adverse effects of the shocks. Other economic policies might be necessarily complementary to the limited span of monetary policy that can in turn help strengthening the aggregate demand channel of interest rate. The most important one is policies that help reducing capital share of the economy's output and consecutively could weaken the cost channel of interest rate.

The organization of the rest of this paper is as follows. Section 3.2 presents a dynamic equilibrium model with prices and wage stickiness. Section 3.3 presents the simulation scenarios, parameter calibration and model solution. Section 3.4 analyses the simulation result. Section 3.5 concludes the study and infers some policy recommendations.

2 The model

This study extends the dynamic general equilibrium model used in Hutabarat (2007), which is a variant of optimizing models with staggered wage and prices-setting that have been widely used in literatures on inflation and monetary policy. I extend the model by incorporating the interest-rate risk premium on foreign-denominated asset as a function of the ratio of net foreign debt to GDP. Then, the balance of payment block is developed that results in the equations of current account, capital account, trade and service account, and net foreign asset. Moreover, I assume that the government also collects the income tax on the capital goods lessor's and the firm owner's dividend in addition to the wage income tax in the previous model. I also change the Cobb-Douglas production technology with a constant elasticity of substitution technology to allow lower elasticities of factor inputs' demand with respect to input prices. Therefore, it enables partial parameter estimations for some input demand equations. The model's extension is described as follows.

2.1 The household

The dynamic budget constraint is expressed in domestic currency's nominal and real terms as follows.

$$P_t c_t + M_t^d + B_t^{HG} + s_t B_t^{H*} + P_t k_t \le M_{t-1}^d + (1+i_{t-1})B_{t-1}^{HG} + (1+\tilde{i}_{t-1}^*)s_t B_{t-1}^{H*} \\ + P_t(1-\delta)k_{t-1} + (1-\tau_t)(W_t l_t + z_{t-1}P_t k_{t-1} + P_t^m im_t^{rm} + P_t \Pi_t) \tag{1.1}$$

$$c_t + m_t^d + b_t^{HG} + q_t b_t^{H*} + k_t - (1-\delta)k_{t-1} \le \frac{m_{t-1}^d}{1+\pi_t} + (1+r_{t-1})b_{t-1}^{HG} + (1+\tilde{r}_{t-1}^*)q_t b_{t-1}^{H*} \\ + (1-\tau_t)\left(w_t l_t + z_{t-1}k_{t-1} + p_t^m im_t^{rm} + \Pi_t\right) \tag{1.2}$$

Sources of household's revenues are income from supplying labour services (wages), selling imported intermediate goods, renting capital goods to the firm, owning firm (dividend) and selling the previous period's depreciated capital goods, as well as interest income on government bonds and foreign assets.

I assume that the household's net foreign asset position is negative $(B_t^{H*} < 0)$, meaning that the household is a net debtor of foreign asset. I further assume that foreign investors require a risk premium, κ_t, for the rate of interest, $\tilde{i}_t^*$, of foreign currency-denominated loans they extend to the domestic household, so that $(1+\tilde{i}_t^*) = (1+i_t^*)(1+\kappa_t)$. Hence the principal and interest income from foreign asset is $(1+i_{t-1}^*)(1+\kappa_{t-1})s_t B_{t-1}^{H*} < 0$.

I follow Al-Eyd and Hall (2006), Murchison, et. al (2004), and Schmitt-Grohe and Uribe (2003) in defining the country-specific risk premium, κ_t, which is a positive function depending on the net foreign debt-to-GDP ratio. The risk premium is also subject to a shock process, ε_t^{κ}, representing unforecastable changes in investor's preferences.

$$\kappa_t = \varsigma\left(e^{-\frac{s_t B_t^*}{P_t y_t}} - 1\right) + \varepsilon_t^{\kappa}, \tag{1.3}$$

where ς is scaling parameter, B_t^{H*} is net foreign asset, and $\varepsilon_t^{\kappa} = \omega_{\kappa}\varepsilon_{t-1}^{\kappa} + v_t^{\kappa}$; $v_t^{\kappa} \sim (0, \sigma_{\kappa}^2)$. The equation says that foreign asset interest-rate risk premium depends on net foreign debt, exchange rate, output, and exogenous shock to the risk premium. An increase in the net foreign debt (or a decrease in the net foreign asset), negatively affects the ability of domestic resident to repay the debt. An exchange rate depreciation increases the amount of domestic currency required to pay foreign debt and, in turn, worsens the domestic resident's ability to repay their foreign debt. A declining real income worsens the economy's capability for foreign debt repayment. The risk premium on the foreign debt is absent when foreign asset equals foreign debt and negative if net foreign asset is positive. The later means that the domestic household can enjoy a lower-than-world interest rate for its foreign debt.

From the maximization of household utility function with respect to labour supply and consumption, we can find the real marginal cost of working of the form

$$mc_t^w = \left(\frac{A_t^{\lambda(\nu-1)} c_t^{\sigma} (\alpha_L y_t)^{\lambda}}{1-\tau_t}\right)^{\frac{1}{\nu\lambda+1}} \tag{1.4}$$

The household rents out capital goods to the firm with real rental rate of capital, z_t, which is obtained by combining the first order condition of utility maximization with respect to the real capital stock and the nominal domestic bonds as follow

$$z_t = \frac{r_t + \delta}{1 - E_t \tau_{t+1}} \tag{1.5}$$

Real rental price of capital that the household-lessor charges to the firm should cover real interest rate, depreciation rate of capital and the expected future income tax rate.

Real marginal cost of imports equals the real import price equation when prices are fully flexible, which is the real exchange rate divided by disposable income rate.

$$mc_t^m = \frac{q_t}{1-\tau_t} \tag{1.6}$$

Nominal exchange rate is obtained by combining the first order condition of the household's utility maximization with respect to the nominal domestic and foreign bonds, which implies the covered interest rate parity.

$$s_t = E_t s_{t+1}\left(\frac{1+i_t^*}{1+i_t}\right)(1+\kappa_t) \tag{1.7}$$

In order to obtain the household's financial assets and financial account, we can elaborate the equality of nominal budget constraint (1.2) by substituting the firm's real profit $(\Pi_t = y_t - w_t l_t - p_t^m im_t - z_{t-1}k_{t-1})$, capital accumulation equation, $[k_t = (1-\delta)k_{t-1} + iv_t]$, and the decomposition of real investment as domestic and imported capital goods $(iv_t = iv_t^d + im_t^{kg})$. We can further substitute the decomposition of imported goods as finished goods, intermediate goods and capital goods $(im_t = im_t^{rm} + im_t^{cg} + im_t^{kg})$, and take into account that the domestic output, y_t, is supplied to the domestic household as consumption goods (c_t^d), to the firm as additional capital goods (iv_t^d), to the government as consumption and investment goods (g_t), and to the foreign importers as exported goods (x_t). These substitutions result in the household's dynamic real budget constraint that can be rearranged to get the household's real financial assets of the form

$$b_t^H = (x_t - q_t im_t) + g_t + [(1+r_{t-1})b_{t-1}^{HG} + (1+r_{t-1}^*)(1+\kappa_{t-1})q_t b_{t-1}^{H*}] - \tau_t y_t - \left(m_t^d - \frac{m_{t-1}^d}{1+\pi_t}\right) \tag{1.8}$$

where b_t^H is the household's real financial investment on the government bonds and foreign bonds in period t, which is equal to their net real revenues as exporter and importer and as the supplier of goods for government, plus the principal and interest real income from the previous period's financial investment, minus the real income tax expenditure and changes in real money holding.

2.2 The firm-producer

The firm produces output using a Constant Elasticity of Substitution (CES) production technology that utilizes labour, capital, and foreign and domestically produced intermediate goods as production input. The aggregate real output of the economy takes the form

$$y_t = \left(\alpha_L^{\frac{1}{\nu}} (A_t l_t^d)^{\frac{\nu-1}{\nu}} + \alpha_K^{\frac{1}{\nu}} (u_t k_{t-1})^{\frac{\nu-1}{\nu}} + \alpha_M^{\frac{1}{\nu}} (im_t^{rm})^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}} \tag{2.1}$$

where $\alpha_L, \alpha_K, \alpha_M$ are labour, capital and import share, respectively, which are assumed to be constant and form the constant return-to-scale technology of production, and ν is the elasticity of substitution between factor inputs. The objective of the firm is to choose the level of factor inputs that maximize its present discounted values of lifetime real profit, which is the deviation of total real revenues from total real cost.

$$\Pi_t = \left(\alpha_L^{\frac{1}{\nu}} (A_t l_t^d)^{\frac{\nu-1}{\nu}} + \alpha_K^{\frac{1}{\nu}} (u_t k_{t-1})^{\frac{\nu-1}{\nu}} + \alpha_M^{\frac{1}{\nu}} (im_t^{rm})^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}} - w_t l_t^d - p_t^m im_t^{rm} - z_{t-1} k_{t-1} \tag{2.2}$$

The employment equation is given by the first order condition with respect to labour demand

$$l_t^d = \frac{\alpha_L A_t^{\nu-1} y_t}{w_t^{\nu}} \tag{2.3}$$

From the first order condition of the firm's profit maximization, we can obtain the demand for the imported intermediate goods of the form

$$im_t^{rm} = \frac{\alpha_M y_t}{p_t^{m^\nu}} \tag{2.4}$$

The firm's stock of capital goods required for production is obtained from the first order condition of the firm's profit maximization with respect to the capital:

$$k_t = \frac{\beta \alpha_K E_t u_{t+1}^{\nu-1} E_t y_{t+1}}{z_t^{\nu}} \tag{2.5}$$

The real marginal cost of producing goods is derived from the firm's real cost minimization problem in which the aggregate firm chooses the level of factors inputs that minimize the aggregate total real cost, $tc_t = w_t l_t + p_t^m im_t^{rm} + z_{t-1} k_{t-1}$, subject to the CES production function (2.1). The aggregate firm's real marginal cost, mc_t^d, is expressed as a function of real wage, real rental price of capital, real import price and the level of technology of the form:

$$mc_t^d = \frac{w_t}{A_t \alpha_L^{\frac{1}{\nu-1}}} \left(1 + \frac{1}{\alpha_L} \left(\frac{w_t}{A_t} \right)^{\nu-1} \left(\alpha_K \left(\frac{u_t}{z_{t-1}} \right)^{\nu-1} + \alpha_M \left(\frac{1}{p_t^m} \right)^{\nu-1} \right) \right)^{-\frac{1}{\nu-1}} \tag{2.6}$$

2.3 The fiscal authority

Government expenditure is financed through collecting income tax on the importer's, capital goods lessor's, and firm owner's dividend or issuing domestic- and foreign-denominated bonds. The government's nominal dynamic budget constraint is expressed as

$$B_t^{GH} + s_t B_t^{G*} + \tau_t P_t y_t + M_t^s - M_{t-1}^s = (1+i_{t-1}) B_{t-1}^{GH} + (1+i_{t-1}^*)(1+\kappa_{t-1}) s_t B_{t-1}^{G*} + P_t g_t \tag{3.1}$$

where $B_t^G = B_t^{GH} + s_t B_t^{G*}$ is the government revenue from issuing domestic bonds (B_t^{GH}) and the government foreign debt (B_t^{G*}), $\tau_t P_t y_t$ is the tax revenue, $(M_t^s - M_{t-1}^s)$

is seignorage revenue, g_t is real government spending, and s_t is nominal exchange rate. The government real debt, which comprises its debt to the household and to the foreign economy, $b_t^G = b_t^{GH} + q_t b_t^{G*}$, takes the form

$$b_t^G = g_t + \left((1+r_{t-1})b_{t-1}^{GH} + (1+r_{t-1}^*)(1+\kappa_{t-1})b_{t-1}^{G*}q_t\right) - \tau_t y_t - \left(m_t^s - \frac{m_{t-1}^s}{1+\pi_t}\right) \tag{3.2}$$

2.4 The real net foreign debt and financial account

The real net foreign debt, d_t^*, is obtained from the household's and the government's real budget constraints. It is used to finance trade deficit and repay the previous period's foreign debt.

$$d_t^* = (im_t - x_t / q_t) + (1+r_{t-1}^*)(1+\kappa_{t-1})d_{t-1}^* \tag{4.1}$$

The financial account (foreign debt flow), FA_t, is the total of changes in the government's net foreign debt and changes in the private sector's net foreign debt. We can get the national debt flow from the household and the government's nominal budget constraints by assuming that the government's domestic debt equals the household's holding on government bonds $(B_t^{GH} = B_t^{HG})$, that the foreign residents don not hold government domestic-denominated bond, and the equilibrium of money holds.

$$FA_t = \left(P_t^* im_t - P_t x_t / s_t\right) - [(1+i_{t-1}^*)(1+\kappa_{t-1}) - 1]B_{t-1}^* \tag{4.2}$$

2.5 The goods market equilibrium

The equilibrium of goods market is defined by resource constraint that equate the aggregate demand for output with the aggregate supply of output (2.1) of the form

$$c_t + g_t + iv_t + x_t - im_t = \left(\alpha_L^{\frac{1}{\nu}}(A_t l_t^d)^{\frac{\nu-1}{\nu}} + \alpha_K^{\frac{1}{\nu}}(u_t k_{t-1})^{\frac{\nu-1}{\nu}} + \alpha_M^{\frac{1}{\nu}}(im_t^{rm})^{\frac{\nu-1}{\nu}}\right)^{\frac{\nu}{\nu-1}} \tag{5}$$

3 Simulation Scenario and Parameter Setting

I conduct a simulation by applying an eight-quarter one percentage point positive exogenous shocks to the risk premium equation[4]. The type, magnitude and length of the shock are meant to resemble a moderate currency crisis. The objective of the simulation is to evaluate the effect of such shocks on economic performance, in particular the exchange rate, balance of payment and monetary policy response. By applying one single type of shock, it is implicitly assumed that other kinds of shocks are not present and the economy is not pursuing disinflation. I also conduct a one-time exogenous shock to the interest rate policy in order to confirm how the channel of monetary transmission works.

Table 1 exhibits the parameter calibration. The discount factor of the firm, the importer and the wage setter, β, is set at unity. From the consumption Euler equation, we get the steady-state real interest rate that equals the household's rate of time preference. Setting the real interest rate at 0.02 corresponds to the household discount factor, ϑ, at 0.98. The economy's structure of output and demand for output are assumed to aproximately follow current figures. The share of capital goods, labour and imported intermediate goods in the aggregate output of the economy are set at α_K = 0. 5, α_L = 0.35, and α_M = 0.15.

Government spending-to-GDP ratio is set at α_g = 0.18 and export-to-GDP ratio at $\alpha_x = 0.28$. The share of imported consumption good in total consumption, α_{mcg}, and imported capital goods in total investment, α_{mkg}, are both 0.14. The share of government bond in household's assets, α_{HG}, is assumed equals 0.5, and the share of

[4] Steady-state values and the simulation paths are solved by using GAMS software that employ the Generalized Reduced Gradient method of solution for non-linear programming problems (Rosenthal (2006), Drud (2006))

domestic debt in government liabilities, α_{GH}, is 0.6. The ratio of debt to GDP in steady-state is 20%.

Some parameters are estimated partially over the post-crisis period using ordinary least square method. All data are adjusted to the same base year of 2000. The resulting estimated equation of real consumption is (standard errors in brackets):

$$\ln c_t = \ln c_{t+1} - \underset{(0.00067)}{0.003778} * (\ln(1+r_t) + \ln(0.98))$$

Where c_t is the quarterly level of real private consumption and r_t is the real ex ante 3 month deposit rate. Real money demand equation is estimated using real M1 and nominal 3 month deposit rate as follow:

$$\ln m_t = \underset{(0.00355)}{1.02154} * \ln c_t - \underset{(0.00115)}{0.008331} * i_t$$

The real exports is estimated using data of real effective exchange rate and index of real GDP volume of six importing partner countries.

$$\ln \boldsymbol{x_t} = \underset{(0.000201)}{\ln(0.00018)} - \underset{(0.19581)}{0.0155} * \ln \boldsymbol{q_t} + \underset{(0.27309)}{2.8718} * \ln \boldsymbol{y_t^*}$$

Table 1
Model Calibration

Parameter	Description	Value
ϑ	the household's discount factor	0.98
β	the firm's, importer's and wage setters' discount factor	1
σ	inverse of consumption intertemporal elasticity of substitution	265
ρ	inverse of nominal interest rate elasticity of real money holding	120
λ	inverse of the real wage elasticity of labour supply	500
δ	depreciation rate of capital	0.01
ν	elasticity of substitution between factor inputs	0.3
$\alpha_{\boldsymbol{K}}$	capital share	0. 5
$\alpha_{\boldsymbol{L}}$	labour share	0.35
$\alpha_{\boldsymbol{M}}$	imported intermediate goods share	0.15
$\alpha_{\boldsymbol{M}}^*$	share of domestic country's export in the rest of the world's total demand	0.00018
$\alpha_{\boldsymbol{mcg}}$	share of imported consumption good	0.14
$\alpha_{\boldsymbol{mkg}}$	share of imported capital goods investment	0.14

α_g	ratio of government expenditure-to-output	0.08
α_x	ratio of exports-to-output	0.28
η	real exchange rate elasticity of exports	0.015
θ	degree of price stickiness	0.35
θ^m	degree of import price stickiness	0.1
θ^w	degree of wage stickiness	0.75
γ^w	degree of wage indexation to lag inflation	0.9
ψ	target of fiscal deficit ratio	2%
χ	degree of interest rate inertia	0.5
α_π	monetary policy response parameter	very large
Θ	fiscal policy response paramater	0.5
ς	scaling parameter of risk premium	0.00000001
α_{HG}	share of government bond in household's assets	0.5
α_{GH}	share of domestic bond in government liabilities	0.6

As a result of the estimations, I set the real consumption intertemporal elasticity of substitution at σ^{-1}= 0.0038, nominal interest rate elasticity of real money holding at ρ^{-1}=0.0083, real exchange rate elasticity of exports at η= 0.015, and the share of Indonesia's export in the rest of the world's total demand at α_M^* = 0.018%. I calibrate the real wage elasticity of labour supply at λ^{-1}= 0.002, due to lack of data. This value is much lower than the estimated elasticity in developed economies commonly used in related research. This reflects a labor market that is characterized by low real level of wage income, excess supply of labour and low appreciation for leisure time. The constant elasticity of substitution between factor input is set at ν = 0.3.

The degree of price rigidity of domestically-produced goods, θ, is set at 0.35 implying that the average time between domestic price adjustment is about one and a half quarters. Domestic price of imported goods is assumed less rigid than domestically-produced goods (θ^m = 0.1), implying the average duration of import price is 3.3 months. In setting the rigidity parameter, I refer to business price setting survey for Indonesia's economy in Darsono et al. (2002), which found that manufacturing goods

prices stay an average of 4.6 months and that exchange rate changes is passed-through to import price in the same quarter. Wage rigidity is assumed at θ^{w} = 0.75, corresponding to yearly nominal wage changes. However, the refference for wage changes heavily base on previous wage inflation rather than forward looking optimal price setting. This behaviour is reflected in parameter γ^{w} that is equal to 0.9.

The coefficient of inflation feedback parameter in the simple interest rate rule is set at a value that minimizes the present discounted value of dynamic welfare loss over a hundred quarters after the shock. The loss function is symmetric of the form $L = E_t \sum_{s=0}^{\infty} \beta_L{}^{s} \left((\pi_{t+s} - \bar{\pi})^2 + (y_{t+s} - \bar{y})^2 \right)$, where monetary policy makers have equal preferences on both inflation and output stabilization. The inflation feedback coefficient is contingent on the magnitude and extent of a shock to the risk premium. I search the optimal policy feedback coefficient by fixing the interest rate smoothing coefficient at χ =0.5, reflecting equally backward- and forward-looking behaviour of the monetary authority in formulating interest rate policy. Figure 1 shows the range of feasible inflation feedback parameters when interest rate responds to a future period's inflation gap. The figures show that the feasible set of the monetary authority response to the risk premium shock is a rising interest rate. However, the optimal response, which produces the lowest inflation effect and the smallest short-run output contraction, is the smallest interest rate increases within the feasible set. The highest interest rate increase in the set corresponds to the most nonoptimal response.

4 Simulation Results

4.1 Exchange rate and balance of payment

Figure 2 exhibit the responses to an eight-quarter one percentage point shock to the risk premium. Nominal exchange rate contemporaneously depreciates as a response to risk

premium shock, but its extent is lowered by immediate interest rate response. The exchange rate depreciates further as the shock persists for eight periods with the existence of a unitary expectation channel of the nominal exchange rate. The rate of nominal exchange finally achieves a new, weaker steady-state level when the nominal rate of interest returns to and stabilizes at the initial rate, leaving the expectation channel works solely.

The real exchange rate initially weakens against the baseline level but is lower than the depreciation of nominal exchange rate. It then strengthens as the relative price of foreign to domestic goods declines more than the nominal exchange rate depreciation. The real exchange rate finally returns to its initial steady-state level as the new deteriorated nominal exchange rate is offset by a higher new steady-state price level. Real export follows the movement of real exchange rate in the absence of changes to foreign demand. With a very low elasticity of real export with respect to real exchange rate, real export only moves up by about 0.003%. It then falls below initial steady-state when the real exchange rate strengthens several quarters after the shock.

Following an increase in real import price, real import falls by about 1.5%, much larger than the increase of real exports in the early period of shocks. Foreign price value of imports declines sharply since foreign price quarterly inflation stays the same. On the other side, foreign price value of exported goods also declines accordingly as the nominal exchange rate depreciates more than an increase in real export and consumer price. The net effect is a huge jump in trade surplus, exhibiting an inverted J-curve phenomenon. Indonesia's trade surplus and real exports and imports in the period of currency crisis justify the simulation result, to some extent, in terms of direction of related variables. Figure 3 shows that in the aftermath of currency crisis in 1998, when

nominal exchange rate depreciated by 123%, real exports expanded 11.2% and real imports contracted 2.9%, resulted in 83% trade surplus increases.

The movement of output, real import price and consumer inflation influence the following cyclical pattern of trade account. Real import rebounds as an aggregate demand and output recovered and real import price lessens, resulting in a higher foreign price value of imports. Conversely, external demand for domestic goods decreases due to the appreciation of real exchange rate, leading to a lower foreign price value of exports. Trade surplus gets back toward initial level and finally stabilizes in the long-run at a slightly lower level than the initial steady-state value. Some factors affect trade surplus dynamic. Exchange rate depreciation affects the volume of imports more than that of export since import price is less rigid than the domestic price of exported goods. Moreover, imports plunges by significantly more than an upsurge of export in the short-run owing to quite high import content in production structure. In addition, real import price elasticity of imports is higher than real exchange rate elasticity of exports so that the sum of the elasticity is less than unity. The last factor explains why the Marshall-Lerner condition does not hold. Hence the shock to the risk premium could worsen trade balance in the long term.

This result is in line with an empirical study on J-curve effect. Using a VECM model on the quarterly data of Indonesia and its trading partners, Husman (2005) concluded that the J-curve phenomenon is not found in the aggregate level data. It is only found in the case of the bilateral trade account with Japan, South Korea and Germany. However, unlike this model simulation's result, she suggested that the condition of Marshall-Lerner is satisfied in the overall sample, implying the Rupiah's depreciation will increase the Indonesia exports in the long-run. She further found that although the Marshal-Lerner condition is satisfied, the exchange rate elasticity of

bilateral trade account is quite small. One percent change of real exchange rate only increases export to import ratio by 0.37%. Different finding regarding Marshall-Lerner condition might imply an overestimated price elasticity of imports assumed in this study.

Short-run improvement of the trade account surplus enables the economy to reduce its net foreign debt. Afterwards, as trade account surplus worsens in the medium run and at last stabilises below its initial steady-state level, the economy has to increase net foreign debt continuously in the long-run. In line with the net foreign debt's dynamics, service account deficit improves in the short-run then is getting worse in the long-run, diverging from initial steady-state level. Overall, deficit current account lessens in the short-run because a better trade account surplus is enhanced by a smaller service account deficit. Ultimately, current account deficit becomes stable in the long-run at a worse level. The surplus of the flow of net foreign debt (financial account) decreases in the short-run, then increases in the medium-run and reaches a higher steady-state surplus in the long-run.

4.2 Demand for and supply of input and output

The aggregate demand channel of interest rate policy works through exports, consumption and investment. Consumption drops off contemporaneously as the expected lower future consumption outweighs a small decrease in the current real interest rate. It further decreases in several more periods as the real interest rate increases in the following periods. When real interest rate closely approaches its initial steady-state value in the long-run, consumption stabilises at a higher new steady-state. The very small intertemporal consumption elasticity of substitution, combined with the unitary elasticity of current consumption with respect to expected future consumption, explains such consumption behaviour.

When the shock to the risk premium hits the economy, demand for the stock of capital goods, to be utilized in the next period, falls. Expected weakened aggregate demand in the following periods is behind the firm decision to ration its capital stock. This is often called as the firm's balance sheet channel of interest rate to aggregate demand. A stronger external demand for domestic goods and domestic demand for domestic intermediate and final goods dampen the contraction in investment demand. The net effect is a fall in aggregate demand for domestic output in the wake of the shock. Thus, exchange rate depreciation triggered by a temporary shock to the risk premium is contractionary to output.

Demand for other factor inputs drops as well. As import price is less rigid, a depreciated real exchange rate leads to a more expensive real import price. Combined with a contemporaneous lowered aggregate demand, this strongly discourages demand for imported intermediate goods.

Employment falls because it is more affected by a much weakened aggregate demand than by a slightly more inexpensive real wage. This result is caused by the unitary elasticity of wage with respect to real output and low elasticity of labour supply with respect to real wage.

4.3 Costs, Prices and Inflations

A squeezed labour demand brings downward pressure on the real marginal cost of working. On the other side, as the demand for consumption decreases, leisure decreases as well hence increases the supply of labour and puts a downward pressure on the real marginal cost of working. Since nominal wage is quite rigid and highly indexed to its past inflation, nominal wage is not responsive to changes in the real marginal cost of working resulted from immediate adjustment in consumption and output.

Real wage declines because output price goes up and is more flexible than wage. Therefore, the immediate domestic inflation response to a lower aggregate demand is decreasing. In the following period of shock, investment starts to increase and consumption get stronger, causing upward pressure to the real marginal cost of working and wage inflation. Real wage is still below the initial steady-state level temporarily due to a more flexible output price than wage. Therefore, throughout the shocks period, the inflation response to a higher aggregate demand is decreasing. In addition, it is interesting to see that when interest rate rises in the absence of other shock, aggregate demand channel, unfortunately, passes the interest rate hike to an increasing domestic inflation (Figure 4). The explanation is that, as output shrinks, demand for labour weakens hence reducing real marginal cost of working. However, the resulted real wage flexibility puts upward pressure on domestic inflation.

Low real wage rigidity resulted from high nominal wage rigidity and low prices rigidity suggests a high real rigidity. It shows low willingness of individual firm to change their relative price in response to a change in real output resulting from variations in real aggregate demand. A larger real rigidity corresponds to a greater consideration on competitor prices in price-setting behaviour: when real rigidity is high, each firm wants its price to move more closely with other prices (Romer, 2006). Bank Indonesia's business price setting survey (Darsono et al., 2002) revealed that the cost-based approach is the most widely adopted price setting strategies among manufacturing and trading companies. The finding can justify the presence of price rigidities. It reflects the firm's reluctance to change prices when no cost changes occur. The survey also found that 'cost plus variable profit margin' and 'competitor prices' are the next most price setting methods used in manufacturing and retail firms, while 'market condition' is not the important factor in price setting policy. The survey results can be interpreted

as the low nominal price rigidity in response to cost changes and high price flexibility in response to changes in competitor price. The latter means a high real rigidity, which is a high real price (relative price) rigidity in response to changes in real output stimulated by alteration in aggregate demand[5].

The risk-premium-induced exchange rate depreciation is passed-through to domestically-produced goods inflation using three channels. First, direct pass-through via the cost of imported intermediate goods, which has an increasing effect on domestic inflation. Second, indirect pass-through via demand for imported factors input, which has a decreasing effect on domestic inflation. Third, indirect pass-through via external demand for domestic output. The latter has a decreasing effect on domestic inflation as well since an increased exports put small upward pressure on the rigid wage thus, with less rigid output price, causes a decline in real cost of employment.

A direct cost-push pass-through of exchange rate to domestic inflation strongly dominates its demand side pass-through because of several factors. First, a high import content in production structure. Second, a very low real exchange rate elasticity of export. Third, a high wage rigidity, which means a low aggregate demand elasticity of wage inflation. Fourth, a low real import price elasticity of demand for imported intermediate goods. The pass-through to consumer inflation is even higher as it is a combination of net cost-push pass-through to domestic inflation and direct cost-push pass-through of imported consumption goods to consumer inflation.

Large weight on the cost of capital reflects a strong cost channel of interest rate policy, which gives an upward pressure to domestic inflation. It amplifies the strong

[5] Romer (2006) explains that, assuming the stylized aggregate demand curve, $\ln y = \ln M - \ln P$ (where M reflects factors that shift aggregate demand), the real rigidities expression for the representative firm's profit-maximizing relative price, $\ln \boldsymbol{P_i^*} - \ln \boldsymbol{P} = \phi \ln \boldsymbol{y}$, implies $\ln P_i^* = \phi \ln M + (1-\phi) \ln P$, where high real rigidity is indicated by low ϕ.

pass-through extent of risk-premium-induced exchange rate depreciation to a higher domestic price. However, a lowered real interest rate in the first period of shock helps dampening a rise in domestic inflation as the real marginal cost of production decreases in that period.

4.4 Tax, interest rate and money

As a consequence of a lesser aggregate demand, the government faces a reduced tax base and a higher interest payment on the existing debt. Thus, the fiscal authority needs to raise the tax rate and increases debt financing to keep its consumption expenditure constant amid pressure from a rising primary deficit. Since the tax rule responds to the primary deficit, a higher debt interest payment has no strengthening effect on tax increase. Accordingly, government debt is sustainable but the economy needs a longer time to bring down the government debt toward its initial path.

An increase in tax rate has a tiny effect in dampening down the inelastic labour supply, causing a slight upward pressure on the real marginal cost of working. However, its pass-through to wage is in a much smaller magnitude since the wage is quite rigid. As output price is more flexible than wage, the immediate domestic inflation response to a higher interest rate through the aggregate supply channel of interest rate policy is decreasing but exceedingly weak.

The model recommends the central bank to raise per annum interest rate up to the level that is 1.34 percentage points higher than the initial rate in one year after the initial shock. It then needs to be lowered but stays above the steady-state values for nine quarters, before finally stabilizes around the initial rate of 7%. This interest rate response still results in a one percentage point peak jump of year-on-year consumer inflation.

The response of interest rate manages to ease the inflationary effect of exchange rate depreciation. It is unable to eliminate the effect of shock due to strong cost channel of monetary policy, strong cost channel of exchange rate depreciation, interest smoothing purposes and minimization of both output and inflation variability from their target. Real interest rate is below steady-state in the first period because an increase in inflation is greater than a rise in interest rate. As nominal interest rate increases further by more than an increase in consumer inflation, the ex ante real interest rate starts to go up temporarily up to a level that is 1.28 percentage points above the initial steady-state rate of 2%.

It is important to highlight the impact of implementing nonoptimal monetary policy response, which corresponds to the highest interest rate increase among the feasible response parameter. Figure 5 shows that such policy response results in a worse state of the economy in both the short and long-run: a higher nominal interest rate, more volatile real interest rate, more volatile domestic inflation, higher output contraction and variation, higher unemployment, more depreciated exchange rate, higher money, higher net foreign debt, lower long-run trade surplus, and more volatile fiscal deficit.

Both simulations reveal how strong the cost channel of monetary policy is. The interest rate rise results in upward pressure on domestic inflation through an increased cost of capital, which is further magnified by an increased inflation stemmed from the aggregate demand channel. The only source of downward pressure to domestic and consumer inflation is a decreasing real cost of importing goods caused by appreciated exchange rate in the economy that features a more flexible import price than the domestic price and high import content. A strong cost channel of interest rate policy, more rigid wage than output price and high wage indexation to its past inflation account for the inattentiveness of consumer price disinflation to interest rate increase.

Macroeconometric model of Bank Indonesia even predicts a weaker power of interest rate tightening in combating consumer inflation. It suggests that one percentage point increase in interest rate can only reduce consumer inflation by around 0.06 percentage point. The difference of the empirical finding with the simulation result of this study might be explained by the model limitation. In this study, the simulation model does not take into account the asymmetric price and wage rigidity, in which wage is perfectly rigid downward and prices are stickier downward. Nominal exchange rate response to interest rate changes might also be asymmetric so that real import price does not decline that much. Moreover, the model's implied assumption of full central bank credibility leads to a strong reaction to interest rate changes among the price setters who behave fully rationally in their price expectation.

Real money demand, which is the opportunity cost of holding money by giving up both consuming goods and having return on money, falls off in the short-run and achieves a higher steady-state value in the long-run. The immediate response is not owing to the interest rate rise but rather simply follows the pattern of real consumption. This is due to a high real consumption elasticity of real money demand of $\sigma / \rho = 2.2$ despite small changes in consumption. On the other hand, low nominal interest rate elasticity of real money demand $(1/\rho = 0.0083)$ dampens down the effect of relatively large interest rate increase. Therefore, a weakened demand for consumption goods strongly lowers the demand for money holding.

The short-run fall in the real money demand is less than the increase in the consumer price. Therefore, when the central bank responds to the risk premium shock by raising the interest rate, nominal money supply has to be higher to clear the money market. In this case, the direction of money and interest rate is contradictory, in the sense that monetary policy is tight in terms of interest rate but loose in terms of money

supply. However, in the case of an interest rate policy shock with the absence of other shocks, in which a one-time increase in interest rate permanently lowers consumption, a one-occasion interest rate tightening corresponds to a permanently lower money balance.

Table 2
Correlation between currency growth and interest rate

Period	Coefficient of correlation	
	1-month SBI rate	3-month deposit rate
1990Q1-1997Q2	-0.33	-0.65
1997Q3-1998Q4	0.84	0.42
1999Q1-2007Q1	-0.13	-0.28

Table 2 shows that the interest rate became positively correlated with the growth of currency during the currency crisis. However, the relation was partly due to a massive increase of liquidity support combined with a large increase in interest rate. Moreover, Figure 6 shows that an increase (a decrease) in Bank Indonesia interest rate policy (SBI rate), which is positively highly correlated with changes in deposit rate, does not necessarily slow down (speed up) the growth of currency in circulation over the post-crisis period. The negative correlation between interest rate and the growth of currency weakened during the period as shown in Table 2. Since money growth and policy interest rate could move in the same direction, the tightening or easing stance of monetary policy should, therefore, only be represented and clearly communicated by interest rate policy.

5 Conclusion

This study found that, even in the presence of monetary policy response, a nominal exchange rate depreciation, triggered by a two-years shock to the interest risk premium, causes the economy to suffer in the short-run from a higher inflation, lower output, higher nominal and real interest rate, higher import price, higher cost of capital, lower

investment, higher fiscal deficit and debt, higher tax rate, and higher unemployment. The shocks will even be worse for the economy in the long-run. It is characterised by a weaker nominal exchange rate, higher real import, lower export-to-import ratio, higher real wage and lower employment, and worse balance of payment (higher import, lower trade surplus, higher current account deficit, higher capital inflow, increasing net foreign debt, higher but decreasing government debt). However, an appropriate monetary policy response, which is the smallest interest rate increases within the feasible set of interest rate responses, should manage to reduce such adverse effects.

Such property of shocks occurs because of the weak response of disinflation to increases in interest rate policy, which stems from the combination of high real rigidity, and a strong cost channel of interest rates and exchange rate pass-through. Both aggregate demand channel of interest rates and demand-side channel of exchange rate pass-through have a weak effect on inflation.

Some policy implications might be appropriate. Such characteristics of monetary transmission complicate an optimal monetary policy response. The central bank might be better pursuing a lower demand-induced inflation when adverse shock is nonexistent or in the presence of favourable supply shocks. When disinflation is successful, interest rate can, in turn, be lowered and finally helps reduce the cost channel of interest rate and strengthen the aggregate demand channel.

Since the exchange rate shocks and cost-push shocks frequently harm the economy, other policies are necessary to complement monetary policy that can in turn help strengthen the aggregate demand channel of monetary policy. The important thing is that the cost channel of interest rate needs to be weakened. It implies that the proportion of domestic income that goes to capital owner, investor or lender, should be reduced.

Production structure switching, by increasing labour-intensive goods producers, could be a proper industrial policy to help reducing capital share of output.

Other possible policies are the ones that contribute to the reduction of cost of capital. This model and its simulation result are unable to suggest such policies that directly reduce cost of capital, as the absence of the bank lending channel implies the equality of central bank policy rate and bank lending rate. However, when the channel exists, policy suggestions that encourage the reduction of financial intermediary's marginal cost and profit margin might be able to reduce the cost of physical capital. Other policies are the ones that help cut the nonmonetary-induced inflation, which in practice, will indirectly reduce cost of capital for a given real interest rate and spread between lending and deposit rate. In the modelling framework of this study, the success of such policies will directly decrease both lending and policy rates. Given that price equals marginal cost plus profit margin, such policies are in the form of (i) reducing nonmonetary-induced marginal cost, (ii) decreasing profit margin, and (iv) enhancing profit margin flexibility to cost increases[6]. Nonmonetary-induced marginal cost, which is not modelled in this study, might take the form of marginal cost of 'external labour'[7] and other determinants of marginal cost that are not included in marginal cost equation (eq. 2.6).

Finally, it is important to address the model limitations that should be taken into account when interpreting the simulation result for policy purposes. This model is still deficient in its bank lending channel, implying the absent of banks and that the central bank is part of the government. The other crucial point is the model's less realistic

[6] The price of domestically produced goods can be set as nominal marginal cost multiplied by gross profit margin, $P = MC^d(1+\mu)$, in which $mc^d = mc^{dm} + mc^{dnm}$, where $\boldsymbol{mc^{dm}}$ is monetary-induced real marginal cost, as in (2.6), $\boldsymbol{mc^{dnm}}$ is nonmonetary-induced real marginal cost and μ is net profit margin.

[7] Cost of 'external labour' is the extra cost firms have to spend persistently, for any given reasons, for persons who are not the firm's employees or do not supply their labour in the form of production input.

assumption of symmetric nominal wage and prices rigidities. It would be interesting to find out how the economy reacts in the presence of bank as financial intermediary. Finally, it would be useful to assess the real effect of monetary policy under asymmetric prices and wage rigidities. This could open opportunities for further research.

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Appendix

A. Figures

Figure 1 Range of Feasible Response Parameter

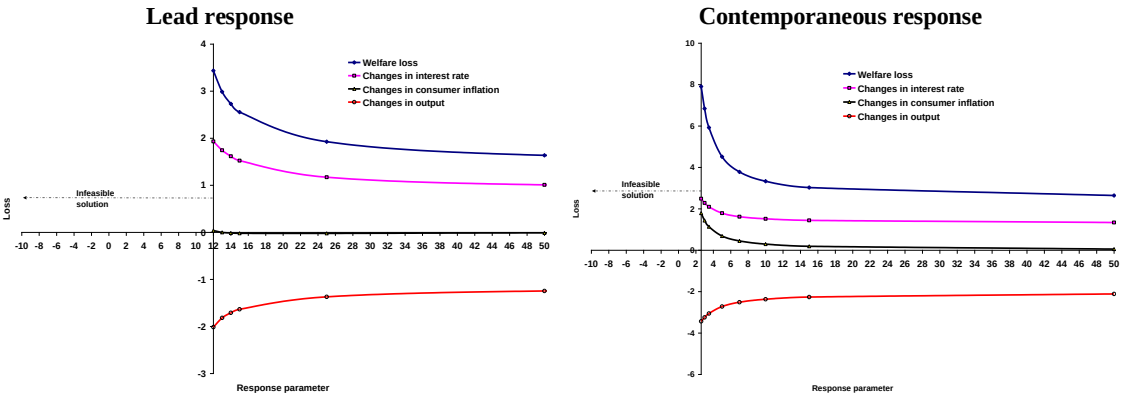
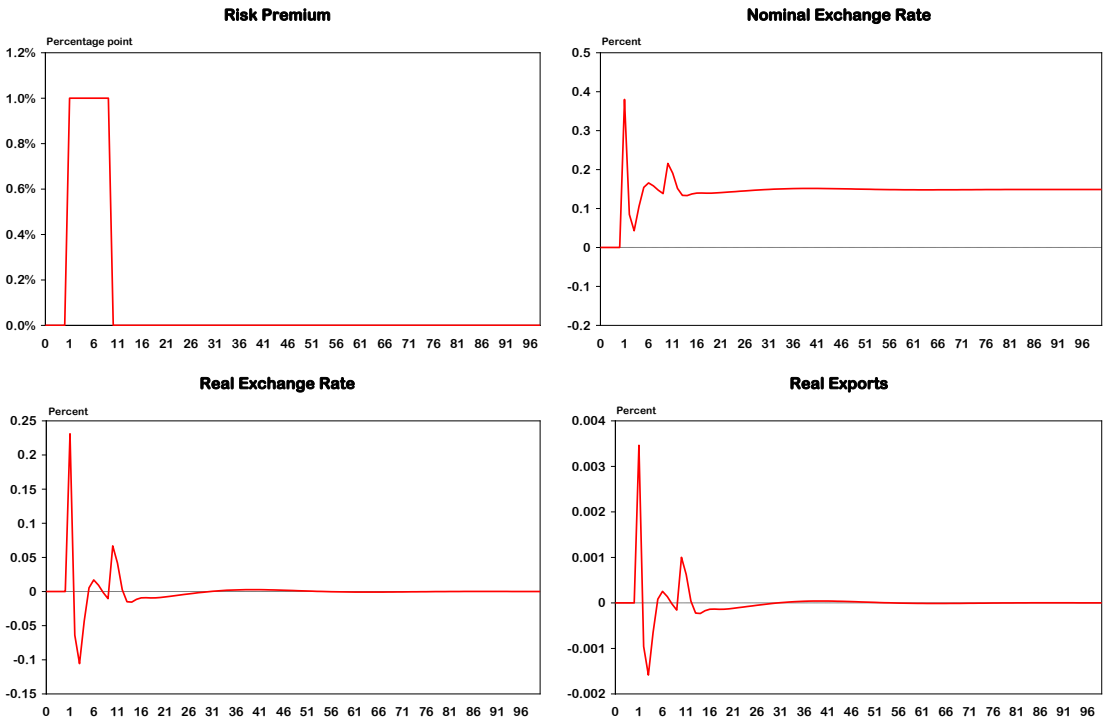
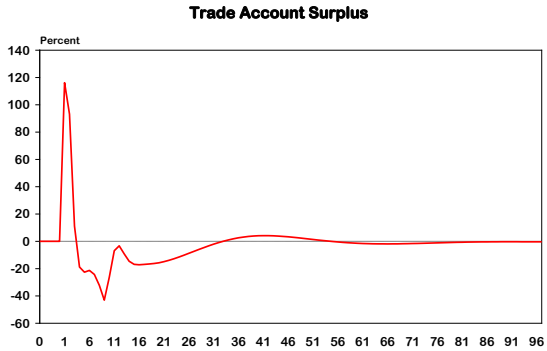
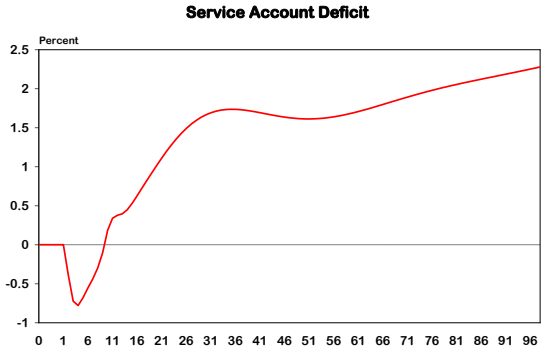


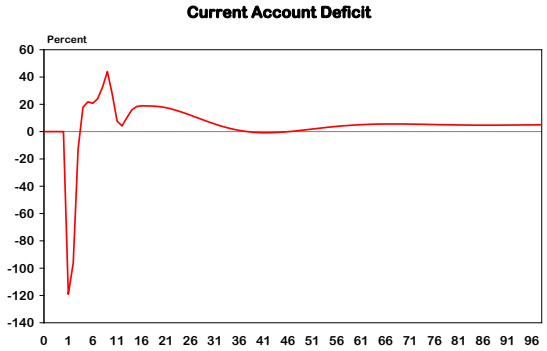
Figure 2 Responses to an eight-quarter one percentage point shock to the risk premium
(percent or percentage point deviation from baseline initial steady-state)

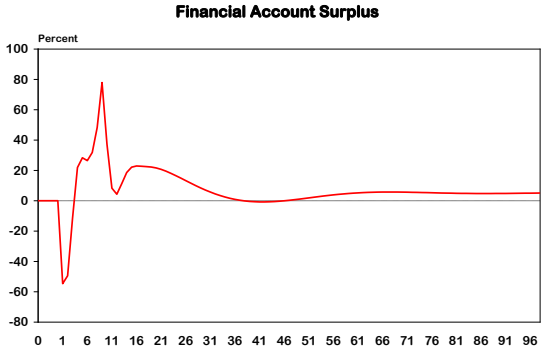


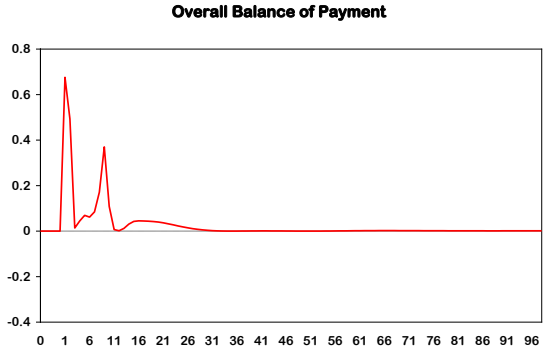

Real Imports
Percent
1
0.5
0
-0.5
-1
-1.5
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

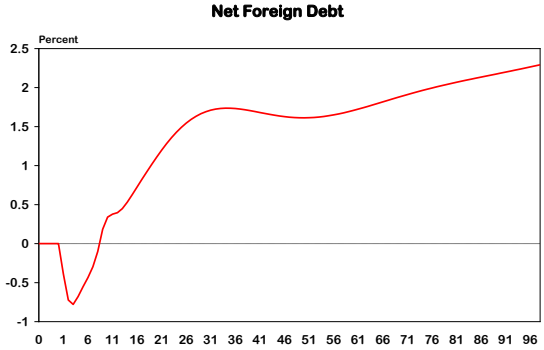

Trade Account Surplus
Percent
140
120
100
80
60
40
20
0
-20
-40
-60
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

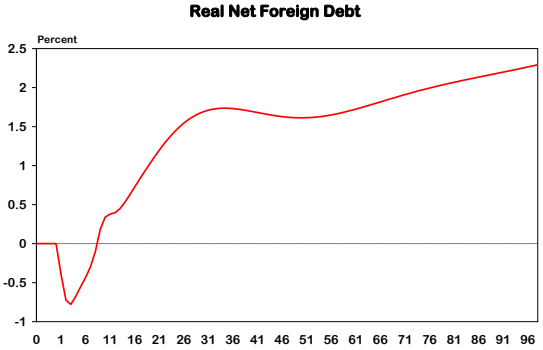

Service Account Deficit
Percent
2.5
2
1.5
1
0.5
0
-0.5
-1
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

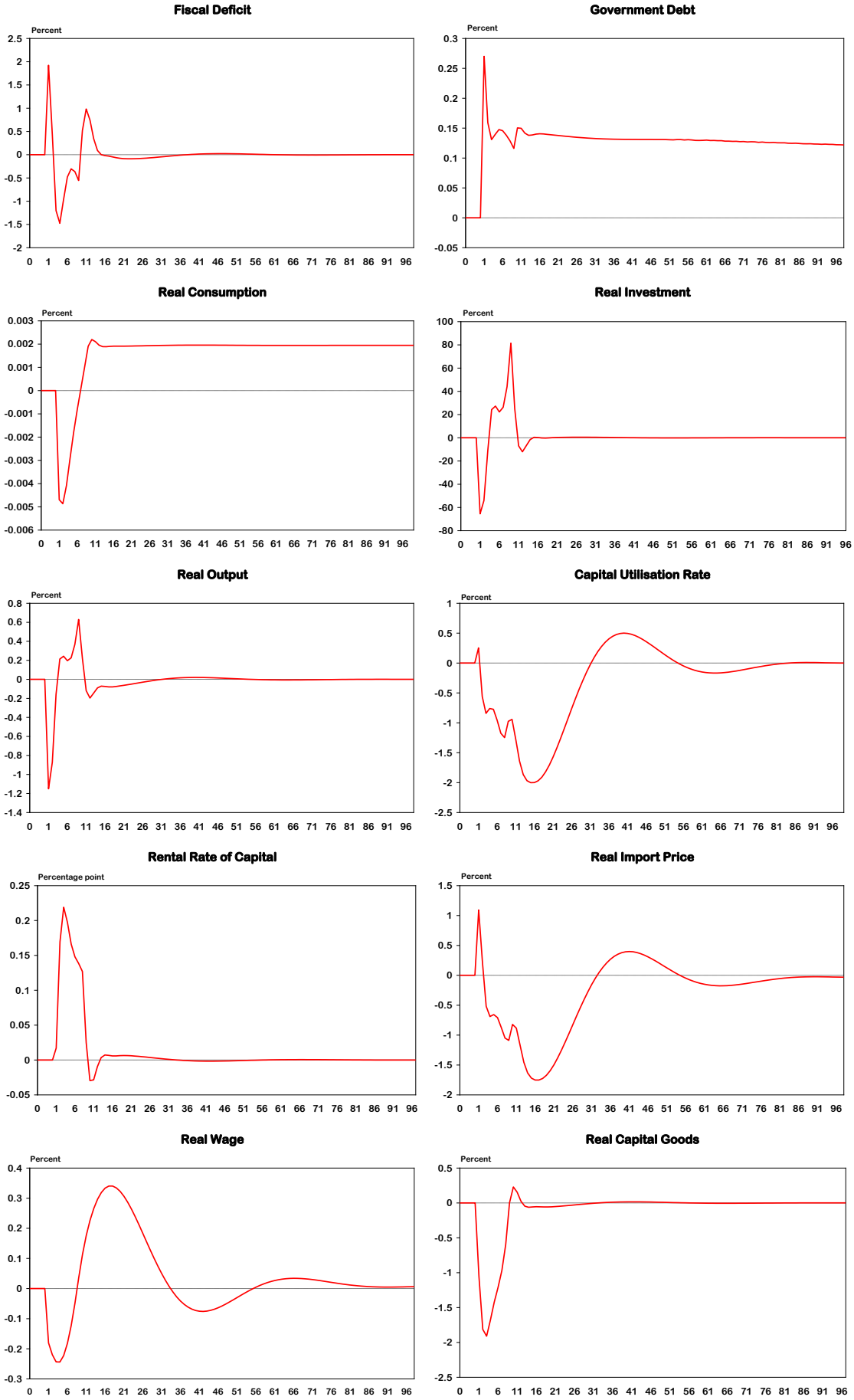

Current Account Deficit
Percent
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

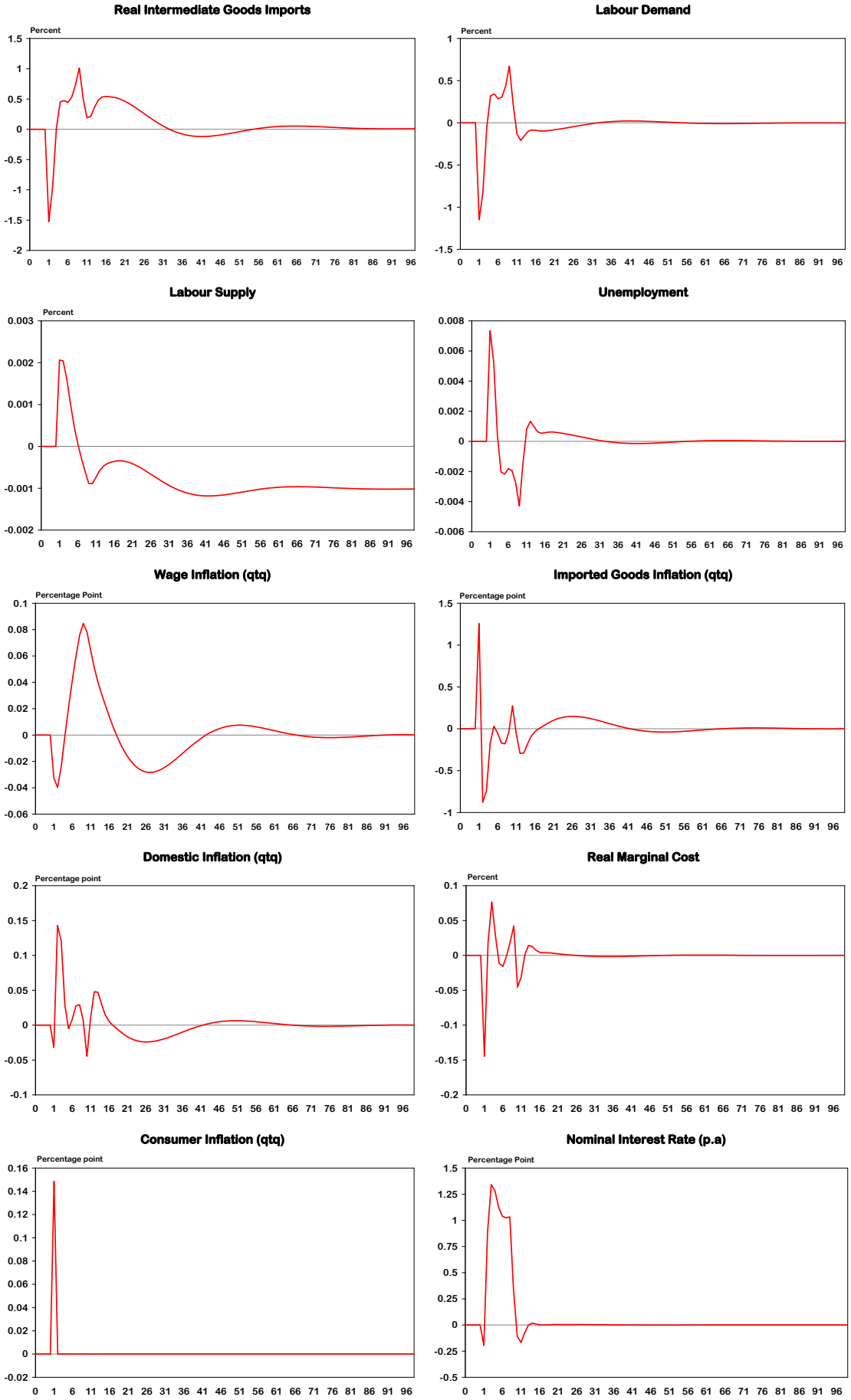

Financial Account Surplus
Percent
100
80
60
40
20
0
-20
-40
-60
-80
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

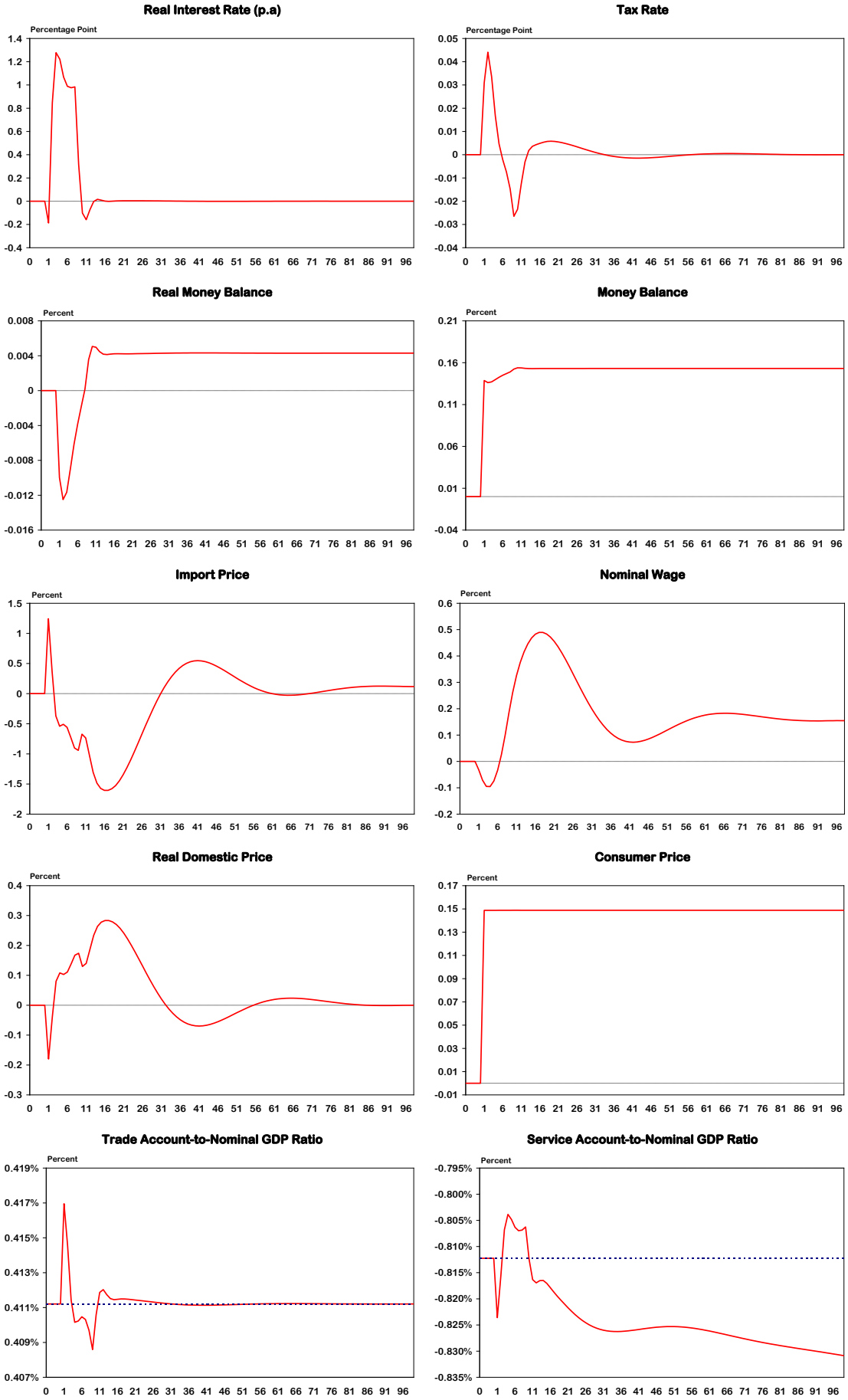

Overall Balance of Payment
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Net Foreign Debt
Percent
2.5
2
1.5
1
0.5
0
-0.5
-1
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Real Net Foreign Debt
Percent
2.5
2
1.5
1
0.5
0
-0.5
-1
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Fiscal Deficit
Percent
Government Debt
Percent
Real Consumption
Percent
Real Investment
Percent
Real Output
Percent
Capital Utilisation Rate
Percent
Rental Rate of Capital
Percentage point
Real Import Price
Percent
Real Wage
Percent
Real Capital Goods
Percent


Real Intermediate Goods Imports
Percent
Labour Demand
Percent
Labour Supply
Percent
Unemployment
Wage Inflation (qtq)
Percentage Point
Imported Goods Inflation (qtq)
Percentage point
Domestic Inflation (qtq)
Percentage point
Real Marginal Cost
Percent
Consumer Inflation (qtq)
Percentage point
Nominal Interest Rate (p.a)
Percentage Point


Real Interest Rate (p.a)
Percentage Point
Tax Rate
Percentage Point
Real Money Balance
Percent
Money Balance
Percent
Import Price
Percent
Nominal Wage
Percent
Real Domestic Price
Percent
Consumer Price
Percent
Trade Account-to-Nominal GDP Ratio
Percent
Service Account-to-Nominal GDP Ratio
Percent

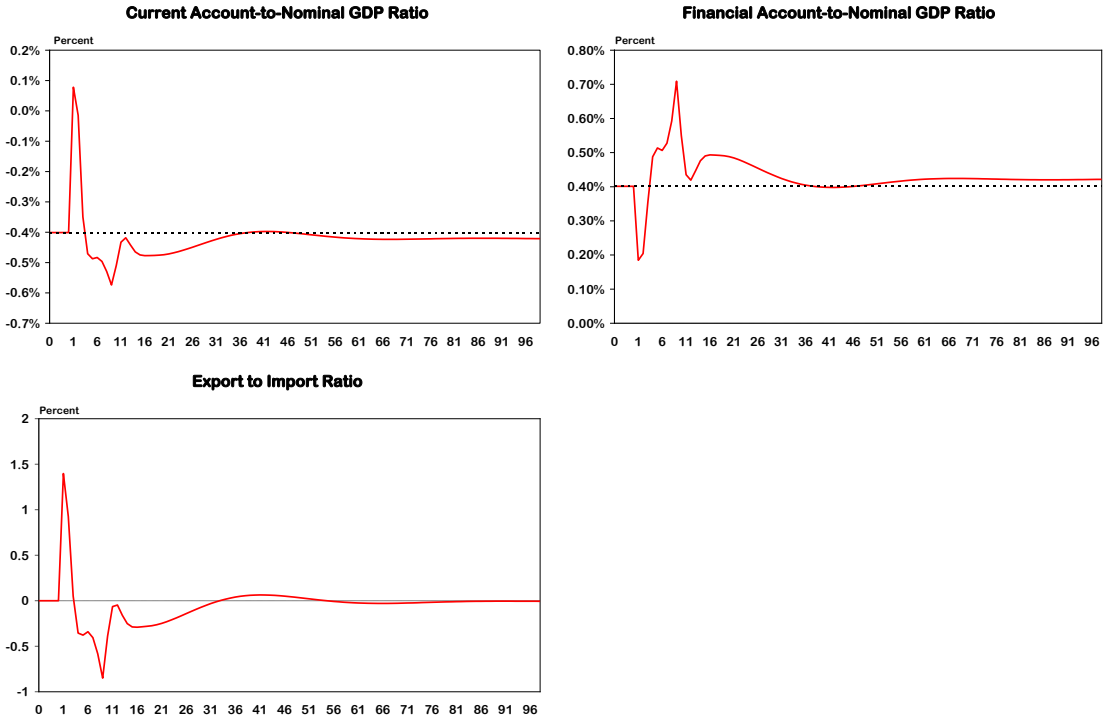


Figure 3 Real Exports, Real Imports and Trade Surplus of Indonesia

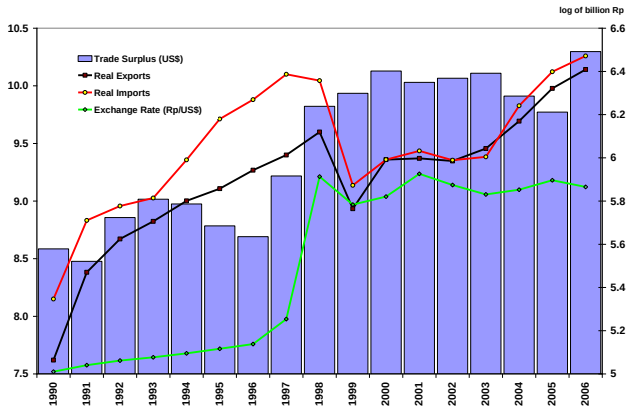
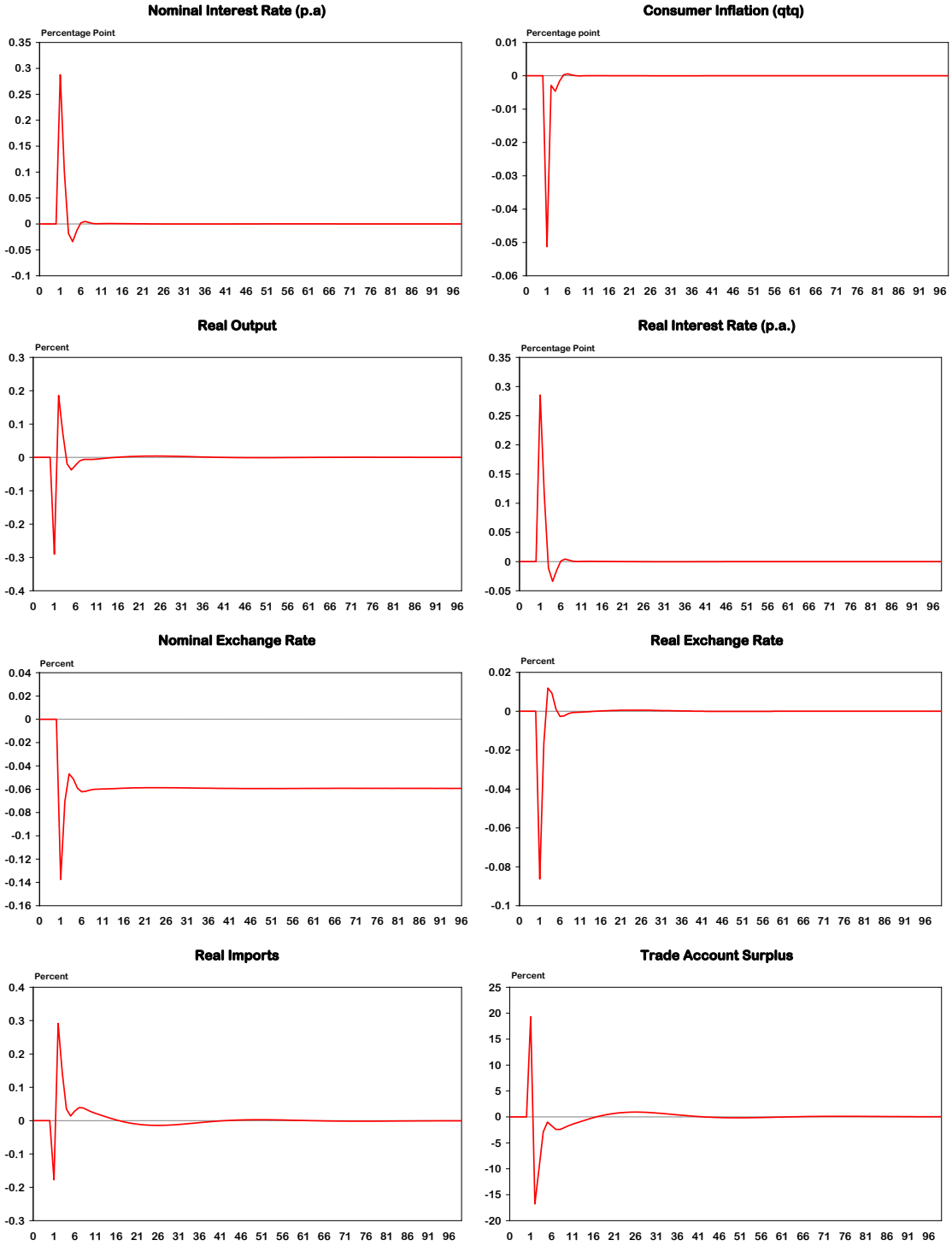
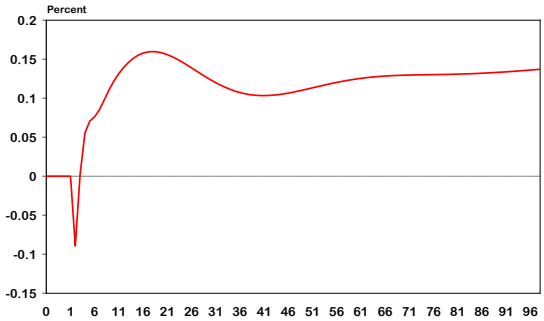


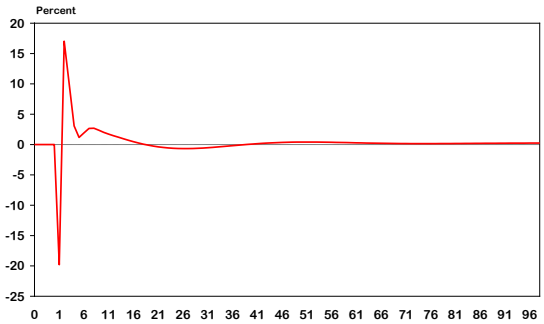
Figure 4 Responses to one-quarter one percentage point shock to interest rate
(percent or percentage point deviation from baseline initial steady-state)



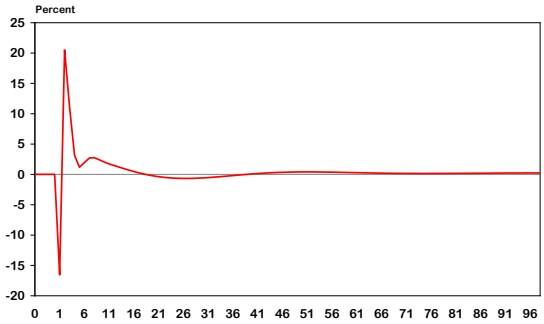
Service Account Deficit



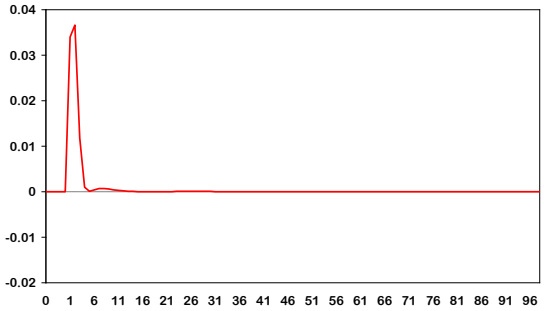
Current Account Deficit



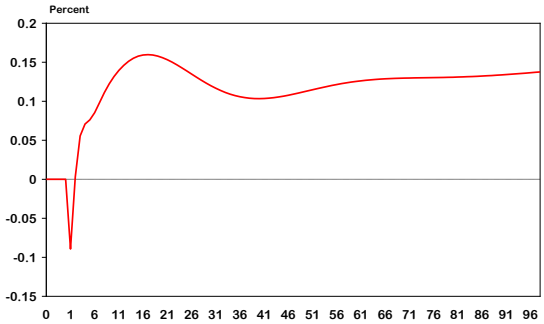
Financial Account Surplus



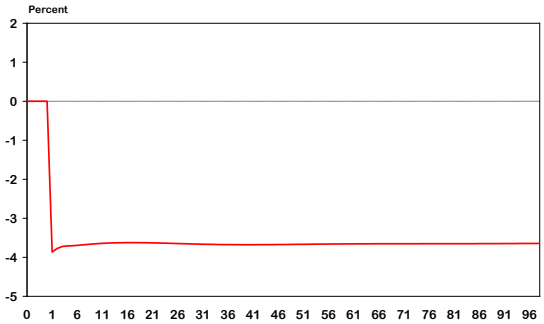
Overall Balance of Payment



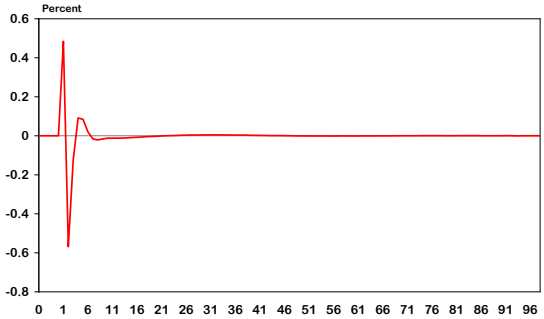
Net Foreign Debt



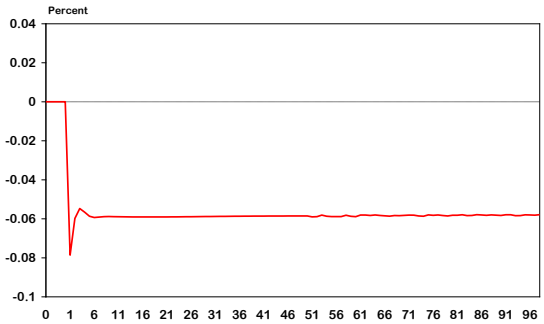
Real Net Foreign Debt



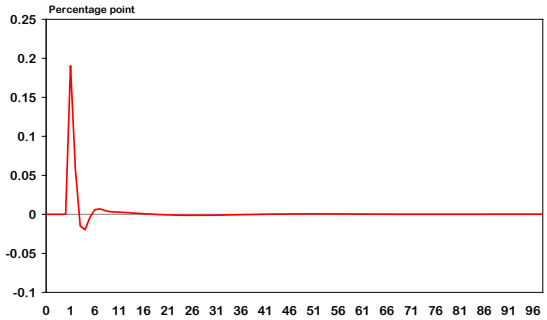
Fiscal Deficit



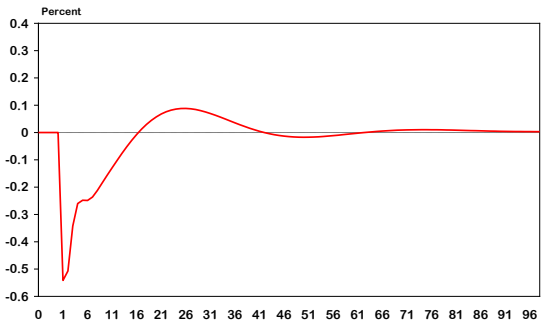
Government Debt

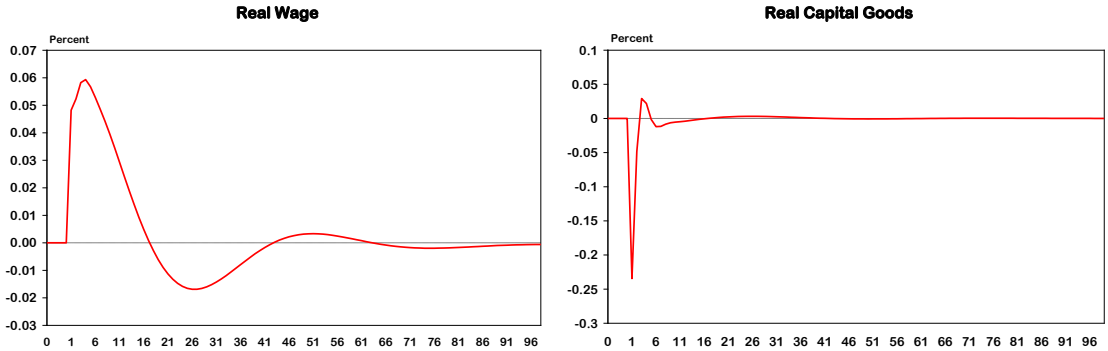


Capital Real Rental Rate

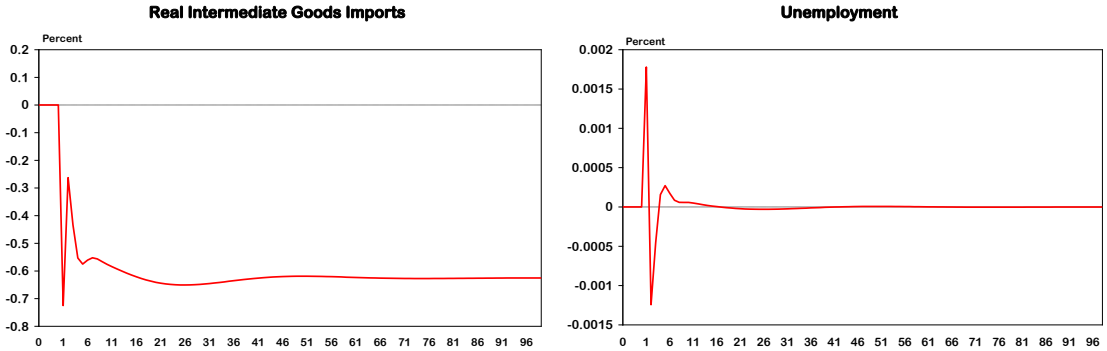


Real Import Price

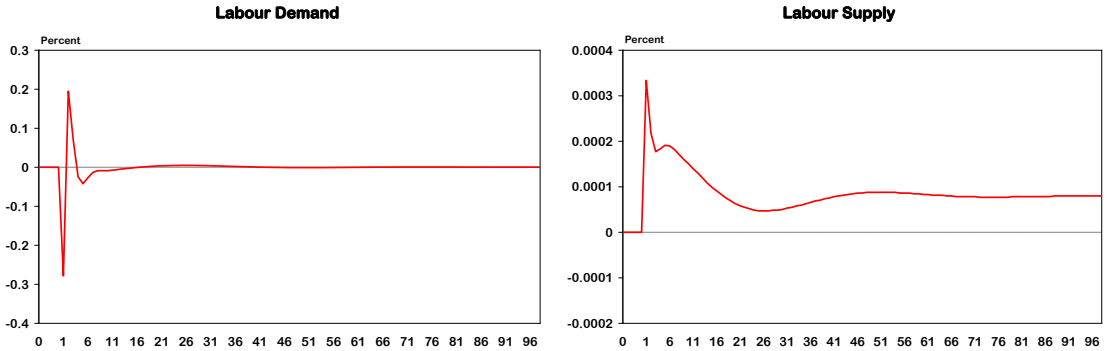



Real Wage
Percent
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

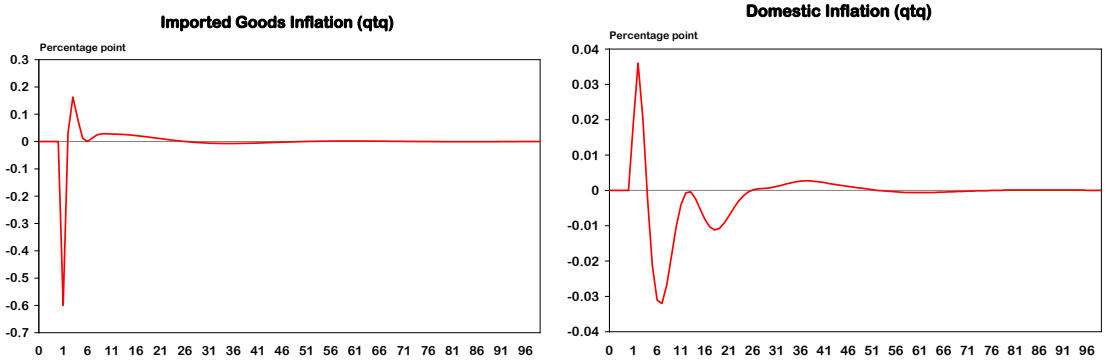
Real Capital Goods
Percent
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Real Intermediate Goods Imports
Percent
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

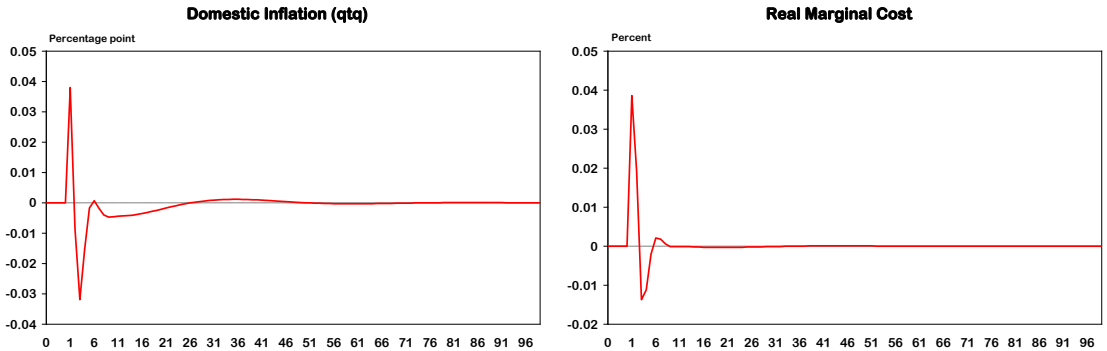
Unemployment
Percent
0.002
0.0015
0.001
0.0005
0
-0.0005
-0.001
-0.0015
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Labour Demand
Percent
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

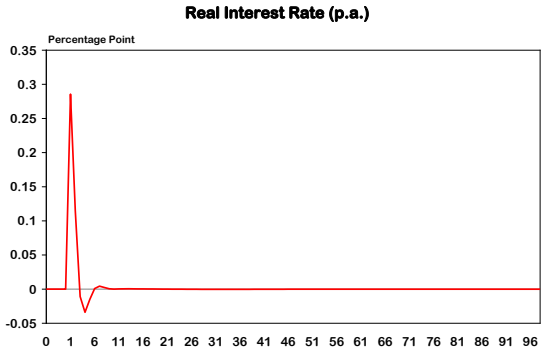
Labour Supply
Percent
0.0004
0.0003
0.0002
0.0001
0
-0.0001
-0.0002
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

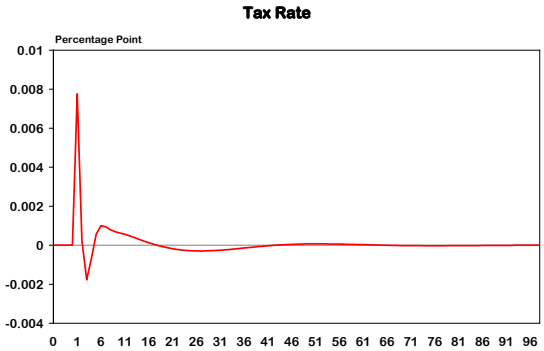

Imported Goods Inflation (qtq)
Percentage point
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

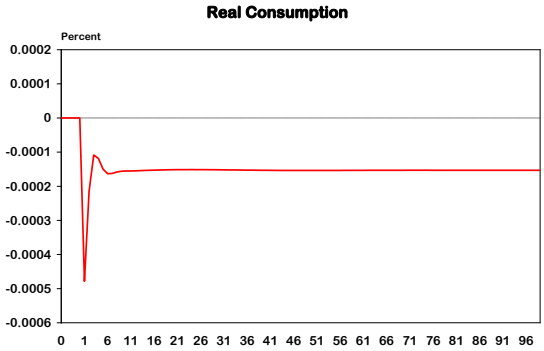
Domestic Inflation (qtq)
Percentage point
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

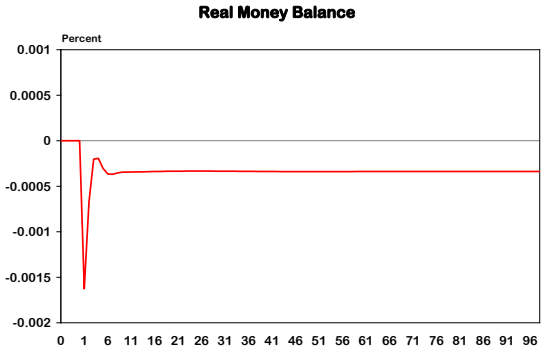

Domestic Inflation (qtq)
Percentage point
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

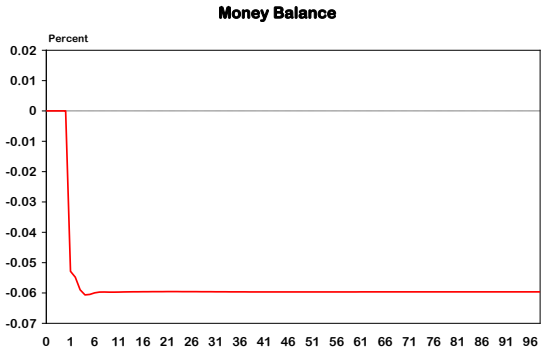
Real Marginal Cost
Percent
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Real Interest Rate (p.a.)
Percentage Point
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

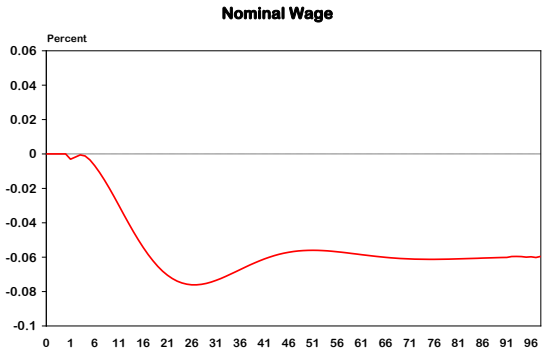

Tax Rate
Percentage Point
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

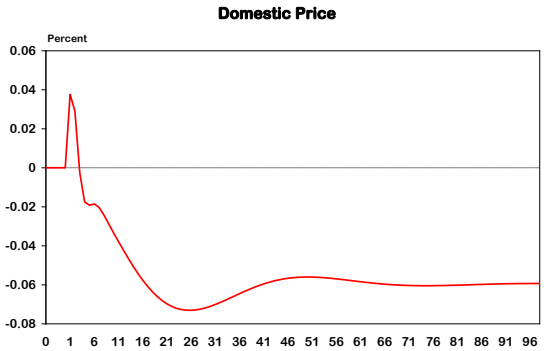

Real Consumption
Percent
0.0002
0.0001
0
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Real Money Balance
Percent
0.001
0.0005
0
-0.0005
-0.001
-0.0015
-0.002
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Money Balance
Percent
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Import Price
Percent
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Nominal Wage
Percent
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96


Domestic Price
Percent
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

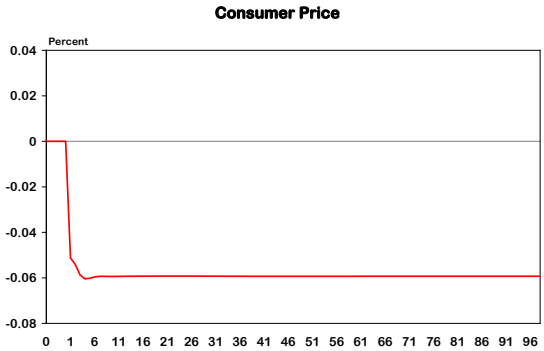
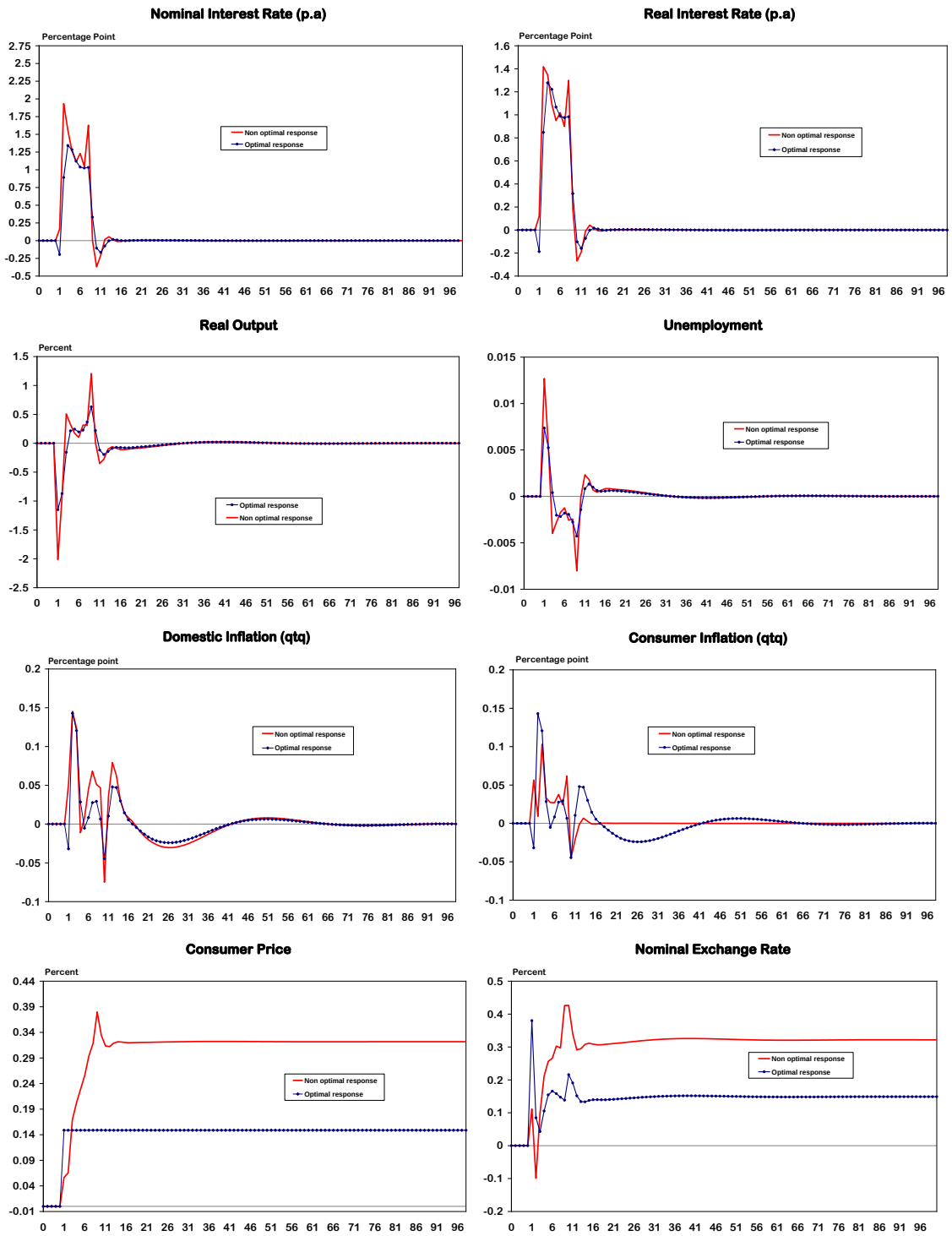

Consumer Price
Percent
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
0 1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

Figure 5 Effect of the optimality of monetary policy response to risk premium shock



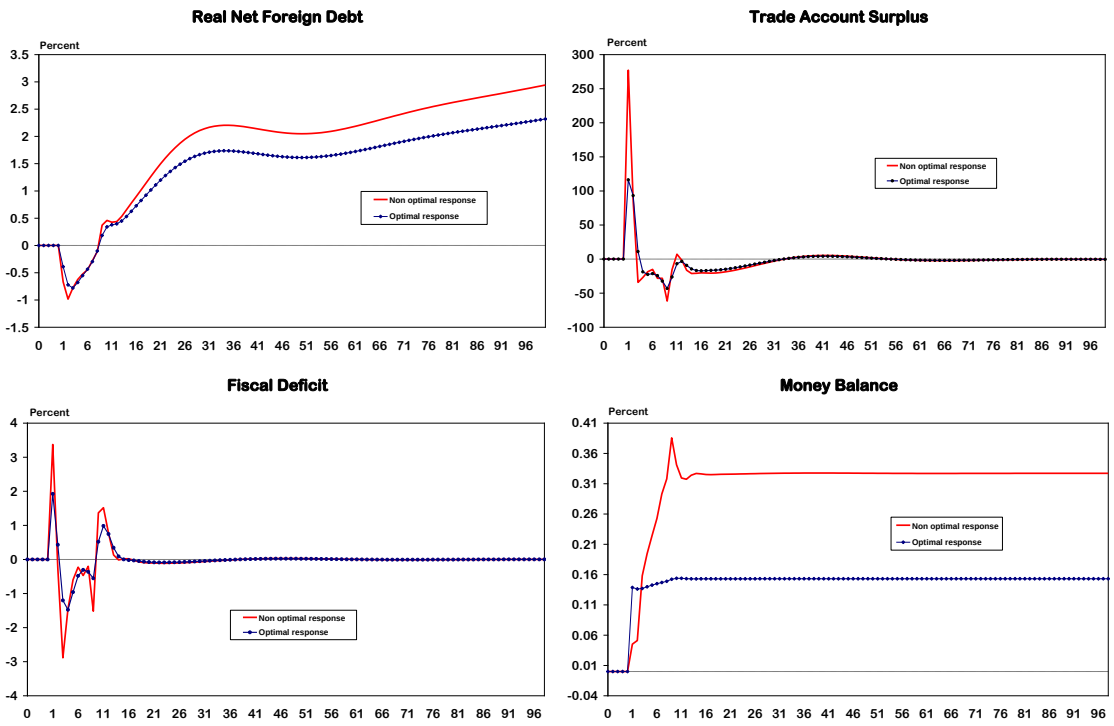
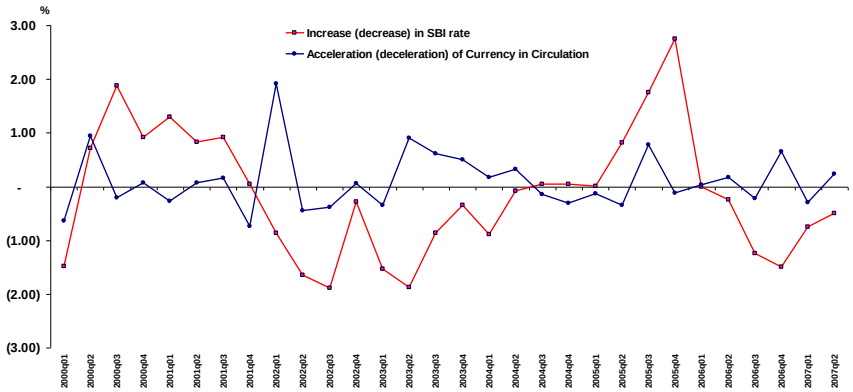


Figure 6 Direction of interest rate and growth of currency in Indonesia



B. The steady-state equations

Nominal exchange rate	$\bar{s}_t = E_t \bar{s}_{t+1} \left(\frac{1+\bar{i}^*}{1+\bar{i}} \right) (1+\bar{\kappa})\,;\ \bar{r} = \bar{r}^*$
Real exchange rate	$\bar{q} = \bar{s}_t \frac{\bar{P}_t^*}{\bar{P}_t}$
Real money demand	$\bar{m}^d = \bar{c}^{\sigma/\rho} \left(\frac{\bar{i}}{1+\bar{i}} \right)^{-\frac{1}{\rho}}$
Labour supply	$\bar{l}^s = \bar{c}^{-\frac{\sigma}{\lambda}} \bar{w}^{\frac{1}{\lambda}} (1-\bar{\tau})^{\frac{1}{\lambda}}$
Labour demand	$\bar{l}^d = \alpha_L \left(\frac{\bar{p}^d}{\bar{w}} \right)^{\nu} \bar{A}^{\nu-1} \bar{y}$
Real marginal cost of domestic goods	$\overline{mc}^d = \frac{\bar{w}}{\bar{A}\alpha_L^{\frac{1}{\nu-1}}} \left(1 + \frac{1}{\alpha_L} \left(\frac{\bar{w}}{\bar{A}} \right)^{\nu-1} \left(\alpha_K \left(\frac{\bar{u}}{\bar{z}} \right)^{\nu-1} + \alpha_M \left(\frac{1}{\bar{p}^m} \right)^{\nu-1} \right) \right)^{-\frac{1}{\nu-1}}$
Real marginal cost of importing goods	$\overline{mc}^m = \frac{\bar{q}}{1-\bar{\tau}}$
Real marginal cost of working	$\overline{mc}^w = \left(\frac{\bar{A}^{\lambda(\nu-1)} \bar{c}^{\sigma} (\alpha_L \bar{y})^{\lambda}}{1-\bar{\tau}} \right)^{\frac{1}{\nu\lambda+1}}$
Technology	$\bar{A} = 1$
Capital utilization rate	$\bar{u} = 1$
Real capital stock	$\bar{k} = \beta \alpha_K \left(\frac{\bar{p}^d}{\bar{z}} \right)^{\nu} \bar{u}^{\nu-1} \bar{y}$
Real investment	$\overline{iv} = \delta \bar{k}$
Real consumption	$\bar{r} = \vartheta^{-1} - 1$
Real consumption of imported finished goods	$\bar{c}^{mcg} = \alpha_{mcg} \bar{c}$
Real government consumption	$\bar{g} = g_r \bar{y}$
Real exports	$\bar{x} = \alpha_M^* \bar{q}^{\eta} \bar{y}^*$
Real imports	$\overline{im} = \overline{im}^{rm} + \overline{im}^{cg} + \overline{im}^{kg}$
Real imports of raw material	$\overline{im}^{rm} = \alpha_M \left(\frac{\bar{p}^d}{\bar{p}^m} \right)^{\nu} \bar{y}$
Real imports of consumption goods	$\overline{im}^{cg} = \bar{c}^{mcg} = \alpha_{mcg} \bar{c}$
Real imports of capital goods	$\overline{im}^{kg} = \alpha_{mkg} \overline{iv}$
Real demand for goods	$\bar{y} = \bar{c} + \bar{g} + \overline{iv} + \bar{x} - \overline{im}$

Real output

$$\bar{y} = \left(\alpha_L^{\frac{1}{\nu}} (\bar{A}\bar{l}^d)^{\frac{\nu-1}{\nu}} + \alpha_K^{\frac{1}{\nu}} (\bar{u}\bar{k})^{\frac{\nu-1}{\nu}} + \alpha_M^{\frac{1}{\nu}} (\overline{im}_t^{rm})^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}}$$

Consumer goods inflation	$1+\bar{\pi} = (1+\bar{\pi}^d)^{(1-\alpha_{mcg})}(1+\bar{\pi}^m)^{\alpha_{mcg}}$
Domestic goods inflation	$\bar{\pi}^d = \log \overline{MC}_t^d - \log \overline{MC}_{t-1}^d$
Imported goods inflation	$\bar{\pi}^m = \log \overline{MC}_t^m - \log \overline{MC}_{t-1}^m$
Wage inflation	$\bar{\pi}^w = \log \overline{MC}_t^w - \log \overline{MC}_{t-1}^w$
Domestic goods' marginal cost	$\overline{MC}_t^d = \bar{P}_t \, \overline{mc}^d$
Imported goods' marginal cost	$\overline{MC}_t^m = \bar{P}_t \, \overline{mc}^m$
Nominal marginal cost of working	$\overline{MC}_t^w = \bar{P}_t \, \overline{mc}^w$
Consumer price	$\bar{P}_t = \bar{P}_{t-1}(1+\bar{\pi})$
Domestic goods price	$\bar{P}_t^d = \bar{P}_{t-1}^d(1+\bar{\pi}_t^d)$
Import price	$\bar{P}_t^m = \bar{P}_{t-1}^m(1+\bar{\pi}^m)$
Nominal wage	$\bar{W}_t = \bar{W}_{t-1}(1+\bar{\pi}^w)$
Real price of domestical good	$\bar{p}^d = \dfrac{\bar{P}_t^d}{\bar{P}_t}$
Real import price	$\bar{p}^m = \dfrac{\bar{q}}{1-\bar{\tau}}$
Flexible real import price	$\bar{p}^{mn} = \dfrac{\bar{q}^n}{1-\bar{\tau}^n}$
Real wage	$\bar{w} = \left(\dfrac{\bar{A}^{\lambda(\nu-1)}\bar{c}^{\sigma}(\alpha_L \bar{y})^{\lambda}}{1-\bar{\tau}} \right)^{\frac{1}{\nu\lambda+1}}$
Real Rental price of capital	$\bar{z} = \dfrac{\bar{r}+\delta}{1-\bar{\tau}}$
Fiscal policy rule	$\bar{\tau} = \dfrac{\bar{g}}{\bar{y}} - \psi$
Monetary policy rule	$\bar{\pi} = \bar{\pi}^T$
Real interest rate	$1+\bar{r} = \dfrac{1+\bar{i}}{1+\bar{\pi}}$; $\bar{r} = \bar{r}^*$
Households' real financial assets	$\bar{b}^H = \bar{b}^{HG} + \bar{q}\bar{b}^{H*}$
	$\bar{b}^H = \dfrac{1}{\bar{r}+(1+\bar{r})\bar{\kappa}(1-\alpha_{HG})}\left(\bar{\tau}\bar{y} + \dfrac{\overline{\pi m}^d}{1+\bar{\pi}} - (\bar{x} - \bar{q}\overline{im}) - \bar{g} \right)$
Households' nominal financial assets	$\bar{B}_t^H = \bar{P}_t \bar{b}^H$
Households' real financial assets on government bond	$\bar{b}^{HG} = \alpha_{HG}\bar{b}^H$
Household's nominal financial assets on government bond	$\bar{B}_t^{HG} = \bar{P}_t \bar{b}^{HG}$

Household's real financial assets

on foreign bond $\bar{b}^{H*} = \dfrac{(1-\alpha_{HG})\bar{b}^{H}}{\bar{q}}$

Household's nominal financial assets

on foreign bond $\bar{B}_t^{H*} = \bar{P}_t^* \bar{b}^{H*}$

Household's real financial liabilities

$$\bar{d}^{H} = \frac{1}{\bar{r} + (1+\bar{r})\bar{\kappa}(1-\alpha_{HG})}\left((\bar{x} - \bar{q}\overline{im}) + \bar{g} - \bar{\tau}\bar{y} - \frac{\bar{\pi}\overline{m}^{d}}{1+\bar{\pi}}\right)$$

Government's real debt $\bar{b}^{G} = \bar{b}^{GH} + \bar{q}\bar{b}^{G*}$

$$\bar{b}^{G} = \bar{g} + (1+\bar{r})\left(\bar{b}^{GH} + (1+\bar{\kappa})\bar{b}^{G*}\bar{q}\right) - \bar{\tau}\bar{y} - \frac{\overline{m}^{s}\bar{\pi}}{(1+\bar{\pi})}$$

Government's nominal debt $\bar{B}_t^{G} = \bar{P}_t \bar{b}^{G}$

Government's real domestic debt $\bar{b}^{GH} = \alpha_{GH}\bar{b}^{G}$

Government's nominal domestic debt $\bar{B}_t^{GH} = \bar{P}_t \bar{b}^{GH}$

Government's real foreign debt $\bar{b}^{G*} = \dfrac{(1-\alpha_{GH})\bar{b}^{G}}{\bar{q}}$

Government's nominal foreign debt $\bar{B}_t^{G*} = \bar{P}_t^* \bar{b}^{G*}$

Real Net Foreign Liabilities $\bar{d}^{*} = -\dfrac{(\overline{im} - \bar{x}/\bar{q})}{\bar{r}^* + \bar{\kappa} + \bar{r}^*\bar{\kappa}}$

Nominal Net Foreign Liabilities $\bar{D}_t^{*} = \bar{P}_t^* \bar{d}^{*}$

Financial Account $\overline{FA}_t = \bar{D}_t^{*} - \bar{D}_{t-1}^{*} = \bar{d}^{*}\bar{\pi}^{*}\bar{P}_{t-1}^{*}$

Current Account $\overline{CA}_t = (\bar{P}_t\bar{x}/\bar{s}_t - \bar{P}_t^*\overline{im}) - [(1+\bar{i}^*)(1+\bar{\kappa}) - 1]\bar{D}_{t-1}^{*}$

Interest-rate risk premium $\bar{\kappa} = \varsigma\left(e^{-\frac{\bar{q}\bar{b}^*}{y}} - 1\right)$

C. The log-linearised dynamic equations in deviation from steady-state

Nominal exchange rate $\hat{s}_t = E_t\hat{s}_{t+1} + (1+\hat{i}_t^*) - (1+\hat{i}_t) + (1+\hat{\kappa}_t)$

Real exchange rate $\hat{q}_t = \hat{s}_t + \hat{P}_t^* - \hat{P}_t$

Real money demand $\hat{m}_t^{d} = \dfrac{\sigma}{\rho}\hat{c}_t - \dfrac{1}{\rho}\hat{i}_t^{'}$ where $i_t^{'} = \dfrac{i_t}{1+i_t}$

Labour supply $\hat{l}_t^{s} = \dfrac{1}{\lambda}\left(\hat{w}_t + (1-\hat{\tau}_t) - \sigma\hat{c}_t\right),$

Labour demand $\hat{l}_t^{d} = \nu\left(\hat{p}_t^{d} - \hat{w}_t\right) + (\nu-1)\hat{A}_t + \hat{y}_t$

Real marginal cost of producing goods

$$m\hat{c}_t^{d} = \left[1 - m\bar{c}^{d(\nu-1)}\left[\alpha_K\left(\frac{\bar{u}}{\bar{z}}\right)^{\nu-1} + \alpha_M\left(\frac{1}{\bar{p}^{m}}\right)^{(\nu-1)}\right]\right](\hat{w}_t - \hat{A}_t)$$
$$+ m\bar{c}^{d\nu-1}\left(\alpha_K\left(\frac{\bar{u}}{\bar{z}}\right)^{\nu-1}(\hat{z}_{t-1} - \hat{u}_t) + \alpha_M\left(\frac{1}{\bar{p}^{m}}\right)^{\nu-1}\hat{p}_t^{m}\right)$$

Real marginal cost of importing goods	$m\hat{c}_t^m = \hat{q}_t$
Real marginal cost of working	$m\hat{c}_t^w = \frac{1}{\nu\lambda+1}\left(\lambda(\nu-1)\hat{A}_t + \sigma\hat{c}_t + \lambda\hat{y}_t - (1-\hat{\tau}_t)\right)$
Technology	$\hat{A}_t = \varsigma\hat{A}_{t-1}$
Real capital stock	$\hat{k}_t = \nu\left(E_t\hat{p}_{t+1}^d - \hat{z}_t\right) + (\nu-1)E_t\hat{u}_{t+1} + E_t\hat{y}_{t+1}$
Real investment	$i\hat{v}_t = \frac{1}{\delta}\left(\hat{k}_t - (1-\delta)\hat{k}_{t-1}\right)$
Real consumption	$\hat{c}_t = E_t\hat{c}_{t+1} - \frac{1}{\sigma}(1+\hat{r}_t)$
Real consumption of imported finished goods	$\hat{c}_t^{mcg} = \hat{c}_t$
Real government consumption	$\hat{g}_t = \hat{g}_{t-1}$
Real exports	$\hat{x}_t = \eta\hat{q}_t + \hat{y}_t^*$
Real imports	$i\hat{m}_t = \frac{\overline{im}^{rm}}{\overline{im}} i\hat{m}_t^{rm} + \frac{\overline{im}^{cg}}{\overline{im}} i\hat{m}_t^{cg} + \frac{\overline{im}^{kg}}{\overline{im}} i\hat{m}_t^{kg}$
Real imports of raw material	$i\hat{m}_t^{rm} = \nu(\hat{p}_t^d - \hat{p}_t^m) + \hat{y}_t$
Real imports of consumption goods	$i\hat{m}_t^{cg} = \hat{c}_t^{mcg} = \hat{c}_t$
Real imports of capital goods	$i\hat{m}_t^{kg} = i\hat{v}_t$
Real demand for goods	$\hat{y}_t = \frac{\bar{c}}{\bar{y}}\hat{c}_t + \frac{\bar{g}}{\bar{y}}\hat{g}_t + \frac{\overline{iv}}{\bar{y}} i\hat{v}_t + \frac{\bar{x}}{\bar{y}}\hat{x}_t - \frac{\overline{im}}{\bar{y}} i\hat{m}_t$
Real output	$\hat{y}_t = \bar{y}^{\frac{1-\nu}{\nu}}\left(\begin{array}{l}\alpha_L^{\frac{1}{\nu}}(\bar{A}\bar{l}^d)^{\frac{\nu-1}{\nu}}(\hat{A}_t + \hat{l}_t^d) + \alpha_K^{\frac{1}{\nu}}(\bar{u}\bar{k})^{\frac{\nu-1}{\nu}}(\hat{u}_t + \hat{k}_{t-1}) \\ + \alpha_M^{\frac{1}{\nu}}\overline{im}^{rm\frac{\nu-1}{\nu}} i\hat{m}_t^{rm}\end{array}\right)$
Consumer goods inflation	$\hat{\pi}_t = (1-\alpha_{mcg})(\hat{\pi}_t^d + e^{\hat{\varepsilon}_t^a}) + \alpha_{mcg}\hat{\pi}_t^m$
Domestic goods inflation	$\hat{\pi}_t^d = \beta E_t\hat{\pi}_{t+1}^d + \left(\frac{(1-\theta)(1-\beta\theta)}{\theta}\right)m\hat{c}_t^d$
Imported goods inflation	$\hat{\pi}_t^m = \beta E_t\hat{\pi}_{t+1}^m + \left(\frac{(1-\theta^m)(1-\beta\theta^m)}{\theta^m}\right)\left(\hat{q}_t - (1-\hat{\tau}_t)\right)$
Wage inflation	$\hat{\pi}_t^w = \frac{1}{\theta^w + \gamma^w[1-\theta^w(1-\beta)]}\left[\begin{array}{l}\left(\beta\theta^w\hat{\pi}_{t-1}^w + \gamma^w E_t\hat{\pi}_{t+1}^w\right) \\ + \frac{(1-\gamma^w)(1-\theta^w)(1-\beta\theta^w)}{\nu\lambda+1}\left(\lambda(\nu-1)\hat{A}_t + \sigma\hat{c}_t + \lambda\hat{y}_t - (1-\hat{\tau}_t)\right)\end{array}\right]$
Domestic goods' marginal cost	$\hat{MC}_t^d = \hat{P}_t + m\hat{c}_t^d$
Imported goods' marginal cost	$\hat{MC}_t^m = \hat{P}_t + m\hat{c}_t^m$
Nominal marginal cost of working	$\hat{MC}_t^w = \hat{P}_t + m\hat{c}_t^w$
Consumer price	$\hat{P}_t = \hat{P}_{t-1} + \hat{\pi}_t$
Domestically-produced goods price	$\hat{P}_t^d = \hat{P}_{t-1}^d + \hat{\pi}_t^d$

Import price	$\hat{P}_t^m = \hat{P}_{t-1}^m + \hat{\pi}_t^m$
Nominal wage	$\hat{W}_t = \hat{W}_{t-1} + \hat{\pi}_t^w$
Real domestic good price	$\hat{p}_t^d = \hat{P}_t^d - \hat{P}_t$
Real import price	$\hat{p}_t^m = \hat{P}_t^m - \hat{P}_t$
Flexible real import price	$\hat{p}_t^{mn} = \hat{q}_t^n - (1-\hat{\tau}_t^n)$
Real wage	$\hat{w}_t = \hat{W}_t - \hat{P}_t$
Rental rate of capital	$\hat{z}_t = \frac{\bar{r}}{\bar{z}(1-\bar{\tau})}\hat{r}_t + \left(\frac{\bar{\tau}}{1-\bar{\tau}}\right)E_t\hat{\tau}_{t+1}$
Fiscal policy rule	$\hat{\tau}_t = \frac{1}{1+\Theta}\left[\hat{\tau}_{t-1} + \frac{\Theta\bar{g}}{\bar{\tau}\bar{y}}\left(\hat{g}_t - \hat{y}_t\right)\right]$
Monetary policy rule	$\hat{i}_t = \chi\hat{i}_{t-1} + \frac{(1-\chi)\alpha_\pi\bar{\pi}}{\bar{i}}\left[\pi_t - \pi_t^T\right]$
Real interest rate	$1+\hat{r}_t = (1+\hat{i}_t) - (1+E_t\hat{\pi}_{t+1})$
Household's real financial asset	$\hat{b}_t^H = \frac{1}{\bar{b}^H}\begin{pmatrix} \bar{x}\hat{x}_t - \bar{q}\overline{im}(i\hat{m}_t + \hat{q}_t) + \bar{g}\hat{g}_t \\ + (1+\bar{r})(\bar{b}^{HG} + (1+\bar{\kappa})\bar{q}\bar{b}^{H*})\hat{b}_{t-1}^H \\ + \bar{r}(\bar{b}^{HG}\hat{r}_{t-1} + (1+\bar{\kappa})\bar{q}\bar{b}^{H*}\hat{r}_{t-1}^*) \\ + (1+\bar{r})\bar{q}\bar{b}^{H*}[(1+\bar{\kappa})(\hat{q}_t - \hat{q}_{t-1}) + \bar{\kappa}\hat{\kappa}_{t-1}] \\ - \bar{\tau}\bar{y}(\hat{y}_t + \hat{\tau}_t) - \bar{m}^d\hat{m}_t^d \\ + \frac{\bar{m}^d}{(1+\bar{\pi})}\left(\hat{m}_{t-1}^d - \frac{\bar{\pi}}{1+\bar{\pi}}\hat{\pi}_t\right) \end{pmatrix}$
Household's nominal financial assets	$\hat{B}_t^H = \hat{P}_t + \hat{b}_t^H$
Household's real financial assets on government bond	$\hat{b}_t^{HG} = \hat{b}_t^H$
Household's nominal financial assets on government bond	$\hat{B}_t^{HG} = \hat{P}_t + \hat{b}_t^{HG}$
Household's real financial assets on foreign bond	$\hat{b}_t^{H*} = \hat{b}_t^H - \hat{q}_t$
Household's nominal financial assets on foreign bond	$\hat{B}_t^{H*} = \hat{P}_t^* + \hat{b}_t^{H*}$
Household's nominal financial debt	$\hat{D}_t^H = \hat{P}_t + \hat{d}_t^H$
Household's real financial debt on government bond	$\hat{d}_t^{HG} = \hat{d}_t^H$

Household's real financial liabilities $\hat{d}_t^H = \frac{1}{\bar{d}^H}\begin{pmatrix} \bar{x}\hat{x}_t - \bar{q}\overline{im}(i\hat{m}_t + \hat{q}_t) + \bar{g}\hat{g}_t \\ +(1+\bar{r})(\bar{d}^{HG} + (1+\bar{\kappa})\bar{q}\bar{d}^{H*})\hat{d}_{t-1}^H \\ -\bar{r}(\bar{d}^{HG}\hat{r}_{t-1} + (1+\bar{\kappa})\bar{q}\bar{d}^{H*}\hat{r}_{t-1}^*) \\ -(1+\bar{r})\bar{q}\bar{d}^{H*}[(1+\bar{\kappa})(\hat{q}_t - \hat{q}_{t-1}) + \bar{\kappa}\hat{\kappa}_{t-1}] \\ -\bar{\tau}\bar{y}(\hat{y}_t + \hat{\tau}_t) - \bar{m}^d\hat{m}_t^d \\ +\frac{\bar{m}^d}{(1+\bar{\pi})}\left(\hat{m}_{t-1}^d - \frac{\bar{\pi}}{1+\bar{\pi}}\hat{\pi}_t\right) \end{pmatrix}$

Household's nominal financial liabilities on government bond $\hat{D}_t^{HG} = \hat{P}_t + \hat{d}_t^{HG}$

Household's real financial liabilities on foreign bond $\hat{d}_t^{H*} = \hat{d}_t^H - \hat{q}_t$

Household's nominal financial liabilities on foreign bond $\hat{B}_t^{H*} = \hat{P}_t^* + \hat{d}_t^{H*}$

Government's real debt

$$\hat{b}_t^G = \frac{1}{\bar{b}^G}\begin{pmatrix} \bar{g}\hat{g}_t + (1+\bar{r})(\bar{b}^{GH} + \bar{q}\bar{b}^{G*}(1+\bar{\kappa}))\hat{b}_{t-1}^G \\ +\bar{r}[\bar{b}^{GH}\hat{r}_{t-1} + (1+\bar{\kappa})\bar{q}\bar{b}^{G*}\hat{r}_{t-1}^*] \\ +(1+\bar{r}^*)\bar{q}\bar{b}^{G*}[(1+\bar{\kappa})(\hat{q}_t - \hat{q}_{t-1}) + \bar{\kappa}\hat{\kappa}_{t-1}] \\ -\bar{\tau}\bar{y}(\hat{y}_t + \hat{\tau}_t) - \bar{m}^s\hat{m}_t^s + \frac{\bar{m}^s}{1+\bar{\pi}}\left(\hat{m}_{t-1}^s - \frac{\bar{\pi}}{1+\bar{\pi}}\hat{\pi}_t\right) \end{pmatrix}$$

Government's nominal debt $\hat{B}_t^G = \hat{P}_t + \hat{b}_t^G$

Government's real domestic debt $\hat{b}_t^{GH} = \hat{b}_t^G$

Government's nominal domestic debt $\hat{B}_t^{GH} = \hat{P}_t + \hat{b}_t^{GH}$

Government's real foreign debt $\hat{b}_t^{G*} = \hat{b}_t^G - \hat{q}_t$

Government's nominal foreign debt $\hat{B}_t^{G*} = \hat{P}_t^* + \hat{b}_t^{G*}$

Real Net Foreign Liabilities $\hat{d}_t^* = \frac{\overline{im}}{\bar{d}^*}i\hat{m}_t - \frac{\bar{x}}{\bar{q}\bar{d}^*}(\hat{x}_t - \hat{q}_t) + \hat{d}_{t-1}^* + \bar{r}^*(\hat{r}_{t-1}^* + \hat{d}_{t-1}^*)$

$+\bar{\kappa}(\hat{\kappa}_{t-1} + \hat{d}_{t-1}^*) + \bar{r}^*\bar{\kappa}(\hat{\kappa}_{t-1} + \hat{r}_{t-1}^* + \hat{d}_{t-1}^*)$

Nominal Net Foreign Liabilities $\hat{D}_t^* = \hat{P}_t^* + \hat{d}_t^*$

Financial Account $F\hat{A}_t = \frac{\bar{D}_t^*}{\overline{FA}_t}\hat{D}_t^* - \frac{\bar{D}_{t-1}^*}{\overline{FA}_t}\hat{D}_{t-1}^*$

Current Account $C\hat{A}_t = \frac{1}{\overline{CA}_t}\begin{pmatrix} \frac{\bar{P}_t\bar{x}}{\bar{s}_t}(\hat{P}_t + \hat{x}_t - \hat{s}_t) - \bar{P}_t^*\overline{im}(\hat{P}_t^* + i\hat{m}_t) \\ -\bar{D}_{t-1}^*\bar{i}^*(\hat{i}_{t-1}^* + \hat{D}_{t-1}^*) \\ -\bar{\kappa}\bar{D}_{t-1}^*(\hat{D}_{t-1}^* + \hat{\kappa}_{t-1}) \\ -\bar{i}^*\bar{\kappa}\bar{D}_{t-1}^*(\hat{D}_{t-1}^* + \hat{\kappa}_{t-1} + \hat{i}_{t-1}^*) \end{pmatrix}$

Interest-rate risk premium $\hat{\kappa}_t = \frac{\bar{q}\bar{d}^*(\bar{\kappa} + \varsigma)}{\bar{y}\bar{\kappa}}\left(\hat{q}_t + \hat{d}_t^* - \hat{y}_t\right) + \varepsilon_t^\kappa$