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1 CONSUMER

1.1 Optimisation problem

$$\max_{K_t, C_t, H_t, I_t} U_t = \beta \mathrm{E}_t \left[U_{t+1} \right] + (1-\eta)^{-1} \left({C_t}^{\mu} (1-H_t)^{1-\mu} \right)^{1-\eta} \tag{1.1}$$

s.t. :

$$C_t + I_t + T_t = \pi_t + TR_t + K_{t-1} r_t + H_t W_t - \psi K_{t-1} \left(-\delta + {K_{t-1}}^{-1} I_t \right)^2 \quad (\lambda_t^{\mathrm{c}}) \tag{1.2}$$

$$K_t = I_t + K_{t-1} (1-\delta) \quad \left(\lambda_t^{\mathrm{CONSUMER}^2} \right) \tag{1.3}$$

1.2 First order conditions

$$-\lambda_t^{\mathrm{CONSUMER}^2} + \beta \left((1-\delta) \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{CONSUMER}^2} \right] + \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}} \left(r_{t+1} - \psi \left(-\delta + {K_t}^{-1} I_{t+1} \right)^2 + 2\psi {K_t}^{-1} I_{t+1} \left(-\delta + {K_t}^{-1} I_{t+1} \right) \right) \right] \right) = 0 \quad (K_t) \tag{1.4}$$

$$-\lambda_t^{\mathrm{c}} + \mu {C_t}^{-1+\mu} (1-H_t)^{1-\mu} \left({C_t}^{\mu} (1-H_t)^{1-\mu} \right)^{-\eta} = 0 \quad (C_t) \tag{1.5}$$

$$\lambda_t^{\mathrm{c}} W_t + (-1+\mu) {C_t}^{\mu} (1-H_t)^{-\mu} \left({C_t}^{\mu} (1-H_t)^{1-\mu} \right)^{-\eta} = 0 \quad (H_t) \tag{1.6}$$

$$\lambda_t^{\mathrm{CONSUMER}^2} + \lambda_t^{\mathrm{c}} \left(-1 - 2\psi \left(-\delta + {K_{t-1}}^{-1} I_t \right) \right) = 0 \quad (I_t) \tag{1.7}$$

2 FIRM

2.1 Optimisation problem

$$\max_{K_t^{\mathrm{d}}, H_t^{\mathrm{d}}, Y_t, \pi_t} \Pi_t = \pi_t \tag{2.1}$$

s.t. :

$$Y_t = Z_t {H_t^{\mathrm{d}}}^{1-\alpha} {K_t^{\mathrm{d}}}^{\alpha} \quad \left(\lambda_t^{\mathrm{FIRM}^1} \right) \tag{2.2}$$

$$\pi_t = Y_t - H_t^{\mathrm{d}} W_t - r_t K_t^{\mathrm{d}} \quad \left(\lambda_t^{\mathrm{FIRM}^2} \right) \tag{2.3}$$

2.2 First order conditions

$$-\lambda_t^{\mathrm{FIRM}^2} r_t + \alpha \lambda_t^{\mathrm{FIRM}^1} Z_t {H_t^{\mathrm{d}}}^{1-\alpha} {K_t^{\mathrm{d}}}^{-1+\alpha} = 0 \quad \left(K_t^{\mathrm{d}}\right) \tag{2.4}$$

$$-\lambda_t^{\mathrm{FIRM}^2} W_t + \lambda_t^{\mathrm{FIRM}^1} Z_t \left(1-\alpha\right) {H_t^{\mathrm{d}}}^{-\alpha} {K_t^{\mathrm{d}}}^{\alpha} = 0 \quad \left(H_t^{\mathrm{d}}\right) \tag{2.5}$$

$$-\lambda_t^{\mathrm{FIRM}^1} + \lambda_t^{\mathrm{FIRM}^2} = 0 \quad \left(Y_t\right) \tag{2.6}$$

$$1 - \lambda_t^{\mathrm{FIRM}^2} = 0 \quad \left(\pi_t\right) \tag{2.7}$$

2.3 First order conditions after reduction

$$-r_t + \alpha Z_t {H_t^{\mathrm{d}}}^{1-\alpha} {K_t^{\mathrm{d}}}^{-1+\alpha} = 0 \quad \left(K_t^{\mathrm{d}}\right) \tag{2.8}$$

$$-W_t + Z_t \left(1-\alpha\right) {H_t^{\mathrm{d}}}^{-\alpha} {K_t^{\mathrm{d}}}^{\alpha} = 0 \quad \left(H_t^{\mathrm{d}}\right) \tag{2.9}$$

3 CONSUMER*

3.1 Optimisation problem

$$\max_{K_t^*, C_t^*, H_t^*, I_t^*} U_t^* = \beta \mathrm{E}_t \left[U_{t+1}^*\right] + \left(1-\eta\right)^{-1} \left(C_t^{*\mu} (1-H_t^*)^{1-\mu}\right)^{1-\eta} \tag{3.1}$$

s.t. :

$$C_t^* + I_t^* + T_t^* = \pi_t^* - TR_t + K_{t-1}^* r_t^* + H_t^* W_t^* - \psi K_{t-1}^* \left(-\delta + {K_{t-1}^*}^{-1} I_t^*\right)^2 \quad \left(\lambda_t^{\mathrm{c}^*}\right) \tag{3.2}$$

$$K_t^* = I_t^* + K_{t-1}^* \left(1-\delta\right) \quad \left(\lambda_t^{\mathrm{CONSUMER}^{*^2}}\right) \tag{3.3}$$

3.2 First order conditions

$$-\lambda_t^{\mathrm{CONSUMER}^{*^2}} + \beta \left(\left(1-\delta\right) \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{CONSUMER}^{*^2}}\right] + \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}^*} \left(r_{t+1}^* - \psi \left(-\delta + {K_t^*}^{-1} I_{t+1}^*\right)^2 + 2\psi {K_t^*}^{-1} I_{t+1}^* \left(-\delta + {K_t^*}^{-1} I_{t+1}^*\right)\right)\right]\right) = 0 \quad \left(K_t^*\right) \tag{3.4}$$

$$-\lambda_t^{\mathrm{c}^*} + \mu C_t^{*-1+\mu} (1-H_t^*)^{1-\mu} \left(C_t^{*\mu} (1-H_t^*)^{1-\mu}\right)^{-\eta} = 0 \quad \left(C_t^*\right) \tag{3.5}$$

$$\lambda_t^{\mathrm{c}^*} W_t^* + \left(-1+\mu\right) C_t^{*\mu} (1-H_t^*)^{-\mu} \left(C_t^{*\mu} (1-H_t^*)^{1-\mu}\right)^{-\eta} = 0 \quad \left(H_t^*\right) \tag{3.6}$$

$$\lambda_t^{\mathrm{CONSUMER}^{*^2}} + \lambda_t^{\mathrm{c}^*} \left(-1 - 2\psi \left(-\delta + {K_{t-1}^*}^{-1} I_t^*\right)\right) = 0 \quad \left(I_t^*\right) \tag{3.7}$$

4 FIRM*

4.1 Optimisation problem

$$\max_{K_t^{\mathrm{d}^*}, H_t^{\mathrm{d}^*}, Y_t^*, \pi_t^*} \Pi_t^* = \pi_t^* \tag{4.1}$$

s.t. :

$$Y_t^* = Z_t^* {H_t^{\mathrm{d}^*}}^{1-\alpha} {K_t^{\mathrm{d}^*}}^{\alpha} \quad \left(\lambda_t^{\mathrm{FIRM}^{*1}}\right) \tag{4.2}$$

$$\pi_t^* = Y_t^* - H_t^{\mathrm{d}^*} W_t^* - r_t^* K_t^{\mathrm{d}^*} \quad \left(\lambda_t^{\mathrm{FIRM}^{*2}}\right) \tag{4.3}$$

4.2 First order conditions

$$-\lambda_t^{\mathrm{FIRM}^{*2}} r_t^* + \alpha \lambda_t^{\mathrm{FIRM}^{*1}} Z_t^* {H_t^{\mathrm{d}^*}}^{1-\alpha} {K_t^{\mathrm{d}^*}}^{-1+\alpha} = 0 \quad \left(K_t^{\mathrm{d}^*}\right) \tag{4.4}$$

$$-\lambda_t^{\mathrm{FIRM}^{*2}} W_t^* + \lambda_t^{\mathrm{FIRM}^{*1}} Z_t^* (1-\alpha) {H_t^{\mathrm{d}^*}}^{-\alpha} {K_t^{\mathrm{d}^*}}^{\alpha} = 0 \quad \left(H_t^{\mathrm{d}^*}\right) \tag{4.5}$$

$$-\lambda_t^{\mathrm{FIRM}^{*1}} + \lambda_t^{\mathrm{FIRM}^{*2}} = 0 \quad (Y_t^*) \tag{4.6}$$

$$1 - \lambda_t^{\mathrm{FIRM}^{*2}} = 0 \quad (\pi_t^*) \tag{4.7}$$

4.3 First order conditions after reduction

$$-r_t^* + \alpha Z_t^* {H_t^{\mathrm{d}^*}}^{1-\alpha} {K_t^{\mathrm{d}^*}}^{-1+\alpha} = 0 \quad \left(K_t^{\mathrm{d}^*}\right) \tag{4.8}$$

$$-W_t^* + Z_t^* (1-\alpha) {H_t^{\mathrm{d}^*}}^{-\alpha} {K_t^{\mathrm{d}^*}}^{\alpha} = 0 \quad \left(H_t^{\mathrm{d}^*}\right) \tag{4.9}$$

5 EQUILIBRIUM

5.1 Identities

$$K_t^{\mathrm{d}} = K_{t-1} \tag{5.1}$$

$$H_t^{\mathrm{d}} = H_t \tag{5.2}$$

$$T_t = G_t^{\mathrm{d}} \tag{5.3}$$

$$K_t^{\mathrm{d}^*} = K_{t-1}^* \tag{5.4}$$

$$H_t^{\mathrm{d}^*} = H_t^* \tag{5.5}$$

$$T_t^* = G_t^{\mathrm{d}^*} \tag{5.6}$$

$$\lambda_t^{\mathrm{c}} = \lambda_t^{\mathrm{c}^*} \tag{5.7}$$

6 EXOG

6.1 Identities

$$G_t^{\mathrm{d}} = \epsilon_t^{\mathrm{G}} + \phi^{\mathrm{G}} G_{t-1}^{\mathrm{d}} \tag{6.1}$$

$$Z_t = e^{\epsilon_t^{\mathrm{Z}} + \phi^{\mathrm{Z}} \log Z_{t-1}} \tag{6.2}$$

$$G_t^{\mathrm{d}^*} = \epsilon_t^{\mathrm{G}^*} + \phi^{\mathrm{G}} G_{t-1}^{\mathrm{d}^*} \tag{6.3}$$

$$Z_t^* = e^{\epsilon_t^{\mathrm{Z}^*} + \phi^{\mathrm{Z}} \log Z_{t-1}^*} \tag{6.4}$$

7 Equilibrium relationships (after reduction)

$$-\lambda_t^{\mathrm{c}} + \lambda_t^{\mathrm{c}^*} = 0 \tag{7.1}$$

$$-\lambda_t^{\mathrm{c}} + \mu {C_t}^{-1+\mu} (1 - H_t)^{1-\mu} \left({C_t}^{\mu} (1 - H_t)^{1-\mu} \right)^{-\eta} = 0 \tag{7.2}$$

$$-\lambda_t^{\mathrm{c}^*} + \mu {C_t^*}^{-1+\mu} (1 - H_t^*)^{1-\mu} \left({C_t^*}^{\mu} (1 - H_t^*)^{1-\mu} \right)^{-\eta} = 0 \tag{7.3}$$

$$-r_t + \alpha Z_t {K_{t-1}}^{-1+\alpha} {H_t}^{1-\alpha} = 0 \tag{7.4}$$

$$-r_t^* + \alpha Z_t^* {K_{t-1}^*}^{-1+\alpha} {H_t^*}^{1-\alpha} = 0 \tag{7.5}$$

$$-W_t + Z_t \left(1 - \alpha\right) {K_{t-1}}^{\alpha} {H_t}^{-\alpha} = 0 \tag{7.6}$$

$$-W_t^* + Z_t^* \left(1-\alpha\right) {K_{t-1}^*}^{\alpha} {H_t^*}^{-\alpha} = 0 \tag{7.7}$$

$$-Y_t + Z_t {K_{t-1}}^{\alpha} {H_t}^{1-\alpha} = 0 \tag{7.8}$$

$$-Y_t^* + Z_t^* {K_{t-1}^*}^{\alpha} {H_t^*}^{1-\alpha} = 0 \tag{7.9}$$

$$-Z_t + e^{\epsilon_t^{\mathrm{Z}} + \phi^{\mathrm{Z}} \log Z_{t-1}} = 0 \tag{7.10}$$

$$-Z_t^* + e^{\epsilon_t^{\mathrm{Z}^*} + \phi^{\mathrm{Z}} \log Z_{t-1}^*} = 0 \tag{7.11}$$

$$\beta \left(-\left(1-\delta\right) \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}} \left(-1 - 2\psi \left(-\delta + {K_t}^{-1} I_{t+1} \right) \right) \right] + \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}} \left(r_{t+1} - \psi \left(-\delta + {K_t}^{-1} I_{t+1} \right)^2 + 2\psi {K_t}^{-1} I_{t+1} \left(-\delta + {K_t}^{-1} I_{t+1} \right) \right) \right] \right) + \lambda_t^{\mathrm{c}} \left(-1 - 2\psi \left(-\delta + {K_{t-1}}^{-1} I_t \right) \right) = 0 \tag{7.12}$$

$$\beta \left(-\left(1-\delta\right) \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}^*} \left(-1 - 2\psi \left(-\delta + {K_t^*}^{-1} I_{t+1}^* \right) \right) \right] + \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{c}^*} \left(r_{t+1}^* - \psi \left(-\delta + {K_t^*}^{-1} I_{t+1}^* \right)^2 + 2\psi {K_t^*}^{-1} I_{t+1}^* \left(-\delta + {K_t^*}^{-1} I_{t+1}^* \right) \right) \right] \right) + \lambda_t^{\mathrm{c}^*} \left(-1 - 2\psi \left(-\delta + {K_{t-1}^*}^{-1} I_t^* \right) \right) = 0 \tag{7.13}$$

$$\lambda_t^{\mathrm{c}} W_t + \left(-1+\mu\right) {C_t}^{\mu} (1-H_t)^{-\mu} \left({C_t}^{\mu} (1-H_t)^{1-\mu} \right)^{-\eta} = 0 \tag{7.14}$$

$$\lambda_t^{\mathrm{c}^*} W_t^* + \left(-1+\mu\right) {C_t^*}^{\mu} (1-H_t^*)^{-\mu} \left({C_t^*}^{\mu} (1-H_t^*)^{1-\mu} \right)^{-\eta} = 0 \tag{7.15}$$

$$\epsilon_t^{\mathrm{G}} - G_t^{\mathrm{d}} + \phi^{\mathrm{G}} G_{t-1}^{\mathrm{d}} = 0 \tag{7.16}$$

$$\epsilon_t^{\mathrm{G}^*} - G_t^{\mathrm{d}^*} + \phi^{\mathrm{G}} G_{t-1}^{\mathrm{d}^*} = 0 \tag{7.17}$$

$$I_t - K_t + K_{t-1} \left(1-\delta\right) = 0 \tag{7.18}$$

$$I_t^* - K_t^* + K_{t-1}^* \left(1-\delta\right) = 0 \tag{7.19}$$

$$U_t - \beta \mathrm{E}_t \left[U_{t+1} \right] - \left(1-\eta\right)^{-1} \left({C_t}^{\mu} (1-H_t)^{1-\mu} \right)^{1-\eta} = 0 \tag{7.20}$$

$$U_t^* - \beta \mathrm{E}_t \left[U_{t+1}^* \right] - (1-\eta)^{-1} \left(C_t^{*\mu} (1 - H_t^*)^{1-\mu} \right)^{1-\eta} = 0 \tag{7.21}$$

$$-C_t - G_t^{\mathrm{d}} - I_t + TR_t + Y_t - \psi K_{t-1} \left(-\delta + {K_{t-1}}^{-1} I_t \right)^2 = 0 \tag{7.22}$$

$$-C_t^* - G_t^{\mathrm{d}^*} - I_t^* - TR_t + Y_t^* - \psi K_{t-1}^* \left(-\delta + {K_{t-1}^*}^{-1} I_t^* \right)^2 = 0 \tag{7.23}$$

8 Steady state relationships (after reduction)

$$-\lambda_{\mathrm{ss}}^{\mathrm{c}} + \lambda_{\mathrm{ss}}^{\mathrm{c}^*} = 0 \tag{8.1}$$

$$-\lambda_{\mathrm{ss}}^{\mathrm{c}} + \mu {C_{\mathrm{ss}}}^{-1+\mu} (1 - H_{\mathrm{ss}})^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - H_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} = 0 \tag{8.2}$$

$$-\lambda_{\mathrm{ss}}^{\mathrm{c}^*} + \mu {C_{\mathrm{ss}}^*}^{-1+\mu} (1 - H_{\mathrm{ss}}^*)^{1-\mu} \left({C_{\mathrm{ss}}^*}^{\mu} (1 - H_{\mathrm{ss}}^*)^{1-\mu} \right)^{-\eta} = 0 \tag{8.3}$$

$$-r_{\mathrm{ss}} + \alpha Z_{\mathrm{ss}} {H_{\mathrm{ss}}}^{1-\alpha} {K_{\mathrm{ss}}}^{-1+\alpha} = 0 \tag{8.4}$$

$$-r_{\mathrm{ss}}^* + \alpha Z_{\mathrm{ss}}^* {H_{\mathrm{ss}}^*}^{1-\alpha} {K_{\mathrm{ss}}^*}^{-1+\alpha} = 0 \tag{8.5}$$

$$-W_{\mathrm{ss}} + Z_{\mathrm{ss}} (1-\alpha) {H_{\mathrm{ss}}}^{-\alpha} {K_{\mathrm{ss}}}^{\alpha} = 0 \tag{8.6}$$

$$-W_{\mathrm{ss}}^* + Z_{\mathrm{ss}}^* (1-\alpha) {H_{\mathrm{ss}}^*}^{-\alpha} {K_{\mathrm{ss}}^*}^{\alpha} = 0 \tag{8.7}$$

$$-Y_{\mathrm{ss}} + Z_{\mathrm{ss}} {H_{\mathrm{ss}}}^{1-\alpha} {K_{\mathrm{ss}}}^{\alpha} = 0 \tag{8.8}$$

$$-Y_{\mathrm{ss}}^* + Z_{\mathrm{ss}}^* {H_{\mathrm{ss}}^*}^{1-\alpha} {K_{\mathrm{ss}}^*}^{\alpha} = 0 \tag{8.9}$$

$$-Z_{\mathrm{ss}} + e^{\phi^{\mathrm{Z}} \log Z_{\mathrm{ss}}} = 0 \tag{8.10}$$

$$-Z_{\mathrm{ss}}^* + e^{\phi^{\mathrm{Z}} \log Z_{\mathrm{ss}}^*} = 0 \tag{8.11}$$

$$\beta \left(\lambda_{\mathrm{ss}}^{\mathrm{c}} \left(r_{\mathrm{ss}} - \psi \left(-\delta + I_{\mathrm{ss}} {K_{\mathrm{ss}}}^{-1} \right)^2 + 2\psi I_{\mathrm{ss}} {K_{\mathrm{ss}}}^{-1} \left(-\delta + I_{\mathrm{ss}} {K_{\mathrm{ss}}}^{-1} \right) \right) - \lambda_{\mathrm{ss}}^{\mathrm{c}} \left(-1 - 2\psi \left(-\delta + I_{\mathrm{ss}} {K_{\mathrm{ss}}}^{-1} \right) \right) (1-\delta) \right) + \lambda_{\mathrm{ss}}^{\mathrm{c}} \left(-1 - 2\psi \left(-\delta + I_{\mathrm{ss}} {K_{\mathrm{ss}}}^{-1} \right) \right) = 0 \tag{8.12}$$

$$\beta\left(\lambda_{\mathrm{ss}}^{\mathrm{c}^*}\left(r_{\mathrm{ss}}^*-\psi\left(-\delta+I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\right)^2+2\psi I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\left(-\delta+I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\right)\right)-\lambda_{\mathrm{ss}}^{\mathrm{c}^*}\left(-1-2\psi\left(-\delta+I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\right)\right)(1-\delta)\right)+\lambda_{\mathrm{ss}}^{\mathrm{c}^*}\left(-1-2\psi\left(-\delta+I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\right)\right)=0 \tag{8.13}$$

$$\lambda_{\mathrm{ss}}^{\mathrm{c}}W_{\mathrm{ss}}+(-1+\mu)\,{C_{\mathrm{ss}}}^{\mu}(1-H_{\mathrm{ss}})^{-\mu}\left({C_{\mathrm{ss}}}^{\mu}(1-H_{\mathrm{ss}})^{1-\mu}\right)^{-\eta}=0 \tag{8.14}$$

$$\lambda_{\mathrm{ss}}^{\mathrm{c}^*}W_{\mathrm{ss}}^*+(-1+\mu)\,{C_{\mathrm{ss}}^*}^{\mu}(1-H_{\mathrm{ss}}^*)^{-\mu}\left({C_{\mathrm{ss}}^*}^{\mu}(1-H_{\mathrm{ss}}^*)^{1-\mu}\right)^{-\eta}=0 \tag{8.15}$$

$$-G_{\mathrm{ss}}^{\mathrm{d}}+\phi^{\mathrm{G}}G_{\mathrm{ss}}^{\mathrm{d}}=0 \tag{8.16}$$

$$-G_{\mathrm{ss}}^{\mathrm{d}^*}+\phi^{\mathrm{G}}G_{\mathrm{ss}}^{\mathrm{d}^*}=0 \tag{8.17}$$

$$I_{\mathrm{ss}}-K_{\mathrm{ss}}+K_{\mathrm{ss}}\,(1-\delta)=0 \tag{8.18}$$

$$I_{\mathrm{ss}}^*-K_{\mathrm{ss}}^*+K_{\mathrm{ss}}^*\,(1-\delta)=0 \tag{8.19}$$

$$U_{\mathrm{ss}}-\beta U_{\mathrm{ss}}-(1-\eta)^{-1}\left({C_{\mathrm{ss}}}^{\mu}(1-H_{\mathrm{ss}})^{1-\mu}\right)^{1-\eta}=0 \tag{8.20}$$

$$U_{\mathrm{ss}}^*-\beta U_{\mathrm{ss}}^*-(1-\eta)^{-1}\left({C_{\mathrm{ss}}^*}^{\mu}(1-H_{\mathrm{ss}}^*)^{1-\mu}\right)^{1-\eta}=0 \tag{8.21}$$

$$-C_{\mathrm{ss}}-G_{\mathrm{ss}}^{\mathrm{d}}-I_{\mathrm{ss}}+TR_{\mathrm{ss}}+Y_{\mathrm{ss}}-\psi K_{\mathrm{ss}}\left(-\delta+I_{\mathrm{ss}}{K_{\mathrm{ss}}}^{-1}\right)^2=0 \tag{8.22}$$

$$-C_{\mathrm{ss}}^*-G_{\mathrm{ss}}^{\mathrm{d}^*}-I_{\mathrm{ss}}^*-TR_{\mathrm{ss}}+Y_{\mathrm{ss}}^*-\psi K_{\mathrm{ss}}^*\left(-\delta+I_{\mathrm{ss}}^*{K_{\mathrm{ss}}^*}^{-1}\right)^2=0 \tag{8.23}$$

9 Parameter settings

$$\alpha=0.4 \tag{9.1}$$

$$\beta=0.99 \tag{9.2}$$

$$\delta=0.025 \tag{9.3}$$

$$\eta = 2 \tag{9.4}$$

$$\mu = 0.3 \tag{9.5}$$

$$\phi^{\mathrm{G}} = 0.95 \tag{9.6}$$

$$\phi^{\mathrm{Z}} = 0.95 \tag{9.7}$$

$$\psi = 0.8 \tag{9.8}$$

∞

10 Steady-state values

	Steady-state value
λ^{c}	0.3934
λ^{c^*}	0.3934
r	0.0351
r^*	0.0351
C	0.9578
C^*	0.9578
G^{d}	0
G^{d^*}	0
H	0.2645
H^*	0.2645
I	0.3816
I^*	0.3816
K	15.2627
K^*	15.2627
TR	0
U	-125.6048
U^*	-125.6048
W	3.0384
W^*	3.0384
Y	1.3393
Y^*	1.3393
Z	1
Z^*	1

11 The solution of the 1st order perturbation

Matrix P

$$
\begin{array}{c}
 \\
G_t^{\mathrm{d}} \\
G_t^{\mathrm{d}^*} \\
K_t \\
K_t^* \\
Z_t \\
Z_t^*
\end{array}
\begin{array}{c}
\begin{array}{cccccc}
G_{t-1}^{\mathrm{d}} & G_{t-1}^{\mathrm{d}^*} & K_{t-1} & K_{t-1}^* & Z_{t-1} & Z_{t-1}^*
\end{array} \\
\left(\begin{array}{cccccc}
0.95 & 0 & 0 & 0 & 0 & 0 \\
0 & 0.95 & 0 & 0 & 0 & 0 \\
-0.1542 & -0.1542 & 0.9454 & 0.0244 & 2.2856 & -1.0704 \\
-0.1542 & -0.1542 & 0.0244 & 0.9454 & -1.0704 & 2.2856 \\
0 & 0 & 0 & 0 & 0.95 & 0 \\
0 & 0 & 0 & 0 & 0 & 0.95
\end{array}\right)
\end{array}
$$

Matrix Q

$$
\begin{array}{c}
 \\
G^{\mathrm{d}} \\
G^{\mathrm{d}^*} \\
K \\
K^* \\
Z \\
Z^*
\end{array}
\begin{array}{c}
\begin{array}{cccc}
\epsilon^{\mathrm{Z}} & \epsilon^{\mathrm{G}} & \epsilon^{\mathrm{G}^*} & \epsilon^{\mathrm{Z}^*}
\end{array} \\
\left(\begin{array}{cccc}
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
2.4059 & -0.1623 & -0.1623 & -1.1267 \\
-1.1267 & -0.1623 & -0.1623 & 2.4059 \\
1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1
\end{array}\right)
\end{array}
$$

Matrix R

	G^{d}_{t-1}	$G^{\mathrm{d}^*}_{t-1}$	K_{t-1}	K^*_{t-1}	Z_{t-1}	Z^*_{t-1}
λ^{c}_t	0.1022	0.1022	−0.0091	−0.0091	−0.1072	−0.1072
$\lambda^{\mathrm{c}^*}_t$	0.1022	0.1022	−0.0091	−0.0091	−0.1072	−0.1072
r_t	0.0044	0.0044	−0.0012	−0.0004	0.0497	−0.0046
r^*_t	0.0044	0.0044	−0.0004	−0.0012	−0.0046	0.0497
C_t	−0.1525	−0.1525	0.0187	0.0136	0.3448	0.1599
C^*_t	−0.1525	−0.1525	0.0136	0.0187	0.1599	0.3448
H_t	0.0554	0.0554	0.0023	−0.0049	0.2054	−0.0581
H^*_t	0.0554	0.0554	−0.0049	0.0023	−0.0581	0.2054
I_t	−0.1542	−0.1542	−0.0296	0.0244	2.2856	−1.0704
I^*_t	−0.1542	−0.1542	0.0244	−0.0296	−1.0704	2.2856
TR_t	0.475	−0.475	−0.053	0.053	0.7338	−0.7338
U_t	−3.1408	−3.1408	0.1608	0.2366	0.053	8.3603
U^*_t	−3.1408	−3.1408	0.2366	0.1608	8.3603	0.053
W_t	−0.2547	−0.2547	0.0689	0.0227	1.9424	0.2672
W^*_t	−0.2547	−0.2547	0.0227	0.0689	0.2672	1.9424
Y_t	0.1684	0.1684	0.0422	−0.015	1.8966	−0.1767
Y^*_t	0.1684	0.1684	−0.015	0.0422	−0.1767	1.8966

Matrix S

	ϵ^{Z}	ϵ^{G}	ϵ^{G^*}	ϵ^{Z^*}
λ^{c}	−0.1128	0.1075	0.1075	−0.1128
λ^{c^*}	−0.1128	0.1075	0.1075	−0.1128
r	0.0523	0.0046	0.0046	−0.0049
r^*	−0.0049	0.0046	0.0046	0.0523
C	0.3629	−0.1605	−0.1605	0.1683
C^*	0.1683	−0.1605	−0.1605	0.3629
H	0.2163	0.0583	0.0583	−0.0612
H^*	−0.0612	0.0583	0.0583	0.2163
I	2.4059	−0.1623	−0.1623	−1.1267
I^*	−1.1267	−0.1623	−0.1623	2.4059
TR	0.7724	0.5	−0.5	−0.7724
U	0.0557	−3.3061	−3.3061	8.8003
U^*	8.8003	−3.3061	−3.3061	0.0557
W	2.0446	−0.2681	−0.2681	0.2812
W^*	0.2812	−0.2681	−0.2681	2.0446
Y	1.9964	0.1773	0.1773	−0.186
Y^*	−0.186	0.1773	0.1773	1.9964

12 Model statistics

12.1 Basic statistics

	Steady-state value	Std. dev.	Variance	Loglin
r	0.0351	0.0051	0	N
C	0.9578	0.0373	0.0014	N
G^{d}	0	0.0922	0.0085	N
H	0.2645	0.026	0.0007	N
I	0.3816	0.2659	0.0707	N
K	15.2627	0.9072	0.8231	N
TR	0	0.1943	0.0378	N
U	-125.6048	1.065	1.1342	N
W	3.0384	0.1882	0.0354	N
Y	1.3393	0.2048	0.042	N
Z	1	0.0922	0.0085	N

12.2 Correlation matrix

	r	C	G^{d}	H	I	K	TR	U	W	Y	Z
r	1	0.569	0.552	0.89	0.816	0.169	0.516	-0.237	0.865	0.922	0.979
C		1	0.055	0.39	0.432	0.264	0.182	0.431	0.851	0.595	0.702
G^{d}			1	0.6	0.354	0.137	0.403	-0.287	0.377	0.538	0.5
H				1	0.733	0.532	0.338	-0.458	0.815	0.972	0.89
I					1	0.231	0.829	-0.563	0.69	0.75	0.793
K						1	-0.129	-0.329	0.47	0.532	0.296
TR							1	-0.517	0.308	0.342	0.449
U								1	0.01	-0.29	-0.145
W									1	0.928	0.949
Y										1	0.956
Z											1

12.3 Cross correlations with the reference variable (Y)

	$\sigma[\cdot]$ rel. to $\sigma[Y]$	Y_{t-5}	Y_{t-4}	Y_{t-3}	Y_{t-2}	Y_{t-1}	Y_t	Y_{t+1}	Y_{t+2}	Y_{t+3}	Y_{t+4}	Y_{t+5}
r_t	0.025	0.163	0.276	0.41	0.563	0.734	0.922	0.574	0.294	0.077	-0.087	-0.205
C_t	0.182	-0.052	0.027	0.129	0.256	0.411	0.595	0.473	0.36	0.258	0.168	0.09
G_t^{d}	0.45	0.048	0.116	0.199	0.297	0.41	0.538	0.368	0.227	0.112	0.021	-0.048
H_t	0.127	0.067	0.196	0.352	0.534	0.741	0.972	0.723	0.504	0.314	0.155	0.025
I_t	1.298	0.197	0.289	0.393	0.506	0.626	0.75	0.439	0.193	0.005	-0.134	-0.229
K_t	4.429	-0.217	-0.127	-0.009	0.14	0.32	0.532	0.647	0.688	0.672	0.616	0.533
TR_t	0.949	0.235	0.268	0.298	0.322	0.338	0.342	0.074	-0.119	-0.249	-0.328	-0.367
U_t	5.199	-0.137	-0.177	-0.215	-0.249	-0.275	-0.29	-0.179	-0.087	-0.014	0.042	0.083
W_t	0.919	0.005	0.129	0.282	0.465	0.681	0.928	0.71	0.513	0.341	0.194	0.071
Y_t	1	0.045	0.178	0.34	0.531	0.752	1	0.752	0.531	0.34	0.178	0.045
Z_t	0.45	0.105	0.226	0.372	0.542	0.737	0.956	0.648	0.393	0.186	0.023	-0.1

12.4 Autocorrelations

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
r	0.704	0.456	0.254	0.093	0
C	0.746	0.524	0.332	0.172	0.041
G^{d}	0.713	0.471	0.271	0.11	-0.016
H	0.755	0.536	0.345	0.184	0.05
I	0.697	0.446	0.242	0.081	-0.042
K	0.956	0.852	0.708	0.544	0.373
TR	0.72	0.482	0.283	0.122	-0.006
U	0.731	0.5	0.304	0.143	0.014
W	0.747	0.525	0.333	0.172	0.039
Y	0.752	0.531	0.34	0.178	0.045
Z	0.713	0.471	0.271	0.11	-0.016

12.5 Variance decomposition

	ϵ^{Z}	ϵ^{G}	ϵ^{G^*}	ϵ^{Z^*}
r	0.979	0.005	0.006	0.01
C	0.547	0.119	0.076	0.259
G^{d}	0.25	0.75	0	0
H	0.81	0.032	0.029	0.128
I	0.641	0.002	0.126	0.23
K	0.648	0.003	0.124	0.225
TR	0.291	0.042	0.369	0.298
U	0.022	0.061	0.022	0.895
W	0.95	0.013	0.014	0.023
Y	0.944	0.005	0.011	0.04
Z	1	0	0	0

13 Impulse response functions

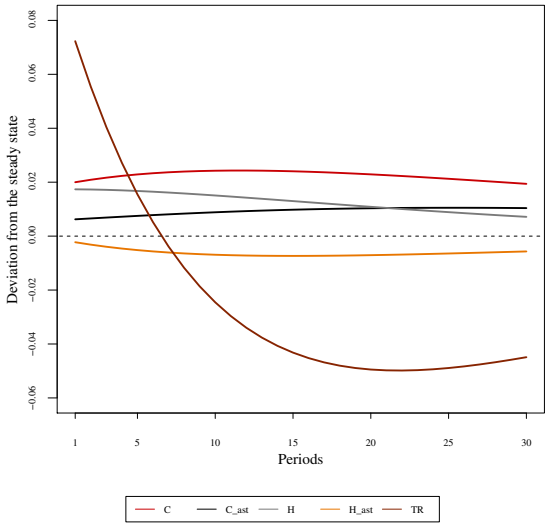

Figure 1: Impulse responses (C, C^*, H, H^*, TR) to ϵ^{Z} shock

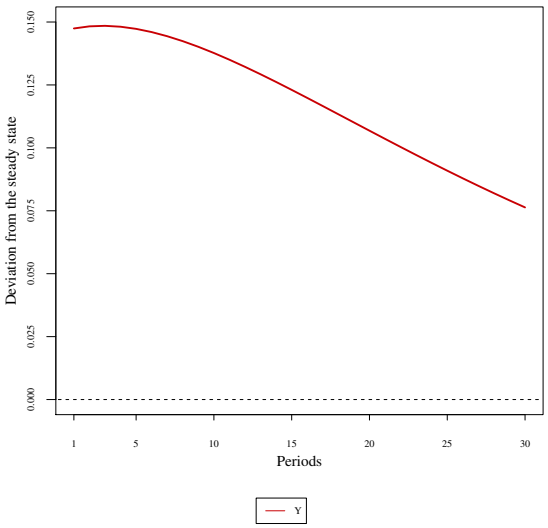

Figure 2: Impulse response (Y) to ϵ^{Z} shock

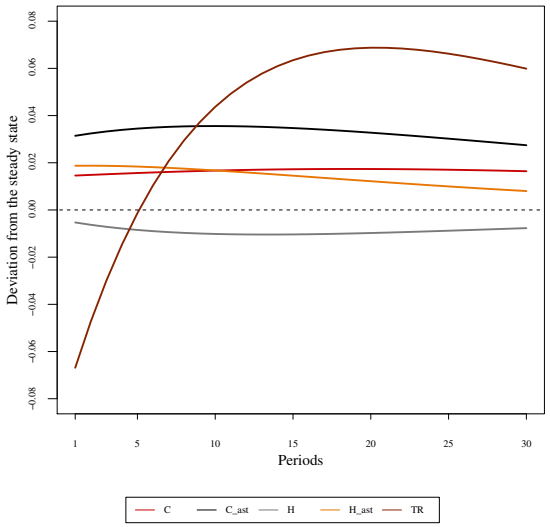

Figure 3: Impulse responses (C, C^*, H, H^*, TR) to ϵ^{Z^*} shock

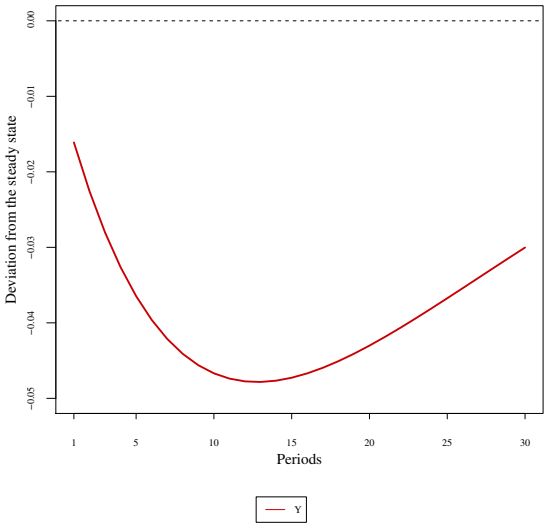

Figure 4: Impulse response (Y) to ϵ^{Z^*} shock