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Model name: `rbc_mc`

1 CONSUMER

1.1 Optimisation problem

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

s.t. :

$$C_t P^{\mathrm{FIN}}_t = \pi_t + \pi^{\mathrm{ps}}_t + L^{\mathrm{s}}_t W_t \quad \left(\lambda^{\mathrm{c}}_t \right) \tag{1.2}$$

1.2 First order conditions

$$\beta - \lambda^{\mathrm{U}}_t = 0 \quad (U_t) \tag{1.3}$$

$$-\lambda^{\mathrm{c}}_t P^{\mathrm{FIN}}_t + \mu {C_t}^{-1+\mu} (1 - L^{\mathrm{s}}_t)^{1-\mu} \left({C_t}^{\mu} (1 - L^{\mathrm{s}}_t)^{1-\mu} \right)^{-\eta} = 0 \quad (C_t) \tag{1.4}$$

$$\lambda^{\mathrm{c}}_t W_t + (-1 + \mu) {C_t}^{\mu} (1 - L^{\mathrm{s}}_t)^{-\mu} \left({C_t}^{\mu} (1 - L^{\mathrm{s}}_t)^{1-\mu} \right)^{-\eta} = 0 \quad (L^{\mathrm{s}}_t) \tag{1.5}$$

2 INTERMEDIATE FIRM

2.1 Optimisation problem

$$\max_{K_t, L^{\mathrm{d}}_t, Y_t, I_t, \pi_t} \Pi_t = \pi_t + {\lambda^{\mathrm{c}}_t}^{-1} \mathrm{E}_t \left[\lambda^{\mathrm{c}}_{t+1} \lambda^{\mathrm{U}}_{t+1} \Pi_{t+1} \right] \tag{2.1}$$

s.t. :

$$\pi_t = -I_t - L^{\mathrm{d}}_t W_t + P_t Y_t \quad \left(\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^1}}_t \right) \tag{2.2}$$

$$Y_t = {K_{t-1}}^{\alpha} \left(L^{\mathrm{d}}_t Z_t \right)^{1-\alpha} \quad \left(\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^2}}_t \right) \tag{2.3}$$

$$K_t = I_t + K_{t-1} (1 - \delta) \quad \left(\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^3}}_t \right) \tag{2.4}$$

2.2 First order conditions

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}} + {\lambda_{t-1}^{\mathrm{c}}}^{-1}\lambda_t^{\mathrm{c}}\lambda_t^{\mathrm{U}} = 0 \quad (\Pi_t) \tag{2.5}$$

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{3}}} + \mathrm{E}_t\left[\lambda_{t+1}^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}}\left(\lambda_{t+1}^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{3}}}(1-\delta) + \alpha\lambda_{t+1}^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}}{K_t}^{-1+\alpha}\left(L_{t+1}^{\mathrm{d}}Z_{t+1}\right)^{1-\alpha}\right)\right] = 0 \quad (K_t) \tag{2.6}$$

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{1}}}W_t + \lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}}Z_t\,(1-\alpha)\,{K_{t-1}}^{\alpha}\left(L_t^{\mathrm{d}}Z_t\right)^{-\alpha} = 0 \quad \left(L_t^{\mathrm{d}}\right) \tag{2.7}$$

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}} + \lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{1}}}P_t = 0 \quad (Y_t) \tag{2.8}$$

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{1}}} + \lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{3}}} = 0 \quad (I_t) \tag{2.9}$$

$$1 - \lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{1}}} = 0 \quad (\pi_t) \tag{2.10}$$

2.3 First order conditions after reduction

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}} + {\lambda_{t-1}^{\mathrm{c}}}^{-1}\lambda_t^{\mathrm{c}}\lambda_t^{\mathrm{U}} = 0 \quad (\Pi_t) \tag{2.11}$$

$$-1 + \mathrm{E}_t\left[\lambda_{t+1}^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}}\left(1-\delta + \alpha\lambda_{t+1}^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}}{K_t}^{-1+\alpha}\left(L_{t+1}^{\mathrm{d}}Z_{t+1}\right)^{1-\alpha}\right)\right] = 0 \quad (K_t) \tag{2.12}$$

$$-W_t + \lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}}Z_t\,(1-\alpha)\,{K_{t-1}}^{\alpha}\left(L_t^{\mathrm{d}}Z_t\right)^{-\alpha} = 0 \quad \left(L_t^{\mathrm{d}}\right) \tag{2.13}$$

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{2}}} + P_t = 0 \quad (Y_t) \tag{2.14}$$

3 PRICE SETTING

3.1 Optimisation problem

$$\max_{\pi_t^{\mathrm{ps}},Y_t^{\mathrm{MON}},P_t^{\mathrm{MON}}} \Pi_t^{\mathrm{PS}} = \pi_t^{\mathrm{ps}} \tag{3.1}$$

s.t. :

$$\pi_t^{\mathrm{ps}} = Y_t^{\mathrm{MON}}\left(-P_t + P_t^{\mathrm{MON}}\right) \quad \left(\lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^{1}}}\right) \tag{3.2}$$

$$Y_t^{\mathrm{MON}} = Y_t^{\mathrm{FIN}}\left({P_t^{\mathrm{FIN}}}^{-1}P_t^{\mathrm{MON}}\right)^{-\rho} \quad \left(\lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^{2}}}\right) \tag{3.3}$$

3.2 First order conditions

$$1 - \lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^1}} = 0 \quad (\pi_t^{\mathrm{ps}}) \tag{3.4}$$

$$-\lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^2}} + \lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^1}} \left(-P_t + P_t^{\mathrm{MON}}\right) = 0 \quad \left(Y_t^{\mathrm{MON}}\right) \tag{3.5}$$

$$\lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^1}} Y_t^{\mathrm{MON}} - \rho \lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^2}} P_t^{\mathrm{FIN}^{-1}} Y_t^{\mathrm{FIN}} \left(P_t^{\mathrm{FIN}^{-1}} P_t^{\mathrm{MON}}\right)^{-1-\rho} = 0 \quad \left(P_t^{\mathrm{MON}}\right) \tag{3.6}$$

3.3 First order conditions after reduction

$$Y_t^{\mathrm{MON}} - \rho P_t^{\mathrm{FIN}^{-1}} Y_t^{\mathrm{FIN}} \left(-P_t + P_t^{\mathrm{MON}}\right) \left(P_t^{\mathrm{FIN}^{-1}} P_t^{\mathrm{MON}}\right)^{-1-\rho} = 0 \quad \left(P_t^{\mathrm{MON}}\right) \tag{3.7}$$

4 FINAL FIRM

4.1 Identities

$$Y_t^{\mathrm{FIN}} = Y_t^{\mathrm{MON}} \tag{4.1}$$

5 EQUILIBRIUM

5.1 Identities

$$L_t^{\mathrm{d}} = L_t^{\mathrm{s}} \tag{5.1}$$

$$P_t^{\mathrm{FIN}} = 1 \tag{5.2}$$

$$Y_t^{\mathrm{MON}} = Y_t \tag{5.3}$$

6 EXOG

6.1 Identities

$$Z_t = e^{\epsilon_t^{\mathrm{Z}} + \phi \log Z_{t-1}} \tag{6.1}$$

7 Equilibrium relationships (after reduction)

$$-1+\beta\left(C_t{}^{-1+\mu}\right)^{-1}\left((1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-1}\left(\left(C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-\eta}\right)^{-1}\mathrm{E}_t\left[\left(1-\delta+\alpha P_{t+1}K_t{}^{-1+\alpha}\left(L^{\mathrm{s}}_{t+1}Z_{t+1}\right)^{1-\alpha}\right)C_{t+1}{}^{-1+\mu}\left(1-L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\left(C_{t+1}{}^{\mu}\left(1-L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\right)^{-\eta}\right]=0 \tag{7.1}$$

$$-\pi^{\mathrm{ps}}_t+\Pi^{\mathrm{PS}}_t=0 \tag{7.2}$$

$$-\pi^{\mathrm{ps}}_t+Y_t\left(-P_t+P^{\mathrm{MON}}_t\right)=0 \tag{7.3}$$

$$-W_t+P_tZ_t\left(1-\alpha\right)K_{t-1}{}^{\alpha}(L^{\mathrm{s}}_tZ_t)^{-\alpha}=0 \tag{7.4}$$

$$-Y_t+Y_tP^{\mathrm{MON}\,-\rho}_t=0 \tag{7.5}$$

$$-Y_t+K_{t-1}{}^{\alpha}(L^{\mathrm{s}}_tZ_t)^{1-\alpha}=0 \tag{7.6}$$

$$Y_t-\rho Y_t\left(-P_t+P^{\mathrm{MON}}_t\right)P^{\mathrm{MON}\,-1-\rho}_t=0 \tag{7.7}$$

$$-Z_t+e^{\epsilon^{\mathrm{Z}}_t+\phi\log Z_{t-1}}=0 \tag{7.8}$$

$$\left(-1+\mu\right)C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{-\mu}\left(C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-\eta}+\mu W_tC_t{}^{-1+\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\left(C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-\eta}=0 \tag{7.9}$$

$$-\pi_t+\Pi_t-\beta\left(C_t{}^{-1+\mu}\right)^{-1}\left((1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-1}\left(\left(C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{-\eta}\right)^{-1}\mathrm{E}_t\left[\Pi_{t+1}C_{t+1}{}^{-1+\mu}\left(1-L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\left(C_{t+1}{}^{\mu}\left(1-L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\right)^{-\eta}\right]=0 \tag{7.10}$$

$$I_t-K_t+K_{t-1}\left(1-\delta\right)=0 \tag{7.11}$$

$$U_t-\beta\mathrm{E}_t\left[U_{t+1}\right]-(1-\eta)^{-1}\left(C_t{}^{\mu}(1-L^{\mathrm{s}}_t)^{1-\mu}\right)^{1-\eta}=0 \tag{7.12}$$

$$-\pi_t-I_t-L^{\mathrm{s}}_tW_t+P_tY_t=0 \tag{7.13}$$

$$\pi_t+\pi^{\mathrm{ps}}_t-C_t+L^{\mathrm{s}}_tW_t=0 \tag{7.14}$$

8 Steady state relationships (after reduction)

$$-1+\beta\left(1-\delta+\alpha P_{\mathrm{ss}}{K_{\mathrm{ss}}}^{-1+\alpha}(L^{\mathrm{s}}_{\mathrm{ss}}Z_{\mathrm{ss}})^{1-\alpha}\right){C_{\mathrm{ss}}}^{-1+\mu}{C_{\mathrm{ss}}}^{1-\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{-1+\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}=0 \tag{8.1}$$

$$-\pi^{\mathrm{ps}}_{\mathrm{ss}}+\Pi^{\mathrm{PS}}_{\mathrm{ss}}=0 \tag{8.2}$$

$$-\pi^{\mathrm{ps}}_{\mathrm{ss}}+Y_{\mathrm{ss}}\left(-P_{\mathrm{ss}}+P^{\mathrm{MON}}_{\mathrm{ss}}\right)=0 \tag{8.3}$$

$$-W_{\mathrm{ss}}+P_{\mathrm{ss}}Z_{\mathrm{ss}}\left(1-\alpha\right){K_{\mathrm{ss}}}^{\alpha}(L^{\mathrm{s}}_{\mathrm{ss}}Z_{\mathrm{ss}})^{-\alpha}=0 \tag{8.4}$$

$$-Y_{\mathrm{ss}}+Y_{\mathrm{ss}}P^{\mathrm{MON}^{-\rho}}_{\mathrm{ss}}=0 \tag{8.5}$$

$$-Y_{\mathrm{ss}}+{K_{\mathrm{ss}}}^{\alpha}(L^{\mathrm{s}}_{\mathrm{ss}}Z_{\mathrm{ss}})^{1-\alpha}=0 \tag{8.6}$$

$$Y_{\mathrm{ss}}-\rho Y_{\mathrm{ss}}\left(-P_{\mathrm{ss}}+P^{\mathrm{MON}}_{\mathrm{ss}}\right)P^{\mathrm{MON}^{-1-\rho}}_{\mathrm{ss}}=0 \tag{8.7}$$

$$-Z_{\mathrm{ss}}+e^{\phi\log Z_{\mathrm{ss}}}=0 \tag{8.8}$$

$$\left(-1+\mu\right){C_{\mathrm{ss}}}^{\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{-\mu}\left({C_{\mathrm{ss}}}^{\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}\right)^{-\eta}+\mu W_{\mathrm{ss}}{C_{\mathrm{ss}}}^{-1+\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}\left({C_{\mathrm{ss}}}^{\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}\right)^{-\eta}=0 \tag{8.9}$$

$$-\pi_{\mathrm{ss}}+\Pi_{\mathrm{ss}}-\beta\Pi_{\mathrm{ss}}1(1-L^{\mathrm{s}}_{\mathrm{ss}})^{-1+\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}=0 \tag{8.10}$$

$$I_{\mathrm{ss}}-K_{\mathrm{ss}}+K_{\mathrm{ss}}\left(1-\delta\right)=0 \tag{8.11}$$

$$U_{\mathrm{ss}}-\beta U_{\mathrm{ss}}-(1-\eta)^{-1}\left({C_{\mathrm{ss}}}^{\mu}(1-L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu}\right)^{1-\eta}=0 \tag{8.12}$$

$$-\pi_{\mathrm{ss}}-I_{\mathrm{ss}}-L^{\mathrm{s}}_{\mathrm{ss}}W_{\mathrm{ss}}+P_{\mathrm{ss}}Y_{\mathrm{ss}}=0 \tag{8.13}$$

$$\pi_{\mathrm{ss}}+\pi^{\mathrm{ps}}_{\mathrm{ss}}-C_{\mathrm{ss}}+L^{\mathrm{s}}_{\mathrm{ss}}W_{\mathrm{ss}}=0 \tag{8.14}$$

9 Parameter settings

$$\alpha = 0.33 \tag{9.1}$$

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

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

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

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

$$\phi = 0.95 \tag{9.6}$$

$$\rho = 11 \tag{9.7}$$

10 Steady-state values

	Steady-state value
π	0.0619
π^{ps}	0.0652
C	0.5638
I	0.1532
K	6.1285
L^{s}	0.2492
P	0.9091
P^{MON}	1
Π	6.1904
Π^{PS}	0.0652
U	-145.144
W	1.7524
Y	0.7171
Z	1

11 The solution of the 1st order perturbation

Matrix P

$$\begin{array}{c} \\ K_t \\ Z_t \end{array} \begin{array}{c} \begin{array}{cc} K_{t-1} & Z_{t-1} \end{array} \\ \begin{pmatrix} 0.958 & 0.0744 \\ 0 & 0.95 \end{pmatrix} \end{array}$$

Matrix Q

$$\begin{array}{c} \\ K \\ Z \end{array} \begin{array}{c} \epsilon^{\text{Z}} \\ \begin{pmatrix} 0.0783 \\ 1 \end{pmatrix} \end{array}$$

Matrix R

$$\begin{array}{c} \\ \pi_t \\ \pi_t^{\text{ps}} \\ C_t \\ I_t \\ L_t^{\text{s}} \\ P_t \\ P_t^{\text{MON}} \\ \Pi_t \\ \Pi_t^{\text{PS}} \\ U_t \\ W_t \\ Y_t \end{array} \begin{array}{c} \begin{array}{cc} K_{t-1} & Z_{t-1} \end{array} \\ \begin{pmatrix} 2.4086 & -4.1777 \\ 0.2085 & 0.9179 \\ 0.45 & 0.3585 \\ -0.6804 & 2.9768 \\ -0.1813 & 0.42 \\ 0 & 0 \\ 0 & 0 \\ 0.9725 & 0.0319 \\ 0.2085 & 0.9179 \\ 0.0343 & 0.0442 \\ 0.3898 & 0.4979 \\ 0.2085 & 0.9179 \end{pmatrix} \end{array}$$

Matrix S

$$\begin{array}{l} \\ \pi \\ \pi^{\mathrm{ps}} \\ C \\ I \\ L^{\mathrm{s}} \\ P \\ P^{\mathrm{MON}} \\ \Pi \\ \Pi^{\mathrm{PS}} \\ U \\ W \\ Y \end{array} \begin{array}{c} \epsilon^{\mathrm{Z}} \\ \begin{pmatrix} -4.3976 \\ 0.9662 \\ 0.3773 \\ 3.1334 \\ 0.4421 \\ 0 \\ 0 \\ 0.0336 \\ 0.9662 \\ 0.0465 \\ 0.5241 \\ 0.9662 \end{pmatrix} \end{array}$$

12 Model statistics

12.1 Basic statistics

	Steady-state value	Std. dev.	Variance	Loglin
C	0.5638	0.5188	0.2691	Y
I	0.1532	4.0905	16.732	Y
K	6.1285	0.3617	0.1308	Y
L^{s}	0.2492	0.5797	0.336	Y
U	-145.144	0.0619	0.0038	Y
W	1.7524	0.6982	0.4875	Y
Y	0.7171	1.262	1.5927	Y
Z	1	1.3034	1.699	Y

12.2 Correlation matrix

	C	I	K	L^{s}	U	W	Y	Z
C	1	0.929	0.573	0.908	0.993	0.993	0.967	0.95
I		1	0.229	0.999	0.966	0.965	0.993	0.998
K			1	0.177	0.473	0.474	0.344	0.287
L^{s}				1	0.951	0.95	0.985	0.994
U					1	1	0.99	0.98
W						1	0.99	0.979
Y							1	0.998
Z								1

12.3 Autocorrelations

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
C	0.76	0.545	0.357	0.196	0.063
I	0.71	0.465	0.264	0.103	-0.022
K	0.959	0.861	0.725	0.568	0.403
L^{s}	0.708	0.463	0.261	0.1	-0.025
U	0.738	0.51	0.316	0.156	0.026
W	0.738	0.51	0.317	0.156	0.026
Y	0.719	0.48	0.281	0.12	-0.007
Z	0.713	0.471	0.271	0.11	-0.016

13 Model statistics

13.1 Basic statistics

	Steady-state value	Std. dev.	Variance	Loglin
C	0.5638	2.7633	7.6358	Y
I	0.1532	8.4869	72.0273	Y
K	6.1285	4.0317	16.255	Y
L^s	0.2492	1.0854	1.1781	Y
U	-145.144	0.2617	0.0685	Y
W	1.7524	2.9592	8.7567	Y
Y	0.7171	3.7017	13.7022	Y
Z	1	3.2026	10.2564	Y

13.2 Correlation matrix

	C	I	K	L^s	U	W	Y	Z
C	1	0.722	0.959	0.498	0.994	0.994	0.941	0.869
I		1	0.495	0.959	0.792	0.791	0.914	0.97
K			1	0.23	0.922	0.923	0.805	0.692
L^s				1	0.588	0.586	0.762	0.862
U					1	1	0.972	0.917
W						1	0.971	0.916
Y							1	0.985
Z								1

13.3 Autocorrelations

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
C	0.99	0.98	0.968	0.955	0.941
I	0.929	0.863	0.801	0.743	0.688
K	0.999	0.996	0.991	0.984	0.976
L^s	0.913	0.832	0.756	0.686	0.62
U	0.984	0.967	0.95	0.933	0.915
W	0.984	0.968	0.951	0.933	0.915
Y	0.965	0.932	0.899	0.868	0.837
Z	0.95	0.903	0.857	0.815	0.774

14 Impulse response functions

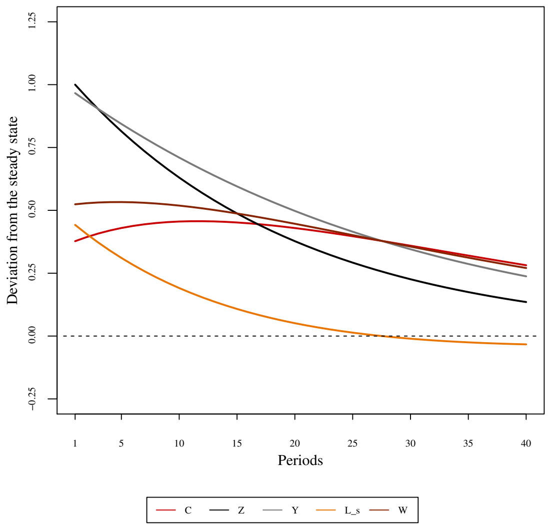

Figure 1: Impulse responses (C, Z, Y, L^s, W) to ϵ^Z shock

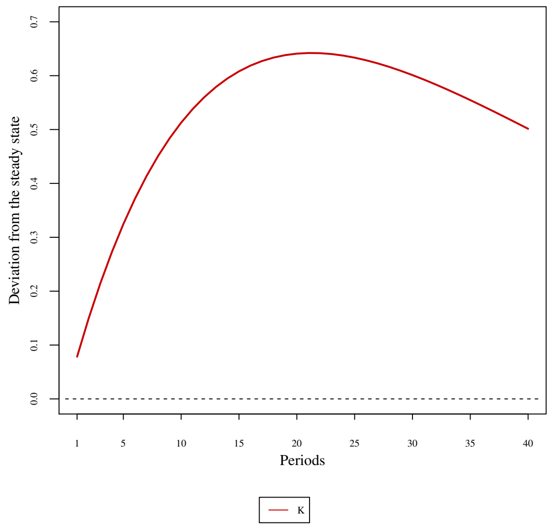

Figure 2: Impulse response (K) to ϵ^Z shock

15 Random path simulation

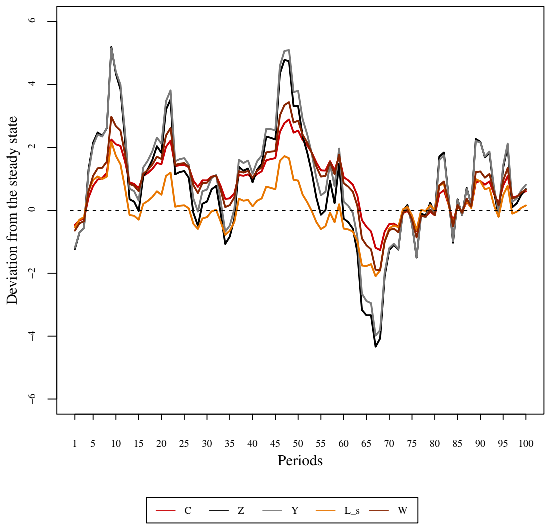

Figure 3: Random path simulation (C, Z, Y, L^s, W)

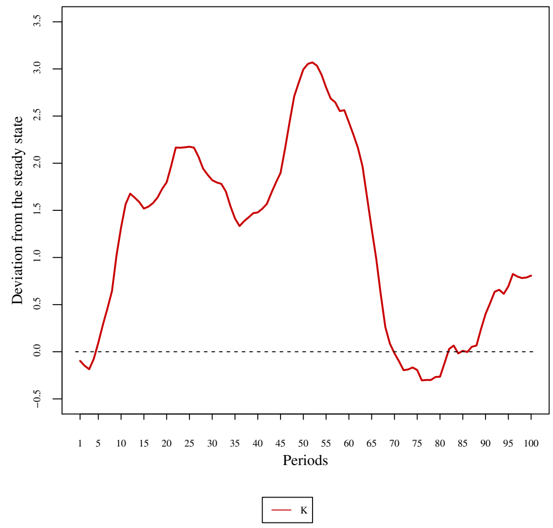

Figure 4: Random path simulation (K)