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Model name: `rbc_mc`

1 CONSUMER

1.1 Optimization problem

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

s.t. :

$$C_t P^{\mathrm{FIN}}_t = \pi_t + \pi^{\mathrm{ps}}_t + L^s_t W_t \quad (\lambda^c_t) \tag{1.2}$$

1.2 First order conditions

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

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

$$\lambda^c_t W_t + (-1+\mu) {C_t}^{\mu} (1 - L^s_t)^{-\mu} \left({C_t}^{\mu} (1 - L^s_t)^{1-\mu}\right)^{-\eta} = 0 \quad (L^s_t) \tag{1.5}$$

2 INTERMEDIATE FIRM

2.1 Optimization problem

$$\max_{K_t, L^d_t, Y_t, I_t, \pi_t} \Pi_t = \pi_t + {\lambda^c_t}^{-1} \mathrm{E}_t \left[\lambda^c_{t+1} \lambda^U_{t+1} \Pi_{t+1}\right] \tag{2.1}$$

s.t. :

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

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

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

2.2 First order conditions

$$-\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}}_t + {\lambda^c_{t-1}}^{-1} \lambda^c_t \lambda^U_t = 0 \quad (\Pi_t) \tag{2.5}$$

$$-\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^3}}_t + \mathrm{E}_t \left[\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}}_{t+1} \left(\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^3}}_{t+1} (1-\delta) + \alpha \lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^2}}_{t+1} {K_t}^{-1+\alpha} \left(L^d_{t+1} Z_{t+1}\right)^{1-\alpha}\right)\right] = 0 \tag{2.6}$$

$$-\lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^1}}_t W_t + \lambda^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^2}}_t Z_t (1-\alpha) {K_{t-1}}^{\alpha} \left(L^d_t Z_t\right)^{-\alpha} = 0 \quad (L^d_t) \tag{2.7}$$

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

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

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

2.3 First order conditions after reduction

$$-\lambda_t^{\mathrm{INTERMEDIATE}^{\mathrm{FIRM}^{\Pi}}} + {\lambda^c_{t-1}}^{-1}\lambda^c_t\lambda^U_t = 0 \quad (\Pi_t) \tag{2.11}$$

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

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

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

3 PRICE SETTING

3.1 Optimization problem

$$\max_{\pi^{ps}_t, Y^{\mathrm{MON}}_t, P^{\mathrm{MON}}_t} \Pi^{\mathrm{PS}}_t = \pi^{ps}_t \tag{3.1}$$

s.t. :

$$\pi^{ps}_t = Y^{\mathrm{MON}}_t\left(-P_t + P^{\mathrm{MON}}_t\right) \quad \left(\lambda_t^{\mathrm{PRICE}^{\mathrm{SETTING}^{1}}}\right) \tag{3.2}$$

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

3.2 First order conditions

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

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

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

3.3 First order conditions after reduction

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

4 FINAL FIRM

4.1 Identities

$$Y^{\mathrm{FIN}}_t = Y^{\mathrm{MON}}_t \tag{4.1}$$

5 EQUILIBRIUM

5.1 Identities

$$L^d_t = L^s_t \tag{5.1}$$

$$P^{\mathrm{FIN}}_t = 1 \tag{5.2}$$

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

6 EXOG

6.1 Identities

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

7 Equilibrium relationships

$$-1 + \lambda_t^{c}{}^{-1} \mathrm{E}_t \left[\lambda_{t+1}^c \lambda_{t+1}^U \left(1 - \delta + \alpha P_{t+1} K_t{}^{-1+\alpha} \left(L_{t+1}^s Z_{t+1} \right)^{1-\alpha} \right) \right] = 0 \tag{7.1}$$

$$\beta - \lambda_t^U = 0 \tag{7.2}$$

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

$$-\pi_t^{\mathrm{ps}} + \Pi_t^{\mathrm{PS}} = 0 \tag{7.4}$$

$$-\pi_t^{\mathrm{ps}} + Y_t \left(-P_t + P_t^{\mathrm{MON}} \right) = 0 \tag{7.5}$$

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

$$-Y_t + Y_t P_t^{\mathrm{MON}}{}^{-\rho} = 0 \tag{7.7}$$

$$-Y_t + K_{t-1}{}^\alpha (L_t^s Z_t)^{1-\alpha} = 0 \tag{7.8}$$

$$Y_t - \rho Y_t \left(-P_t + P_t^{\mathrm{MON}} \right) P_t^{\mathrm{MON}}{}^{-1-\rho} = 0 \tag{7.9}$$

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

$$\lambda_t^c W_t + \left(-1 + \mu\right) C_t{}^\mu (1 - L_t^s)^{-\mu} \left(C_t{}^\mu (1 - L_t^s)^{1-\mu} \right)^{-\eta} = 0 \tag{7.11}$$

$$-\pi_t + \Pi_t - \lambda_t^{c}{}^{-1} \mathrm{E}_t \left[\lambda_{t+1}^c \lambda_{t+1}^U \Pi_{t+1} \right] = 0 \tag{7.12}$$

$$I_t - K_t + K_{t-1} \left(1 - \delta\right) = 0 \tag{7.13}$$

$$U_t - \beta \mathrm{E}_t \left[U_{t+1} \right] - (1 - \eta)^{-1} \left(C_t{}^\mu (1 - L_t^s)^{1-\mu} \right)^{1-\eta} = 0 \tag{7.14}$$

$$-\pi_t - I_t - L_t^s W_t + P_t Y_t = 0 \tag{7.15}$$

$$\pi_t + \pi_t^{\mathrm{ps}} - C_t + L_t^s W_t = 0 \tag{7.16}$$

8 Steady state relationships

$$-1 + \lambda_{\mathrm{ss}}^U \left(1 - \delta + \alpha P_{\mathrm{ss}} (L_{\mathrm{ss}}^s Z_{\mathrm{ss}})^{1-\alpha} K_{\mathrm{ss}}{}^{-1+\alpha} \right) = 0 \tag{8.1}$$

$$\beta - \lambda_{\mathrm{ss}}^U = 0 \tag{8.2}$$

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

$$-\pi_{\mathrm{ss}}^{\mathrm{ps}} + \Pi_{\mathrm{ss}}^{\mathrm{PS}} = 0 \tag{8.4}$$

$$-\pi_{\mathrm{ss}}^{\mathrm{ps}} + Y_{\mathrm{ss}} \left(-P_{\mathrm{ss}} + P_{\mathrm{ss}}^{\mathrm{MON}} \right) = 0 \tag{8.5}$$

$$-W_{\mathrm{ss}} + P_{\mathrm{ss}} Z_{\mathrm{ss}} \left(1 - \alpha\right) K_{\mathrm{ss}}{}^\alpha (L_{\mathrm{ss}}^s Z_{\mathrm{ss}})^{-\alpha} = 0 \tag{8.6}$$

$$-Y_{\mathrm{ss}} + Y_{\mathrm{ss}} P_{\mathrm{ss}}^{\mathrm{MON}}{}^{-\rho} = 0 \tag{8.7}$$

$$-Y_{\mathrm{ss}} + K_{\mathrm{ss}}{}^\alpha (L_{\mathrm{ss}}^s Z_{\mathrm{ss}})^{1-\alpha} = 0 \tag{8.8}$$

$$Y_{\mathrm{ss}} - \rho Y_{\mathrm{ss}} \left(-P_{\mathrm{ss}} + P_{\mathrm{ss}}^{\mathrm{MON}} \right) P_{\mathrm{ss}}^{\mathrm{MON}}{}^{-1-\rho} = 0 \tag{8.9}$$

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

$$\lambda^c_{\mathrm{ss}} W_{\mathrm{ss}} + (-1+\mu)\, {C_{\mathrm{ss}}}^{\mu} (1 - L^s_{\mathrm{ss}})^{-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^s_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} = 0 \tag{8.11}$$

$$-\pi_{\mathrm{ss}} + \Pi_{\mathrm{ss}} - \lambda^U_{\mathrm{ss}} \Pi_{\mathrm{ss}} = 0 \tag{8.12}$$

$$I_{\mathrm{ss}} - K_{\mathrm{ss}} + K_{\mathrm{ss}}\,(1 - \delta) = 0 \tag{8.13}$$

$$U_{\mathrm{ss}} - \beta U_{\mathrm{ss}} - (1-\eta)^{-1} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^s_{\mathrm{ss}})^{1-\mu} \right)^{1-\eta} = 0 \tag{8.14}$$

$$-\pi_{\mathrm{ss}} - I_{\mathrm{ss}} - L^s_{\mathrm{ss}} W_{\mathrm{ss}} + P_{\mathrm{ss}} Y_{\mathrm{ss}} = 0 \tag{8.15}$$

$$\pi_{\mathrm{ss}} + \pi^{\mathrm{ps}}_{\mathrm{ss}} - C_{\mathrm{ss}} + L^s_{\mathrm{ss}} W_{\mathrm{ss}} = 0 \tag{8.16}$$

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 values
λ^c	0.7723
λ^U	0.99
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 perturbation

11.1 P

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

11.2 Q

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

11.3 R

$$\begin{array}{l} \\ \lambda^c \\ \lambda^U \\ \pi \\ \pi^{\text{ps}} \\ C \\ I \\ L^s \\ P \\ P^{\text{MON}} \\ \Pi \\ \Pi^{\text{PS}} \\ U \\ W \\ Y \end{array}\begin{array}{c} \begin{array}{cc} K_{t-1} & Z_{t-1} \end{array} \\ \begin{pmatrix} -0.6272 & -0.3684 \\ 0 & 0 \\ 2.4086 & -4.1777 \\ 0.2085 & 0.9179 \\ 0.45 & 0.3585 \\ -0.6804 & 2.9768 \\ -0.1813 & 0.42 \\ 0 & 0 \\ 0 & 0 \\ 0.9725 & 0.0319 \\ 0.2085 & 0.9179 \\ -0.0343 & -0.0442 \\ 0.3898 & 0.4979 \\ 0.2085 & 0.9179 \end{pmatrix} \end{array}$$

11.4 S

$$\begin{array}{l} \\ \lambda^c \\ \lambda^U \\ \pi \\ \pi^{\text{ps}} \\ C \\ I \\ L^s \\ P \\ P^{\text{MON}} \\ \Pi \\ \Pi^{\text{PS}} \\ U \\ W \\ Y \end{array}\begin{array}{c} \epsilon^Z \\ \begin{pmatrix} -0.3878 \\ 0 \\ -4.3976 \\ 0.9662 \\ 0.3773 \\ 3.1334 \\ 0.4421 \\ 0 \\ 0 \\ 0.0336 \\ 0.9662 \\ -0.0465 \\ 0.5241 \\ 0.9662 \end{pmatrix} \end{array}$$

12 Statistics of the model

12.1 Moments

	Steady state value	Std. dev.	Variance	Loglinear
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
λ^c	-0.9948	-0.8864	-0.6533	-0.8605	0.9761	-0.9764	-0.9354	-0.9127
λ^U	0	0	0	0	0	0	0	0
π	-0.8915	-0.9959	-0.1395	-0.9993	0.9384	-0.9379	-0.9779	-0.9886
π^{ps}	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
C	1	0.9289	0.5729	0.9079	-0.9931	0.9933	0.9666	0.9495
I	0.9289	1	0.2287	0.9986	-0.9659	0.9655	0.9928	0.9982
K	0.5729	0.2287	1	0.1766	-0.4731	0.4744	0.3436	0.2868
L^s	0.9079	0.9986	0.1766	1	-0.9507	0.9503	0.985	0.9936
P	0	0	0	0	0	0	0	0
P^{MON}	0	0	0	0	0	0	0	0
Π	0.4328	0.0682	0.9868	0.0151	-0.3243	0.3257	0.1871	0.1281
Π^{PS}	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
U	-0.9931	-0.9659	-0.4731	-0.9507	1	-1	-0.9899	-0.9797
W	0.9933	0.9655	0.4744	0.9503	-1	1	0.9897	0.9794
Y	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
Z	0.9495	0.9982	0.2868	0.9936	-0.9797	0.9794	0.9982	1

12.3 Autocorrelations

	$t-1$	$t-2$	$t-3$	$t-4$	$t-5$
C	0.7598	0.5448	0.3569	0.1964	0.0629
I	0.7097	0.4654	0.2644	0.1031	-0.0225
K	0.9593	0.8611	0.7252	0.5682	0.403
L^s	0.708	0.4628	0.2614	0.1	-0.0253
U	0.7378	0.5101	0.3164	0.1556	0.0256
W	0.7381	0.5105	0.3169	0.1561	0.026
Y	0.7186	0.4796	0.2809	0.1198	-0.0072
Z	0.7133	0.4711	0.2711	0.1098	-0.0163

13 Statistics of the model

13.1 Moments

	Steady state value	Std. dev.	Variance	Loglinear
C	0.5638	0.5188	0.2691	Y
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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

13.2 Correlation matrix

	C	I	K	L^s	U	W	Y	Z
λ^c	-0.9948	-0.8864	-0.6533	-0.8605	0.9761	-0.9764	-0.9354	-0.9127
λ^U	0	0	0	0	0	0	0	0
π	-0.8915	-0.9959	-0.1395	-0.9993	0.9384	-0.9379	-0.9779	-0.9886
π^{ps}	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
C	1	0.9289	0.5729	0.9079	-0.9931	0.9933	0.9666	0.9495
I	0.9289	1	0.2287	0.9986	-0.9659	0.9655	0.9928	0.9982
K	0.5729	0.2287	1	0.1766	-0.4731	0.4744	0.3436	0.2868
L^s	0.9079	0.9986	0.1766	1	-0.9507	0.9503	0.985	0.9936
P	0	0	0	0	0	0	0	0
P^{MON}	0	0	0	0	0	0	0	0
Π	0.4328	0.0682	0.9868	0.0151	-0.3243	0.3257	0.1871	0.1281
Π^{PS}	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
U	-0.9931	-0.9659	-0.4731	-0.9507	1	-1	-0.9899	-0.9797
W	0.9933	0.9655	0.4744	0.9503	-1	1	0.9897	0.9794
Y	0.9666	0.9928	0.3436	0.985	-0.9899	0.9897	1	0.9982
Z	0.9495	0.9982	0.2868	0.9936	-0.9797	0.9794	0.9982	1

13.3 Autocorrelations

	$t-1$	$t-2$	$t-3$	$t-4$	$t-5$
C	0.7598	0.5448	0.3569	0.1964	0.0629
I	0.7097	0.4654	0.2644	0.1031	-0.0225
K	0.9593	0.8611	0.7252	0.5682	0.403
L^s	0.708	0.4628	0.2614	0.1	-0.0253
U	0.7378	0.5101	0.3164	0.1556	0.0256
W	0.7381	0.5105	0.3169	0.1561	0.026
Y	0.7186	0.4796	0.2809	0.1198	-0.0072
Z	0.7133	0.4711	0.2711	0.1098	-0.0163

14 Impulse response functions

14.1 Shock ϵ^Z

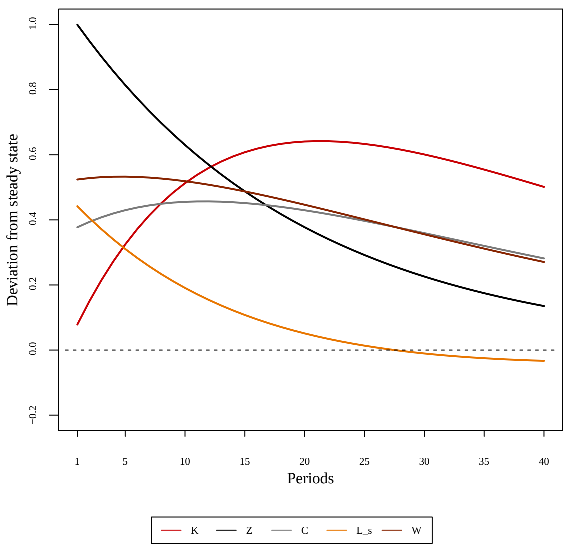

Figure 1: Impulse response function for ϵ^Z shock

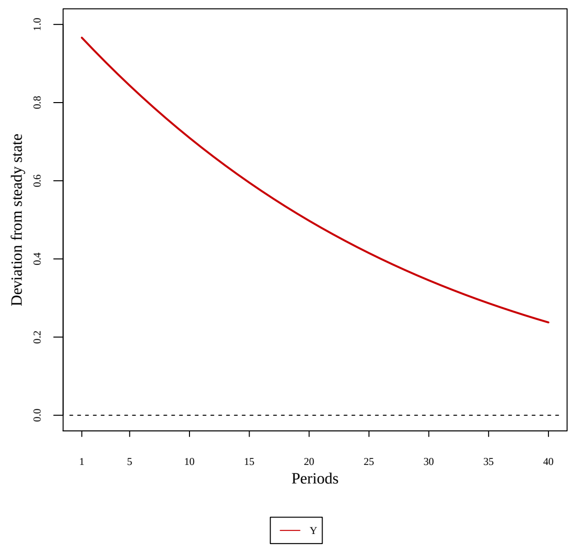

Figure 2: Impulse response function for ϵ^Z shock

15 Random path simulation

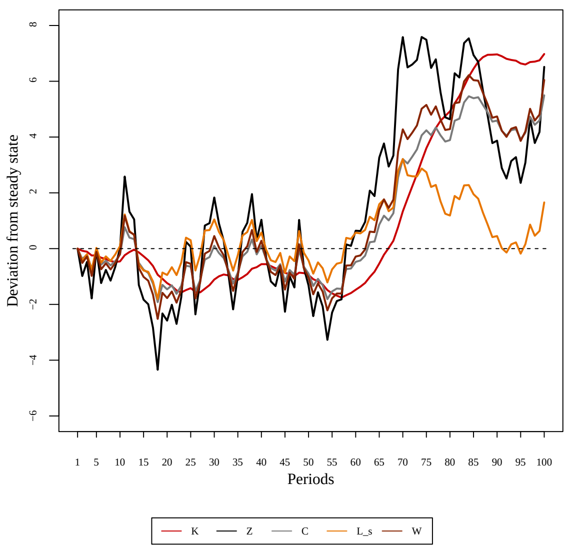

Figure 3: Random path simulation for 100 periods

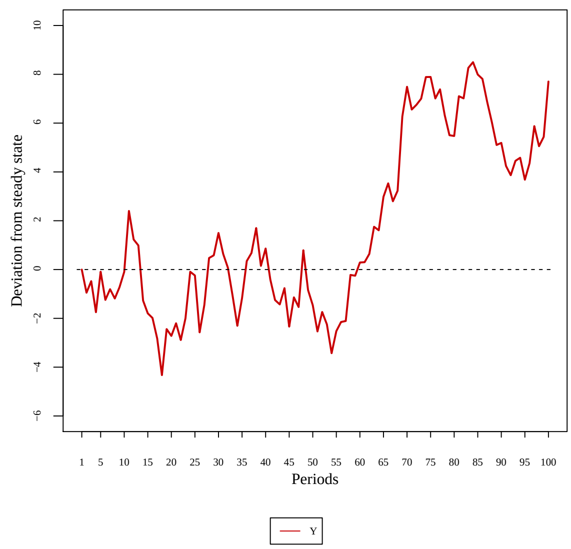

Figure 4: Random path simulation for 100 periods