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Model name: `rbc`

1 CONSUMER

1.1 Optimisation problem

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

s.t. :

$$C_t + I_t = \pi_t + K^{\mathrm{s}}_{t-1} r_t + L^{\mathrm{s}}_t W_t \quad \left(\lambda^{\mathrm{CONSUMER}^1}_t\right) \tag{1.2}$$

$$K^{\mathrm{s}}_t = I_t + K^{\mathrm{s}}_{t-1} \left(1-\delta\right) \quad \left(\lambda^{\mathrm{CONSUMER}^2}_t\right) \tag{1.3}$$

1.2 First order conditions

$$-\lambda^{\mathrm{CONSUMER}^2}_t + \beta \left(\left(1-\delta\right) \mathrm{E}_t \left[\lambda^{\mathrm{CONSUMER}^2}_{t+1} \right] + \mathrm{E}_t \left[\lambda^{\mathrm{CONSUMER}^1}_{t+1} r_{t+1} \right] \right) = 0 \quad (K^{\mathrm{s}}_t) \tag{1.4}$$

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

$$\lambda^{\mathrm{CONSUMER}^1}_t W_t + \left(-1+\mu\right) \left(1 - L^{\mathrm{s}}_t\right)^{-\mu} \left((1 - L^{\mathrm{s}}_t)^{1-\mu} {C_t}^{\mu} \right)^{-\eta} {C_t}^{\mu} = 0 \quad (L^{\mathrm{s}}_t) \tag{1.6}$$

$$-\lambda^{\mathrm{CONSUMER}^1}_t + \lambda^{\mathrm{CONSUMER}^2}_t = 0 \quad (I_t) \tag{1.7}$$

2 FIRM

2.1 Optimisation problem

$$\max_{K^{\mathrm{d}}_t, L^{\mathrm{d}}_t, Y_t} \pi_t = Y_t - L^{\mathrm{d}}_t W_t - r_t K^{\mathrm{d}}_t \tag{2.1}$$

s.t. :

$$Y_t = Z_t {K^{\mathrm{d}}_t}^{\alpha} {L^{\mathrm{d}}_t}^{1-\alpha} \quad \left(\lambda^{\mathrm{FIRM}^1}_t\right) \tag{2.2}$$

2.2 First order conditions

$$-r_t + \alpha \lambda^{\mathrm{FIRM}^1}_t Z_t {K^{\mathrm{d}}_t}^{-1+\alpha} {L^{\mathrm{d}}_t}^{1-\alpha} = 0 \quad \left(K^{\mathrm{d}}_t\right) \tag{2.3}$$

$$-W_t + \lambda^{\mathrm{FIRM}^1}_t Z_t \left(1-\alpha\right) {K^{\mathrm{d}}_t}^{\alpha} {L^{\mathrm{d}}_t}^{-\alpha} = 0 \quad \left(L^{\mathrm{d}}_t\right) \tag{2.4}$$

$$1 - \lambda^{\mathrm{FIRM}^1}_t = 0 \quad \left(Y_t\right) \tag{2.5}$$

2.3 First order conditions after reduction

$$-r_t + \alpha Z_t {K^{\mathrm{d}}_t}^{-1+\alpha} {L^{\mathrm{d}}_t}^{1-\alpha} = 0 \quad \left(K^{\mathrm{d}}_t\right) \tag{2.6}$$

$$-W_t + Z_t \left(1-\alpha\right) {K^{\mathrm{d}}_t}^{\alpha} {L^{\mathrm{d}}_t}^{-\alpha} = 0 \quad \left(L^{\mathrm{d}}_t\right) \tag{2.7}$$

3 EQUILIBRIUM

3.1 Identities

$$K^{\mathrm{d}}_t = K^{\mathrm{s}}_{t-1} \tag{3.1}$$

$$L^{\mathrm{d}}_t = L^{\mathrm{s}}_t \tag{3.2}$$

4 EXOG

4.1 Identities

$$Z_t = e^{\epsilon^{\mathrm{Z}}_t + \phi \log Z_{t-1}} \tag{4.1}$$

5 Equilibrium relationships (after reduction)

$$-r_t + \alpha Z_t {K^{\mathrm{s}}_{t-1}}^{-1+\alpha} {L^{\mathrm{s}}_t}^{1-\alpha} = 0 \tag{5.1}$$

$$-W_t + Z_t \left(1-\alpha\right) {K^{\mathrm{s}}_{t-1}}^{\alpha} {L^{\mathrm{s}}_t}^{-\alpha} = 0 \tag{5.2}$$

$$-Y_t + Z_t {K^{\mathrm{s}}_{t-1}}^{\alpha} {L^{\mathrm{s}}_t}^{1-\alpha} = 0 \tag{5.3}$$

$$Z_t - e^{\epsilon^{\mathrm{Z}}_t + \phi \log Z_{t-1}} = 0 \tag{5.4}$$

$$\beta \left(\mu \mathrm{E}_t \left[r_{t+1} {C_{t+1}}^{-1+\mu} \left(1 - L^{\mathrm{s}}_{t+1}\right)^{1-\mu} \left({C_{t+1}}^{\mu} \left(1 - L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\right)^{-\eta}\right] + \mu \left(1-\delta\right) \mathrm{E}_t \left[{C_{t+1}}^{-1+\mu} \left(1 - L^{\mathrm{s}}_{t+1}\right)^{1-\mu} \left({C_{t+1}}^{\mu} \left(1 - L^{\mathrm{s}}_{t+1}\right)^{1-\mu}\right)^{-\eta}\right]\right) - \mu {C_t}^{-1+\mu} \left(1 - L^{\mathrm{s}}_t\right)^{1-\mu} \left({C_t}^{\mu} \left(1 - L^{\mathrm{s}}_t\right)^{1-\mu}\right)^{-\eta} = \tag{5.5}$$

$$\left(-1+\mu\right) {C_t}^{\mu} \left(1 - L^{\mathrm{s}}_t\right)^{-\mu} \left({C_t}^{\mu} \left(1 - L^{\mathrm{s}}_t\right)^{1-\mu}\right)^{-\eta} + \mu W_t {C_t}^{-1+\mu} \left(1 - L^{\mathrm{s}}_t\right)^{1-\mu} \left({C_t}^{\mu} \left(1 - L^{\mathrm{s}}_t\right)^{1-\mu}\right)^{-\eta} = 0 \tag{5.6}$$

$$-C_t - I_t + Y_t = 0 \tag{5.7}$$

$$I_t - K^{\mathrm{s}}_t + K^{\mathrm{s}}_{t-1} (1 - \delta) = 0 \tag{5.8}$$

$$U_t - \beta \mathrm{E}_t [U_{t+1}] - (1 - \eta)^{-1} \left({C_t}^{\mu} (1 - L^{\mathrm{s}}_t)^{1-\mu} \right)^{1-\eta} = 0 \tag{5.9}$$

6 Steady state relationships (after reduction)

$$-r_{\mathrm{ss}} + \alpha Z_{\mathrm{ss}} {K^{\mathrm{s}}_{\mathrm{ss}}}^{-1+\alpha} {L^{\mathrm{s}}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{6.1}$$

$$-W_{\mathrm{ss}} + Z_{\mathrm{ss}} (1 - \alpha) {K^{\mathrm{s}}_{\mathrm{ss}}}^{\alpha} {L^{\mathrm{s}}_{\mathrm{ss}}}^{-\alpha} = 0 \tag{6.2}$$

$$-Y_{\mathrm{ss}} + Z_{\mathrm{ss}} {K^{\mathrm{s}}_{\mathrm{ss}}}^{\alpha} {L^{\mathrm{s}}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{6.3}$$

$$Z_{\mathrm{ss}} - e^{\phi \log Z_{\mathrm{ss}}} = 0 \tag{6.4}$$

$$\beta \left(\mu r_{\mathrm{ss}} {C_{\mathrm{ss}}}^{-1+\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} + \mu (1 - \delta) {C_{\mathrm{ss}}}^{-1+\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} \right) - \mu {C_{\mathrm{ss}}}^{-1+\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} = 0 \tag{6.5}$$

$$(-1 + \mu) {C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} + \mu W_{\mathrm{ss}} {C_{\mathrm{ss}}}^{-1+\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{-\eta} = 0 \tag{6.6}$$

$$-C_{\mathrm{ss}} - I_{\mathrm{ss}} + Y_{\mathrm{ss}} = 0 \tag{6.7}$$

$$I_{\mathrm{ss}} - K^{\mathrm{s}}_{\mathrm{ss}} + K^{\mathrm{s}}_{\mathrm{ss}} (1 - \delta) = 0 \tag{6.8}$$

$$U_{\mathrm{ss}} - \beta U_{\mathrm{ss}} - (1 - \eta)^{-1} \left({C_{\mathrm{ss}}}^{\mu} (1 - L^{\mathrm{s}}_{\mathrm{ss}})^{1-\mu} \right)^{1-\eta} = 0 \tag{6.9}$$

7 Calibrating equations

$$-0.36 Y_{\mathrm{ss}} + r_{\mathrm{ss}} K^{\mathrm{s}}_{\mathrm{ss}} = 0 \tag{7.1}$$

8 Parameter settings

$$\beta = 0.99 \tag{8.1}$$

$$\delta = 0.025 \tag{8.2}$$

$$\eta = 2 \tag{8.3}$$

$$\mu = 0.3 \tag{8.4}$$

$$\phi = 0.95 \tag{8.5}$$

9 Steady-state values

	Steady-state values
r	0.0351
C	0.7422
I	0.2559
K^{s}	10.2368
L^{s}	0.2695
U	-136.2372
W	2.3706
Y	0.9981
Z	1

10 The solution of the perturbation

10.1 P

$$\begin{array}{c} \\ K^{\mathrm{s}} \\ Z \end{array} \begin{array}{c} \begin{array}{cc} K^{\mathrm{s}}_{t-1} & Z_{t-1} \end{array} \\ \begin{pmatrix} 0.9631 & 0.0962 \\ 0 & 0.95 \end{pmatrix} \end{array}$$

10.2 Q

$$\begin{array}{c} \\ K^{\mathrm{s}} \\ Z \end{array} \begin{array}{c} \epsilon^{\mathrm{Z}} \\ \begin{pmatrix} 0.1012 \\ 1 \end{pmatrix} \end{array}$$

10.3 R

$$\begin{array}{c} \\ r \\ C \\ I \\ L^{\mathrm{s}} \\ U \\ W \\ Y \end{array} \begin{array}{c} \begin{array}{cc} K^{\mathrm{s}}_{t-1} & Z_{t-1} \end{array} \\ \begin{pmatrix} -0.7559 & 1.3521 \\ 0.4919 & 0.4921 \\ -0.4745 & 3.8461 \\ -0.181 & 0.6282 \\ -0.0418 & -0.0644 \\ 0.4252 & 0.7238 \\ 0.2441 & 1.3521 \end{pmatrix} \end{array}$$

10.4 S

$$\begin{array}{c} \\ r \\ C \\ I \\ L^{\mathrm{s}} \\ U \\ W \\ Y \end{array} \begin{array}{c} \epsilon^{\mathrm{Z}} \\ \begin{pmatrix} 1.4232 \\ 0.518 \\ 4.0485 \\ 0.6613 \\ -0.0678 \\ 0.7619 \\ 1.4232 \end{pmatrix} \end{array}$$

11 Statistics of the model

11.1 Moments

	Steady-state value	Std. dev.	Variance	Loglinear
r	0.0351	0.1893	0.0358	Y
C	0.7422	0.0711	0.0051	Y
I	0.2559	0.5284	0.2792	Y
K^{s}	10.2368	0.0469	0.0022	Y
L^{s}	0.2695	0.0867	0.0075	Y
U	-136.2372	0.009	0.0001	Y
W	2.3706	0.1011	0.0102	Y
Y	0.9981	0.1857	0.0345	Y
Z	1	0.1303	0.017	Y

11.2 Correlation matrix

	r	C	I	K^{s}	L^{s}	U	W	Y	Z
r	1	0.8683	0.9893	0.0841	0.9959	-0.9182	0.926	0.9689	0.9823
C	0.8683	1	0.9313	0.5674	0.9095	-0.9938	0.9913	0.964	0.9458
I	0.9893	0.9313	1	0.2285	0.9984	-0.9661	0.9711	0.9946	0.9991
K^{s}	0.0841	0.5674	0.2285	1	0.1737	-0.472	0.4541	0.3282	0.2693
L^{s}	0.9959	0.9095	0.9984	0.1737	1	-0.9502	0.9563	0.9873	0.9952
U	-0.9182	-0.9938	-0.9661	-0.472	-0.9502	1	-0.9998	-0.9877	-0.9761
W	0.926	0.9913	0.9711	0.4541	0.9563	-0.9998	1	0.9906	0.9803
Y	0.9689	0.964	0.9946	0.3282	0.9873	-0.9877	0.9906	1	0.9981
Z	0.9823	0.9458	0.9991	0.2693	0.9952	-0.9761	0.9803	0.9981	1

11.3 Autocorrelations

	$t-1$	$t-2$	$t-3$	$t-4$
r	0.7098	0.4657	0.2647	0.1034
C	0.7596	0.5446	0.3568	0.1964
I	0.7109	0.4674	0.2668	0.1055
K^{s}	0.9597	0.8621	0.7271	0.5709
L^{s}	0.7092	0.4647	0.2636	0.1023
U	0.7389	0.5118	0.3185	0.1578
W	0.7356	0.5066	0.3125	0.1517
Y	0.7183	0.4791	0.2803	0.1192
Z	0.7133	0.4711	0.2711	0.1098

12 Statistics of the model

12.1 Moments relative to moments of the reference variable

	Steady-state value relative to Y	Std. dev. relative to Y	Variance relative to Y	Loglinear
r	0.0352	1.0193	1.0389	Y
C	0.7436	0.3827	0.1465	Y
I	0.2564	2.8453	8.0959	Y
K^{s}	10.2561	0.2526	0.0638	Y
L^{s}	0.27	0.4669	0.218	Y
U	-136.4937	0.0486	0.0024	Y
W	2.3751	0.5441	0.2961	Y
Y	1	1	1	Y
Z	1.0019	0.7018	0.4926	Y

12.2 Correlations with the reference variable

	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}
r	0.2344	0.3779	0.5477	0.7447	0.9689	0.6234	0.343	0.1215	-0.0479
C	-0.0128	0.1562	0.3722	0.64	0.964	0.7703	0.5919	0.4314	0.2902
I	0.1684	0.3233	0.5115	0.7348	0.9946	0.684	0.4257	0.2159	0.0501
K^{s}	-0.4149	-0.3135	-0.1616	0.0493	0.3282	0.5125	0.6196	0.6649	0.6624
L^{s}	0.1941	0.3451	0.5267	0.7405	0.9873	0.6625	0.3951	0.1802	0.0127
U	-0.0425	-0.2097	-0.4203	-0.6785	-0.9877	-0.7553	-0.5498	-0.3718	-0.221
W	0.0524	0.2191	0.4285	0.6846	0.9906	0.7516	0.5414	0.3605	0.2082
Y	0.1192	0.2803	0.4791	0.7183	1	0.7183	0.4791	0.2803	0.1192
Z	0.1486	0.3063	0.499	0.7291	0.9981	0.6988	0.448	0.2424	0.0783

13 Impulse response functions

13.1 Shock ϵ^{Z}

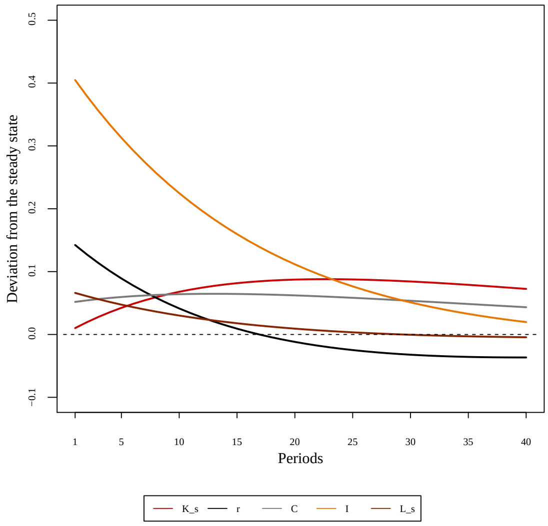

Figure 1: Impulse response function for ϵ^{Z} shock

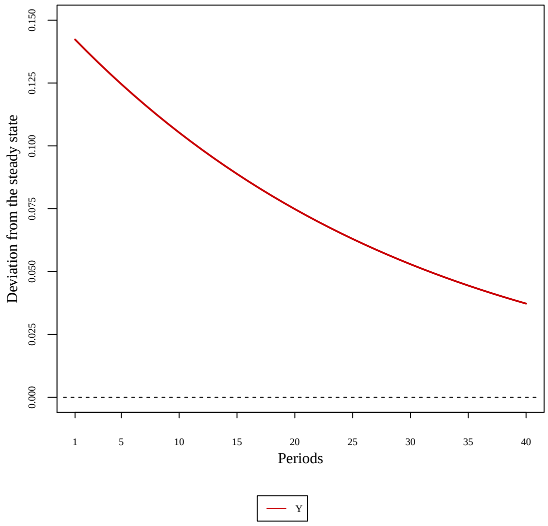

Figure 2: Impulse response function for ϵ^{Z} shock