Generated on 2014-10-27 16:04:56 by `gEcon` version 0.7.0 (2014-10-27)
Model name: `rbc_ts`

1 CONSUMER

1.1 Optimization problem

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

s.t. :

$$C_t + p_t I_t = \pi_t^C + \pi_t^I + K_{t-1}^s r_t + L_t^s W_t \quad (\lambda_t^{\mathrm{CONSUMER}^1}) \tag{1.2}$$

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

1.2 Identities

$$Y_t = C_t + p_t I_t \tag{1.4}$$

1.3 First order conditions

$$-\lambda_t^{\mathrm{CONSUMER}^2} + \beta \left((1-\delta) \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{CONSUMER}^2}\right] + \mathrm{E}_t \left[\lambda_{t+1}^{\mathrm{CONSUMER}^1} r_{t+1}\right]\right) = 0 \quad (K_t^s) \tag{1.5}$$

$$-\lambda_t^{\mathrm{CONSUMER}^1} + \mu {C_t}^{-1+\mu} (1-L_t^s)^{1-\mu} \left((1-L_t^s)^{1-\mu} {C_t}^{\mu}\right)^{-\eta} = 0 \quad (C_t) \tag{1.6}$$

$$\lambda_t^{\mathrm{CONSUMER}^1} W_t + (-1+\mu)(1-L_t^s)^{-\mu} \left((1-L_t^s)^{1-\mu} {C_t}^{\mu}\right)^{-\eta} {C_t}^{\mu} = 0 \quad (L_t^s) \tag{1.7}$$

$$\lambda_t^{\mathrm{CONSUMER}^2} - \lambda_t^{\mathrm{CONSUMER}^1} p_t = 0 \quad (I_t) \tag{1.8}$$

2 FIRM C

2.1 Optimization problem

$$\max_{K_t^{C^d}, L_t^{C^d}, C_t^s} \pi_t^C = C_t^s - L_t^{C^d} W_t - r_t K_t^{C^d} \tag{2.1}$$

s.t. :

$$C_t^s = Z_t {K_t^{C^d}}^{\alpha} {L_t^{C^d}}^{1-\alpha} \quad (\lambda_t^{\mathrm{FIRM}^{C^1}}) \tag{2.2}$$

2.2 First order conditions

$$-r_t + \alpha \lambda_t^{\mathrm{FIRM}^{C^1}} Z_t {K_t^{C^d}}^{-1+\alpha} {L_t^{C^d}}^{1-\alpha} = 0 \quad (K_t^{C^d}) \tag{2.3}$$

$$-W_t + \lambda_t^{\mathrm{FIRM}^{C^1}} Z_t (1-\alpha) {K_t^{C^d}}^{\alpha} {L_t^{C^d}}^{-\alpha} = 0 \quad (L_t^{C^d}) \tag{2.4}$$

$$1 - \lambda_t^{\mathrm{FIRM}^{C^1}} = 0 \quad (C_t^s) \tag{2.5}$$

2.3 First order conditions after reduction

$$-r_t + \alpha Z_t {K_t^{C^d}}^{-1+\alpha} {L_t^{C^d}}^{1-\alpha} = 0 \quad (K_t^{C^d}) \tag{2.6}$$

$$-W_t + Z_t (1-\alpha) {K_t^{C^d}}^{\alpha} {L_t^{C^d}}^{-\alpha} = 0 \quad (L_t^{C^d}) \tag{2.7}$$

3 FIRM I

3.1 Optimization problem

$$\max_{K_t^{I^d}, L_t^{I^d}, I_t^s} \pi_t^I = I_t^s - L_t^{I^d} W_t - r_t K_t^{I^d} \tag{3.1}$$

s.t. :

$$I_t^s = Z_t {K_t^{I^d}}^{\sigma} {L_t^{I^d}}^{1-\alpha} \quad (\lambda_t^{\text{FIRM}^{I^1}}) \tag{3.2}$$

3.2 First order conditions

$$-r_t + \sigma \lambda_t^{\text{FIRM}^{I^1}} Z_t {K_t^{I^d}}^{-1+\sigma} {L_t^{I^d}}^{1-\alpha} = 0 \quad (K_t^{I^d}) \tag{3.3}$$

$$-W_t + \lambda_t^{\text{FIRM}^{I^1}} Z_t (1-\alpha) {K_t^{I^d}}^{\sigma} {L_t^{I^d}}^{-\alpha} = 0 \quad (L_t^{I^d}) \tag{3.4}$$

$$1 - \lambda_t^{\text{FIRM}^{I^1}} = 0 \quad (I_t^s) \tag{3.5}$$

3.3 First order conditions after reduction

$$-r_t + \sigma Z_t {K_t^{I^d}}^{-1+\sigma} {L_t^{I^d}}^{1-\alpha} = 0 \quad (K_t^{I^d}) \tag{3.6}$$

$$-W_t + Z_t (1-\alpha) {K_t^{I^d}}^{\sigma} {L_t^{I^d}}^{-\alpha} = 0 \quad (L_t^{I^d}) \tag{3.7}$$

4 EQUILIBRIUM

4.1 Identities

$$K_t^{C^d} + K_t^{I^d} = K_{t-1}^s \tag{4.1}$$

$$L_t^{C^d} + L_t^{I^d} = L_t^s \tag{4.2}$$

$$C_t = C_t^s \tag{4.3}$$

5 EXOG

5.1 Identities

$$Z_t = e^{\epsilon_t^Z + \phi \log Z_{t-1}} \tag{5.1}$$

6 Equilibrium relationships

$$-r_t + \alpha Z_t {K_t^{C^d}}^{-1+\alpha} {L_t^{C^d}}^{1-\alpha} = 0 \tag{6.1}$$

$$-r_t + \sigma Z_t {K_t^{I^d}}^{-1+\sigma} {L_t^{I^d}}^{1-\alpha} = 0 \tag{6.2}$$

$$-C_t + Z_t {K_t^{C^d}}^{\alpha} {L_t^{C^d}}^{1-\alpha} = 0 \tag{6.3}$$

$$-I_t^s + Z_t {K_t^{I^d}}^{\sigma} {L_t^{I^d}}^{1-\alpha} = 0 \tag{6.4}$$

$$-W_t + Z_t (1-\alpha) {K_t^{C^d}}^{\alpha} {L_t^{C^d}}^{-\alpha} = 0 \tag{6.5}$$

$$-W_t + Z_t (1-\alpha) {K_t^{I^d}}^{\sigma} {L_t^{I^d}}^{-\alpha} = 0 \tag{6.6}$$

$$Z_t - e^{\epsilon_t^Z + \phi \log Z_{t-1}} = 0 \tag{6.7}$$

$$\beta\left(\mu \mathrm{E}_t\left[r_{t+1} {C_{t+1}}^{-1+\mu} \left(1-L^s_{t+1}\right)^{1-\mu} \left({C_{t+1}}^{\mu} \left(1-L^s_{t+1}\right)^{1-\mu}\right)^{-\eta}\right] + \mu\left(1-\delta\right) \mathrm{E}_t\left[p_{t+1} \left(1-L^s_{t+1}\right)^{1-\mu} \left({C_{t+1}}^{\mu} \left(1-L^s_{t+1}\right)^{1-\mu}\right)^{-\eta} C_{t+ \tag{6.8}$$

$$\left(-1+\mu\right) \left(1-L^s_t\right)^{-\mu} \left(\left(1-L^s_t\right)^{1-\mu} {C_t}^{\mu}\right)^{-\eta} {C_t}^{\mu} + \mu W_t {C_t}^{-1+\mu} \left(1-L^s_t\right)^{1-\mu} \left(\left(1-L^s_t\right)^{1-\mu} {C_t}^{\mu}\right)^{-\eta} = 0 \tag{6.9}$$

$$-K^s_{t-1} + K^{C^d}_t + K^{I^d}_t = 0 \tag{6.10}$$

$$-C_t + Y_t - p_t I_t = 0 \tag{6.11}$$

$$I_t - K^s_t + K^s_{t-1}\left(1-\delta\right) = 0 \tag{6.12}$$

$$-L^s_t + L^{C^d}_t + L^{I^d}_t = 0 \tag{6.13}$$

$$U_t - \beta \mathrm{E}_t\left[U_{t+1}\right] - \left(1-\eta\right)^{-1} \left(\left(1-L^s_t\right)^{1-\mu} {C_t}^{\mu}\right)^{1-\eta} = 0 \tag{6.14}$$

$$I^s_t + K^s_{t-1} r_t - p_t I_t - r_t K^{C^d}_t - r_t K^{I^d}_t + L^s_t W_t - L^{C^d}_t W_t - L^{I^d}_t W_t = 0 \tag{6.15}$$

7 Steady state relationships

$$-r_{\mathrm{ss}} + \alpha Z_{\mathrm{ss}} {K^{C^d}_{\mathrm{ss}}}^{-1+\alpha} {L^{C^d}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{7.1}$$

$$-r_{\mathrm{ss}} + \sigma Z_{\mathrm{ss}} {K^{I^d}_{\mathrm{ss}}}^{-1+\sigma} {L^{I^d}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{7.2}$$

$$-C_{\mathrm{ss}} + Z_{\mathrm{ss}} {K^{C^d}_{\mathrm{ss}}}^{\alpha} {L^{C^d}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{7.3}$$

$$-I^s_{\mathrm{ss}} + Z_{\mathrm{ss}} {K^{I^d}_{\mathrm{ss}}}^{\sigma} {L^{I^d}_{\mathrm{ss}}}^{1-\alpha} = 0 \tag{7.4}$$

$$-W_{\mathrm{ss}} + Z_{\mathrm{ss}}\left(1-\alpha\right) {K^{C^d}_{\mathrm{ss}}}^{\alpha} {L^{C^d}_{\mathrm{ss}}}^{-\alpha} = 0 \tag{7.5}$$

$$-W_{\mathrm{ss}} + Z_{\mathrm{ss}}\left(1-\alpha\right) {K^{I^d}_{\mathrm{ss}}}^{\sigma} {L^{I^d}_{\mathrm{ss}}}^{-\alpha} = 0 \tag{7.6}$$

$$Z_{\mathrm{ss}} - e^{\phi \log Z_{\mathrm{ss}}} = 0 \tag{7.7}$$

$$\beta\left(\mu r_{\mathrm{ss}} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu} \left(\left(1-L^s_{\mathrm{ss}}\right)^{1-\mu} {C_{\mathrm{ss}}}^{\mu}\right)^{-\eta} {C_{\mathrm{ss}}}^{-1+\mu} + \mu p_{\mathrm{ss}}\left(1-\delta\right) {C_{\mathrm{ss}}}^{-1+\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu}\right)^{-\eta}\right) - \mu p_{\mathrm{ss}} {C_{\mathrm{ss}}}^{-1+\mu} (1- \tag{7.8}$$

$$\left(-1+\mu\right) {C_{\mathrm{ss}}}^{\mu} \left(1-L^s_{\mathrm{ss}}\right)^{-\mu} \left({C_{\mathrm{ss}}}^{\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu}\right)^{-\eta} + \mu W_{\mathrm{ss}} {C_{\mathrm{ss}}}^{-1+\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu} \left({C_{\mathrm{ss}}}^{\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu}\right)^{-\eta} = 0 \tag{7.9}$$

$$-K^s_{\mathrm{ss}} + K^{C^d}_{\mathrm{ss}} + K^{I^d}_{\mathrm{ss}} = 0 \tag{7.10}$$

$$-C_{\mathrm{ss}} + Y_{\mathrm{ss}} - p_{\mathrm{ss}} I_{\mathrm{ss}} = 0 \tag{7.11}$$

$$I_{\mathrm{ss}} - K^s_{\mathrm{ss}} + K^s_{\mathrm{ss}}\left(1-\delta\right) = 0 \tag{7.12}$$

$$-L^s_{\mathrm{ss}} + L^{C^d}_{\mathrm{ss}} + L^{I^d}_{\mathrm{ss}} = 0 \tag{7.13}$$

$$U_{\mathrm{ss}} - \beta U_{\mathrm{ss}} - \left(1-\eta\right)^{-1} \left({C_{\mathrm{ss}}}^{\mu} \left(1-L^s_{\mathrm{ss}}\right)^{1-\mu}\right)^{1-\eta} = 0 \tag{7.14}$$

$$I^s_{\mathrm{ss}} - p_{\mathrm{ss}} I_{\mathrm{ss}} + r_{\mathrm{ss}} K^s_{\mathrm{ss}} - r_{\mathrm{ss}} K^{C^d}_{\mathrm{ss}} - r_{\mathrm{ss}} K^{I^d}_{\mathrm{ss}} + L^s_{\mathrm{ss}} W_{\mathrm{ss}} - L^{C^d}_{\mathrm{ss}} W_{\mathrm{ss}} - L^{I^d}_{\mathrm{ss}} W_{\mathrm{ss}} = 0 \tag{7.15}$$

8 Parameter settings

$$\alpha = 0.2 \tag{8.1}$$

$$\beta = 0.99 \tag{8.2}$$

$$\delta = 0.025 \tag{8.3}$$

$$\eta = 2 \tag{8.4}$$

$$\mu = 0.3 \tag{8.5}$$

$$\phi = 0.95 \tag{8.6}$$

$$\sigma = 0.4 \tag{8.7}$$

9 Steady state values

	Steady state values
p	1.5318
r	0.0538
C	0.3374
I	0.0439
I^s	0.0672
K^s	1.7551
K^{C^d}	1.2551
K^{I^d}	0.5
L^s	0.2914
L^{C^d}	0.243
L^{I^d}	0.0484
U	-176.3002
W	1.111
Y	0.4046
Z	1

10 The solution of the perturbation

10.1 P

$$\begin{array}{cc} & \begin{array}{cc} K^s_{t-1} & Z_{t-1} \end{array} \\ \begin{array}{c} K^s \\ Z \end{array} & \begin{pmatrix} 0.9522 & -0.0054 \\ 0 & 0.95 \end{pmatrix} \end{array}$$

10.2 Q

$$\begin{array}{cc} & \epsilon^Z \\ \begin{array}{c} K^s \\ Z \end{array} & \begin{pmatrix} -0.0056 \\ 1 \end{pmatrix} \end{array}$$

10.3 R

$$
\begin{array}{l}
 \\ p \\ r \\ C \\ I \\ I^s \\ K^{C^d} \\ K^{I^d} \\ L^s \\ L^{C^d} \\ L^{I^d} \\ U \\ W \\ Y
\end{array}
\begin{array}{c}
\begin{array}{cc} K^s_{t-1} & Z_{t-1} \end{array} \\
\begin{pmatrix}
-0.1506 & 1.1645 \\
-1.0646 & 0.95 \\
0.3338 & 0.95 \\
-0.9139 & -0.2145 \\
-1.0646 & 0.95 \\
1.3984 & 0 \\
0 & 0 \\
-0.1646 & 0 \\
0.0677 & 0 \\
-1.3307 & 0 \\
-0.0257 & -0.0456 \\
0.2661 & 0.95 \\
0.1015 & 0.95
\end{pmatrix}
\end{array}
$$

10.4 S

$$
\begin{array}{l}
 \\ p \\ r \\ C \\ I \\ I^s \\ K^{C^d} \\ K^{I^d} \\ L^s \\ L^{C^d} \\ L^{I^d} \\ U \\ W \\ Y
\end{array}
\begin{array}{c}
\epsilon^Z \\
\begin{pmatrix}
1.2258 \\
1 \\
1 \\
-0.2258 \\
1 \\
0 \\
0 \\
0 \\
0 \\
0 \\
-0.048 \\
1 \\
1
\end{pmatrix}
\end{array}
$$

11 Statistics of the model

11.1 Moments

	Steady state value	Std. dev.	Variance	Loglinear
p	1.5318	0.113	0.0128	Y
r	0.0538	0.0922	0.0085	Y
C	0.3374	0.0922	0.0085	Y
I	0.0439	0.0208	0.0004	Y
I^s	0.0672	0.0922	0.0085	Y
K^s	1.7551	0.0018	0	Y
L^s	0.2914	0.0003	0	Y
U	-176.3002	0.0044	0	Y
W	1.111	0.0922	0.0085	Y
Y	0.4046	0.0922	0.0085	Y

11.2 Correlation matrix

	p	r	C	I	I^s	K^s	L^s	U	W	Y
p	1	0.9998	1	-0.9966	0.9998	-0.3088	0.0262	-0.9999	1	1
r	0.9998	1	0.9996	-0.9948	1	-0.3265	0.0449	-0.9995	0.9997	0.9997
C	1	0.9996	1	-0.9973	0.9996	-0.3001	0.0172	-1	1	1
I	-0.9966	-0.9948	-0.9973	1	-0.9948	0.229	0.0566	0.9976	-0.9972	-0.9969
I^s	0.9998	1	0.9996	-0.9948	1	-0.3265	0.0449	-0.9995	0.9997	0.9997
K^s	-0.3088	-0.3265	-0.3001	0.229	-0.3265	1	-0.9589	0.2963	-0.3014	-0.3045
K^{C^d}	-0.0262	-0.0449	-0.0172	-0.0566	-0.0449	0.9589	-1	0.0131	-0.0185	-0.0218
K^{I^d}	0	0	0	0	0	0	0	0	0	0
L^s	0.0262	0.0449	0.0172	0.0566	0.0449	-0.9589	1	-0.0131	0.0185	0.0218
L^{C^d}	-0.0262	-0.0449	-0.0172	-0.0566	-0.0449	0.9589	-1	0.0131	-0.0185	-0.0218
L^{I^d}	0.0262	0.0449	0.0172	0.0566	0.0449	-0.9589	1	-0.0131	0.0185	0.0218
U	-0.9999	-0.9995	-1	0.9976	-0.9995	0.2963	-0.0131	1	-1	-1
W	1	0.9997	1	-0.9972	0.9997	-0.3014	0.0185	-1	1	1
Y	1	0.9997	1	-0.9969	0.9997	-0.3045	0.0218	-1	1	1
Z	1	0.9998	1	-0.9968	0.9998	-0.3065	0.0238	-0.9999	1	1

11.3 Autocorrelations

	$t-1$	$t-2$	$t-3$	$t-4$	$t-5$
p	0.7135	0.4715	0.2715	0.1102	-0.016
r	0.7152	0.4742	0.2746	0.1134	-0.0131
C	0.7127	0.4703	0.2701	0.1088	-0.0173
I	0.708	0.4629	0.2615	0.1001	-0.0252
I^s	0.7152	0.4742	0.2746	0.1134	-0.0131
K^s	0.9589	0.8598	0.7228	0.5647	0.3987
L^s	0.9589	0.8598	0.7228	0.5647	0.3987
U	0.7124	0.4698	0.2695	0.1082	-0.0178
W	0.7128	0.4704	0.2703	0.109	-0.0171
Y	0.7131	0.4709	0.2708	0.1095	-0.0166

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
p	3.7858	1.226	1.503	Y
r	0.1329	1.0008	1.0015	Y
C	0.8339	0.9999	0.9998	Y
I	0.1084	0.2261	0.0511	Y
I^s	0.1661	1.0008	1.0015	Y
K^s	4.3375	0.0199	0.0004	Y
K^{C^d}	3.1018	0.0278	0.0008	Y
K^{I^d}	1.2357	0	0	Y
L^s	0.7201	0.0033	0	Y
L^{C^d}	0.6005	0.0013	0	Y
L^{I^d}	0.1196	0.0265	0.0007	Y
U	-435.7117	0.048	0.0023	Y
W	2.7457	0.9999	0.9999	Y
Y	1	1	1	Y
Z	2.4714	1	1.0001	Y

12.2 Correlations with the reference variable

	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}
p	-0.0189	0.1073	0.2688	0.4693	0.7122	1	0.7144	0.473	0.2734	0.1124	-0.0137
r	-0.0284	0.098	0.2604	0.4626	0.7082	0.9997	0.7196	0.4819	0.2845	0.1245	-0.0015
C	-0.0143	0.1118	0.2728	0.4725	0.714	1	0.7118	0.4686	0.268	0.1065	-0.0196
I	-0.0234	-0.1479	-0.3046	-0.4968	-0.727	-0.9969	-0.6883	-0.4316	-0.2231	-0.0583	0.0677
I^s	-0.0284	0.098	0.2604	0.4626	0.7082	0.9997	0.7196	0.4819	0.2845	0.1245	-0.0015
K^s	0.491	0.4367	0.3392	0.1896	-0.0218	-0.3045	-0.4925	-0.6029	-0.6512	-0.6515	-0.616
K^{C^d}	0.5104	0.491	0.4367	0.3392	0.1896	-0.0218	-0.3045	-0.4925	-0.6029	-0.6512	-0.6515
K^{I^d}	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
L^s	-0.5104	-0.491	-0.4367	-0.3392	-0.1896	0.0218	0.3045	0.4925	0.6029	0.6512	0.6515
L^{C^d}	0.5104	0.491	0.4367	0.3392	0.1896	-0.0218	-0.3045	-0.4925	-0.6029	-0.6512	-0.6515
L^{I^d}	-0.5104	-0.491	-0.4367	-0.3392	-0.1896	0.0218	0.3045	0.4925	0.6029	0.6512	0.6515
U	0.0122	-0.1138	-0.2746	-0.4739	-0.7148	-1	-0.7106	-0.4667	-0.2656	-0.1039	0.0223
W	-0.0149	0.1111	0.2722	0.472	0.7138	1	0.7121	0.4693	0.2688	0.1074	-0.0188
Y	-0.0166	0.1095	0.2708	0.4709	0.7131	1	0.7131	0.4709	0.2708	0.1095	-0.0166
Z	-0.0177	0.1085	0.2699	0.4702	0.7127	1	0.7137	0.4718	0.272	0.1108	-0.0153

13 Impulse response functions

13.1 Shock ϵ^Z

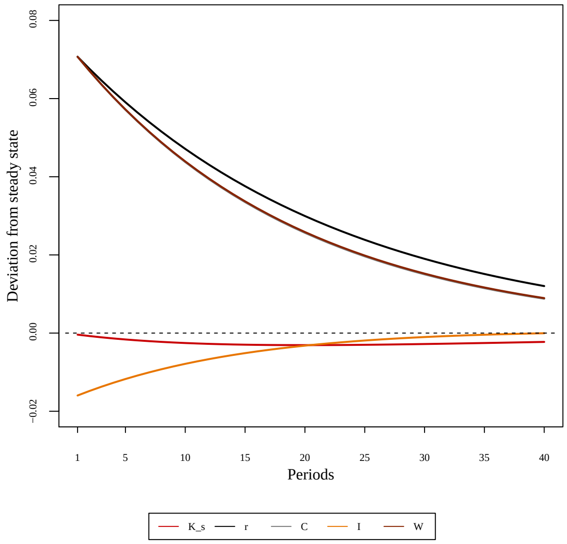

Figure 1: Impulse response function for ϵ^Z shock

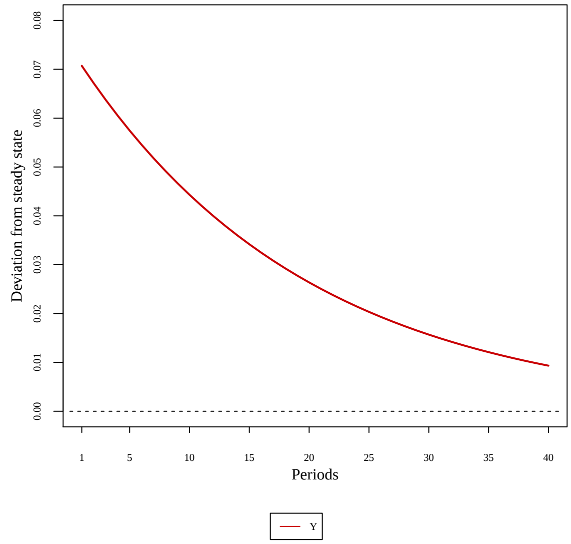

Figure 2: Impulse response function for ϵ^Z shock