Technical Appendix: Toward a Taylor Rule for Fiscal Policy

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A Model solution

A.1 Competitive equilibrium conditions

The following set of equations are the necessary competitive equilibrium conditions to resolves the model as described in the section 2. All variables are denoted in real terms, a line over a variable indicates its steady state value:

Welfare & Utility:

$$U_t = \frac{\left(c_t - hc_{t-1}\right)^{1-\sigma_c}}{1-\sigma_c} - \psi_l \frac{\tilde{w}_t^+ \left(\frac{l_t}{w_t^+}\right)^{1+\sigma_l}}{1+\sigma_l} \tag{1}$$

$$\mathcal{W}_t = U_t + \beta \mathcal{W}_{t+1} \tag{2}$$

Household:

$$\chi_t = \left(c_t - hc_{t-1}\right)^{-\sigma_c} - h\beta\left(c_{t+1} - hc_t\right)^{-\sigma_c} \tag{3}$$

$$\frac{1}{R_t} = \beta E_t \left[\frac{\chi_{t+1}}{\chi_t \pi_{t+1}}\right] \varepsilon_{q,t} \tag{4}$$

$$q_t = \frac{1 - \beta E_t \left[\frac{\chi_{t+1}}{\chi_t} q_{t+1} s'_{t+1} \varepsilon_{i,t+1} \left(\frac{I_{t+1}}{I_t}\right)^2\right]}{1 - s_t - s'_t \frac{\varepsilon_{i,t} I_t}{I_{t-1}}} \tag{5}$$

$$s_t = \frac{\nu}{2}\left(\frac{\varepsilon_{i,t} I_t}{I_{t-1}} - 1\right)^2 \tag{6}$$

$$s'_t = \nu \left(\frac{\varepsilon_{i,t} I_t}{I_{t-1}} - 1\right) \tag{7}$$

$$q_t = \beta E_t \left[\frac{\chi_{t+1}}{\chi_t}\left(\phi'\left(u_{t+1}\right) u_{t+1} - \phi\left(u_{t+1}\right) + q_{t+1}\left(1-\delta\right)\right)\right] \tag{8}$$

$$\phi_t\left(u_t\right) = \frac{\bar{r}^k\left(1-\bar{\tau}^k\right)}{\sigma_u}\left(\exp\left(\sigma_u\left(u_t - 1\right)\right) - 1\right) \tag{9}$$

$$\phi'_t\left(u_t\right) = \bar{r}^k\left(1-\bar{\tau}^k\right)\exp\left(\sigma_u\left(u_t-1\right)\right) \tag{10}$$

$$\phi'_t\left(u_t\right) = r_t^k\left(1-\bar{\tau}_t^k\right) \tag{11}$$

$$k_t = (1-\delta)\, k_{t-1} + (1 - s_t)\, I_t \tag{12}$$

Staggered Price & Wages:

$$p_t^+ = (1-\gamma_p)\,(p_t^*)^{-\theta_p} + \gamma_p \left(\frac{\bar{\pi}}{\pi_t}\right)^{-\theta_p} p_{t-1}^+ \tag{13}$$

$$F_t^p = y_t \chi_t + \gamma_p \beta \left(\frac{\bar{\pi}}{\pi_{t+1}}\right)^{1-\theta_p} F_{t+1}^p \tag{14}$$

$$K_t^p = \frac{\theta_p}{\theta_p - 1} y_t \chi_t z_t + \gamma_p \beta \left(\frac{\bar{\pi}}{\pi_{t+1}}\right)^{-\theta_p} K_{t+1}^p \tag{15}$$

$$\frac{K_t^p}{F_t^p} = p_t^* \tag{16}$$

$$1 = \gamma_p \left(\frac{\bar{\pi}}{\pi_t}\right)^{1-\theta_p} + (1-\gamma_p)\,(p_t^*)^{1-\theta_p} \tag{17}$$

$$K_t^w = \left(\frac{l_t}{w_t^+}\right)^{1+\sigma_l} + \beta\gamma_w \left(\frac{\bar{\pi}}{\pi_{t+1}^w}\right)^{-\theta_w(1+\sigma_l)} K_{t+1}^w \tag{18}$$

$$F_t^w = \frac{(\theta_w - 1)}{\theta_w} (1 - \tau_t^w)\, \frac{l_t}{w_t^+} \chi_t + \beta\gamma_w \left(\frac{\pi_{t+1}}{\pi_{t+1}^w}\right)^{-\theta_w} \left(\frac{\bar{\pi}}{\pi_{t+1}}\right)^{1-\theta_w} F_{t+1}^w \tag{19}$$

$$\frac{Kw}{Fw} = \frac{1}{\psi_l}\,(w_t^*)^{1+\theta_w\sigma_l}\, w_t \tag{20}$$

$$\pi_t^w = \frac{w_t}{w_{t-1}} \pi_t \tag{21}$$

$$1 = \gamma_w \left(\frac{\bar{\pi}}{\pi_t^w}\right)^{1-\theta_w} + (1-\gamma_w)\,(w_t^*)^{1-\theta_p} \tag{22}$$

$$w_t^+ = (1-\gamma_w)\,(w_t^*)^{-\theta_w} + \gamma_w \left(\frac{\bar{\pi}}{\pi_t^w}\right)^{-\theta_w} w_{t-1}^+ \tag{23}$$

$$\tilde{w}_t^+ = (1-\gamma_w)\,(w_t^*)^{-\theta_w(1+\sigma_l)} + \gamma_w \left(\frac{\bar{\pi}}{\pi_t^w}\right)^{-\theta_w(1+\sigma_l)} \tilde{w}_{t-1}^+ \tag{24}$$

Firm:

$$mc_t\,(1-\alpha)\,(u_t k_{t-1})^{\alpha} \left(\frac{l_t}{w_t^+}\varepsilon_{z,t}\right)^{-\alpha} = w_t \tag{25}$$

$$mz_t\alpha\left(u_tk_{t-1}\right)^{\alpha-1}\left(\frac{l_t}{w_t^+}\varepsilon_{z,t}\right)^{1-\alpha}=r_t^k \tag{26}$$

$$d_t=y_t-r_t^ku_tk_{t-1}-w_t\frac{l_t}{w_t^+} \tag{27}$$

Supply & Demand:

$$y_t=c_t+I_t+c_t^g+\phi\left(u_t\right)k_{t-1} \tag{28}$$

$$p_t^+y_t=\left(u_tk_{t-1}\right)^{\alpha}\left(\frac{l_t}{w_t^+}\varepsilon_{z,t}\right)^{1-\alpha}-\Omega \tag{29}$$

Government:

$$\left[b_t-\frac{b_{t-1}\varepsilon_{q,t-1}R_{t-1}}{\pi_t}\right]=c_t^g-x_t-\tau_t^L \tag{30}$$

$$x_t=\tau_t^ww_t\frac{l_t}{w_t^+}+\tau_t^k\left[r_t^ku_tk_{t-1}+d_t\right] \tag{31}$$

Policy Rules:

$$\log\left(\frac{R_t}{\bar{R}}\right)=\rho_R\log\left(\frac{R_{t-1}}{\bar{R}}\right)+\left(1-\rho_R\right)\left(\rho_\pi\log\left(\frac{\pi_t}{\bar{\pi}}\right)+\rho_y\log\left(\frac{y_t}{\bar{y}}\right)\right)+\epsilon_t^m \tag{32}$$

$$\log\left(\frac{\tau_t^w}{\bar{\tau}^w}\right)=\rho_w\log\left(\frac{\tau_{t-1}^w}{\bar{\tau}^w}\right)+\left(1-\rho_w\right)\left(\eta_{wb}\log\left(\frac{b_{t-1}}{\bar{b}}\right)+\eta_{wy}\log\left(\frac{y_t}{\bar{y}}\right)\right)+\epsilon_t^{\tau^w} \tag{33}$$

$$\log\left(\frac{\tau_t^k}{\bar{\tau}^k}\right)=\rho_k\log\left(\frac{\tau_{t-1}^k}{\bar{\tau}^k}\right)+\left(1-\rho_k\right)\left(\eta_{kb}\log\left(\frac{b_{t-1}}{\bar{b}}\right)+\eta_{ky}\log\left(\frac{y_t}{\bar{y}}\right)\right)+\epsilon_t^{\tau^k} \tag{34}$$

Exogenous Variables:

$$\log\left(\frac{c_t^g}{\bar{c}^g}\right)=\rho_{cg}\log\left(\frac{c_{t-1}^g}{\bar{c}^g}\right)+\epsilon_t^{cg} \tag{35}$$

$$\log\left(\frac{\tau_t^L}{\bar{\tau}^L}\right)=\rho_{\tau^L}\log\left(\frac{\tau_{t-1}^L}{\bar{\tau}^L}\right)+\epsilon_t^{\tau^L} \tag{36}$$

$$\log\varepsilon_{z,t}=\rho_z\log\varepsilon_{z,t-1}+\epsilon_t^z \tag{37}$$

$$\log\varepsilon_{i,t}=\rho_i\log\varepsilon_{i,t-1}+\epsilon_t^i \tag{38}$$

$$\log\varepsilon_{q,t}=\rho_q\log\varepsilon_{q,t-1}+\epsilon_t^q \tag{39}$$

A.2 Steady-state

To solve for the steady state we take the following as given: $\bar{\tau}^k$, $\bar{\tau}^w$, $\bar{R}$, $\bar{c}^g/\bar{y}$, $\bar{\tau}^L/\bar{y}$, $\bar{\varepsilon}_i = 1$, $\bar{\varepsilon}_q = 1$, and $\bar{\varepsilon}_z = 1$. Moreover it is easy to figure out that:

$$\bar{u} = 1 \text{ and } \bar{s} = \bar{s}' = 0, \tag{40}$$

that the Tobin's q condition is satisfied for:

$$\bar{q} = 1, \tag{41}$$

and the capital adjustment cost equations can be solved for:

$$\bar{\phi} = 0 \quad \bar{\phi}' = \bar{r}^k \left(1 - \bar{\tau}^k\right) \tag{42}$$

Given these conditions we can solve for the steady state in the following way:

$$\bar{\pi} = \bar{R}\beta \tag{43}$$

$$\bar{\pi}^w = \bar{\pi} \tag{44}$$

$$\bar{z} = \frac{\theta_p - 1}{\theta_p} \tag{45}$$

$$\bar{r}^k = \frac{1 - \beta(1 - \delta)}{\beta(1 - \bar{\tau}^k)} \tag{46}$$

$$\bar{\phi}' = \bar{r}^k \left(1 - \bar{\tau}^k\right) \tag{47}$$

$$\bar{w} = (1 - \alpha) \left(\bar{r}^k\right)^{\frac{-\alpha}{(1-\alpha)}} \left(\alpha^\alpha \bar{z}\right)^{\frac{1}{1-\alpha}} \tag{48}$$

$$\frac{\bar{l}}{\bar{k}} = \frac{1 - \alpha}{\alpha} \frac{\bar{r}^k}{\bar{w}} \tag{49}$$

$$\frac{\bar{c}}{\bar{k}} = \left(1 - \frac{\bar{c}}{\bar{y}}\right) \bar{z} \left(\frac{\bar{l}}{\bar{k}}\right)^{1-\alpha} - \delta \tag{50}$$

Now, we assume that labor supply in steady state is $\bar{l} = 1/3$ and solve for the corresponding scaling parameter:

$$\psi_l = \frac{\bar{w}^{\frac{\theta_w - 1}{\theta_w}} (1-h)^{-\sigma_c} (1-\bar{\tau}^w)(1-\beta h) \frac{\bar{c}^g}{\bar{k}}^{-\sigma_c} \frac{\bar{l}}{\bar{k}}^{\sigma_c}}{l^{\sigma_c + \sigma_l}} \tag{51}$$

$$\bar{k} = \bar{l}\frac{\bar{k}}{\bar{l}} \tag{52}$$

Now, we solve for the fixed costs of the firm to ensure that dividends in the steady state are $\bar{d} = 0$.

$$\Omega = (1-\bar{z})\,\bar{k}^{\alpha}\bar{l}^{1-\alpha}; \tag{53}$$

$$\bar{y} = \bar{k}^{\alpha}\bar{l}^{1-\alpha} - \Omega \tag{54}$$

$$\bar{c} = \frac{\bar{c}}{\bar{k}}\bar{k} \tag{55}$$

$$\bar{I} = \delta\bar{k}; \tag{56}$$

$$\bar{c}^g = \frac{\bar{c}^g}{\bar{y}}\bar{y} \tag{57}$$

$$\bar{\tau}^L = \frac{\bar{\tau}^L}{\bar{y}}\bar{y} \tag{58}$$

$$\bar{x} = \bar{\tau}^w\bar{w}\bar{l} + \bar{\tau}^k\left(\bar{r}^k\bar{k} + \bar{d}\right) \tag{59}$$

$$\bar{b} = \frac{\left(-\bar{\tau}^L + \bar{c}^g - \bar{x}\right)}{1 - 1/\beta} \tag{60}$$

A.3 Log-linearization

Household:

$$(1-\beta h)\,\hat{\chi}_t = \frac{-\sigma_c}{1-h}\left(\hat{c}_t - h\hat{c}_{t-1}\right) + \frac{h\beta\sigma_c}{1-h}\left(\hat{c}_{t+1} - h\hat{c}_t\right) \tag{61}$$

$$0 = \hat{\chi}_{t+1} - \hat{\chi}_t - \hat{\pi}_{t+1} + \hat{R}_t + \hat{\varepsilon}_{q,t} \tag{62}$$

$$\hat{k}_t = (1-\delta)\,\hat{k}_{t-1} + \delta\hat{I}_t \tag{63}$$

$$\hat{I}_t = \frac{\hat{I}_{t-1}}{(1+\beta)} + \frac{\beta \hat{I}_{t+1}}{(1+\beta)} + \frac{\hat{q}_t}{\nu(1+\beta)} + \frac{\beta \hat{\varepsilon}_{i,t+1}}{(1+\beta)} - \frac{\hat{\varepsilon}_{i,t}}{(1+\beta)} \tag{64}$$

$$\hat{\chi}_t + \hat{q}_t = \hat{\chi}_{t+1} + \beta \left[(1-\delta) \hat{q}_{t+1} + \bar{r}^k \left(1 - \bar{\tau}^k\right) \hat{r}^k_{t+1} - \bar{r}^k \bar{\tau}^k \hat{\tau}^k_{t+1} \right] \tag{65}$$

$$\sigma_u \hat{u}_t = \hat{r}^k - \frac{\bar{\tau}^k}{1 - \bar{\tau}^k} \hat{\tau}^k_t \tag{66}$$

Staggered Prices & Wages:

$$\hat{\pi}^w_t = \beta \hat{\pi}^w_{t+1} + \frac{(1-\gamma_w)(1-\beta\gamma_w)}{\gamma_w(1+\theta_w\sigma_l)} \left(\sigma_l \hat{l}_t - \hat{\chi}_t - \hat{w}_t + \frac{\bar{\tau}^w}{(1-\bar{\tau}^w)} \hat{\tau}^w \right) \tag{67}$$

$$\hat{\pi}_t = \beta \hat{\pi}_{t+1} + \frac{(1-\gamma_p)(1-\beta\gamma_p)}{\gamma_p} \hat{z}_t \tag{68}$$

$$\hat{\pi}^w_t = \hat{w}_t - \hat{w}_{t-1} + \hat{\pi}_t \tag{69}$$

Firm:

$$\hat{z}_t + (1-\alpha)\hat{\varepsilon}_{z,t} + \alpha \left(\hat{u}_t + \hat{k}_{t-1} \right) - \alpha \hat{l}_t = \hat{w}_t \tag{70}$$

$$\hat{z}_t + (1-\alpha)\hat{\varepsilon}_{z,t} + (\alpha - 1) \left(\hat{u}_t + \hat{k}_{t-1} \right) + (1-\alpha) \hat{l}_t = \hat{r}^k_t \tag{71}$$

$$\bar{d}\hat{d}_t = \bar{y}\hat{y}_t - \bar{r}^k \bar{k} \left(\hat{u}_t + \hat{k}_{t-1} + \hat{r}^k_t \right) - \bar{w}\bar{l} \left(\hat{w}_t + \hat{l}_t \right); \tag{72}$$

Supply & Demand:

$$\bar{y}\hat{y}_t = \bar{k}^\alpha \bar{l}^{1-\alpha} \left(\alpha \hat{k}_{t-1} + (1-\alpha) \left(\hat{l}_t + \hat{\varepsilon}_{z,t} \right) + \alpha \hat{u}_t \right) \tag{73}$$

$$\bar{y}\hat{y}_t = \bar{c}\hat{c}_t + \bar{I}\hat{I}_t + \bar{c}^g \hat{c}^g_t + \bar{r}^k \left(1 - \bar{\tau}^k\right) \bar{k} u_t \tag{74}$$

Government:

$$\bar{b}\hat{b}_t - \frac{\bar{b}}{\beta} \left(\hat{R}_{t-1} + \hat{\varepsilon}_{q,t-1} + \hat{b}_{t-1} - \hat{\pi}_t \right) = \bar{c}^g \hat{c}^g_t - \bar{\tau}^L \hat{\tau}^L_t - \bar{x}\hat{x}_t \tag{75}$$

$$\bar{x}\hat{x}_t = \bar{\tau}^w \bar{w}\bar{l}\left(\hat{\tau}_t^w + \hat{w}_t + \hat{l}_t\right) + \bar{\tau}^k \bar{r}^k \bar{k}\left(\hat{\tau}_t^k + \hat{r}_t^k + \hat{u}_t + \hat{k}_{t-1}\right) + \bar{\tau}^k \bar{d}\left(\hat{d}_t + \hat{\tau}_t^k\right) \tag{76}$$

Policy Rules:

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)\left(\rho_\pi \hat{\pi}_t + \rho_y \hat{y}_t\right) + \hat{\epsilon}_t^m \tag{77}$$

$$\hat{\tau}_t^w = \rho_w \hat{\tau}_{t-1}^w + (1-\rho_w)\left(\eta_{wb}\hat{b}_{t-1} + \eta_{wy}\hat{y}_t\right) + \hat{\epsilon}_t^{\tau^w} \tag{78}$$

$$\hat{\tau}_t^k = \rho_k \hat{\tau}_{t-1}^k + (1-\rho_k)\left(\eta_{kb}\hat{b}_{t-1} + \eta_{ky}\hat{y}_t\right) + \hat{\epsilon}_t^{\tau^k} \tag{79}$$

Exogenous Variables:

$$\hat{c}_t^g = \rho_{cg}\hat{c}_{t-1}^g + \hat{\epsilon}_t^{cg} \tag{80}$$

$$\hat{\tau}_t^L = \rho_{\tau_L}\hat{\tau}_{t-1}^L + \hat{\epsilon}_t^{\tau^L} \tag{81}$$

$$\hat{\varepsilon}_{z,t} = \rho_z \hat{\varepsilon}_{z,t-1} + \hat{\epsilon}_t^z \tag{82}$$

$$\hat{\varepsilon}_{i,t} = \rho_i \hat{\varepsilon}_{i,t-1} + \hat{\epsilon}_t^i \tag{83}$$

$$\hat{\varepsilon}_{q,t} = \rho_q \hat{\varepsilon}_{q,t-1} + \hat{\epsilon}_t^q \tag{84}$$

A.4 Prior, calibration, and data

Description	Symbol	Value
Discount factor	β	0.993
Capital share	α	0.4
Depreciation rate	δ	0.025
Price markup	$\theta_p/(\theta_p-1)$	1.2
Wage markup	$\theta_w/(\theta_w-1)$	1.1
Annualized nominal interest rate	$\bar{R}$	1.0543
Ratio of government consumption to output	$\bar{c}^g/\bar{y}$	0.19
Ratio of government transfers to output	$\bar{\tau}^l/\bar{y}$	-0.08
Steady-state capital tax rate	$\bar{\tau}_k$	0.3572
Steady-state labor tax rate	$\bar{\tau}_w$	0.2343

Table 1: Parameter calibration.

Parameter	Symbol	Domain	Density	Para(1)	Para(2)
Inv. intertemp. subst. elasticity	σ_c	$\mathbb{R}^+$	Gamma	1.75	0.5
Inverse Frisch elasticity	σ_l	$\mathbb{R}^+$	Gamma	2.0	0.5
Habit persistence	h	$[0,1)$	Beta	0.5	0.15
Calvo parameter prices	γ_p	$[0,1)$	Beta	0.5	0.15
Calvo parameter wages	γ_w	$[0,1)$	Beta	0.5	0.15
Investment adjustment cost	ν	$\mathbb{R}^+$	Gamma	4	1.25
Capital utilization cost	σ_u	$\mathbb{R}^+$	Gamma	2	0.5
Interest rate AR coefficient	ρ_R	$[0,1)$	Beta	0.8	0.1
Interest rate inflation coefficient	ρ_π	$\mathbb{R}^+$	Gamma	1.7	0.1
Interest rate output coefficient	ρ_y	$\mathbb{R}$	Gamma	0.125	0.05
Labor tax AR coefficient	ρ_w	$[0,1)$	Beta	0.85	0.1
Labor tax debt coefficient	η_{wb}	$\mathbb{R}^+$	Gamma	0.4	0.2
Labor tax output coefficient	η_{wy}	$\mathbb{R}$	Normal	0	0.5
Capital tax AR coefficient	ρ_k	$[0,1)$	Beta	0.85	0.1
Capital tax debt coefficient	η_{kb}	$\mathbb{R}^+$	Gamma	0.4	0.2
Capital tax output coefficient	η_{ky}	$\mathbb{R}$	Normal	0	0.5
Lump-sum tax AR coefficient	ρ_{τ^l}	$[0,1)$	Beta	0.85	0.1
Adjustment costs AR coefficient	ρ_i	$[0,1)$	Beta	0.85	0.1
Technology AR coefficient	ρ_z	$[0,1)$	Beta	0.85	0.1
Public consumption AR coefficient	ρ_{cg}	$[0,1)$	Beta	0.85	0.1
S.d. adjustment costs shock	ϵ_i	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. technology shock	ϵ_z	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. finance premium shock	ϵ_q	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. monetary policy shock	ϵ_m	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. wage tax shock	ϵ_{τ^w}	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. capital tax shock	ϵ_{τ^k}	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. lump-sum tax shock	ϵ_{τ^l}	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. public consumption shock	ϵ_{cg}	$\mathbb{R}^+$	InvGam	0.01	4.0
S.d. measurement error taxes	ϵ_{tax}	$\mathbb{R}^+$	InvGam	0.01	4.0

Table 2: Prior distribution of model parameters. Para(1) and Para(2) correspond to means and standard deviations for the Beta, Gamma, Inverted Gamma, and Normal distribution.

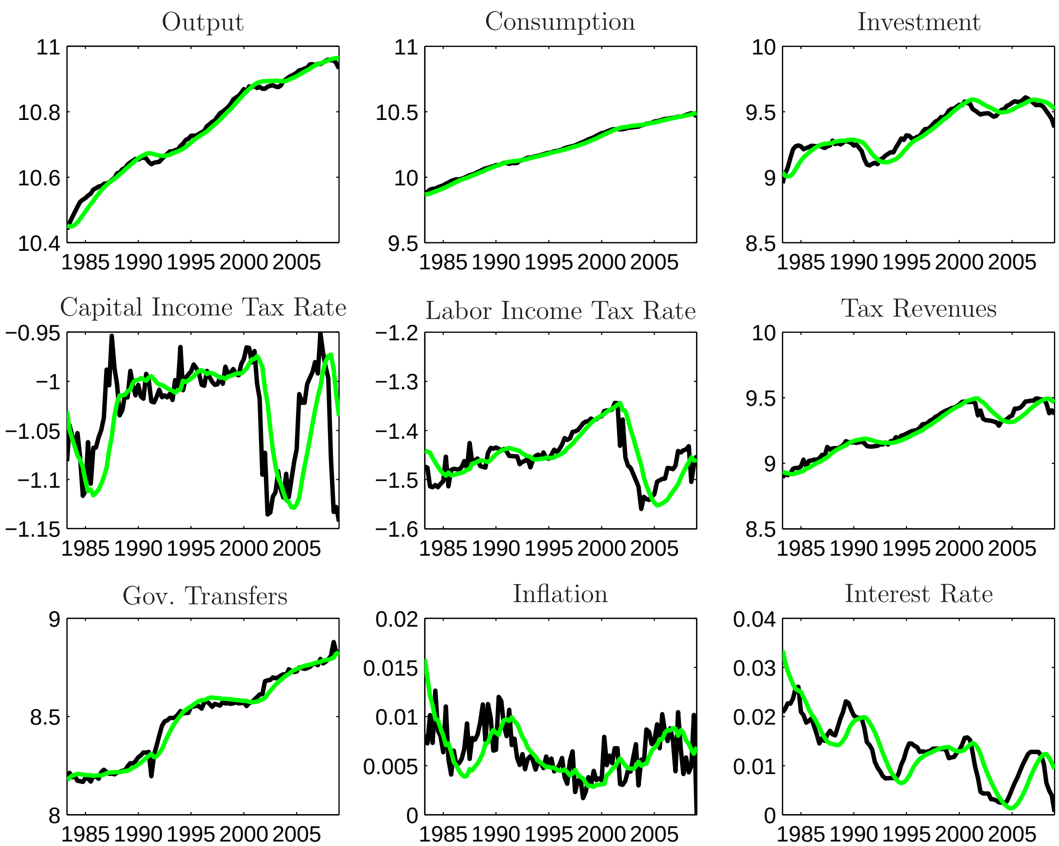

Figure 1: Raw time series (black) and and corresponding trend (green).

B Estimation baseline model

This section contains the Dynare diagnostic output for the estimation of the benchmark economy.

B.1 Posterior mode estimation

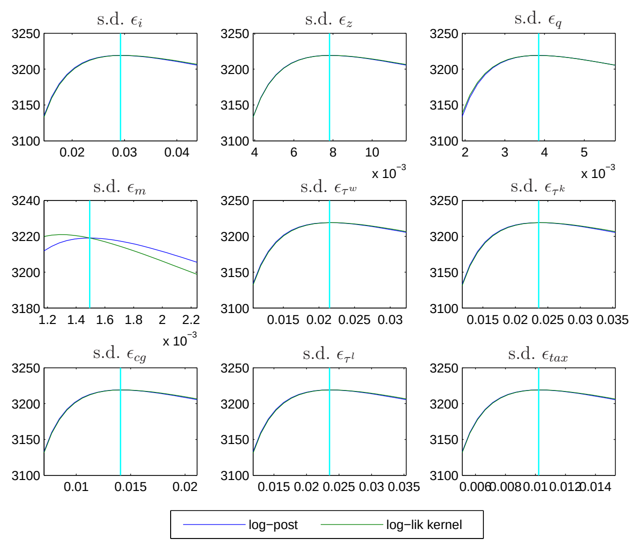

Figure 2: Check plots for posterior mode maximization of the baseline model.

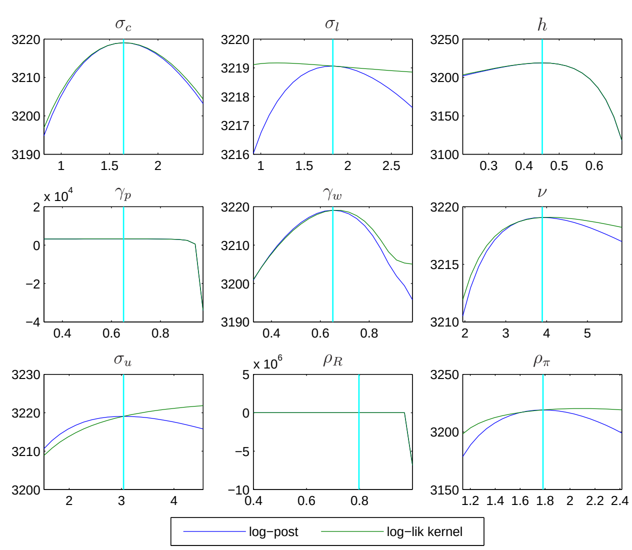

Figure 3: Check plots for posterior mode maximization of the baseline model.

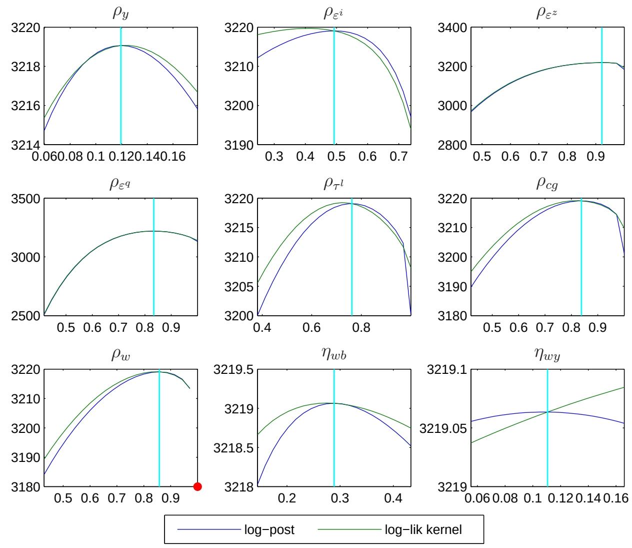

Figure 4: Check plots for posterior mode maximization of the baseline model.

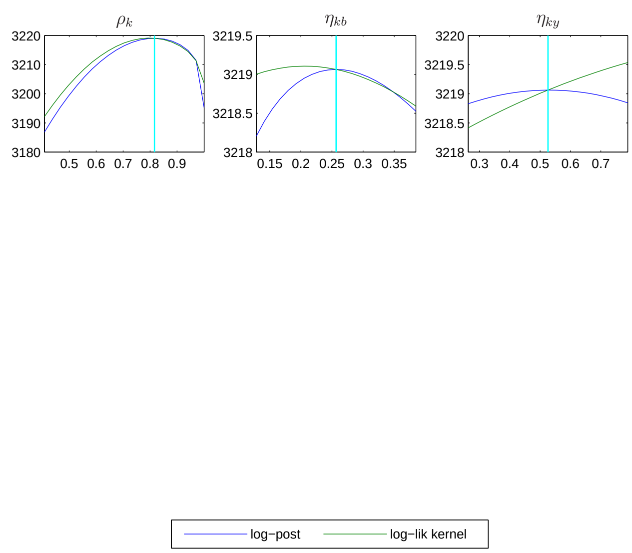

Figure 5: Check plots for posterior mode maximization of the baseline model.

B.2 Posterior distribution

Parameter	Symbol	Mode	Mean	10%	90%
Inv. intertemp. subst. elasticity	σ_c	1.6444	1.7692	1.1765	2.3773
Inverse Frisch elasticity	σ_l	1.8284	1.9383	1.1532	2.7120
Habit persistence	h	0.4519	0.4520	0.3274	0.5704
Price stickiness	γ_p	0.6495	0.6547	0.5877	0.7249
Wage stickiness	γ_w	0.6511	0.6392	0.5359	0.7472
Investment adjustment cost	ν	3.8930	4.3250	2.4786	6.0662
Capital utilization cost	σ_u	3.0383	3.1623	2.3207	3.9756
Interest rate AR coefficient	ρ_R	0.7983	0.7991	0.7597	0.8395
Inflation coefficient	ρ_π	1.7835	1.7915	1.6286	1.9476
Output coefficient	ρ_y	0.1194	0.1230	0.0691	0.1718
Labor tax AR coefficient	ρ_w	0.8577	0.8586	0.7842	0.9405
Labor tax debt coefficient	η_{wb}	0.2887	0.3406	0.1003	0.5574
Labor tax output coefficient	η_{wy}	0.1106	0.0883	-0.6154	0.7909
Capital tax AR coefficient	ρ_k	0.8162	0.8219	0.7410	0.9045
Capital tax debt coefficient	η_{kb}	0.2565	0.2915	0.0819	0.4891
Capital tax output coefficient	η_{ky}	0.5257	0.5035	-0.1822	1.1866
Lump-sum tax AR coefficient	ρ_{τ^l}	0.7617	0.7598	0.6572	0.8605
Adjustment costs AR coefficient	ρ_i	0.4923	0.5032	0.3742	0.6333
Technology AR coefficient	ρ_z	0.9214	0.9132	0.8622	0.9680
Risk premium AR coefficient	ρ_q	0.8335	0.8169	0.7370	0.8962
Public consumption AR coefficient	ρ_{cg}	0.8377	0.8358	0.7515	0.9229
S.d. adjustment costs shock	ϵ_i	0.0292	0.0304	0.0251	0.0356
S.d. technology shock	ϵ_z	0.0078	0.0084	0.0063	0.0104
S.d. risk premium shock	ϵ_q	0.0039	0.0045	0.0026	0.0065
S.d. monetary policy shock	ϵ_m	0.0015	0.0015	0.0013	0.0017
S.d. labor tax shock	ϵ_{τ^w}	0.0215	0.0219	0.0193	0.0244
S.d. capital tax shock	ϵ_{τ^k}	0.0236	0.0240	0.0212	0.0267
S.d. lump-sum tax shock	ϵ_{τ^l}	0.0235	0.0239	0.0211	0.0264
S.d. public consumption shock	ϵ_{cg}	0.0141	0.0143	0.0126	0.0159
S.d. measurement error taxes	ϵ_{tax}	0.0102	0.0104	0.0092	0.0116
Log data density			3133.681		

Table 3: Posterior mode and posterior distribution of the baseline model's parameters.

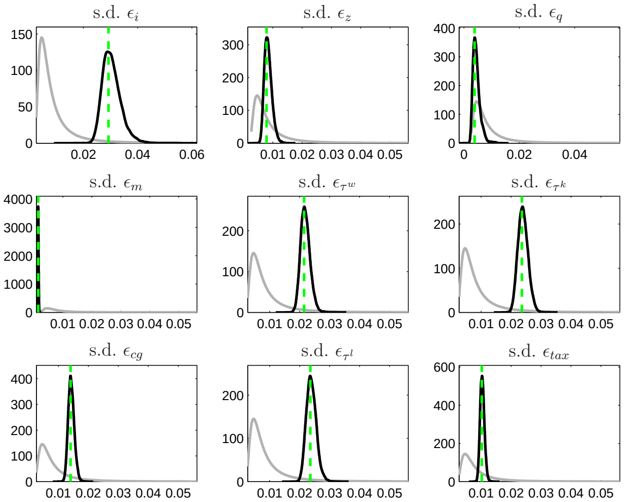

Figure 6: Results from Metropolis-Hastings (standard deviation of structural shocks and measurement errors).

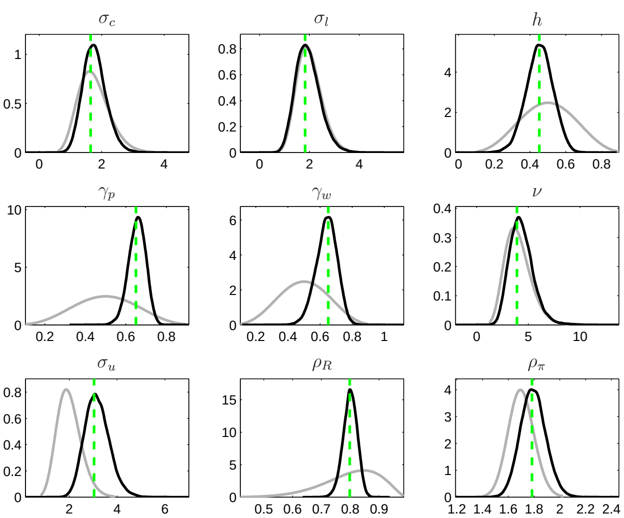

Figure 7: Results from Metropolis-Hastings (parameters).

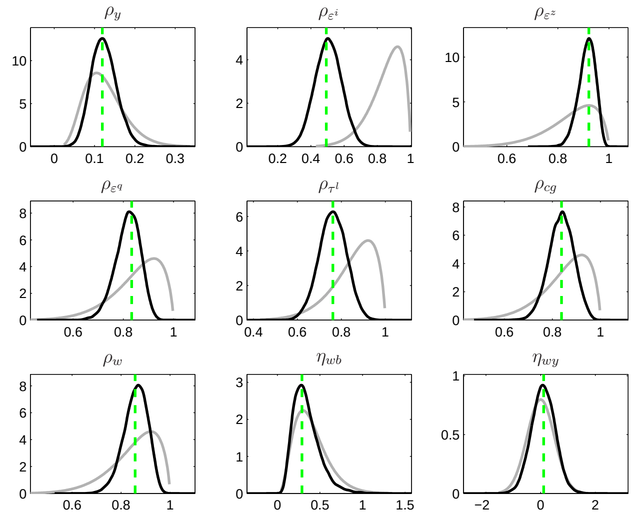

Figure 8: Results from Metropolis-Hastings (parameters).

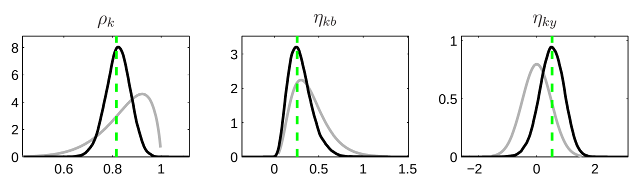

Figure 9: Results from Metropolis-Hastings (parameters).

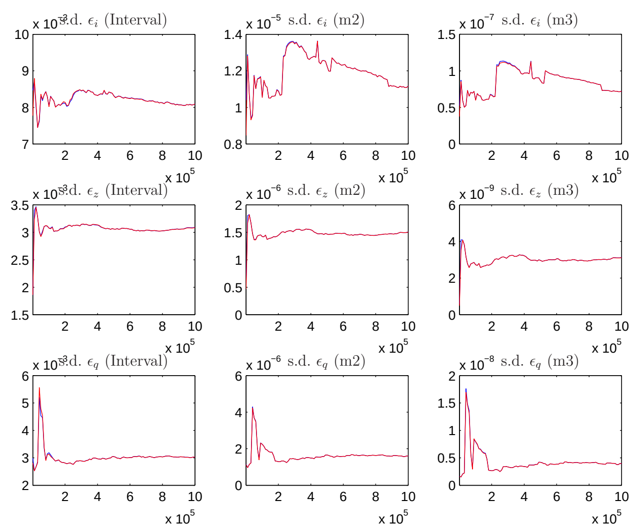

Figure 10: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

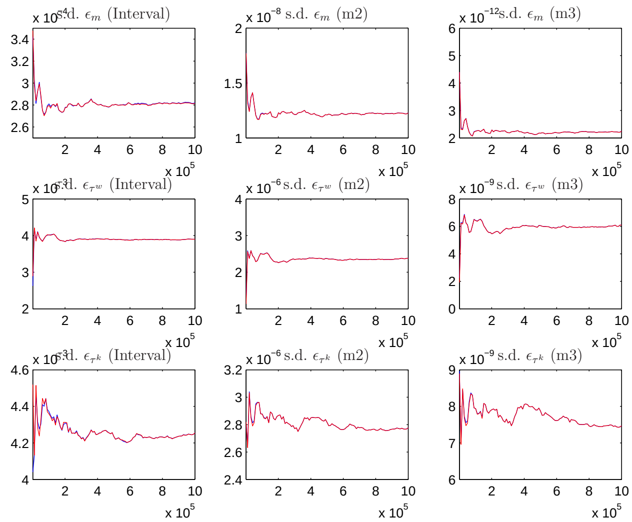

Figure 11: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

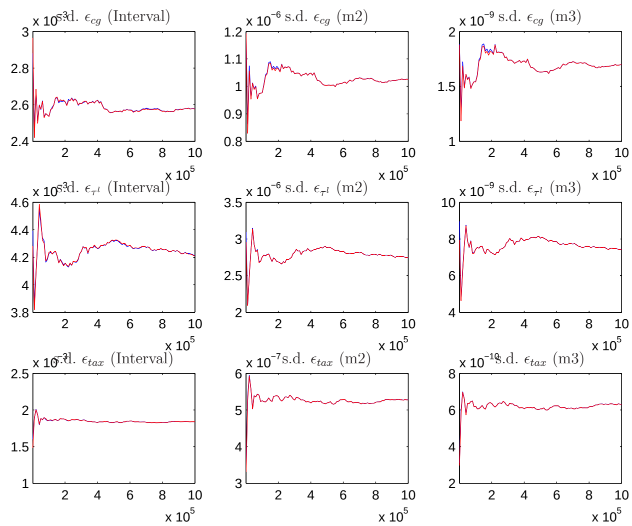

Figure 12: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

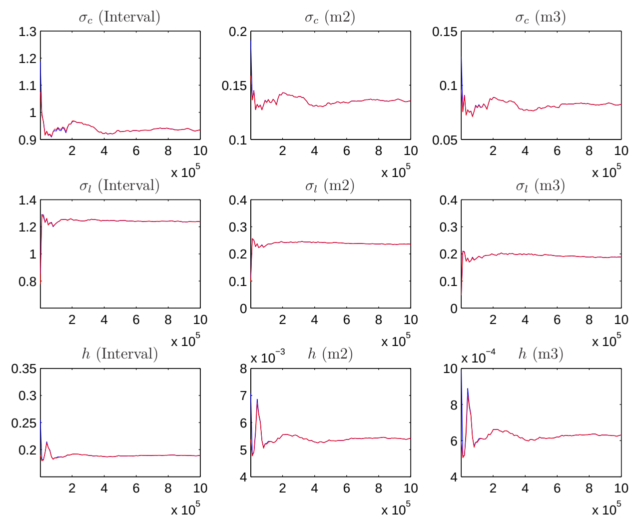

Figure 13: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

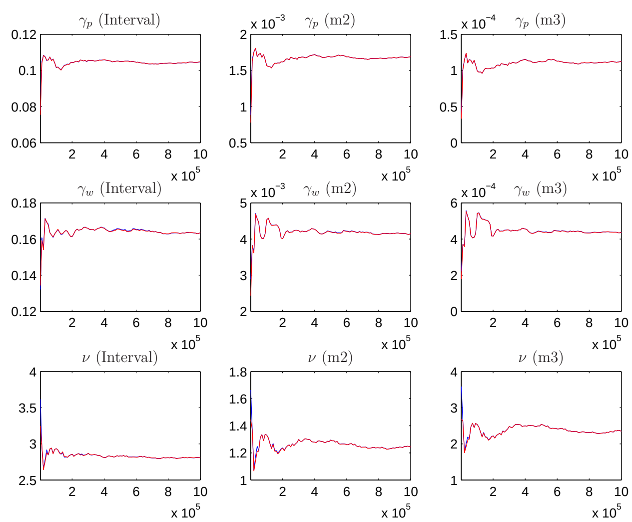

Figure 14: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

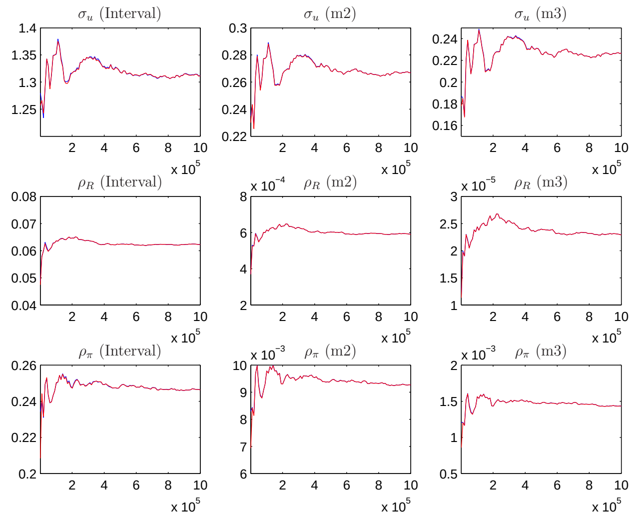

Figure 15: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

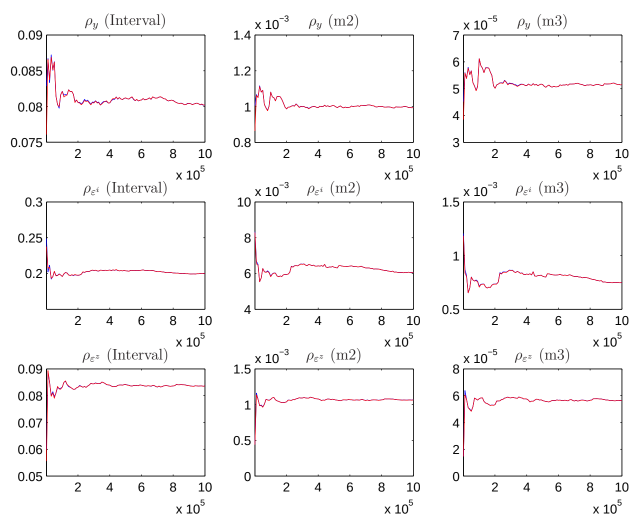

Figure 16: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

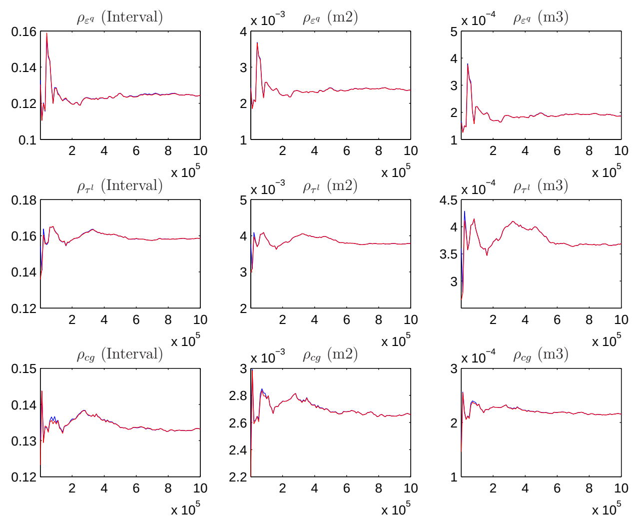

Figure 17: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

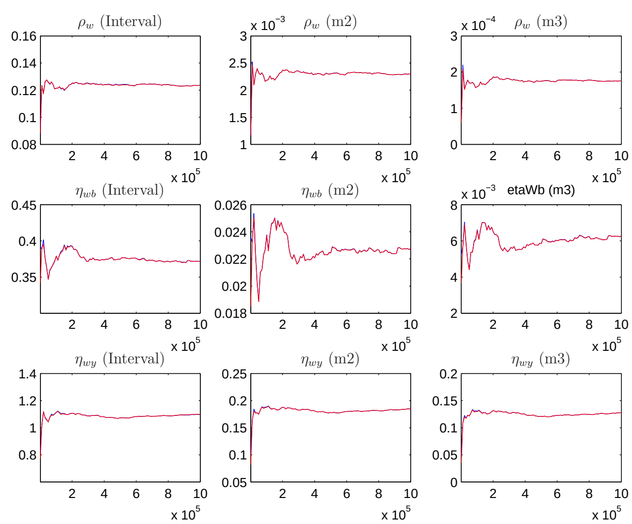

Figure 18: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

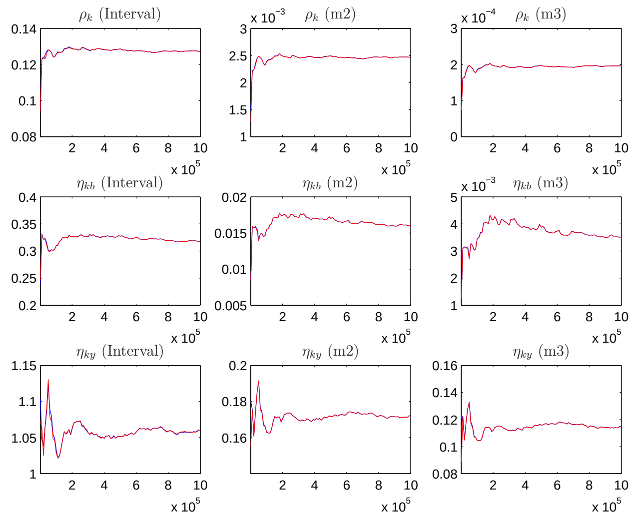

Figure 19: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

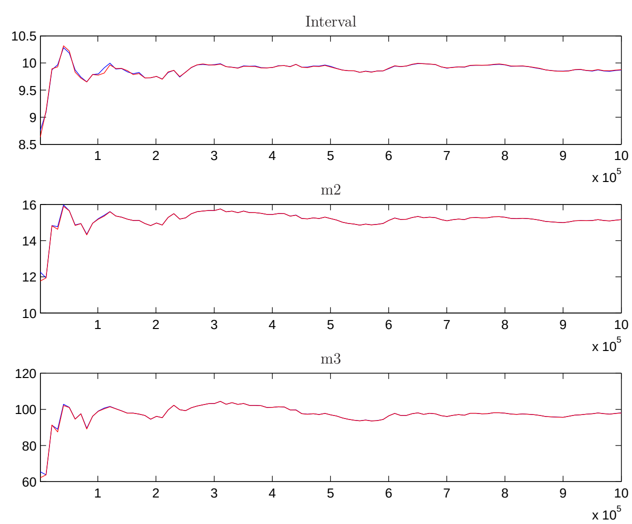

Figure 20: Multivariate convergence diagnostics for the Metropolis-Hastings. The first, second and third rows are respectively the criteria based on the eighty percent interval, the second and third moments. The different parameters are aggregated using the posterior kernel.

B.3 Smoothed shocks and observation errors

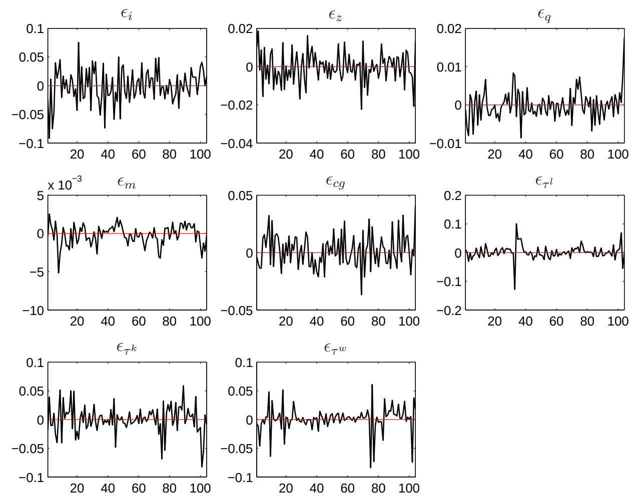

Figure 21: Smoothed shocks baseline model.

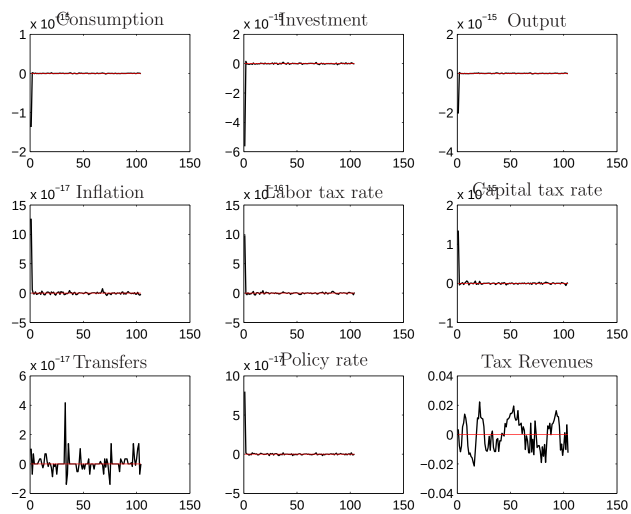

Figure 22: Smoothed observation errors baseline model.

C Estimation general feedback rule

For the posterior mode estimation of the simple linear feedback rules, the DSGE model is closed with the following tax rules:

$$\hat{\tau}_t^w = \eta_{wk}\hat{k}_{t-1} + \eta_{wb}\hat{b}_{t-1} + \eta_{wy}\hat{y}_t + \eta_{wc}\hat{c}_t + \eta_{wh}\hat{l}_t + \eta_{ww}\hat{w}_t + \eta_{wI}\hat{I}_t + \eta_{w\pi}\hat{\pi}_t + \eta_{wR}\hat{R}_t \tag{85}$$

$$\hat{\tau}_t^k = \eta_{kk}\hat{k}_{t-1} + \eta_{kb}\hat{b}_{t-1} + \eta_{ky}\hat{y}_t + \eta_{kc}\hat{c}_t + \eta_{kh}\hat{l}_t + \eta_{kw}\hat{w}_t + \eta_{kI}\hat{I}_t + \eta_{k\pi}\hat{\pi}_t + \eta_{kR}\hat{R}_t \tag{86}$$

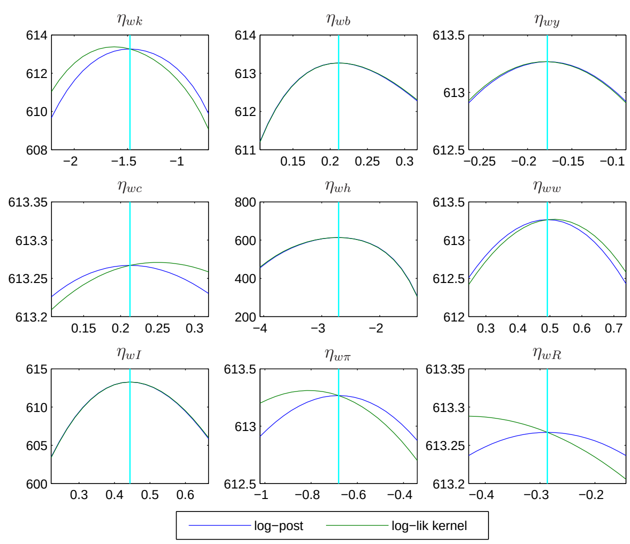

Figure 23: Check plots for posterior mode maximization.

Feedback Parameter	Symbol	Mode	S.d.	T-value
Tax Rate on Labor Income				
Capital	η_{wk}	-1.4772	0.5126	2.8818
Debt	η_{wb}	0.2112	0.1415	1.4928
Output	η_{wy}	-0.1777	0.9059	0.1961
Consumption	η_{wc}	0.2126	0.6268	0.3391
Hours worked	η_{wh}	-2.7104	0.4252	6.3742
Wage rate	η_{ww}	0.4919	0.5868	0.8382
Investment	η_{wI}	0.4434	0.3831	1.1575
Inflation	$\eta_{w\pi}$	-0.6810	0.9110	0.7475
Nominal interest rate	η_{wR}	-0.2868	0.9594	0.2990
Tax Rate on Capital Income				
Capital	η_{kk}	-0.8649	0.9839	0.8790
Debt	η_{kb}	-4.0821	0.9201	4.4365
Output	η_{ky}	2.7774	0.9440	2.9422
Consumption	η_{kc}	0.4917	1.0270	0.4788
Hours worked	η_{kh}	1.9896	0.8723	2.2807
Wage rate	η_{kw}	0.1517	0.9738	0.1558
Investment	η_{kI}	4.6741	0.5581	8.3745
Inflation	$\eta_{k\pi}$	0.2272	1.0050	0.2261
Nominal interest rate	η_{kR}	-0.3189	1.0048	0.3174

Table 4: Posterior mode maximization of optimized feedback coefficients.

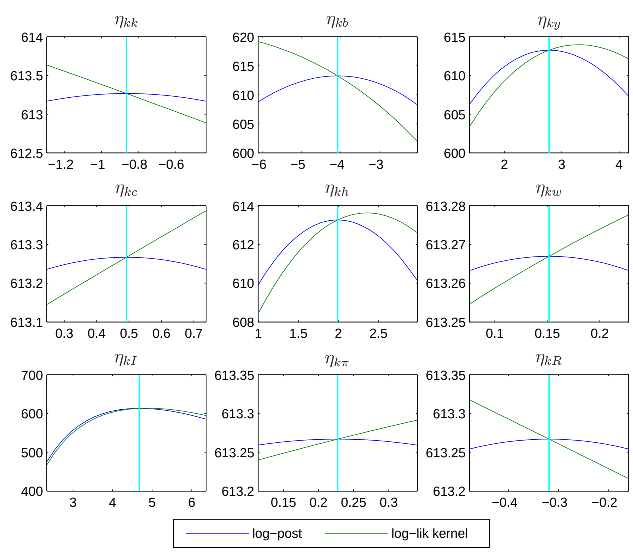

Figure 24: Check plots for posterior mode maximization.

Feedback Parameter	Symbol	Percentile		
		50%	25%	75%
Tax Rate on Labor Income				
Capital	η_{wk}	0.3043	0.1349	0.6144
Debt	η_{wb}	0.2862	0.1887	0.3997
Output	η_{wy}	0.3346	0.1290	0.6545
Consumption	η_{wc}	0.0710	0.0288	0.1535
Hours worked	η_{wh}	2.6759	2.1992	3.1114
Wage rate	η_{ww}	0.1675	0.0519	0.4079
Investment	η_{wI}	0.4187	0.1979	0.7160
Inflation	$\eta_{w\pi}$	0.0317	0.0116	0.0703
Nominal interest rate	η_{wR}	0.0575	0.0240	0.1092
Tax Rate on Capital Income				
Capital	η_{kk}	0.0155	0.0055	0.0345
Debt	η_{kb}	0.2312	0.1062	0.4001
Output	η_{ky}	0.3193	0.2293	0.4115
Consumption	η_{kc}	0.0098	0.0038	0.0201
Hours worked	η_{kh}	0.1778	0.1144	0.2459
Wage rate	η_{kw}	0.0068	0.0022	0.0166
Investment	η_{kI}	1.1474	0.9480	1.3207
Inflation	$\eta_{k\pi}$	0.0007	0.0003	0.0016
Nominal interest rate	η_{kR}	0.0033	0.0012	0.0071

Table 5: Elasticity of income tax rate's variance w.r.t. feedback parameters of the tax rules.

Feedback Parameter	Symbol	Percentile		
		50%	25%	75%
		Welfare		
Capital	η_{wk}	0.2605	0.1319	0.4418
Debt	η_{wb}	0.0333	0.0135	0.0756
Output	η_{wy}	0.0494	0.0162	0.1167
Consumption	η_{wc}	0.0266	0.0090	0.0659
Hours worked	η_{wh}	0.2976	0.2193	0.3926
Wage rate	η_{ww}	0.0335	0.0115	0.0790
Investment	η_{wI}	0.0820	0.0332	0.1625
Inflation	$\eta_{w\pi}$	0.0055	0.0018	0.0138
Nominal interest rate	η_{wR}	0.0048	0.0016	0.0129
Capital	η_{kk}	0.0482	0.0228	0.0817
Debt	η_{kb}	0.2646	0.1240	0.4783
Output	η_{ky}	0.1679	0.1277	0.2085
Consumption	η_{kc}	0.0235	0.0100	0.0452
Hours worked	η_{kh}	0.0135	0.0055	0.0267
Wage rate	η_{kw}	0.0273	0.0124	0.0495
Investment	η_{kI}	0.5591	0.5026	0.6187
Inflation	$\eta_{k\pi}$	0.0032	0.0015	0.0059
Nominal interest rate	η_{kR}	0.0011	0.0004	0.0026

Table 6: Elasticity of welfare's variance w.r.t. feedback parameters of the tax rules.

D Estimation extended model

This section contains the Dynare diagnostic output for the estimation of the economy closed by new tax rules: For the posterior mode estimation of the simple linear feedback rules, the DSGE model is closed with the following tax rules:

$$\hat{\tau}_t^w = \rho_w \hat{\tau}_{t-1}^w + (1-\rho_w)\left(\eta_{wb}\hat{b}_{t-1} + \eta_{wh}\hat{l}_t\right) \tag{87}$$

$$\hat{\tau}_t^k = \rho_k \hat{\tau}_{t-1}^k + (1-\rho_k)\left(\eta_{kb}\hat{b}_{t-1} + \eta_{kI}\hat{I}_t\right) \tag{88}$$

D.1 Posterior mode estimation

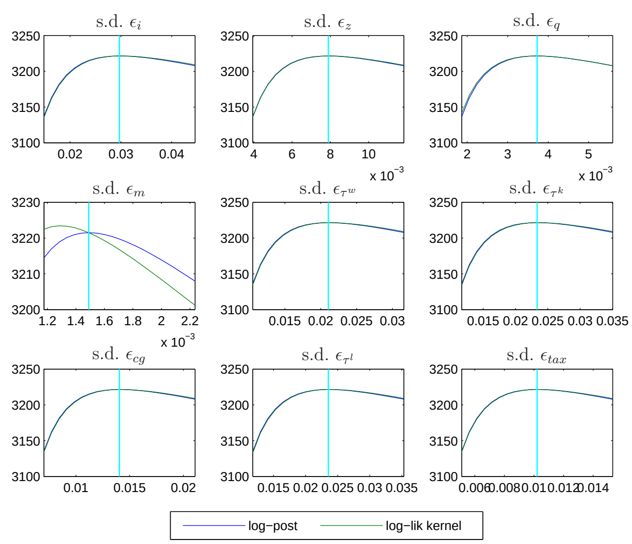

Figure 25: Check plots for posterior mode maximization of the extended model.

Parameter	Symbol	Mode	Mean	10%	90%
Inv. intertemp. subst. elasticity	σ_c	1.6411	1.7852	1.1695	2.4209
Inverse Frisch elasticity	σ_l	1.8538	1.9463	1.1625	2.7435
Habit persistence	h	0.4588	0.4517	0.3319	0.5785
Price stickiness	γ_p	0.6526	0.6572	0.5924	0.7261
Wage stickiness	γ_w	0.6778	0.6596	0.5585	0.7666
Investment adjustment cost	ν	3.8854	4.2443	2.4205	5.9747
Capital utilization cost	σ_u	3.0301	3.1582	2.3275	3.9674
Interest rate AR coefficient	ρ_R	0.8007	0.8002	0.7593	0.8396
Inflation coefficient	ρ_π	1.7741	1.7882	1.6323	1.9437
Output coefficient	ρ_y	0.1237	0.1274	0.0753	0.1795
Labor tax AR coefficient	ρ_w	0.8195	0.8355	0.7485	0.9296
Labor tax debt coefficient	η_{wb}	0.2346	0.3064	0.0883	0.5187
Labor tax labor coefficient	η_{wh}	0.6710	0.5746	-0.1392	1.3256
Capital tax AR coefficient	ρ_k	0.8126	0.8234	0.7434	0.9043
Capital tax debt coefficient	η_{kb}	0.2377	0.2693	0.0692	0.4486
Capital tax investment coefficient	η_{kI}	0.3434	0.3533	0.0377	0.6779
Lump-sum tax AR coefficient	ρ_{τ^l}	0.7620	0.7613	0.6595	0.8630
Adjustment costs AR coefficient	ρ_i	0.4952	0.5011	0.3723	0.6230
Technology AR coefficient	ρ_z	0.9216	0.9132	0.8628	0.9668
Risk premium AR coefficient	ρ_q	0.8439	0.8275	0.7550	0.9041
Public consumption AR coefficient	ρ_{cg}	0.8335	0.8307	0.7445	0.9140
S.d. adjustment costs shock	ϵ_i	0.0297	0.0308	0.0253	0.0358
S.d. technology shock	ϵ_z	0.0079	0.0084	0.0064	0.0104
S.d. risk premium shock	ϵ_q	0.0037	0.0043	0.0025	0.0060
S.d. monetary policy shock	ϵ_m	0.0015	0.0015	0.0013	0.0017
S.d. labor tax shock	ϵ_{τ^w}	0.0211	0.0215	0.0190	0.0241
S.d. capital tax shock	ϵ_{τ^k}	0.0233	0.0237	0.0209	0.0263
S.d. lump-sum tax shock	ϵ_{τ^l}	0.0235	0.0239	0.0212	0.0265
S.d. public consumption shock	ϵ_{cg}	0.0140	0.0143	0.0126	0.0159
S.d. measurement error taxes	ϵ_{tax}	0.0102	0.0104	0.0092	0.0115
Log data density			3134.816		

Table 7: Posterior mode and posterior distribution of the extended model's parameters.

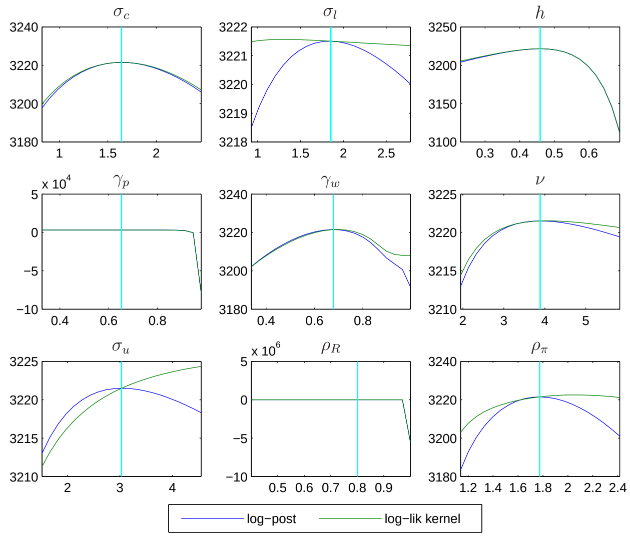

Figure 26: Check plots for posterior mode maximization of the extended model.

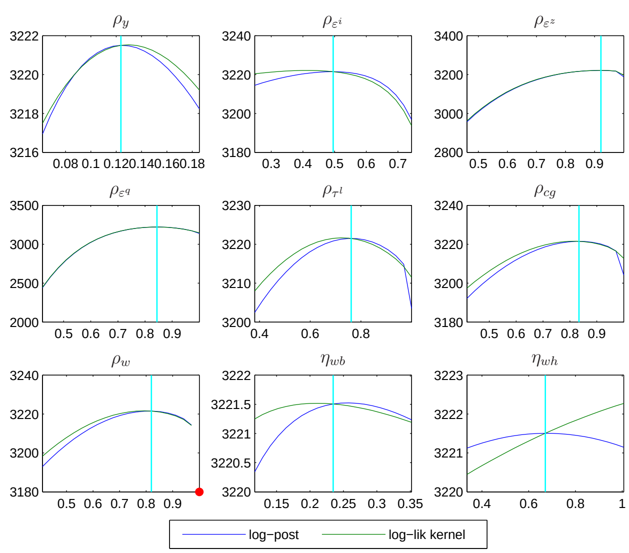

Figure 27: Check plots for posterior mode maximization of the extended model.

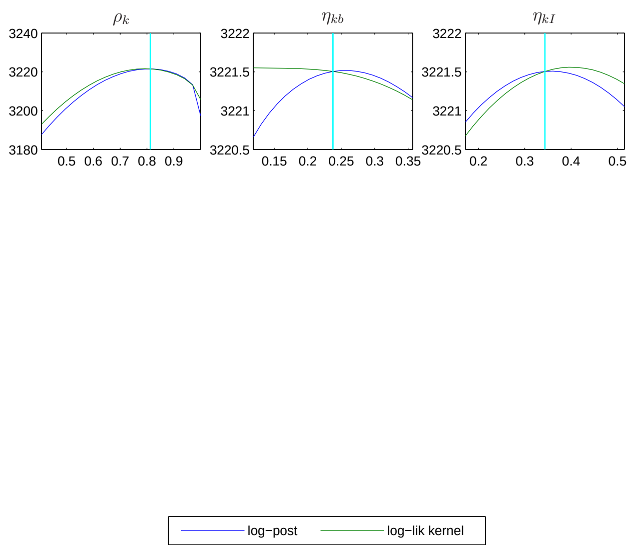

Figure 28: Check plots for posterior mode maximization of the extended model.

D.2 Posterior distribution

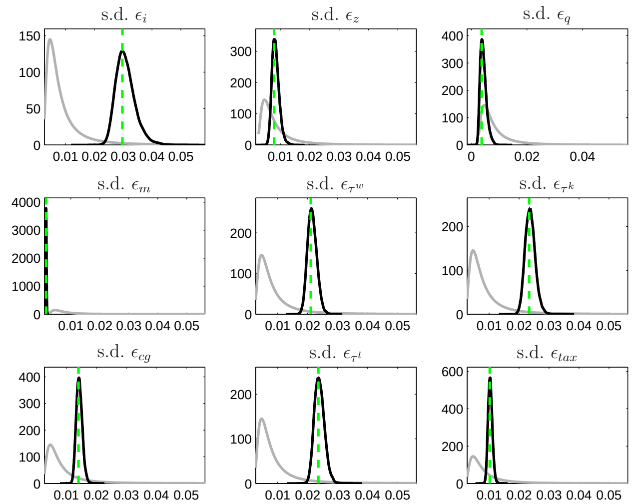

Figure 29: Results from Metropolis-Hastings (standard deviation of structural shocks and measurement errors).

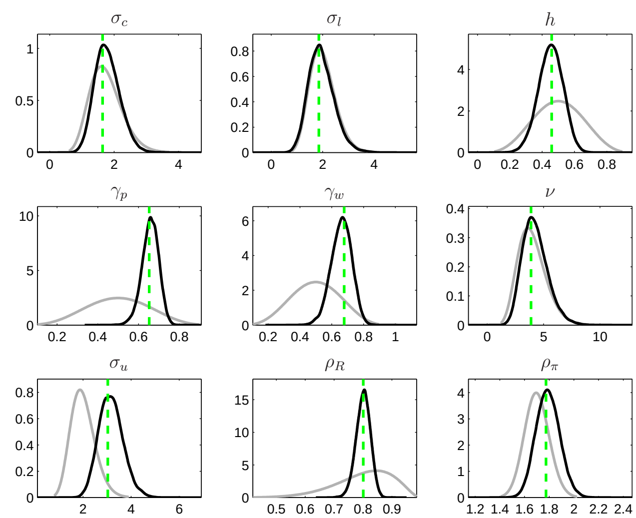

Figure 30: Results from Metropolis-Hastings (parameters).

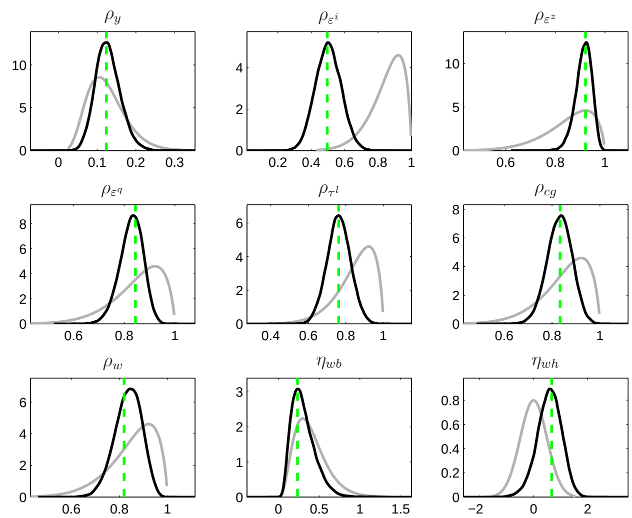

Figure 31: Results from Metropolis-Hastings (parameters).

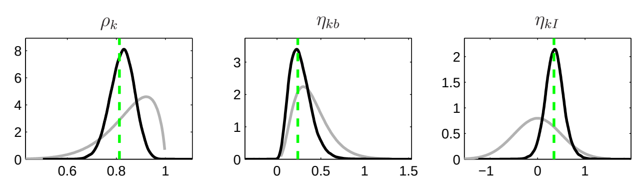

Figure 32: Results from Metropolis-Hastings (parameters).

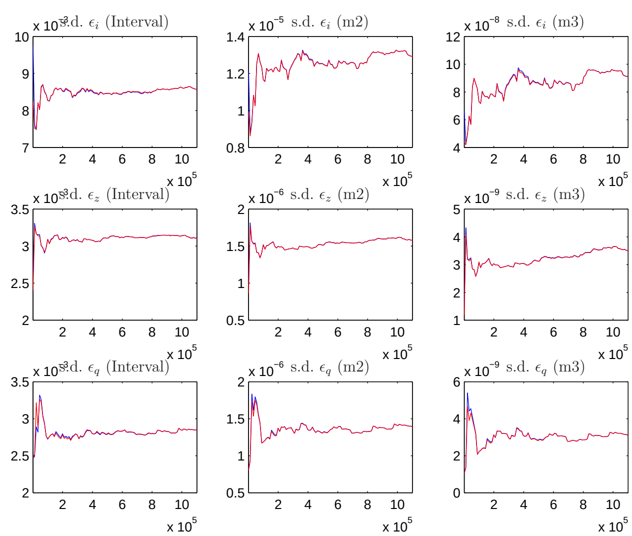

Figure 33: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

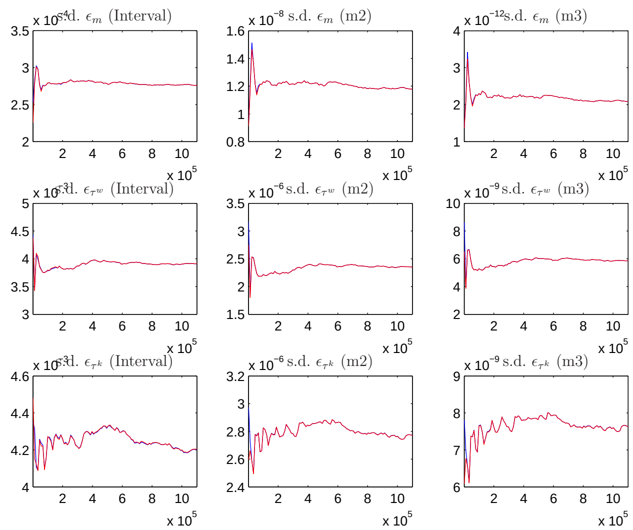

Figure 34: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

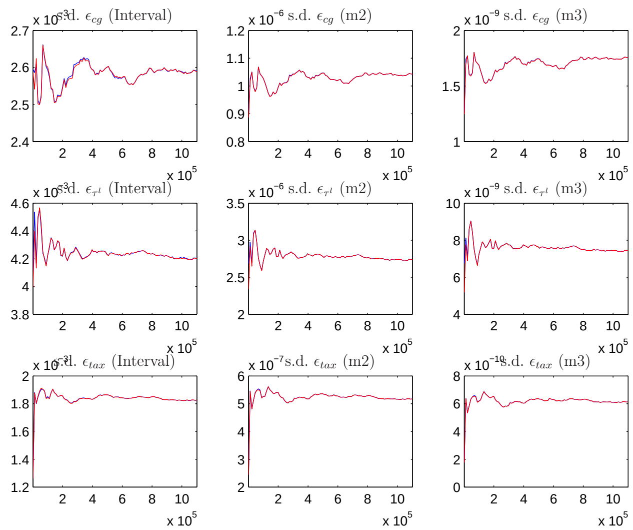

Figure 35: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

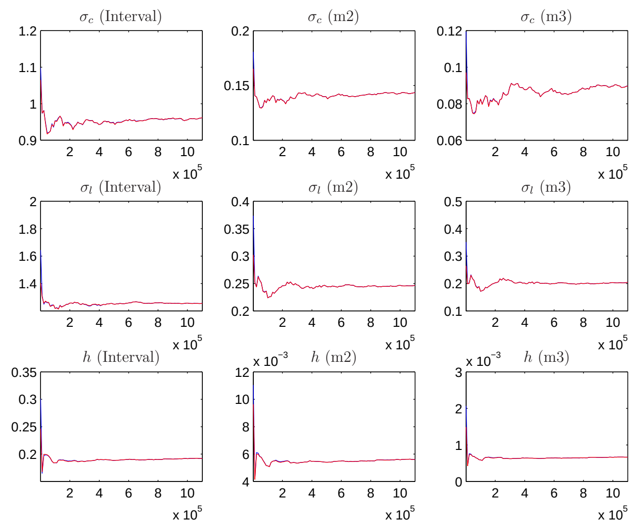

Figure 36: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

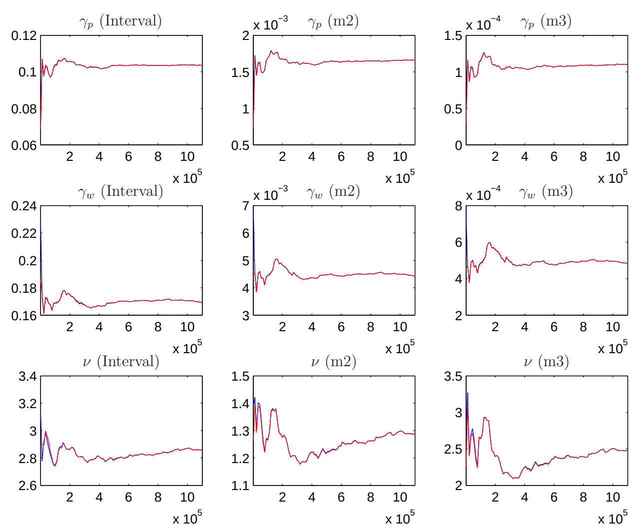

Figure 37: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

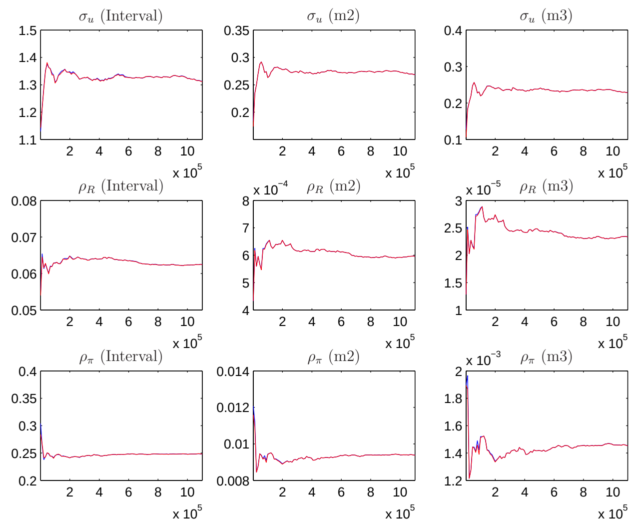

Figure 38: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

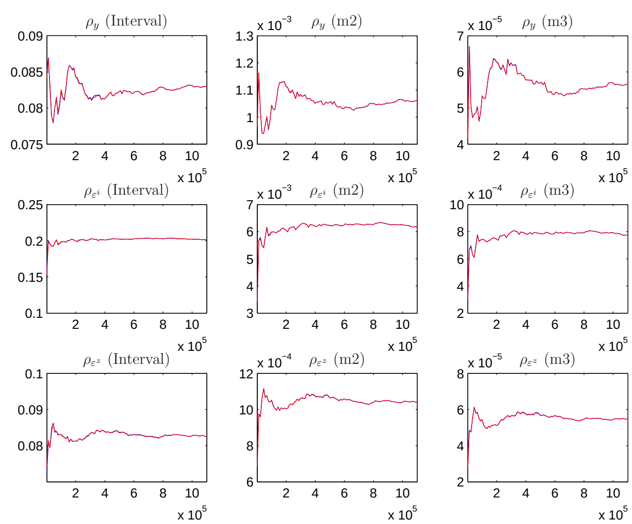

Figure 39: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

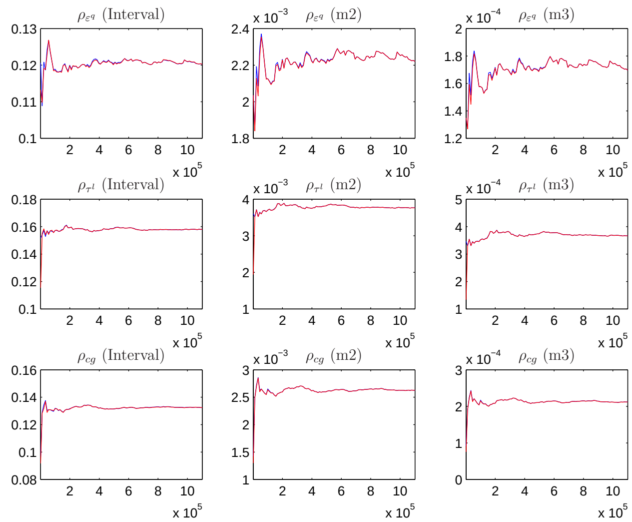

Figure 40: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

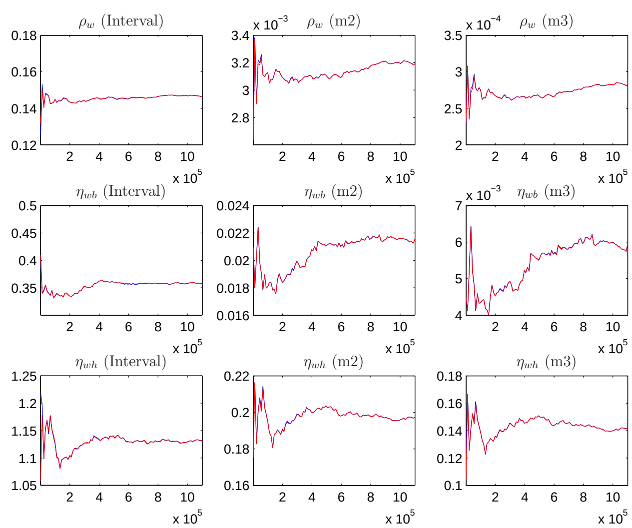

Figure 41: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

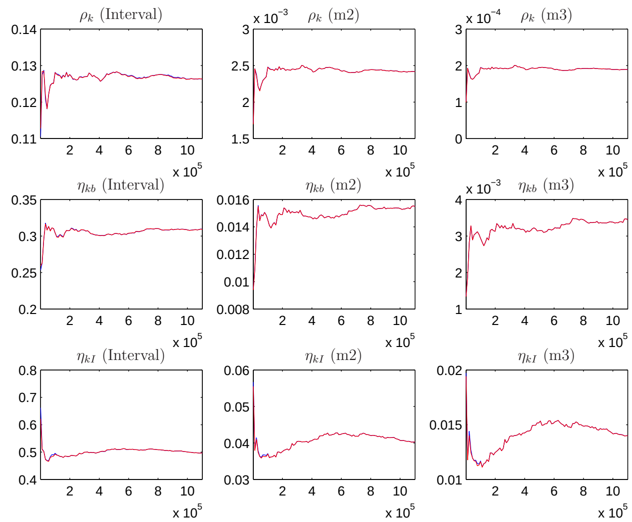

Figure 42: Univariate convergence diagnostics for the Metropolis-Hastings. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

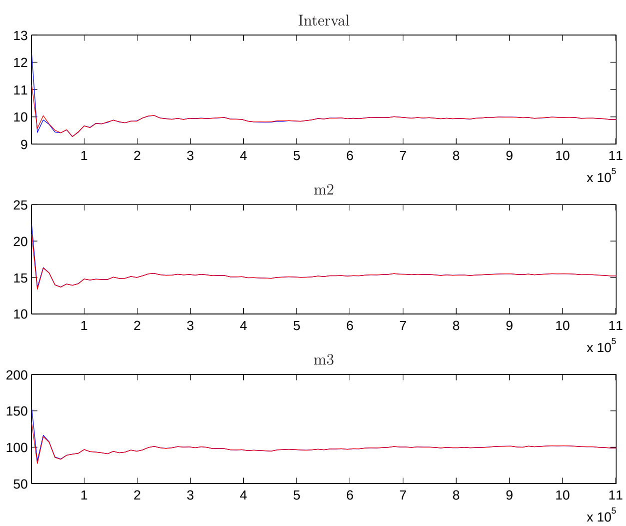

Figure 43: Multivariate convergence diagnostics for the Metropolis-Hastings. The first, second and third rows are respectively the criteria based on the eighty percent interval, the second and third moments. The different parameters are aggregated using the posterior kernel.

D.3 Smoothed shocks

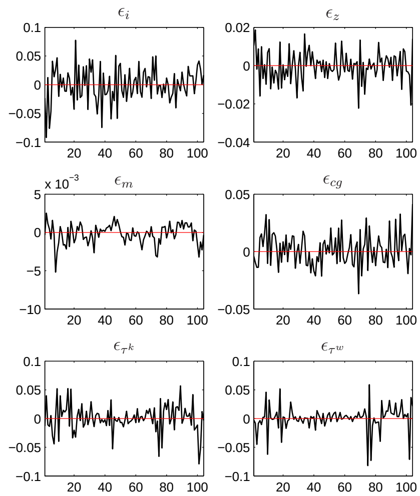

Figure 44: Smoothed shocks extended model.

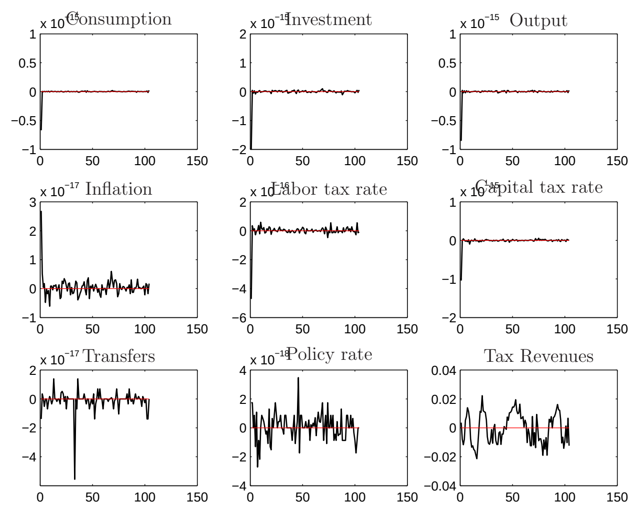

Figure 45: Smoothed observation errors extended model.