OBSERVAÇÕES:

QUESTÃO 01 CORRESPONDE A QUESTÃO 3.3 DE GALÍ (2008)

QUESTÃO 02 CORRESPONDE A QUESTÃO 3.4 DE GALÍ (2008)

QUESTÃO 03 CORRESPONDE A QUESTÃO 2 DA LISTA

QUESTÃO 04 CORRESPONDE A QUESTÃO 3 DA LISTA

UNIVERSIDADE FEDERAL DA PARAÍBA
CENTRO DE CIÊNCIAS SOCIAIS APLICADAS
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA
DISCIPLINA: MACROECONOMIA II
PROFESSOR: DR. EDILEAN ARAGÓN
PERÍODO: 2014.1
ALUNO: ALEXANDRE RODRIGUES LOURES

2

QUESTÃO 01: (EXERCÍCIO 3.3 DE GALÍ (2008))

1.A $y_t = c_t + g_t$ EM QUE $g_t = -\log(1-\tau_t)$ LOGO:

$$y_t = c_t - \log(1-\tau_t)$$

$$c_t = y_t + \log(1-\tau_t) \qquad (1)$$

* SUBSTITUINDO (1) NA EQUAÇÃO DE EULER LOG-LINEARIZADA DAS FAMÍLIAS:

$$c_t = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{c_{t+1}\}$$

$$y_t + \log(1-\tau_t) = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{y_{t+1}\} + E_t\{\log(1-\tau_{t+1})\}$$

$$\boxed{y_t = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{y_{t+1}\} + E_t\{\log(1-\tau_{t+1})\} - \log(1-\tau_t)}$$

1.B FUNÇÃO DE PRODUÇÃO: $y_t = n_t$ 1.A

LOGO O PRODUTO MARGINAL DO TRABALHO É DADO POR:

$$PMg_N = \frac{\partial Y_t}{\partial N_t}$$
$$= 1$$

POR SUA VEZ, O CUSTO MARGINAL REAL É:

$$mc_t = (w_t - p_t) - \log(PMg_N)$$
$$= (w_t - p_t) - \cancel{\log(1)}^{0}$$
$$= (w_t - p_t) \qquad (2)$$

SUBSTITUINDO $w_t - p_t = \sigma c_t + \phi n_t$ EM (2) OBTÉM-SE:

$$mc_t = \sigma c_t + \phi n_t$$
$$= \sigma\{y_t + \log(1-\tau_t)\} + \phi n_t$$

MAS UMA VEZ QUE $y_t = n_t$ TEM-SE:

$$mc_t = \sigma y_t + \sigma\{\log(1-\tau_t)\} + \phi y_t$$
$$= \sigma\{\log(1-\tau_t)\} + (\sigma+\phi) y_t$$
$$\boxed{= (\sigma+\phi) y_t - \sigma \mathring{y}_t}$$

1.C EQUAÇÃO DA INFLAÇÃO É DADA POR:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa y_t \qquad (3)$$

SUBSTITUINDO $y_t \equiv y_t - y_t^n$ EM (3) TEM-SE:

(2)

$$\pi_t = \beta E_t\{\pi_{t+1}\} + K(y_t - y_t^m)$$

$$\pi_t = \beta E_t\{\pi_{t+1}\} + K y_t - K y_t^m$$

$$K y_t^m = \beta E_t\{\pi_{t+1}\} - \pi_t + K y_t$$

$$y_t^m = \frac{\beta E_t\{\pi_{t+1}\} - \pi_t}{K} + \frac{\cancel{K} y_t}{\cancel{K}}$$

$$= \frac{\beta E_t\{\pi_{t+1}\} - \pi_t}{K} + y_t \qquad (4)$$

SUBSTITUINDO O RESULTADO DA LETRA (A) EM (4) OBTÉM-SE:

$$\boxed{y_t^m = \frac{\beta E_t\{\pi_{t+1}\} - \pi_t}{K} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{y_{t+1}\} + E_t\{\log(1-\tau_{t+1})\} - \log(1-\tau_t)}$$

COMO A FRAÇÃO DOS GASTOS GOVERNAMENTAIS É DADO POR τ_t. ENTÃO,

$$\frac{\partial y_t^m}{\partial \tau_t} = \left(\frac{\beta E_t\{\pi_{t+1}\} - \pi_t}{K}\right)'^{\,0} + \left\{-\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho)\right\}'^{\,0} + (E_t\{y_{t+1}\})'^{\,0} +$$

$$+ (E_t\{\log(1-\tau_{t+1})\})'^{\,0} - \{\log(1-\tau_t)\}'$$

$$= -\frac{1}{1-\tau_t}(1-\tau_t)'$$

$$= -\frac{1}{1-\tau_t}(-1)$$

$$\boxed{= \frac{1}{1-\tau_t}}$$

O MECANISMO PELO QUAL UM CHOQUE FISCAL AFETA O PRODUTO DA ECONOMIA PODE SER VERIFICADO PELA DERIVAÇÃO DO PRODUTO NATURAL, y_t^n, EM RELAÇÃO A FRAÇÃO DOS GASTOS GOVERNAMENTAIS, τ_t (DERIVAÇÃO APRESENTADA ACIMA). POR MEIO DESSA RAZÃO, É POSSÍVEL VERIFICAR QUE UMA EXPANSÃO FISCAL, ISTO É, UM CHOQUE FISCAL POSITIVO, ATRAVÉS DA ELEVAÇÃO DA FRAÇÃO DOS GASTOS GOVERNAMENTAIS (τ_t), ACARRETARÁ UM AUMENTO DO PRODUTO NATURAL DA ECONOMIA (y_t^n). ESSA RELAÇÃO É REPRESENTADA PELA SEGUINTE EQUAÇÃO: 2.A

$$y_t^n = \frac{1}{1-\tau_t}$$

1.D SABE-SE QUE:

$$y_t = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{y_{t+1}\} + E_t\{\log(1-\tau_{t+1})\} - \log(1-\tau_t)$$

SUBTRAINDO y_t^n EM AMBOS OS LADOS TEM-SE QUE:

$$y_t - y_t^n = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{y_{t+1}\} - E_t\{y_{t+1}^n\} + E_t\{y_{t+1}^n - y_t^n\} +$$

$$+ E_t\{\log(1-\tau_{t+1})\} - \log(1-\tau_t)$$

$$\tilde{y}_t = -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{\tilde{y}_{t+1}\} + E_t\{\Delta y_{t+1}^n\} + E_t\{\log(1-\tau_{t+1})\} -$$

$$- \log(1-\tau_t)$$

$$= -\frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) + E_t\{\tilde{y}_{t+1}\} + E_t\{\Delta y_{t+1}^n\} - E_t\{g_{t+1}\} + g_t$$

$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho - \sigma E_t\{\Delta y^n\} +$$

$$+ \sigma E_t\{g_{t+1}\} - \sigma g_t)$$

$$= E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho - \sigma E_t\{\Delta y^n\} + \sigma(E_t\{g_{t+1}\} - g_t))$$

$$\boxed{= E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - r_t^n)}$$

EM QUE:

$$r_t^n = \rho + \sigma E_t\{\Delta y^n\} - \sigma(E_t\{g_{t+1}\} - g_t)$$

QUESTÃO 02 (EXERCÍCIO 3.4 DE GALÍ (2008))

2.A * $S(t) \subset [0,1]$ REPRESENTA O CONJUNTO DE FIRMAS QUE NÃO REAJUSTAM SEUS PREÇOS NO PERÍODO t;

* AS FIRMAS QUE REAJUSTAM SEUS PREÇOS EM t ESCOLHERÃO UM PREÇO IDÊNTICO, P_t^*;

* ASSIM, O NÍVEL GERAL DE PREÇOS OU NÍVEL DE PREÇOS AGREGADO EM t É DADO POR:

$$P_t = \left[\int_{S(t)} P_{t-1}(i)^{1-\varepsilon} di + (1-\theta)(P_t^*)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

$$= \left[\theta P_{t-1}^{1-\varepsilon} + (1-\theta)(P_t^*)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \qquad (1)$$

* DIVIDINDO AMBOS OS LADOS DE (1) POR P_{t-1} TEM-SE QUE:

$$\frac{P_t}{P_{t-1}} = \left[\frac{\theta \cancel{P_{t-1}^{1-\varepsilon}}}{\cancel{P_{t-1}^{1-\varepsilon}}} + \frac{(1-\theta)(P_t^*)^{1-\varepsilon}}{P_{t-1}^{1-\varepsilon}}\right]^{\frac{1}{1-\varepsilon}}$$

$$\Pi_t = \left[\theta + (1-\theta)\left(\frac{P_t^*}{P_{t-1}}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

3.A

$$\Pi_t^{1-\varepsilon} = \theta + (1-\theta)\left(\frac{P_t^*}{P_{t-1}}\right)^{1-\varepsilon} \qquad (2)$$

* LOG-LINEARIZANDO (2) PELO MÉTODO DE UHLIG OBTÉM-SE:

$$\bar{\Pi}^{1-\varepsilon} e^{(1-\varepsilon)\tilde{\Pi}_t} = \theta + (1-\theta)\frac{\bar{P}^{*(1-\varepsilon)} e^{(1-\varepsilon)\tilde{P}_t^*}}{\bar{P}^{(1-\varepsilon)} e^{(1-\varepsilon)\tilde{P}_{t-1}}}$$

$$\bar{\Pi}^{1-\varepsilon}[1+(1-\varepsilon)\tilde{\Pi}_t] = \theta + (1-\theta)\left(\frac{\bar{P}^*}{\bar{P}}\right)^{1-\varepsilon}[1+(1-\varepsilon)\tilde{P}_t^* - (1-\varepsilon)\tilde{P}_{t-1}]$$

$$\bar{\Pi}^{1-\varepsilon}[1+(1-\varepsilon)\tilde{\Pi}_t] = \theta + (1-\theta)\left(\frac{\bar{P}^*}{\bar{P}}\right)^{1-\varepsilon}[1+(1-\varepsilon)(\tilde{P}_t^* - \tilde{P}_{t-1})]$$

COMO SE ESTÁ LOG-LINEARIZANDO AO REDOR DE $\Pi = 1$ E $\frac{P_t^*}{P_{t-1}} = 1$. ENTÃO,

$$(1)^{1-\varepsilon}[1+(1-\varepsilon)\tilde{\Pi}_t] = \theta + (1-\theta)(1)^{1-\varepsilon}[1+(1-\varepsilon)(\tilde{P}_t^* - \tilde{P}_{t-1})]$$

$$1+(1-\varepsilon)\tilde{\Pi}_t = \theta + (1-\theta)[1+(1-\varepsilon)(\tilde{P}_t^* - \tilde{P}_{t-1})]$$

$$\cancel{1} + (1-\varepsilon)\tilde{\Pi}_t = \cancel{\theta} + \cancel{1} - \cancel{\theta} + (1-\theta)(1-\varepsilon)(\tilde{P}_t^* - \tilde{P}_{t-1})$$

$$\cancel{(1-\varepsilon)}\tilde{\Pi}_t = (1-\theta)\cancel{(1-\varepsilon)}(\tilde{P}_t^* - \tilde{P}_{t-1})$$

$$\tilde{\Pi}_t = (1-\theta)(\tilde{P}_t^* - \tilde{P}_{t-1})$$

* NO ESTADO ESTACIONÁRIO TEM-SE QUE:

$$\log(\Pi_t) - \overbrace{\cancel{\log(\Pi^{SS})}}^{0} = (1-\theta)[\log(P_t^*) - \cancel{\log(P^{*SS})} - \log(P_{t-1}) + \cancel{\log(P^{SS})}]$$

$$\boxed{\pi_t = (1-\theta)(p_t^* - p_{t-1})} \qquad (3)$$

2.B * AS FIRMAS RE-OTIMIZARÃO SEU PREÇO P_t^* DE MODO QUE ESSE GARANTA A MAXIMIZAÇÃO DOS LUCROS NO PERÍODO (t) BEM COMO NOS PERÍODOS ($t+k$). SENDO QUE A PROBABILIDADE DE P_t^* OCORRER NO PERÍODO $t+K$ É DADA POR θ^K. LOGO, O PROBLEMA É EXPRESSO DA SEGUINTE FORMA:

$$\max \sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ P_t^* \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K} - \Psi_{t+K}\left[\left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} C_{t+K}\right]\right\}\right\}$$ 4

$$\max \sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ \frac{P_t^{*\,1-\varepsilon}}{P_{t+K}^{-\varepsilon}} \cdot C_{t+K} - \Psi_{t+K}\left[\frac{P_t^{*\,-\varepsilon}}{P_{t+K}^{-\varepsilon}} \cdot C_{t+K}\right]\right\}\right\}$$

* A CPO COM A RELAÇÃO A P_t^* É DADO POR:

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ (1-\varepsilon) \frac{P_t^{*\,-\varepsilon}}{P_{t+K}^{-\varepsilon}} \cdot C_{t+K} - \Psi'_{t+K}\left[-\varepsilon \frac{P_t^{*\,-\varepsilon-1}}{P_{t+K}^{-\varepsilon}} \cdot C_{t+K}\right]\right\}\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ (1-\varepsilon) \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K} - \Psi'_{t+K}\left[-\varepsilon . P_t^{*\,-1} \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K}\right]\right\}\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ (1-\varepsilon) \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K} - \Psi'_{t+K}\left[\frac{-\varepsilon}{P_t^*} \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K}\right]\right\}\right\} = 0$$

* COMO $Y_{t+K,t} = \left(\frac{P_t^*}{P_{t+K}}\right)^{-\varepsilon} \cdot C_{t+K}$ TEM-SE QUE:

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left\{ (1-\varepsilon) Y_{t+K,t} - \Psi'_{t+K}\left[-\frac{\varepsilon}{P_t^*} \cdot Y_{t+K,t}\right]\right\}\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left[\frac{P_t^* (1-\varepsilon) Y_{t+K,t} - \Psi'_{t+K} (-\varepsilon) Y_{t+K,t}}{P_t^*}\right]\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \frac{1}{P_t^*} \left[P_t^* (1-\varepsilon) Y_{t+K,t} - \Psi'_{t+K} (-\varepsilon) Y_{t+K,t}\right]\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \frac{1}{P_t^*} \left[P_t^* (1-\varepsilon) Y_{t+K,t} - \frac{(1-\varepsilon)}{(1-\varepsilon)} \Psi'_{t+K} (-\varepsilon) Y_{t+K,t}\right]\right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \frac{1}{P_t^*} \left[P_t^*(1-\varepsilon) Y_{t+K,t} - (1-\varepsilon)\Psi'_{t+K} \left(\frac{-\varepsilon}{1-\varepsilon}\right) Y_{t+K,t} \right] \right\} = 0 \quad \text{4.A}$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \frac{(1-\varepsilon)}{P_t^*} \left[P_t^* Y_{t+K,t} - \Psi'_{t+K} \left(\frac{\varepsilon}{\varepsilon-1}\right) Y_{t+K,t} \right] \right\} = 0$$

* MULTIPLICANDO AMBOS OS LADOS POR $\frac{P_t^*}{1-\varepsilon}$ OBTÉM-SE:

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \frac{\cancel{(1-\varepsilon)}^{1}}{\cancel{P_t^*}_{1}} \cdot \frac{\cancel{P_t^*}^{1}}{\cancel{(1-\varepsilon)}_{1}} \left[P_t^* Y_{t+K,t} - \Psi'_{t+K} \left(\frac{\varepsilon}{\varepsilon-1}\right) Y_{t+K,t} \right] \right\} = (0)\left(\frac{P_t^*}{1-\varepsilon}\right)$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} \left[P_t^* Y_{t+K,t} - \Psi'_{t+K} \left(\frac{\varepsilon}{\varepsilon-1}\right) Y_{t+K,t} \right] \right\} = 0$$

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} Y_{t+K,t} \left[P_t^* - \Psi'_{t+K} \left(\frac{\varepsilon}{\varepsilon-1}\right) \right] \right\} = 0$$

$$\boxed{\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} Y_{t+K,t} \left[P_t^* - \Psi'_{t+K} \mathcal{M} \right] \right\} = 0} \qquad (4)$$

EM QUE $\mathcal{M} = \frac{\varepsilon}{\varepsilon-1}$ E Ψ'_{t+K} É O CUSTO MARGINAL NOMINAL.

2.C * DIVIDINDO (4) POR P_{t-1} E CONSIDERANDO $\Pi_{t,t+K} = \frac{P_{t+K}}{P_{t-1}}$ E

$MC_{t+K|t} = \frac{\Psi'_{t+K}}{P_{t+K}}$ TEM-SE QUE:

$$\sum_{K=0}^{\infty} \theta^K E_t \left\{ Q_{t,t+K} Y_{t+K,t} \left[\frac{P_t^*}{P_{t-1}} - \mathcal{M} \frac{\Psi'_{t+K}}{P_{t-1}} \right] \right\} = 0$$

(5')

$$\sum_{K=0}^{\infty} \theta^{K} E_t\left\{Q_{t,t+K}\, Y_{t+K,t}\left[\frac{P_t^*}{P_{t-1}} - \mathcal{M}\,\frac{\Psi'_{t+K}}{P_{t-1}}\cdot\frac{P_{t+K}}{P_{t+K}}\right]\right\}=0$$

$$\sum_{K=0}^{\infty} \theta^{K} E_t\left\{Q_{t,t+K}\, Y_{t+K,t}\left[\frac{P_t^*}{P_{t-1}} - \mathcal{M}\,\frac{\Psi'_{t+K}}{P_{t+K}}\cdot\frac{P_{t+K}}{P_{t-1}}\right]\right\}=0$$

$$\sum_{K=0}^{\infty} \theta^{K} E_t\left\{Q_{t,t+K}\, Y_{t+K,t}\left[\frac{P_t^*}{P_{t-1}} - \mathcal{M}\, MC_{t+K|t}\, \Pi_{t,t+K}\right]\right\}=0 \qquad (5')$$

*LOG-LINEARIZANDO (5') PELO MÉTODO DE UHLIG E FAZENDO $P_{t+K}=P_t^*$, $Y_{t+K}=Y$, $MC_{t+K}=MC$, $Q_{t,t+K}=\beta^{K}$ E $MC=\frac{1}{\mathcal{M}}$ OBTÉM-SE:

$$\theta^0 E_t\left\{\beta^0 e^{\tilde{Q}_{t+0,t}}\, Y e^{\tilde{Y}_{t+0,t}}\left((1)\frac{e^{p_t^*}}{e^{p_{t-1}}} - \mathcal{M}.\frac{1}{\mathcal{M}}e^{mc_{t+0}-mc}(1)e^{p_{t+0}-p_{t-1}}\right)\right\}+$$

$$+\theta^1 E_t\left\{\beta^1 e^{\tilde{Q}_{t+1,t}}\, Y e^{\tilde{Y}_{t+1,t}}\left((1)\frac{e^{p_t^*}}{e^{p_{t-1}}} - \mathcal{M}.\frac{1}{\mathcal{M}}e^{mc_{t+1}-mc}(1)e^{p_{t+1}-p_{t-1}}\right)\right\}+\dots\approx$$

$$=0$$

$$(1)E_t\left\{(1)Ye^{\tilde{Q}_{t,t}}e^{\tilde{Y}_{t,t}}\left(e^{p_t^*-p_{t-1}}-e^{mc_t-mc}e^{p_t-p_{t-1}}\right)\right\}+$$

$$+\theta E_t\left\{\beta Y e^{\tilde{Q}_{t+1,t}}e^{\tilde{Y}_{t+1,t}}\left(e^{p_t^*-p_{t-1}}-e^{mc_{t+1}-mc}e^{p_{t+1}-p_{t-1}}\right)\right\}+\dots\approx 0$$

$$E_t\left\{Ye^{\tilde{Q}_{t,t}}e^{\tilde{Y}_{t,t}}\left(e^{p_t^*-p_{t-1}}-e^{mc_t-mc}e^{p_t-p_{t-1}}\right)\right\}+$$

$$+\theta E_t\left\{\beta Y e^{\tilde{Q}_{t+1,t}}e^{\tilde{Y}_{t+1,t}}\left(e^{p_t^*-p_{t-1}}-e^{mc_{t+1}-mc}e^{p_{t+1}-p_{t-1}}\right)\right\}+\dots\approx 0$$

$$Y E_t\left\{e^{\tilde{Q}_{t,t}+\tilde{Y}_{t,t}+p_t^*-p_{t-1}}-e^{\tilde{Q}_{t,t}+\tilde{Y}_{t,t}+mc_t-mc+p_t-p_{t-1}}\right\}+$$

$$+\theta\beta Y E_t\left\{e^{\tilde{Q}_{t+1,t}+\tilde{Y}_{t+1,t}+p_t^*-p_{t-1}}-e^{\tilde{Q}_{t+1,t}+\tilde{Y}_{t+1,t}+mc_{t+1}-mc+p_{t+1}-p_{t-1}}\right\}+\dots\approx 0$$

$$Y\left\{E_t\left[\cancel{1}+\cancel{\tilde{Q}_{t,t}}+\cancel{\tilde{Y}_{t,t}}+p_t^*-p_{t-1}-\cancel{1}-\cancel{\tilde{Q}_{t,t}}-\cancel{\tilde{Y}_{t,t}}-mc_t+mc-p_t+p_{t-1}\right]+\right.$$

$$\left.+\theta\beta E_t\left[\cancel{1}+\cancel{\tilde{Q}_{t+1,t}}+\cancel{\tilde{Y}_{t+1,t}}+p_t^*-p_{t-1}-\cancel{1}-\cancel{\tilde{Q}_{t+1,t}}-\cancel{\tilde{Y}_{t+1,t}}-mc_{t+1}+mc-p_{t+1}+p_{t-1}\right]\right\}+\dots\approx 0$$

$E_t[p_t^* - p_{t-1} - mc_t + mc - (p_t - p_{t-1})] +$

$+ \theta\beta E_t[p_t^* - p_{t-1} - mc_{t+1} + mc - (p_{t+1} - p_{t-1})] + \cdots \approx \frac{0}{Y}$

$E_t[p_t^* - p_{t-1} - \hat{mc}_{t,t} - (p_t - p_{t-1})] + \theta\beta E_t[p_t^* - p_{t-1} - \hat{mc}_{t+1,t} - (p_{t+1} - p_{t-1})] +$

$+ \theta^2\beta^2 E_t[p_t^* - p_{t-1} - \hat{mc}_{t+2,t} - (p_{t+2} - p_{t-1})] + \cdots \approx 0$

$(1 + \theta\beta + \theta^2\beta^2 + \theta^3\beta^3 + \cdots)(p_t^* - p_{t-1}) - \sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\} = 0$

$\left(\frac{1}{1-\theta\beta}\right)(p_t^* - p_{t-1}) = \sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\}$

$$\boxed{p_t^* - p_{t-1} = (1-\theta\beta)\sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\}}$$

2-D * DA LETRA A TEM-SE QUE:

EMPREGANDO A REGRA 1

$$\pi_t = (1-\theta)(p_t^* - p_{t-1})$$

$$p_t^* - p_{t-1} = \frac{\pi_t}{1-\theta} \qquad (1)$$

* POR SUA VEZ DA LETRA C TEM-SE:

$$p_t^* - p_{t-1} = (1-\theta\beta)\sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k} + p_{t+k} - p_{t-1}\} \qquad (2)$$

* SUBSTITUINDO (1) EM (2) OBTÉM-SE:

$$\frac{\pi_t}{(1-\theta)} = (1-\theta\beta)\sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k} + p_{t+k} - p_{t-1}\} \qquad (3)$$

* CONSIDERANDO O FATO DE QUE $\sum_{k=0}^{\infty} \theta^k\beta^k E_t(p_t - p_t) = 0$. ENTÃO,

$$\frac{\pi_t}{(1-\theta)(1-\theta\beta)} = \sum_{k=0}^{\infty} \theta^k\beta^k E_t\{\hat{mc}_{t+k} + p_{t+k} - p_{t-1}\} + \sum_{k=0}^{\infty} \theta^k\beta^k E_t\{p_t - p_t\}$$

$$\frac{\pi_t}{(1-\theta)(1-\theta\beta)} = \sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_{t-1} + p_t - p_t\}$$

$$= \sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_t\} + \sum_{k=0}^{\infty}\theta^k\beta^k E_t\{p_t - p_{t-1}\}$$

$$= \theta^0\beta^0 E_t\{\widehat{mc}_{t+0} + p_{t+0} - p_t\} + \sum_{k=1}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_t\} + \sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\pi_t\}$$

$$= E_t\{\widehat{mc}_t + \cancel{p_t} - \cancel{p_t}\} + \sum_{k=0}^{\infty}\theta^{k+1}\beta^{k+1} E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \sum_{k=0}^{\infty}\theta^k\beta^k \pi_t$$

$$= E_t\{\widehat{mc}_t\} + \theta\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \frac{\pi_t}{(1-\theta\beta)}$$

$$= \widehat{mc}_t + \theta\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \frac{\pi_t}{(1-\theta\beta)}$$

$$\frac{\pi_t}{(1-\theta)(1-\theta\beta)} - \frac{\pi_t}{(1-\theta\beta)} = \theta\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \widehat{mc}_t$$

$$\frac{\pi_t - (1-\theta)\pi_t}{(1-\theta)(1-\theta\beta)} = \theta\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \widehat{mc}_t$$

$$\frac{\cancel{\pi_t} - \cancel{\pi_t} + \theta\pi_t}{(1-\theta)(1-\theta\beta)} = \theta\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \widehat{mc}_t$$

$$\pi_t = \frac{(1-\theta)(1-\theta\beta)}{\cancel{\theta}}\cancel{\theta}\beta\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \frac{(1-\theta)(1-\theta\beta)}{\theta}\widehat{mc}_t$$

* COMO $\pi_t = (1-\theta)(1-\theta\beta)\sum_{k=0}^{\infty}\theta^k\beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_{t-1}\}$ TEM-SE QUE:

$$\boxed{\pi_t = \beta E_t\{\pi_{t+1}\} + \lambda\widehat{mc}_t} \quad // \quad \text{EM QUE } \lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$$

6'

EMPREGANDO A REGRA 2

* DA REGRA 1 SABE-SE QUE:

$$\frac{\pi_t}{(1-\theta)(1-\theta\beta)} = \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_{t-1} + p_t - p_t\}$$

$$= \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_t\} + \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{p_t - p_{t-1}\}$$

$$= \theta^0 \beta^0 E_t\{\widehat{mc}_{t+0} + p_{t+0} - p_t\} + \sum_{k=1}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_t\} +$$

$$+ \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\omega \pi_{t-1}\}$$

$$= E_t\{\widehat{mc}_t + p_t - p_t\} + \sum_{k=0}^{\infty} \theta^{k+1} \beta^{k+1} E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} +$$

$$+ \sum_{k=0}^{\infty} \theta^k \beta^k \omega \pi_{t-1}$$

$$= E_t\{\widehat{mc}_t\} + \theta\beta \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \frac{\omega \pi_{t-1}}{(1-\theta\beta)}$$

$$= \widehat{mc}_t + \theta\beta \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} + \frac{\omega \pi_{t-1}}{(1-\theta\beta)}$$

$$\pi_t = (1-\theta)(1-\theta\beta)\widehat{mc}_t + \theta\beta(1-\theta)(1-\theta\beta) \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k+1} + p_{t+k+1} - p_t\} +$$

$$+ \frac{(1-\theta)\cancel{(1-\theta\beta)}\,\omega \pi_{t-1}}{\cancel{(1-\theta\beta)}}$$

* COMO $\pi_t = (1-\theta)(1-\theta\beta) \sum_{k=0}^{\infty} \theta^k \beta^k E_t\{\widehat{mc}_{t+k} + p_{t+k} - p_t\}$ OBTÉM-SE:

$$\boxed{\pi_t = \gamma_b \pi_{t-1} + \gamma_f E_t\{\pi_{t+1}\} + \lambda \widehat{mc}_t}$$

EM QUE:

$\gamma_0 = (1-\theta)\omega$

$\gamma_1 = \theta\beta$

$\lambda = (1-\theta)(1-\theta\beta)$

6''

QUESTÃO 03:

6.A

3.A $\min L_t = \frac{1}{2}(\pi_t^2 + \lambda x_t^2)$ S. A $\pi_t = \beta E_t \pi_{t+1} + K x_t + e_t$

* MONTANDO A LAGRANGIANA:

$$\mathcal{L} = \frac{1}{2}(\pi_t^2 + \lambda x_t^2) + \theta(\pi_t - \beta E_t \pi_{t+1} - K x_t - e_t)$$

* CPO'S

$$\frac{\partial \mathcal{L}}{\partial x_t} = 0 \therefore \lambda x_t - \theta K = 0 \therefore \theta = \frac{\lambda x_t}{K} \quad (1)$$

$$\frac{\partial \mathcal{L}}{\partial \pi_t} = 0 \therefore \pi_t + \theta = 0 \therefore \theta = -\pi_t \quad (2)$$

* IGUALANDO (1) E (2) OBTÉM-SE:

$$\frac{\lambda x_t}{K} = -\pi_t \therefore x_t = -\frac{K}{\lambda}\pi_t \quad (3)$$

NOTA-SE DE (3) QUE SE HOUVER UM AUMENTO DA INFLAÇÃO, DEVIDO A UM CHOQUE QUALQUER, A AUTORIDADE MONETÁRIA DEVERÁ ELEVAR A TAXA DE JUROS OBJETIVANDO REDUZIR x_t. UMA VEZ QUE SE ESTÁ SUPONDO UMA POLÍTICA MONETÁRIA DISCRICIONÁRIA (OU SEJA, O BANCO CENTRAL NÃO TEM COMPROMISSO DE PRODUZIR UMA DEFLAÇÃO FUTURA) A EXPECTATIVA DA INFLAÇÃO AUMENTA RESULTANDO EM AUMENTOS CONSIDERÁVEIS DA TAXA DE JUROS NOMINAL.

* SUBSTITUINDO (3) NA RESTRIÇÃO TEM-SE QUE:

$$\pi_t = \beta E_t \pi_{t+1} + K\left(-\frac{K}{\lambda}\right)\pi_t + e_t$$

$$\pi_t = \beta E_t \pi_{t+1} - \frac{K^2}{\lambda}\pi_t + e_t$$

$$\pi_t + \frac{k^2}{\lambda}\pi_t = \beta E_t \pi_{t+1} + e_t$$

$$\left(1 + \frac{k^2}{\lambda}\right)\pi_t = \beta E_t \pi_{t+1} + e_t \qquad (4)$$

* SUPONDO $\pi_t = \Psi e_t$ TAL QUE $E_t \pi_{t+1} = \Psi \rho_e e_t$ TEM-SE QUE:

$$\left(1 + \frac{k^2}{\lambda}\right)\Psi e_t = \beta \Psi \rho_e e_t + e_t$$

$$\left(\frac{\lambda + k^2}{\lambda}\right)\Psi e_t - \beta\Psi\rho_e e_t - e_t = 0$$

$$\left[\left(\frac{\lambda + k^2}{\lambda}\right)\Psi - \beta\Psi\rho_e - 1\right]e_t = 0$$

$$\left(\frac{\lambda + k^2}{\lambda}\right)\Psi - \beta\Psi\rho_e - 1 = \frac{0}{e_t}$$

$$\left(\frac{\lambda + k^2}{\lambda} - \beta\rho_e\right)\Psi - 1 = 0$$

$$\left(\frac{\lambda + k^2 - \lambda\beta\rho_e}{\lambda}\right)\Psi = 1$$

$$\Psi = \frac{\lambda}{\lambda + k^2 - \lambda\beta\rho_e}$$

$$= \frac{\lambda}{k^2 + (1 - \beta\rho_e)\lambda}$$

* UMA VEZ QUE $\pi_t = \Psi e_t$ TEM-SE QUE:

$$\pi_t = \lambda \Omega e_t \qquad (5)$$

7.A

EM QUE

$$\Omega = \frac{1}{K^2 + (1-\beta\rho_e)\lambda}$$

* SUBSTITUINDO (5) EM (3) OBTÉM-SE:

$$x_t = -\frac{K}{\cancel{\lambda}} \cancel{\lambda} \Omega e_t$$

$$= -K\Omega e_t$$

$$\boxed{\pi_t = \lambda\Omega e_t \quad E \quad x_t = -K\Omega e_t}$$

3.B $$x_t = E_t x_{t+1} - \sigma^{-1}(i_t - E_t \pi_{t+1}) + E_t(z_{t+1} - z_t) + u_t \qquad (6)$$

* MULTIPLICANDO AMBOS OS LADOS DE (6) POR σ OBTÉM-SE:

$$\sigma x_t = \sigma E_t x_{t+1} - \sigma^{1-1}(i_t - E_t \pi_{t+1}) + \sigma E_t(z_{t+1} - z_t) + \sigma u_t$$

$$\sigma x_t = \sigma E_t x_{t+1} - i_t + E_t \pi_{t+1} + \sigma E_t(z_{t+1} - z_t) + \sigma u_t$$

$$i_t = \sigma E_t x_{t+1} - \sigma x_t + E_t \pi_{t+1} + \sigma E_t(z_{t+1} - z_t) + \sigma u_t$$

$$i_t = (E_t x_{t+1} - x_t)\sigma + E_t \pi_{t+1} + \sigma E_t(z_{t+1} - z_t) + \sigma u_t \qquad (7)$$

* SUBSTITUINDO (3) EM (7) TEM-SE

$$i_t = \left(-\frac{K}{\lambda} E_t \pi_{t+1} + \frac{K}{\lambda}\pi_t\right)\sigma + E_t \pi_{t+1} + \sigma E_t(z_{t+1} - z_t) + \sigma u_t$$

$$= (\pi_t - E_t \pi_{t+1})\frac{K}{\lambda}\sigma + E_t \pi_{t+1} + \sigma E_t(z_{t+1} - z_t) + \sigma u_t \qquad (8)$$

*CONSIDERANDO $E_t \pi_{t+1} = \pi_t \rho_e$ PODE-SE REESCREVER (8) DA SEGUINTE FORMA:

$$i_t = \left[\left(\frac{1}{\rho_e} - 1\right)\frac{\kappa}{\lambda}\sigma + 1\right] E_t \pi_{t+1} + \sigma E_t (z_{t+1} - z_t) + \sigma u_t \qquad (9)$$

A EXPRESSÃO (9) CARACTERIZA-SE COMO SENDO A REGRA DA TAXA DE JUROS RESULTANTE DA POLÍTICA DISCRICIONÁRIA:

*REESCREVENDO (9) TEM-SE QUE:

$$i_t = \left[\left(\frac{1}{\rho_e} - 1\right)\frac{\kappa}{\lambda}\sigma\right] E_t \pi_{t+1} + E_t \pi_{t+1} + \sigma E_t (z_{t+1} - z_t) + \sigma u_t$$

$$i_t - E_t \pi_{t+1} = \left[\left(\frac{1}{\rho_e} - 1\right)\frac{\kappa}{\lambda}\sigma\right] E_t \pi_{t+1} + \sigma E_t (z_{t+1} - z_t) + \sigma u_t$$

DESSA FORMA, A CONDIÇÃO PARA QUE UM AUMENTO NA TAXA DE JUROS NOMINAL SEJA SUFICIENTE PARA ELEVAR A TAXA DE JUROS REAL EM RESPOSTA A UM AUMENTO NA INFLAÇÃO ESPERADA É DADA POR:

$$\left[\left(\frac{1}{\rho_e} - 1\right)\frac{\kappa}{\lambda}\sigma\right] > 0$$

QUESTÃO 04:

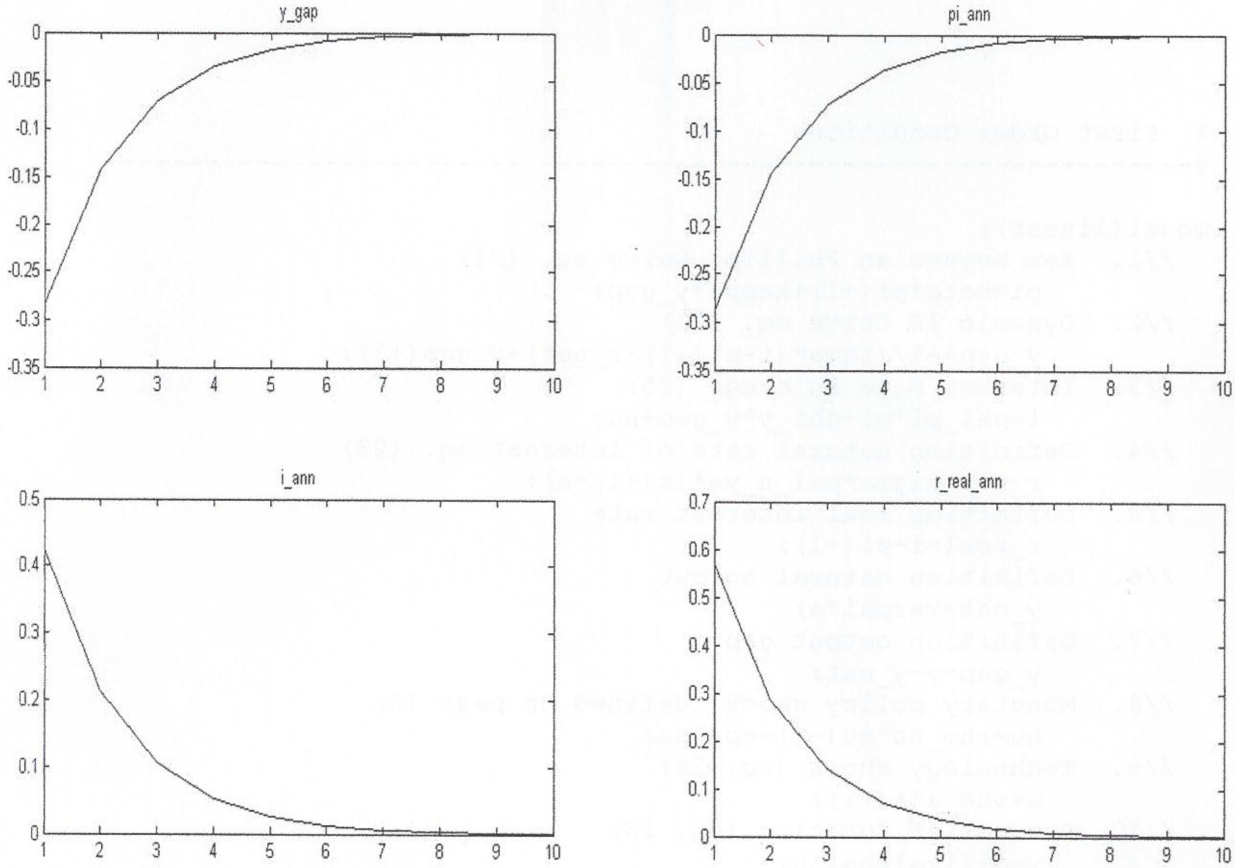
4.A

8.A

```
%-----------------------------------------------------------------
% ROUTINE INTO A MONETARY POLICY SHOCK (QUESTÃO 3 LETRA A)
%-----------------------------------------------------------------

%-----------------------------------------------------------------
% DEFINITION MODEL's VARIABLES AND PARAMETERS
%-----------------------------------------------------------------

var pi              //inflation
    y_gap           //output gap
    y_nat           //natural output (in contrast to the textbook defined
in deviation from steady state)
    y               //output
    r_nat           //natural interest rate
    r_real          //real interest rate
    i               //nominal interst rate
    n               //hours worked
    m_growth_ann    //money growth
    nu              //AR(1) monetary policy shock process
    a               //AR(1) technology shock process
    r_real_ann      //annualized real interest rate
    i_ann           //annualized nominal interest rate
    r_nat_ann       //annualized natural interest rate
    pi_ann;         //annualized inflation rate

varexo eps_nu;      //monetary policy shock

parameters beta sigma psi_n_ya rho_nu rho_a varphi phi_pi phi_y kappa
alpha epsilon eta;

%-----------------------------------------------------------------
% Parametrization, p. 14 and 16
%-----------------------------------------------------------------

sigma   = 1;        //log utility
varphi  = 1;        //unitary Frisch elasticity
phi_pi  = 1.5;      //inflation feedback Taylor Rule
phi_y   = .5/4;     //output feedback Taylor Rule
theta   = 2/3;      //Calvo parameter
rho_nu  = 0.5;      //autocorrelation monetary policy shock
rho_a   = 1;        //a tecnologia é a mesma para todo t
beta    = 0.99;     //discount factor
eta     = 4;        //semi-elasticity of money demand
alpha   = 1/3;      //capital share
epsilon = 6;        //demand elasticity

//Composite parameters

Theta=(1-alpha)/(1-alpha+alpha*epsilon);                //defined page  8
psi_n_ya=(1+varphi)/(sigma*(1-alpha)+varphi+alpha);     //defined page  9
lambda=(1-theta)*(1-beta*theta)/theta*Theta;            //defined page  8
kappa=lambda*(sigma+(varphi+alpha)/(1-alpha));          //defined page 10

%-----------------------------------------------------------------
```

```
%  First Order Conditions
%----------------------------------------------------------------

model(linear);
  //1.  New Keynesian Phillips Curve eq. (21)
          pi=beta*pi(+1)+kappa*y_gap;
  //2.  Dynamic IS Curve eq. (22)
          y_gap=-1/sigma*(i-pi(+1)-r_nat)+y_gap(+1);
  //3.  Interest Rate Rule eq. (25)
          i=phi_pi*pi+phi_y*y_gap+nu;
  //4.  Definition natural rate of interest eq. (23)
          r_nat=sigma*psi_n_ya*(a(+1)-a);
  //5.  Definition real interest rate
          r_real=i-pi(+1);
  //6.  Definition natural output
          y_nat=varphi*a;
  //7.  Definition output gap
          y_gap=y-y_nat;
  //8.  Monetary policy shock (defined on page 12)
          nu=rho_nu*nu(-1)+eps_nu;
  //9.  Technology shock (eq. 28)
          a=rho_a*a(-1);
  //10. Production function (eq. 13)
          y=a+(1-alpha)*n;
  //11. Money growth (derived from eq. (4))
          m_growth_ann=4*(y-y(-1)-eta*(i-i(-1))+pi);
  //12. Annualized nominal interest rate
          i_ann=4*i;
  //13. Annualized real interest rate
          r_real_ann=4*r_real;
  //14. Annualized natural interest rate
          r_nat_ann=4*r_nat;
  //15. Annualized inflation
          pi_ann=4*pi;
end;

%----------------------------------------------------------------
%  define shock variances
%----------------------------------------------------------------

shocks;
var eps_nu = 0.25^2;   //1 standard deviation shock of 25 basis points,
i.e. 1 percentage point annualized
end;

resid(1);
steady;
check;

stoch_simul(order = 1,irf=10) y_gap pi_ann i_ann r_real_ann;
```

9.A



Um choque positivo pode ser interpretado como sendo uma política monetária contracionista, ou seja, um aumento exógeno da taxa de juros nominal (para uma dada inflação e um dado hiato do produto). Assim, um aumento na taxa de juros nominal leva a um declínio persistente no hiato do produto e na inflação. Por sua vez, a taxa de juros real aumentará em resposta a um aumento exógeno da taxa de juros nominal.

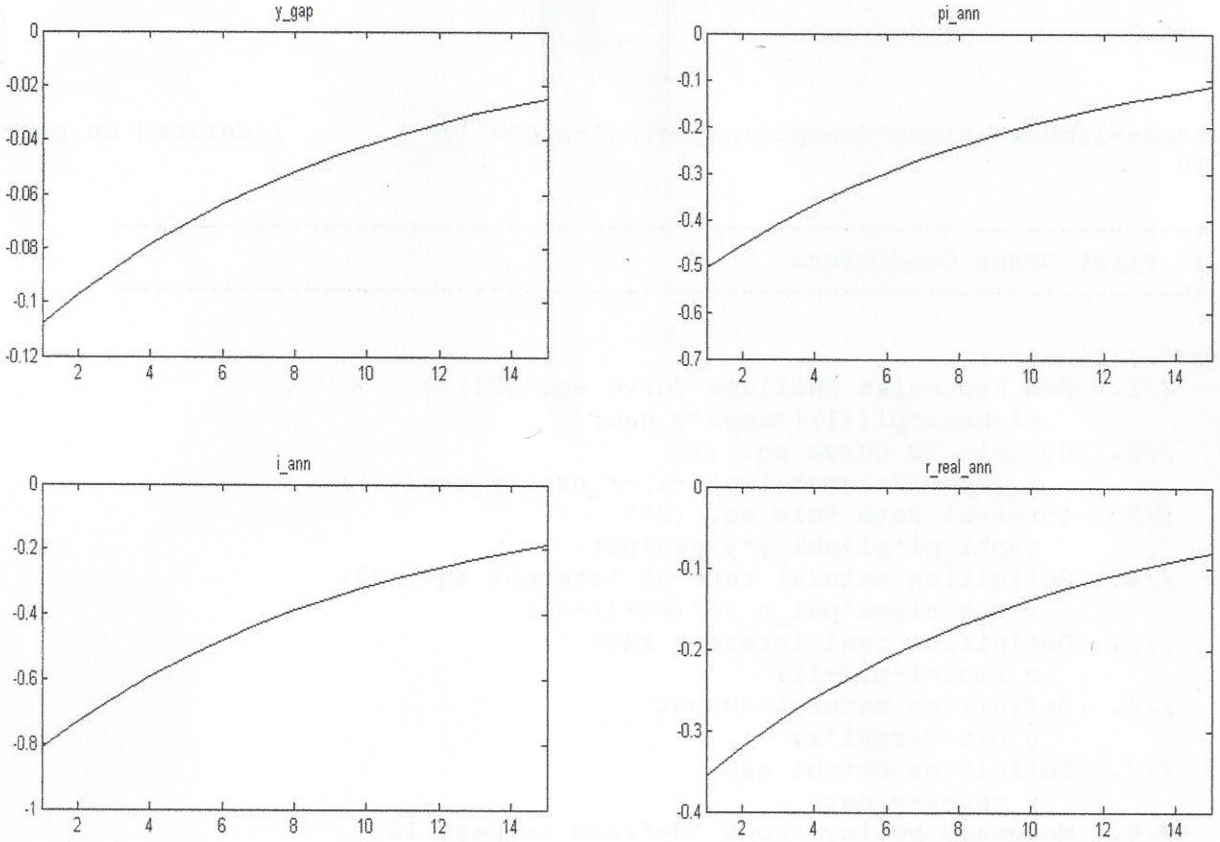
(4.B)

(10)

```
%------------------------------------------------------------------
%  ROUTINE FOR A SHOCK TECHNOLOGY (QUESTÃO 3 LETRA B)
%------------------------------------------------------------------

%------------------------------------------------------------------
%  DEFINITION MODEL's VARIABLES AND PARAMETERS
%------------------------------------------------------------------

var pi              //inflation
    y_gap           //output gap
    y_nat           //natural output (in contrast to the textbook defined
in deviation from steady state)
    y               //output
    r_nat           //natural interest rate
    r_real          //real interest rate
    i               //nominal interst rate
    n               //hours worked
    m_growth_ann    //money growth
    a               //AR(1) technology shock process
    r_real_ann      //annualized real interest rate
    i_ann           //annualized nominal interest rate
    r_nat_ann       //annualized natural interest rate
    pi_ann;         //annualized inflation rate

varexo eps_a;        //technology shock

parameters beta sigma psi_n_ya rho_a varphi phi_pi phi_y kappa alpha
epsilon eta nu;

%------------------------------------------------------------------
%  Parametrization, p. 14 and 16
%------------------------------------------------------------------

nu      = 0;        //exigencia da letra b
sigma   = 1;        //log utility
varphi  = 1;        //unitary Frisch elasticity
phi_pi  = 1.5;      //inflation feedback Taylor Rule
phi_y   = .5/4;     //output feedback Taylor Rule
theta   = 2/3;      //Calvo parameter
rho_a   = 0.9;      //autocorrelation technology shock
beta    = 0.99;     //discount factor
eta     = 4;        //semi-elasticity of money demand
alpha   = 1/3;      //capital share
epsilon = 6;        //demand elasticity

//Composite parameters

Theta=(1-alpha)/(1-alpha+alpha*epsilon);                 //defined on page
8
psi_n_ya=(1+varphi)/(sigma*(1-alpha)+varphi+alpha);     //defined on page
9
lambda=(1-theta)*(1-beta*theta)/theta*Theta;             //defined on page
8
```

10.A

```
kappa=lambda*(sigma+(varphi+alpha)/(1-alpha));          //defined on page
10

%----------------------------------------------------------------
%  First Order Conditions
%----------------------------------------------------------------

model(linear);
  //1.  New Keynesian Phillips Curve eq. (21)
          pi=beta*pi(+1)+kappa*y_gap;
  //2.  Dynamic IS Curve eq. (22)
          y_gap=-1/sigma*(i-pi(+1)-r_nat)+y_gap(+1);
  //3.  Interest Rate Rule eq. (25)
          i=phi_pi*pi+phi_y*y_gap+nu;
  //4.  Definition natural rate of interest eq. (23)
          r_nat=sigma*psi_n_ya*(a(+1)-a);
  //5.  Definition real interest rate
          r_real=i-pi(+1);
  //6.  Definition natural output
          y_nat=varphi*a;
  //7.  Definition output gap
          y_gap=y-y_nat;
  //8.  Monetary policy shock (defined on page 12)
          nu=rho_nu*nu(-1)+eps_nu;
  //9.  Technology shock (eq. 28)
          a=rho_a*a(-1)+eps_a;
  //10. Production function (eq. 13)
          y=a+(1-alpha)*n;
  //11. Money growth (derived from eq. (4))
          m_growth_ann=4*(y-y(-1)-eta*(i-i(-1))+pi);
  //12. Annualized nominal interest rate
          i_ann=4*i;
  //13. Annualized real interest rate
          r_real_ann=4*r_real;
  //14. Annualized natural interest rate
          r_nat_ann=4*r_nat;
  //15. Annualized inflation
          pi_ann=4*pi;
end;

%----------------------------------------------------------------
%  define shock variances
%----------------------------------------------------------------

shocks;
var eps_a  = 1^2;     //unit shock to technology
end;

resid(1);
steady;
check;

stoch_simul(order = 1,irf=15) y_gap pi_ann i_ann r_real_ann;
```


y_gap
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
2 4 6 8 10 12 14
pi_ann
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
2 4 6 8 10 12 14
i_ann
0
-0.2
-0.4
-0.6
-0.8
-1
2 4 6 8 10 12 14
r_real_ann
0
-0.1
-0.2
-0.3
-0.4
2 4 6 8 10 12 14