the fall in the bank spread is softened for increasing degrees of price stickiness. Overall, however, the effects of a government spending expansion are similar to those obtained in the flexible-price case.

In the middle panel of Figure C.1, the Taylor rule features a strong response to the output gap ($\rho_y = 0.5$). In this case, Cantore et al. (2012b, 2013) show that the strong reaction of monetary policy to the output gap offsets the effects of the fiscal expansion to a greater extent because the nominal interest rate falls less relative to the fall in the inflation rate. This leads to a smaller fall in the real interest rate or, for particularly high levels of price stickiness and monetary reactions to the output gap, even to an increase in the real interest rate. For high degrees of price stickiness, investment is crowded-out and the real wage falls, contrary to empirics and baseline results. The rise in lending and the fall in the bank spread are less pronounced, but the sign of the responses of loan market variables is preserved. Unlike in Cantore et al. (2013) the private consumption response and the output multiplier are still quite robust to the choice of ρ_y as the presence of government spending in the utility function prevails on the strong monetary response to the output gap.

The bottom panel of Figure C.1 shows the responses to a government spending expansion in a model with different degrees of price stickiness, a strong reaction to the output gap ($\rho_y = 0.5$) and a "useless" government consumption ($\nu_x = 1$) *versus* a flexible price version. As explained in Subsection B.3 when government consumption does not deliver utility to households, the expansionary effect of the fiscal shock is reduced. This effect, combined with high degrees of price stickiness and a strong reaction of monetary policy to the output gap, leads also to a crowding-out of consumption driven by the positive reaction of the real interest rate. Under this scenario the fall in the bank spread and the rise in lending and output are still present but smaller from a quantitative point of view. Nevertheless, it has to be acknowledged that, first, in the empirical DSGE literature, estimates of the value of ρ_y are typically very low, around the value showed in the top panel of Figure C.1. Second, in the optimal policy literature, optimised interest rate rules using a welfare criterion find a weak long-run response of the interest rate to the output gap; for example, Schmitt-Grohe and Uribe (2007) find $\rho_y = 0.1$ and Cantore et al. (2012b) find a value close to zero in a NK model with deep habits in consumption.

D Symmetric equilibrium

Production function and marginal products:

$$F(H_t, K_t) = H_t^{\alpha} K_t^{1-\alpha} \tag{D.1}$$

$$F_{K,t} = (1-\alpha)\frac{Y_t}{K_t} \tag{D.2}$$

$$F_{H,t} = \alpha\frac{Y_t}{H_t} \tag{D.3}$$

Utility function, marginal utilities and deep habits in consumption:

$$U(X_t, 1-H_t) = \frac{\left[X_t^{\omega}(1-H_t)^{1-\omega}\right]^{1-\sigma}}{1-\sigma} \tag{D.4}$$

$$X_t = \left[\nu_x^{\frac{1}{\sigma_x}}\left(X_t^c\right)^{\frac{\sigma_{x-1}}{\sigma_x}} + (1-\nu_x)^{\frac{1}{\sigma_x}}\left(X_t^g\right)^{\frac{\sigma_{x-1}}{\sigma_x}}\right]^{\frac{\sigma_x}{\sigma_{x-1}}} \tag{D.5}$$

$$U_{X_t^c} = \omega\,(1-H_t)^{1-\omega}\,\nu_x^{\frac{1}{\sigma_x}}\left[X_t^{\omega}\,(1-H_t)^{1-\omega}\right]^{-\sigma} X_t^{\omega-1}\left(\frac{X_t}{X_t^c}\right)^{\frac{1}{\sigma_x}} \tag{D.6}$$

$$U_{H_t} = -(1-\omega)(1-H_t)^{-\omega} X_t^{\omega}\left[X_t^{\omega}\,(1-H_t)^{1-\omega}\right]^{-\sigma} \tag{D.7}$$

$$S_t^c = \rho S_{t-1}^c + (1-\rho^c)C_t \tag{D.8}$$

$$C_t = X_t^c + \theta S_{t-1}^c \tag{D.9}$$

$$-U_{H_t} = U_{X_t^c} W_t \tag{D.10}$$

Intertemporal investment/consumption decisions:

$$K_{t+1} = (1-\delta)K_t + I_t\left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] \tag{D.11}$$

$$S\left(\frac{I_t}{I_{t-1}}\right) = \frac{\gamma}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 \tag{D.12}$$

$$Q_t = E_t \Lambda_{t,t+1}\left[\ \Phi_{t+1} F_{K,t+1} + Q_{t+1}(1-\delta)\ \right] \tag{D.13}$$

$$E_t\left[\Lambda_{t,t+1}(1+R_t^L)\right] = Q_t\left[1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + E_t\Lambda_{t,t+1}\left[\ Q_{t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\ \right] \tag{D.14}$$

$$\Lambda_{t,t+1} = \beta\frac{U_{X_t^C+1}}{U_{X_t^C}} \tag{D.15}$$

$$E_t[\Lambda_{t+1}(1+R_{t+1}^D)] = 1 \tag{D.16}$$

$$\Phi_t F_{H,t} = W_t E_t\left[\Lambda_{t,t+1}(1+R_t^L)\right] \tag{D.17}$$

Further entrepreneurs' and banks' decisions:

$$L_t = I_t + W_t H_t \tag{D.18}$$

$$L_t = X_t^L + \theta^L S_{t-1}^L \tag{D.19}$$

$$S_t^L = \rho^L S_{t-1}^L + (1-\rho^L)L_t \tag{D.20}$$

$$L_t = D_t \tag{D.21}$$

$$\nu_t = E_t\Lambda_{t,t+1}\left[\left(R_{t+1}^L - R_{t+1}^D\right) + \nu_{t+1}\theta^L(1-\rho^L)\right] \tag{D.22}$$

$$E_t\left[\Lambda_{t,t+1}L_{t+1}\right] = \nu_t\eta^L E_t\left[X_{t+1}^L\right] \tag{D.23}$$

$$\text{spread} = R_t^L - R_t^D \tag{D.24}$$

Final good firms' decisions:

$$1-MC_t+(1-\rho)\lambda_t^c=\nu_t^c \tag{D.25}$$

$$E_t\Lambda_{t,t+1}(\theta\nu_{t+1}^c+\rho\lambda_{t+1}^c)=\lambda_t^c \tag{D.26}$$

$$1-MC_t+(1-\rho)\lambda_t^g=\nu_t^g \tag{D.27}$$

$$E_t\Lambda_{t,t+1}(\theta\nu_{t+1}^g+\rho\lambda_{t+1}^g)=\lambda_t^g \tag{D.28}$$

$$\left\{\begin{array}{c} C_t+G_t+(1-\eta)I_t+\eta MC_tI_t-\eta\left(\nu_t^cX_t^c+\nu_t^gX_t^g\right) \\ +\xi E_t\Lambda_{t,t+1}\left[(\Pi_{t+1}-1)\Pi_{t+1}\right]Y_{t+1}-\xi\left[(\Pi_t-1)\Pi_t\right]Y_t \end{array}\right\}=0 \tag{D.29}$$

Government:

$$S_t^g=\rho S_{t-1}^g+(1-\rho)G_t \tag{D.30}$$

$$G_t=X_t^g+\theta S_{t-1}^g \tag{D.31}$$

$$\log\left(\frac{G_t}{\bar{G}}\right)=\rho_G\log\left(\frac{G_{t-1}}{\bar{G}}\right)+\varepsilon_t^g \tag{D.32}$$

Resource constraint:

$$Y_t=C_t+I_t+G_t+\frac{\xi}{2}(\Pi_t-1)^2Y_t \tag{D.33}$$

Taylor rule and Fisher equation (sticky-price model):

$$\log\left(\frac{R_t^n}{\bar{R}^n}\right)=\rho_r\log\left(\frac{R_{t-1}^n}{\bar{R}^n}\right)+(1-\rho_r)\left[\rho_\pi\log\left(\frac{\Pi_t}{\bar{\Pi}}\right)+\rho_y\log\left(\frac{Y_t}{\bar{Y}}\right)\right] \tag{D.34}$$

$$1+R_{t+1}^D=E_t\left[\frac{R_t^n}{\Pi_{t+1}}\right] \tag{D.35}$$

E Steady state

Steady-state values of hours worked, H, capital, K, and the marginal cost, MC, solve simultaneously the definition of the marginal product of labor, (D.3), the banks' demand for deposits, (D.22), and the pricing equation, (D.29), while the value of the remaining unknowns in the system of equations reported in Appendix D can be found recursively by using the following relationships:

$$\overline{\Lambda} = \beta \tag{E.1}$$

$$\overline{R^D} = \frac{1}{\beta} - 1 \tag{E.2}$$

$$\overline{I} = \delta \overline{K} \tag{E.3}$$

$$\overline{Y} = \overline{K}^{1-\alpha} \overline{H}^{\alpha} \tag{E.4}$$

$$\overline{G} = \overline{\left(\frac{G}{Y}\right)} \overline{Y} \tag{E.5}$$

$$\overline{S^g} = \overline{G} \tag{E.6}$$

$$\overline{X^g} = (1-\theta)\overline{G} \tag{E.7}$$

$$\overline{C} = \overline{Y} - \overline{I} - \overline{G} \tag{E.8}$$

$$\overline{S^c} = \overline{C} \tag{E.9}$$

$$\overline{X^C} = (1-\theta)\overline{C} \tag{E.10}$$

$$\overline{X} = \left[\nu_x^{\frac{1}{\sigma_x}} \left(\overline{X^c}\right)^{\frac{\sigma_x - 1}{\sigma_x}} + (1-\nu_x)^{\frac{1}{\sigma_x}} \left(\overline{X^g}\right)^{\frac{\sigma_x - 1}{\sigma_x}} \right]^{\frac{\sigma_x}{\sigma_x - 1}} \tag{E.11}$$

$$\overline{U_{X^c}} = \omega \left(1-\overline{H}\right)^{1-\omega} \nu_x^{\frac{1}{\sigma_x}} \left[\overline{X}^{\omega} \left(1-\overline{H}\right)^{1-\omega}\right]^{-\sigma} \overline{X}^{\omega-1} \left(\frac{\overline{X}}{\overline{X^c}}\right)^{\frac{1}{\sigma_x}} \tag{E.12}$$

$$\overline{U_H} = -\left(1-\omega\right)\left(1-\overline{H}\right)^{-\omega} \overline{X}^{\omega} \left[\overline{X}^{\omega} \left(1-\overline{H}\right)^{1-\omega}\right]^{-\sigma} \tag{E.13}$$

$$\overline{W} = -\frac{\overline{U_H}}{\overline{U_{X^c}}} \tag{E.14}$$

$$\overline{L} = \overline{I} + \overline{WH} \tag{E.15}$$

$$\overline{S^L} = \overline{L} \tag{E.16}$$

$$\overline{X^L} = (1-\theta^L)\overline{L} \tag{E.17}$$

$$\overline{D} = \overline{L} \tag{E.18}$$

$$\overline{F_K} = (1-\alpha)\frac{\overline{Y}}{\overline{K}} \tag{E.19}$$

$$\overline{R^L} = \frac{\beta\left(\overline{MCF_K}\right)}{\beta - \beta^2(1-\delta)} - 1 \tag{E.20}$$

$$\overline{\nu} = \frac{\beta\overline{L}}{\eta^L\overline{X^L}} \tag{E.21}$$

$$\overline{\text{spread}} = \overline{R^L} - \overline{R^D} \tag{E.22}$$

$$\overline{F_H} = \beta \overline{w} \frac{\left(1 + \overline{R^L}\right)}{\overline{MC}} \tag{E.23}$$

$$\overline{\lambda^c} = \frac{\beta \theta \left(1 - \overline{MC}\right)}{1 - \beta \theta (1 - \rho) - \beta \rho} \tag{E.24}$$

$$\overline{\nu^c} = 1 - \overline{MC} + (1 - \rho) \overline{\lambda^c} \tag{E.25}$$

$$\overline{\lambda^g} = \overline{\lambda^c} \tag{E.26}$$

$$\overline{\nu^g} = \overline{\nu^c} \tag{E.27}$$

$$\overline{\Pi} = 1 \tag{E.28}$$