Anexa

Anexă. Ecuațiile modelului Gerali et al. (2010)

Gospodării răbdătoare

$$U_P\left(c_t^P, h_t^P\right) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_P^t \left[\left(1-a^P\right)\epsilon_t^z log\left(c_t^P - a^P c_{t-1}^P\right) + \epsilon_t^h log\left(h_t^P\right) - \frac{\left(l_t^P\right)^{1+\phi}}{1+\phi}\right]$$

Constrângere

$$c_t^P + q_t^h\left(h_t^P - (1-\delta^h)h_{t-1}^P\right) + d_t = w_t^P l_t^P + \frac{1+r_{t-1}^d}{\pi_t} d_{t-1} + Tr_t^P$$

Gospodării nerăbdătoare

$$U_I\left(c_t^I, h_t^I\right) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_I^t \left[\left(1-a^I\right)\epsilon_t^z log\left(c_t^I - a^I c_{t-1}^I\right) + \epsilon_t^h log\left(h_t^I\right) - \frac{\left(l_t^I\right)^{1+\phi}}{1+\phi}\right]$$

Constrângeri

$$c_t^I + q_t^h h_t^I + \frac{1+r_{t-1}^{bI}}{\pi_t} b_{t-1}^I = w_t^I l_t^I + b_t^I + q_t^h(1-\delta^h)h_{t-1}^I$$

$$\left(1+r_t^{bI}\right) b_t^I \leq m^I E_t\left[\pi_{t+1} q_{t+1}^h (1-\delta^h) h_t^I\right]$$

Antreprenorii

$$U_E\left(c_t^E\right) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_E^t log\left(c_t^E - a^E c_{t-1}^E\right)$$

Constrângeri

$$c_t^E + w_t^P l_t^{E,P} + w_t^I l_t^{E,I} + \frac{1+r_{t-1}^{bE}}{\pi_t} b_{t-1}^E + q_t^k k_t^E = \frac{y_t}{x_t} + b_t^E + q_t^k k_{t-1}^E\left(1-\delta^k\right) + J_t^k$$

$$\left(1+r_t^{bE}\right) b_t^E \leq m^E E_t\left[\pi_{t+1} q_{t+1}^k \left(1-\delta\right) k_t^E\right]$$

Formarea de produse

$$y_t = a_t^E \left(k_{t-1}^E\right)^{\alpha} \left(l_t^E\right)^{1-\alpha}$$

$$l_t^E = \left(l_t^{E,P}\right)^{\mu} \left(l_t^{E,I}\right)^{1-\mu}$$

Cererea de credite

$$b_t^I(j) = \left(\frac{r_t^{bI}(j)}{r_t^{bI}}\right)^{-\epsilon_t^{bI}} b_t^I, \qquad b_t^E(j) = \left(\frac{r_t^{bE}(j)}{r_t^{bE}}\right)^{-\epsilon_t^{bE}} b_t^E, \qquad d_t(j) = \left(\frac{r_t^d(j)}{r_t^d}\right)^{-\epsilon_t^d} D_t$$

Sucursala centrală

$$\max_{\{B_t,\, D_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[\left(1+R_t^b\right) B_t - B_{t+1} + D_{t+1} - \left(1+R_t^d\right) D_t + \Delta k_{t+1}^b - \frac{\kappa_{kb}}{2}\left(\frac{k_t^b}{B_t} - \nu_t\right)^2 k_t^b\right]$$

Constrângere

$$B_t = D_t + k_t^b$$

Acumularea de capital bancar

$$k_t^b = \left(1-\delta^b\right)\frac{k_{t-1}^b}{\pi_t} + \left(1-\omega^b\right)\frac{J_{t-1}^b}{\pi_t} + \epsilon_t^k$$

Spreadul ratelor de dobândă

$$S_t^w \equiv R_t^b - r_t = -\kappa_{kb}\left(\frac{k_t^b}{B_t} - \nu_t\right)\left(\frac{k_t^b}{B_t}\right)^2$$

Sucursala pentru creditare

$$\max_{\{r_t^{bI}(j),\, r_t^{bE}(j),\, m_t^E,\, m_t^I\}} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,\,t}^P \Bigg[[1+r_t^{bI}(j)]b_t^I(j) + [1+r_t^{bE}(j)]b_t^E(j) - (1+R_t^b)B_t(j) - \frac{\kappa_{bI}}{2}\left(\frac{r_t^{bI}(j)}{r_{t-1}^{bI}(j)} - 1\right)^2 r_t^{bI} b_t^I - \frac{\kappa_{bE}}{2}\left(\frac{r_t^{bE}(j)}{r_{t-1}^{bE}(j)} - 1\right)^2 r_t^{bE} b_t^E\Bigg]$$

Constrângere

$$B_t(j) = b_t^E(j) + b_t^I(j)$$

Ecuația de stabilire a dobânzilor de creditare

$$\epsilon_t^{bs}\frac{1+R_t^b}{r_t^{bs}}-\kappa_{bs}\left(\frac{r_t^{bs}}{r_{t-1}^{bs}}-1\right)\frac{r_t^{bs}}{r_{t-1}^{bs}}+\beta_p E_t\left\{\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_d\left(1-\epsilon_t^{bs}-\frac{\epsilon_t^{bs}}{r_t^{bs}}\right)+\kappa_{bs}\left(\frac{r_{t+1}^{bs}}{r_t^{bs}}-1\right)\left(\frac{r_{t+1}^{bs}}{r_t^{bs}}\right)^2\frac{b_{t+1}^s}{b_t^s}\right\}=0$$

Sucursala pentru depozite

$$\max_{\{r_t^d(j)\}}\mathbb{E}_0\sum_{t=0}^{\infty}\Lambda_{0,t}^P\left[r_tD_t(j)-r_t^d(j)d_t(j)-\frac{\kappa_d}{2}\left(\frac{r_t^d(j)}{r_{t-1}^d(j)}-1\right)^2r_t^dd_t\right]$$

Constrângere

$$; \; D_t(j)=d_t(j)$$

Ecuația de stabilire a dobânzilor de economisire

$$-1+\epsilon_t^d-\epsilon_t^d\frac{r_t}{r_t^d}-\kappa_d\left(\frac{r_t^d}{r_{t-1}^d}-1\right)\frac{r_t^d}{r_{t-1}^d}+\beta_pE_t\left\{\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_d\left(\frac{r_{t+1}^d}{r_t^d}-1\right)\left(\frac{r_{t+1}^d}{r_t^d}\right)^2\frac{d_{t+1}}{d_t}\right\}=0$$

Regula de stabilire a politicii monetare

$$1+r_t=(1+r)^{(1-\phi_r)}\left(1+r_{t-1}\right)^{\phi_r}\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi(1-\phi_r)}\left(\frac{y_t}{y_{t-1}}\right)^{\phi_y(1-\phi_r)}\exp(\epsilon_t^m)$$

Stabilirea salariilor prin sindicatul muncitorilor

$$\max_{\{W_t^s(m)\}}\mathbb{E}_0\sum_{t=0}^{\infty}\beta_s^t\left\{U_{C_t^s(m)}\left[\frac{W_t^s(m)}{P_t}l_t^s(m)-\frac{\kappa_w}{2}\left(\frac{W_t^s(m)}{W_{t-1}^s(m)}-\pi_{t-1}^{\iota_w}\pi^{1-\iota_w}\right)^2\frac{W_t^s}{P_t}\right]-\frac{l_t^s(m)^{1+\phi}}{1-\phi}\right\}$$

Funcția de cerere a muncii

$$l_t^s(m)=\left(\frac{W_t^s(m)}{W_t^s}\right)^{-\epsilon_t^l}l_t^s$$

Curba Phillips:

$$\kappa_w\left(\pi_t^{ws}-\pi_{t-1}^{\iota_w}\pi^{1-\iota_w}\right)\pi_t^{wi}=\beta_s\frac{\lambda_{t+1}^s}{\lambda_t^s}\kappa_w\left(\pi_{t+1}^{ws}-\pi_t^{\iota_w}\pi^{1-\iota_w}\right)\frac{\left(\pi_{t+1}^{ws}\right)^2}{\pi_{t+1}}+\left(1-\epsilon_t^l\right)l_t^s+\epsilon_t^l\frac{(l_t^s)^{(1+\phi)}}{w_t^s\lambda_t^s}$$

Retaileri de bunuri finale

$$J_t^R = \frac{1}{P_t}\left[P_t y_t - P_t^W y_t - P_t y_t \frac{\kappa_p}{2}\left(\frac{P_t}{P_{t-1}} - \pi_{t-1}^{\iota_p}\pi^{(1-\iota_p)}\right)^2\right]$$

Producătorii de capital

$$\max_{\{q_t^k, I_t^k\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^E P_t \left[q_t^k k_t - q_t^k \left(1-\delta^k\right) k_{t-1} - I_t^k\right]$$

Constrângere

$$k_t^E = \left(1-\delta^k\right) k_{t-1}^E + \left(1 - \frac{\kappa_{ik}}{2}\left(\frac{\epsilon_t^{ik} I_t^k}{I_{t-1}^k} - 1\right)^2\right) I_t^k$$

Producătorii de bunuri imobiliare

$$\max_{\{q_t^h, I_t^h\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P P_t \left[q_t^h h_t - q_t^h \left(1-\delta^h\right) h_{t-1} - I_t^h\right]$$

Constrângere

$$h_t = \left(1-\delta^h\right) h_{t-1} + \left(1 - \frac{\kappa_{ih}}{2}\left(\frac{\epsilon_t^{ih} I_t^h}{I_{t-1}^h} - 1\right)^2\right) I_t^h$$

Condiția de echilibru al piețelor

$$y_t - \delta^b \frac{k_{t-1}^b}{\pi_t} - Adj_t^R - Adj_t^b = c_t + I_t^h + I_t^k$$

Unde

$$Adj_t^R = \frac{\kappa_p}{2} y_t \left(\pi_t - \pi_{t-1}^{\iota_p}\pi^{(1-\iota_p)}\right)^2$$

$$\begin{aligned} Adj_t^b = {} & \frac{\kappa_{kb}}{2}\left(\frac{k_{t-1}^b}{B_{t-1}} - \nu_{t-1}\right)^2 k_{t-1}^b \\ & + \frac{\kappa_{bI}}{2}\left(\frac{r_t^{bI}}{r_{t-1}^{bI}} - 1\right)^2 r_t^{bI} b_t^I - \frac{\kappa_{bE}}{2}\left(\frac{r_t^{bE}}{r_{t-1}^{bE}} - 1\right)^2 r_t^{bE} b_t^E - \frac{\kappa_d}{2}\left(\frac{r_t^d}{r_{t-1}^d} - 1\right)^2 r_t^d d_t + \epsilon_t^{kb} \end{aligned}$$

Calibrarea parametrilor

Calibrated parameters

Parameter	Description	Initial calibration Value	Romanian calibration
β_P	Patient households' discount factor	0.9943	→ 0.9963 (Copaciu et al. 2015)
β_I	Impatient households' discount factor	0.975	
β_E	Entrepreneurs' discount factor	0.975	
ϕ	Inverse of the Frisch elasticity	1.0	→ 7.822 (Copaciu et al. 2015)
μ	Share of unconstrained households	0.8	→ 0.9 (NBR data on no. of debitors)
ε^h	Weight of housing in households' utility function	0.2	
α	Capital share in the production function	0.25	→ 0.55 (Copaciu et al. 2015)
δ	Depreciation rate of physical capital	0.025	→ 0.049 (Copaciu et al. 2015)
ε^y	$\frac{\varepsilon^y}{\varepsilon^y-1}$ is the markup in the goods market	6	
ε^l	$\frac{\varepsilon^l}{\varepsilon^l-1}$ is the markup in the labor market	5	
m^I	Households' LTV ratio	0.7	→ 0.71 (NBR FSR 2022)
m^E	Entrepreneurs' LTV ratio	0.35	
ν^b	Target capital-to-loans ratio	0.09	→ ν^{ss} = 0.16
ε^d	$\frac{\varepsilon^d}{\varepsilon^d-1}$ is the markdown on deposit rate	−1.46	→ -0,5767(NBR data on interest rates)
ε^{bH}	$\frac{\varepsilon^{bH}}{\varepsilon^{bH}-1}$ is the markup on rate on loans to households	2.79	→ 1,1728 (NBR data on interest rates)
ε^{bE}	$\frac{\varepsilon^{bE}}{\varepsilon^{bE}-1}$ is the markup on rate on loans to firms	3.12	→ 2,53004 (NBR data on interest rates
δ^b	Cost for managing the bank's capital position	0.1049	→ 0.1213 (recalculation)
ξ_1	Parameter of adjustment cost for capacity utilization	0.0478	→ 0.0755 (recalculation)
ξ_2	Parameter of adjustment cost for capacity utilization	0.00478	→ 0.00751 (recalculation)

Pentru noii parametrii:

$$\varphi_\nu - CCyB\ multiplicator - 0{,}25$$

$$\delta^h - depreciation\ rate\ of\ housing - 0{,}01$$

Distribuțiile parametrilor structurali estimați

	Parameter	Prior distribution Distrib.	Mean	Std.dev.	Posterior distribution Mean	2.5%	Median	97.5%
κ_p	p stickiness	Gamma	50.0	20.0	30.57	10.68	28.65	49.89
κ_w	w stickiness	Gamma	50.0	20.0	102.35	70.29	99.90	133.81
κ_i	Invest. adj. cost	Gamma	2.5	1.0	10.26	7.57	10.18	12.81
κ_d	Dep. rate adj. cost	Gamma	10.0	2.5	3.63	2.28	3.50	4.96
κ_{bE}	Firms rate adj. cost	Gamma	3.0	2.5	9.51	6.60	9.36	12.31
κ_{bH}	HHs rate adj. cost	Gamma	6.0	2.5	10.22	7.47	10.09	12.88
κ_{Kb}	Leverage dev. cost	Gamma	10.0	5.0	11.49	4.03	11.07	18.27
ϕ_π	T.R. coeff. on π	Gamma	2.0	0.5	2.01	1.72	1.98	2.30
ϕ_R	T.R. coeff. on R	Beta	0.75	0.10	0.77	0.72	0.77	0.81
ϕ_y	T.R. coeff. on y	Normal	0.10	0.15	0.35	0.15	0.35	0.55
ι_p	p indexation	Beta	0.50	0.15	0.17	0.06	0.16	0.28
ι_w	w indexation	Beta	0.50	0.15	0.28	0.16	0.28	0.39
a^h	Habit coefficient	Beta	0.50	0.10	0.85	0.81	0.86	0.90

Pentru noii parametrii:

$$\boldsymbol{\kappa_{ih} - housing\ investment\ adj.cost - Gamma\ -10-1{,}0}$$

Distribuțiile parametrilor estimați din procesele exogene

	Parameter	Prior distribution			Posterior distribution			
		Distribution	Mean	Std.dev.	Mean	2.5%	Median	97.5%
AR coefficients								
ρ_z	Consumpt. prefer.	Beta	0.8	0.10	0.396	0.260	0.394	0.531
ρ_h	Housing prefer.	Beta	0.8	0.10	0.917	0.858	0.921	0.975
ρ_{mE}	Firms' LTV	Beta	0.8	0.10	0.892	0.839	0.894	0.945
ρ_{mI}	HHs' LTV	Beta	0.8	0.10	0.925	0.875	0.929	0.979
ρ_d	Dep. markdown	Beta	0.8	0.10	0.830	0.739	0.838	0.917
ρ_{bH}	HHs loans markup	Beta	0.8	0.10	0.808	0.675	0.820	0.949
ρ_{bE}	Firms loans markup	Beta	0.8	0.10	0.820	0.688	0.834	0.956
ρ_a	Technology	Beta	0.8	0.10	0.936	0.899	0.939	0.975
ρ_{qk}	Invest. efficiency	Beta	0.8	0.10	0.543	0.396	0.548	0.694
ρ_y	p mark-up	Beta	0.8	0.10	0.306	0.205	0.305	0.411
ρ_l	w mark-up	Beta	0.8	0.10	0.636	0.511	0.640	0.769
ρ_{Kb}	Balance sheet	Beta	0.8	0.10	0.810	0.717	0.813	0.906
Standard deviations								
σ_z	Consumpt. prefer.	Inv. Gamma	0.01	0.05	0.027	0.019	0.027	0.035
σ_h	Housing prefer.	Inv. Gamma	0.01	0.05	0.076	0.022	0.071	0.129
σ_{mE}	Firms' LTV	Inv. Gamma	0.01	0.05	0.007	0.005	0.007	0.009
σ_{mI}	HHs' LTV	Inv. Gamma	0.01	0.05	0.003	0.003	0.003	0.004
σ_d	Dep. markdown	Inv. Gamma	0.01	0.05	0.033	0.024	0.032	0.043
σ_{bH}	HHs loans markup	Inv. Gamma	0.01	0.05	0.067	0.035	0.066	0.115
σ_{bE}	Firms loans markup	Inv. Gamma	0.01	0.05	0.063	0.034	0.063	0.096
σ_a	Technology	Inv. Gamma	0.01	0.05	0.006	0.004	0.006	0.007
σ_{qk}	Invest. efficiency	Inv. Gamma	0.01	0.05	0.019	0.013	0.019	0.025
σ_R	Monetary policy	Inv. Gamma	0.01	0.05	0.002	0.001	0.002	0.002
σ_y	p mark-up	Inv. Gamma	0.01	0.05	0.634	0.274	0.598	0.985
σ_l	w mark-up	Inv. Gamma	0.01	0.05	0.577	0.378	0.561	0.761
σ_{Kb}	Balance-sheet	Inv. Gamma	0.01	0.05	0.031	0.026	0.031	0.037

Pentru noii parametrii:

$$\rho_\nu \ - \text{target capital to loans ratio} \ - \text{Beta} \ - 0.1 \ - 0.05$$

σ_ν $-$target capital to loans ratio $-$ Inv. Gamma $-$ 0.01 $-$ 0.05