

I. Quantitative analysis for China and the US

I. Benchmark

Parameters:

$$\{\rho, g_L, s, z, \psi_n, \gamma, \omega, \delta, \pi n, \pi s, \phi, \xi n, \xi f\} = \{0.05, 0.0144, 0.832840, 1.2, 0.06, 1, 5.492537, 0.2, 0.02265611, 0.02935293, 0.03, 0.5, 0.5\}$$

Calibration:

[illegible]

$$\begin{aligned}
& \left((\lambda \psi n) / \left(\lambda \psi n + \left(\left(\gamma (\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \right. \\
& \quad \left(\left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta n} \right) \right. \right. \right. \\
& \quad \quad \left. \left. \left. (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \right. \right. \right. \right. \\
& \quad \quad \quad \left. \left. \left. \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) + \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \right. \right. \right. \\
& \quad \quad \quad \left. \left. \left. \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \lambda \psi n - \gamma \psi n \right) \right) \left. \right) + \psi n \left. \right) \left. \right) \\
& \left((\lambda \psi n) / \left(\lambda \psi n + \left(\left(\gamma (\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \right. \\
& \quad \left(\left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \right. \right. \\
& \quad \quad \left(\left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \right. \\
& \quad \quad \quad \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) + \\
& \quad \quad \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n - \gamma \psi n \right) \left. \right) \left. \right) \left. \right), \\
0.013 = & \left(\left(\left(\gamma (\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \\
& \left(\left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \omega + \right. \right. \right. \\
& \quad \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) + \\
& \quad \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n - \gamma \psi n \right) \left. \right) \left. \right) \\
& \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1 - \beta f}{1 - \beta n} \right) \frac{(1 + \xi n \text{ in})}{(1 + \xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \\
& \left(\frac{1 - s}{s} \right) \\
& \left(1 / \right. \\
& \quad \left(\gamma \left((\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \right. \right. \\
& \quad \left((\lambda \psi n) / \left(\lambda \psi n + \left(\left(\gamma (\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \right. \\
& \quad \quad \left(\left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta n} \right) \right. \right. \right. \\
& \quad \quad \quad \left. \left. \left. (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \left(\left(\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \right. \right. \right. \right.
\end{aligned}$$

$$\begin{aligned}
& \delta \omega \left(\left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \right. \right. \\
& \left. \left. \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n \right) - \gamma \psi n \left. \right) \left. \right) + \psi n \left. \right) \left. \right) \\
& \left((\lambda \psi n) / \left(\lambda \psi n + \left(\left(\gamma (\sigma-1) \left(\frac{1}{1-\beta n} \right) (\rho+\psi n) (1+\xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \right. \\
& \left. \left(\left(\frac{1-s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma-1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma-1) (\rho+\psi n + \phi) \right. \right. \right. \\
& \left. \left(\left(\frac{1}{1-\beta n} \right) (1+\xi n \text{ in}) \gamma \omega + \left(\frac{1}{1-\beta f} \right) (1+\xi f \text{ is}) \right. \right. \\
& \left. \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) \right) + \\
& \left. \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n \right) - \gamma \psi n \right) \left. \right) \left. \right) / \\
& \left(1 + (\rho+\psi n + \phi) \left(\left(\frac{1}{1-\beta f} \right) (1+\xi f \text{ is}) \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) + \right. \right. \\
& \left. \left. \omega \left(\frac{1}{1-\beta n} \right) (1+\xi n \text{ in}) \gamma \right) \left(\frac{1-s}{s} \right) \right. \\
& \left. \left(1 / \left(\gamma \left((\sigma-1) \left(\frac{1}{1-\beta n} \right) (\rho+\psi n) (1+\xi n \text{ in}) \left((\lambda \psi n) / \right. \right. \right. \right. \right. \\
& \left. \left. \left. \left. \lambda \psi n + \left(\left(\gamma (\sigma-1) \left(\frac{1}{1-\beta n} \right) (\rho+\psi n) (1+\xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) \right) / \right. \right. \right. \right. \\
& \left. \left(\left(\frac{1-s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma-1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma-1) (\rho+\psi n + \phi) \left(\left(\frac{1}{1-\beta n} \right) \right. \right. \right. \right. \\
& \left. \left. \left. \left. (1+\xi n \text{ in}) \gamma \omega + \left(\frac{1}{1-\beta f} \right) (1+\xi f \text{ is}) \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \right. \right. \right. \right. \right. \\
& \left. \left. \left. \left. \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) \right) + \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \right. \right. \\
& \left. \left. \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n \right) - \gamma \psi n \left. \right) \left. \right) \left. \right) + \psi n \left. \right) \left. \right) \\
& \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\left(\left(\gamma (\sigma-1) \left(\frac{1}{1-\beta n} \right) (\rho+\psi n) (1+\xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right. \\
& \left. \left(\left(\frac{1-s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma-1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma-1) (\rho+\psi n + \phi) \right. \right. \right. \\
& \left. \left(\left(\frac{1}{1-\beta n} \right) (1+\xi n \text{ in}) \gamma \omega + \left(\frac{1}{1-\beta f} \right) (1+\xi f \text{ is}) \right. \right. \\
& \left. \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \right) \right) \right) + \\
& \left. \left(\left(\frac{\rho+\psi n}{\rho+\psi n+\phi} (\delta \omega)^\sigma - \delta \omega \right) \left(\frac{1-\beta f}{1-\beta n} \right) \frac{(1+\xi n \text{ in})}{(1+\xi f \text{ is})} \left(\frac{\gamma}{\delta} \right) \lambda \psi n \right) - \gamma \psi n \right) \left. \right) / \\
& \left(\lambda \psi n + \left(\left(\gamma (\sigma-1) \left(\frac{1}{1-\beta n} \right) (\rho+\psi n) (1+\xi n \text{ in}) \lambda \psi n + \lambda \gamma (\psi n)^2 \right) \right) / \right.
\end{aligned}$$

Simulation:

$$\begin{aligned}
& \text{FindRoot} \left[\left\{ \frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega = \left(\frac{1 - \beta n}{1 - \beta f} \right) \frac{(1 + \xi f \text{ is})}{(1 + \xi n \text{ in})} \left(\frac{\alpha}{\gamma} \right) \delta, \right. \right. \\
& 1 = \gamma \text{xn} \left((\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) + \psi n \right), \\
& 1 = \text{xn} \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \right. \\
& \quad \left. \left(\left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha \right) + \alpha \lambda \psi n \right), \text{r} == \rho + \frac{gL}{(1 - \xi) (\sigma - 1)}, \\
& \text{gc} == \frac{gL}{(1 - \xi) (\sigma - 1)}, \text{RSN} == \frac{\psi n \gamma \text{xn}}{1 + (1 + \xi n \text{ in}) (\rho + \psi n) \left(\frac{1}{1 - \beta n} \right) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right)}, \text{RSF} == \\
& \quad \frac{\psi f \alpha \left(\frac{1 - s}{s} \right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right)}{1 + (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha + \omega \left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \right) \left(\frac{1 - s}{s} \right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right)}, \\
& \omega n0 == \left(\left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma - 1} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi} \right) \right. \right. \\
& \quad \left. \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) (\delta \omega)^{\sigma - 1} \right) (\text{xn})^{\frac{1}{1 - \xi}}, \text{cn0} == \omega n0 \text{In0}, \text{In0} == \text{ain0} + \text{iin0} + 1 + \text{RDn0}, \\
& \text{ain0} == (\rho - gL) \left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \right), \\
& \text{iin0} == \xi n \text{ in} \psi n \gamma \text{xn}, \text{RDn0} == \left(\frac{\beta n}{1 - \beta n} \right) (1 + \xi n \text{ in}) \psi n \gamma \text{xn}, \\
& \omega s0 == \frac{\omega n0}{\omega}, \text{cs0} == \omega s0 \text{Is0}, \text{Is0} == \text{ais0} + \text{iis0} + 1 + \text{RDs0}, \\
& \text{ais0} == (\rho - gL) \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{iis0} == \xi f \text{ is} \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{RDs0} == \left(\frac{\beta f}{1 - \beta f} \right) (1 + \xi f \text{ is}) \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{Un} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cn0}] + \frac{\text{gc}}{\rho - gL} \right), \text{Us} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cs0}] + \frac{\text{gc}}{\rho - gL} \right) \}, \\
& \{\omega, 5\}, \{\text{xn}, 1\}, \{\psi f, 0.1\}, \{\text{r}, 0.1\}, \{\text{gc}, 0.1\}, \{\text{RSN}, 0.1\}, \\
& \{\text{RSF}, 0.1\}, \{\omega n0, 0.1\}, \{\omega s0, 0.1\}, \{\text{In0}, 0.1\}, \\
& \{\text{ain0}, 0.1\}, \{\text{iin0}, 0.1\}, \{\text{RDn0}, 0.1\}, \\
& \{\text{Is0}, 0.1\}, \{\text{ais0}, 0.1\}, \{\text{iis0}, 0.1\}, \{\text{RDs0}, 0.1\}, \\
& \{\text{cn0}, 0.1\}, \{\text{cs0}, 0.1\}, \{\text{Un}, 0.1\}, \{\text{Us}, 0.1\} \}
\end{aligned}$$

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{ $\omega \rightarrow 5.49254$ ,  $x_n \rightarrow 0.51417$ ,  $\psi_f \rightarrow 0.0663045$ ,  $r \rightarrow 0.06823$ ,
gc  $\rightarrow 0.01823$ , RSN  $\rightarrow 0.026$ , RSF  $\rightarrow 0.013$ ,  $\omega_n0 \rightarrow 0.380391$ ,  $\omega_s0 \rightarrow 0.0692559$ ,
In0  $\rightarrow 1.19656$ , ain0  $\rightarrow 0.0820453$ , iin0  $\rightarrow 0.00140193$ , RDn0  $\rightarrow 0.113109$ ,
Is0  $\rightarrow 1.02685$ , ais0  $\rightarrow 0.00669209$ , iis0  $\rightarrow 0.000710577$ , RDs0  $\rightarrow 0.0194475$ ,
cn0  $\rightarrow 0.455159$ , cs0  $\rightarrow 0.0711155$ , Un  $\rightarrow -7.72556$ , Us  $\rightarrow -59.87$ }

{ $\omega_n01$ ,  $\omega_s01$ , In01, ain01, iin01, RDn01, Is01, ais01, iis01, RDs01,
cn01, cs01, Un1, Us1} = {0.38039073231190385`, 0.06925592532410867`,
1.1965564622939329`, 0.08204527715901806`, 0.0014019277568265173`,
0.11310925737808823`, 1.0268501483034087`, 0.006692094370081574`,
0.0007105766425608322`, 0.019447477290766225`, 0.45515898894453005`,
0.07111545718995078`, -7.725557391270061`, -59.8699975677841`}

{0.380391, 0.0692559, 1.19656, 0.0820453, 0.00140193, 0.113109, 1.02685,
0.00669209, 0.000710577, 0.0194475, 0.455159, 0.0711155, -7.72556, -59.87}
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The effects of monetary policy:

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Clear[in]
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{in} = {0}
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{0}
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$$\begin{aligned}
& \text{FindRoot}\left[\left\{\frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega = \left(\frac{1 - \beta n}{1 - \beta f}\right) \frac{(1 + \xi f \text{ is})}{(1 + \xi n \text{ in})} \left(\frac{\alpha}{\gamma}\right) \delta,\right.\right. \\
& 1 = \gamma \text{xn} \left(\left(\sigma - 1\right) \left(\frac{1}{1 - \beta n}\right) (\rho + \psi n) (1 + \xi n \text{ in}) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) + \psi n\right), \\
& 1 = \text{xn} \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{1 - s}{s}\right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi}\right) (\sigma - 1) (\rho + \psi n + \phi)\right. \\
& \quad \left.\left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f \text{ is}) \alpha\right) + \alpha \lambda \psi n\right), r = \rho + \frac{gL}{(1 - \xi) (\sigma - 1)}, \\
& gc = \frac{gL}{(1 - \xi) (\sigma - 1)}, RSN = \frac{\psi n \gamma \text{xn}}{1 + (1 + \xi n \text{ in}) (\rho + \psi n) \left(\frac{1}{1 - \beta n}\right) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right)}, RSF = \\
& \quad \frac{\psi f \alpha \left(\frac{1 - s}{s}\right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right)}{1 + (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta f}\right) (1 + \xi f \text{ is}) \alpha + \omega \left(\frac{1}{1 - \beta n}\right) (1 + \xi n \text{ in}) \gamma\right) \left(\frac{1 - s}{s}\right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right)}, \\
& \omega n0 = \left(\left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi}\right)\right.\right.\right. \\
& \quad \left.\left.\left(\frac{\psi f}{\lambda \psi n + \psi f}\right) (\delta \omega)^{\sigma - 1}\right) (\text{xn})^{\frac{1}{1 - \xi}}\right)^{\frac{1}{\sigma - 1}}, cn0 = \omega n0 \text{In}0, \text{In}0 = \text{ain}0 + \text{iin}0 + 1 + \text{RDn}0, \\
& \text{ain}0 = (\rho - gL) \left(\frac{1}{1 - \beta n}\right) (1 + \xi n \text{ in}) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right)\right), \\
& \text{iin}0 = \xi n \text{ in} \psi n \gamma \text{xn}, \text{RDn}0 = \left(\frac{\beta n}{1 - \beta n}\right) (1 + \xi n \text{ in}) \psi n \gamma \text{xn}, \\
& \omega s0 = \frac{\omega n0}{\omega}, cs0 = \omega s0 \text{Is}0, \text{Is}0 = \text{ais}0 + \text{iis}0 + 1 + \text{RDs}0, \\
& \text{ais}0 = (\rho - gL) \left(\frac{1}{1 - \beta f}\right) (1 + \xi f \text{ is}) \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{1 - s}{s}\right), \\
& \text{iis}0 = \xi f \text{ is} \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{1 - s}{s}\right), \\
& \text{RDs}0 = \left(\frac{\beta f}{1 - \beta f}\right) (1 + \xi f \text{ is}) \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{1 - s}{s}\right), \\
& \text{Un} = \frac{1}{\rho - gL} \left(\text{Log}[cn0] + \frac{gc}{\rho - gL}\right), \text{Us} = \frac{1}{\rho - gL} \left(\text{Log}[cs0] + \frac{gc}{\rho - gL}\right)\}, \\
& \{\omega, 5\}, \{\text{xn}, 1\}, \{\psi f, 0.1\}, \{r, 0.1\}, \{gc, 0.1\}, \{RSN, 0.1\}, \\
& \{RSF, 0.1\}, \{\omega n0, 0.1\}, \{\omega s0, 0.1\}, \{\text{In}0, 0.1\}, \\
& \{\text{ain}0, 0.1\}, \{\text{iin}0, 0.1\}, \{\text{RDn}0, 0.1\}, \\
& \{\text{Is}0, 0.1\}, \{\text{ais}0, 0.1\}, \{\text{iis}0, 0.1\}, \{\text{RDs}0, 0.1\}, \\
& \{cn0, 0.1\}, \{cs0, 0.1\}, \{\text{Un}, 0.1\}, \{\text{Us}, 0.1\}
\end{aligned}$$

$\{\omega \rightarrow 5.50257, \text{xn} \rightarrow 0.535156, \psi f \rightarrow 0.0656122, r \rightarrow 0.06823, gc \rightarrow 0.01823, RSN \rightarrow 0.0270667,$
 $RSF \rightarrow 0.0134321, \omega n0 \rightarrow 0.400356, \omega s0 \rightarrow 0.0727581, \text{In}0 \rightarrow 1.19432, \text{ain}0 \rightarrow 0.0817127,$
 $\text{iin}0 \rightarrow 0., \text{RDn}0 \rightarrow 0.112608, \text{Is}0 \rightarrow 1.02774, \text{ais}0 \rightarrow 0.00691416, \text{iis}0 \rightarrow 0.000734155,$
 $\text{RDs}0 \rightarrow 0.0200928, cn0 \rightarrow 0.478154, cs0 \rightarrow 0.0747765, \text{Un} \rightarrow -6.34111, \text{Us} \rightarrow -58.4599\}$


```
Clear[iS]
```

$$\begin{aligned}
& \text{FindRoot} \left[\left\{ \frac{\rho + \psi n}{\rho + \psi n + \phi} (\delta \omega)^\sigma - \delta \omega = \left(\frac{1 - \beta n}{1 - \beta f} \right) \frac{(1 + \xi f \text{ is})}{(1 + \xi n \text{ in})} \left(\frac{\alpha}{\gamma} \right) \delta, \right. \right. \\
& 1 = \gamma \text{xn} \left((\sigma - 1) \left(\frac{1}{1 - \beta n} \right) (\rho + \psi n) (1 + \xi n \text{ in}) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) + \psi n \right), \\
& 1 = \text{xn} \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right) \left(\left(\frac{\phi}{\lambda \psi n + \phi} \left(\frac{\sigma}{\sigma - 1} \right)^\sigma + \frac{\lambda \psi n}{\lambda \psi n + \phi} \right) (\sigma - 1) (\rho + \psi n + \phi) \right. \\
& \quad \left. \left(\left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \omega + \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha \right) + \alpha \lambda \psi n \right), \text{r} == \rho + \frac{gL}{(1 - \xi) (\sigma - 1)}, \\
& \text{gc} == \frac{gL}{(1 - \xi) (\sigma - 1)}, \text{RSN} == \frac{\psi n \gamma \text{xn}}{1 + (1 + \xi n \text{ in}) (\rho + \psi n) \left(\frac{1}{1 - \beta n} \right) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right)}, \text{RSF} == \\
& \quad \frac{\psi f \alpha \left(\frac{1 - s}{s} \right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right)}{1 + (\rho + \psi n + \phi) \left(\left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha + \omega \left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \right) \left(\frac{1 - s}{s} \right) \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right)}, \\
& \omega n0 == \left(\left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma - 1} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi} \right) \right. \right. \\
& \quad \left. \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) (\delta \omega)^{\sigma - 1} \right) (\text{xn})^{\frac{1}{1 - \xi}}, \text{cn0} == \omega n0 \text{In0}, \text{In0} == \text{ain0} + \text{iin0} + 1 + \text{RDn0}, \\
& \text{ain0} == (\rho - gL) \left(\frac{1}{1 - \beta n} \right) (1 + \xi n \text{ in}) \gamma \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} + \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \right), \\
& \text{iin0} == \xi n \text{ in} \psi n \gamma \text{xn}, \text{RDn0} == \left(\frac{\beta n}{1 - \beta n} \right) (1 + \xi n \text{ in}) \psi n \gamma \text{xn}, \\
& \omega s0 == \frac{\omega n0}{\omega}, \text{cs0} == \omega s0 \text{Is0}, \text{Is0} == \text{ais0} + \text{iis0} + 1 + \text{RDs0}, \\
& \text{ais0} == (\rho - gL) \left(\frac{1}{1 - \beta f} \right) (1 + \xi f \text{ is}) \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \phi} \right) \left(\frac{\psi f}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{iis0} == \xi f \text{ is} \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{RDs0} == \left(\frac{\beta f}{1 - \beta f} \right) (1 + \xi f \text{ is}) \psi f \alpha \text{xn} \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f} \right) \left(\frac{1 - s}{s} \right), \\
& \text{Un} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cn0}] + \frac{\text{gc}}{\rho - gL} \right), \text{Us} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cs0}] + \frac{\text{gc}}{\rho - gL} \right), \\
& \{\omega, 5\}, \{\text{xn}, 1\}, \{\psi f, 0.1\}, \{\text{r}, 0.1\}, \{\text{gc}, 0.1\}, \{\text{RSN}, 0.1\}, \\
& \{\text{RSF}, 0.1\}, \{\omega n0, 0.1\}, \{\omega s0, 0.1\}, \{\text{In0}, 0.1\}, \\
& \{\text{ain0}, 0.1\}, \{\text{iin0}, 0.1\}, \{\text{RDn0}, 0.1\}, \\
& \{\text{Is0}, 0.1\}, \{\text{ais0}, 0.1\}, \{\text{iis0}, 0.1\}, \{\text{RDs0}, 0.1\}, \\
& \{\text{cn0}, 0.1\}, \{\text{cs0}, 0.1\}, \{\text{Un}, 0.1\}, \{\text{Us}, 0.1\} \Big] \\
& \{\omega \rightarrow 5.48215, \text{xn} \rightarrow 0.515924, \psi f \rightarrow 0.0670823, \text{r} \rightarrow 0.06823, \text{gc} \rightarrow 0.01823, \text{RSN} \rightarrow 0.0260891, \\
& \text{RSF} \rightarrow 0.0131513, \omega n0 \rightarrow 0.381838, \omega s0 \rightarrow 0.0696511, \text{In0} \rightarrow 1.19719, \text{ain0} \rightarrow 0.0822906, \\
& \text{iin0} \rightarrow 0.00140671, \text{RDn0} \rightarrow 0.113495, \text{Is0} \rightarrow 1.02521, \text{ais0} \rightarrow 0.00645491, \text{iis0} \rightarrow 0., \\
& \text{RDs0} \rightarrow 0.0187582, \text{cn0} \rightarrow 0.457133, \text{cs0} \rightarrow 0.0714072, \text{Un} \rightarrow -7.60397, \text{Us} \rightarrow -59.755\}
\end{aligned}$$

```
{wn0fs, ws0fs, In0fs, ain0fs, iin0fs, RDn0fs, Is0fs, ais0fs,
  iis0fs, RDS0fs, cn0fs, cs0fs, Unfs, Usfs} = {0.38183794080846756`,
  0.0696511088953325`, 1.1971922443509553`, 0.08229055991962361`,
  0.0014067085282596587`, 0.11349497590307206`, 1.0252131364068673`,
  0.006454914043339856`, 0., 0.01875822236352738`, 0.45713342133483653`,
  0.07140723180480009`, -7.603969904699699`, -59.75498531738061`}

{0.381838, 0.0696511, 1.19719, 0.0822906, 0.00140671, 0.113495, 1.02521,
  0.00645491, 0., 0.0187582, 0.457133, 0.0714072, -7.60397, -59.755}

{Alnwn0fs, Alnwns0fs, AlnIn0fs, AlnIs0fs, Alnain0fs, Alnais0fs,
  Alniin0fs, Alniis0fs, AlnRDn0fs, AlnRDS0fs, Alncn0fs, Alncs0fs} =
  {(Log[wn0fs] - Log[wn01]) 100, (Log[ws0fs] - Log[ws01]) 100,
  (Log[In0fs] - Log[In01]) 100, (Log[Is0fs] - Log[Is01]) 100,
  (Log[ain0fs] - Log[ain01]) 100, (Log[ais0fs] - Log[ais01]) 100,
  (Log[iin0fs] - Log[iin01]) 100, (Log[iis0fs] - Log[iis01]) 100,
  (Log[RDn0fs] - Log[RDn01]) 100, (Log[RDS0fs] - Log[RDS01]) 100,
  (Log[cn0fs] - Log[cn01]) 100, (Log[cs0fs] - Log[cs01]) 100}

{0.379731, 0.568992, 0.0531202, -0.159548, 0.298514, -3.60852,
  0.340434, Indeterminate, 0.340434, -3.60852, 0.432851, 0.409444}

Quit[]
```

2. Robustness check on the innovation-arrival rate

Parameters: ($\psi_n=0.04$)

```
{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf, σ} = {0.05, 0.0144, 0.832840, 1.2, 0.04, 1,
  5.492537, 0.2, 0.02265611, 0.02935293, 0.03, 0.5, 0.5, 6.195218006549213`}

{0.05, 0.0144, 0.83284, 1.2, 0.04, 1, 5.49254,
  0.2, 0.0226561, 0.0293529, 0.03, 0.5, 0.5, 6.19522}

FindRoot[{{ψn ==  $\frac{gL}{(1-\xi)(z^{\sigma-1}-1)}$ , λ =  $z^{\sigma-1}$ , in ==  $\left(\pi n + \rho + \frac{gL}{(1-\xi)(\sigma-1)}\right)$ ,
  is ==  $\left(\pi s + \rho + \frac{gL}{(1-\xi)(\sigma-1)}\right)$ }, {ξ, 0.9}, {λ, 1.2}, {in, 1}, {is, 1}]

{ξ → 0.771933, λ → 2.57848, in → 0.0848094, is → 0.0915063}

{ξ, λ, in, is} =
  {0.7719325504364716`, 2.5784804043232024`, 0.09088610999999999`, 0.09758293`}

{0.771933, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}

{3.04053, 0.778124, 0.560097}

Quit[]
```

Parameters: ($\psi_n=0.08$)

```

{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf, σ} = {0.05, 0.0144, 0.832840, 1.2, 0.08, 1,
  5.492537, 0.2, 0.02265611, 0.02935293, 0.03, 0.5, 0.5, 6.195218006549213`}
{0.05, 0.0144, 0.83284, 1.2, 0.08, 1, 5.49254,
  0.2, 0.0226561, 0.0293529, 0.03, 0.5, 0.5, 6.19522}

FindRoot[{{ψn ==  $\frac{gL}{(1-\xi)(z^{\sigma-1}-1)}$ , λ ==  $z^{\sigma-1}$ , in ==  $\left(\pi n + \rho + \frac{gL}{(1-\xi)(\sigma-1)}\right)$ ,
  is ==  $\left(\pi s + \rho + \frac{gL}{(1-\xi)(\sigma-1)}\right)$ }, {ξ, 0.9}, {λ, 1.2}, {in, 1}, {is, 1}]

{ξ → 0.885966, λ → 2.57848, in → 0.0969628, is → 0.10366}

{ξ, λ, in, is} =
{0.8859662752182361`, 2.5784804043232024`, 0.09088610999999999`, 0.09758293`}
{0.885966, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}
{3.04053, 0.778124, 0.560097}

Quit[]

```

3. Robustness check on the imitation rate**Parameters: ($\phi=0.07$)**

```

{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf} = {0.05, 0.0144, 0.832840,
  1.2, 0.06, 1, 5.492537, 0.2, 0.02265611, 0.02935293, 0.07, 0.5, 0.5}
{0.05, 0.0144, 0.83284, 1.2, 0.06, 1,
  5.49254, 0.2, 0.0226561, 0.0293529, 0.07, 0.5, 0.5}

{ξ, σ, λ, in, is} = {0.8479550336243143`, 6.195218006549213`,
  2.578480404323203`, 0.09088610999999999`, 0.09758293`}
{0.847955, 6.19522, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}
{3.04053, 0.778124, 0.560097}

Quit[]

```

Parameters: ($\phi=0.11$)

```

{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf} = {0.05, 0.0144, 0.832840,
  1.2, 0.06, 1, 5.492537, 0.2, 0.02265611, 0.02935293, 0.11, 0.5, 0.5}
{0.05, 0.0144, 0.83284, 1.2, 0.06, 1,
  5.49254, 0.2, 0.0226561, 0.0293529, 0.11, 0.5, 0.5}

```

```
{ξ, σ, λ, in, is} = {0.8479550336243143`, 6.195218006549213`,
  2.578480404323203`, 0.09088610999999999`, 0.09758293`}
{0.847955, 6.19522, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}
{3.04053, 0.778124, 0.560097}

Quit[]
```

4. Robustness check on the CIA parameters

Parameters: ($\xi n=I$)

```
{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf} = {0.05, 0.0144, 0.832840,
  1.2, 0.06, 1, 5.492537, 0.2, 0.02265611, 0.02935293, 0.03, 1, 0.5}
{0.05, 0.0144, 0.83284, 1.2, 0.06, 1, 5.49254, 0.2, 0.0226561, 0.0293529, 0.03, 1, 0.5}

{ξ, σ, λ, in, is} = {0.8479550336243143`, 6.195218006549213`,
  2.578480404323203`, 0.09088610999999999`, 0.09758293`}
{0.847955, 6.19522, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}
{3.04053, 0.778124, 0.560097}

Quit[]
```

Parameters: ($\xi f=I$)

```
{ρ, gL, s, z, ψn, γ, ω, δ, πn, πs, φ, ξn, ξf} = {0.05, 0.0144, 0.832840,
  1.2, 0.06, 1, 5.492537, 0.2, 0.02265611, 0.02935293, 0.03, 0.5, 1}
{0.05, 0.0144, 0.83284, 1.2, 0.06, 1, 5.49254, 0.2, 0.0226561, 0.0293529, 0.03, 0.5, 1}

{ξ, σ, λ, in, is} = {0.8479550336243143`, 6.195218006549213`,
  2.578480404323203`, 0.09088610999999999`, 0.09758293`}
{0.847955, 6.19522, 2.57848, 0.0908861, 0.0975829}

{α, βn, βf} = {3.0405332148794404`, 0.7781244658361336`, 0.5600974178408754`}
{3.04053, 0.778124, 0.560097}

Quit[]
```

2. Alternative R&D specification

Parameters:

```
{ρ, gL, s, z, ω, δ, πn, πs, ξn, ξf} =
{0.05, 0.0144, 0.832840, 1.2, 5.492537, 0.2, 0.02265611, 0.02935293, 0.5, 0.5}
{0.05, 0.0144, 0.83284, 1.2, 5.49254, 0.2, 0.0226561, 0.0293529, 0.5, 0.5}

{βn, βf} = {0.7781244658361336`, 0.5600974178408754`}
{0.778124, 0.560097}
```

Calibration:

```
FindRoot[{{in == (πn + ρ + 0.01823), is == (πs + ρ + 0.01823), 0.01823 ==  $\left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n$ ,
λ ==  $z^{\sigma-1} \cdot \left(\frac{\rho + \psi n - gL}{\rho + \psi n + \phi - gL}\right) (\delta \omega)^\sigma - \delta \omega == \delta \left(\frac{1 - \beta n}{1 - \beta f}\right) \left(\frac{s}{1 - s}\right) \left(\frac{1 + \xi f is}{1 + \xi n in}\right) \left(\frac{\alpha}{\gamma}\right)$ ,
1 ==  $\gamma \left((\sigma - 1) \left(\frac{1}{1 - \beta n}\right) (\rho + \psi n - gL) (1 + \xi n in) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) + \psi n\right)$ ,
1 ==  $\left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\phi}{\phi + \lambda \psi n} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma + \frac{\lambda \psi n}{\phi + \lambda \psi n}\right) (\sigma - 1)$ 
 $\left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right) (\rho + \psi n + \phi - gL) + \alpha \psi f$ ,
0.026 ==  $\frac{\psi n \gamma}{1 + (\rho + \psi n - gL) \left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \gamma}$ ,
0.013 ==  $\frac{\psi f \alpha}{1 + (\rho + \psi n + \phi - gL) \left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right)}$ },
{in, 0.1}, {is, 0.1}, {ψn, 0.1}, {λ, 2}, {α, 1},
{γ, 1}, {σ, 2}, {ψf, 0.1}, {φ, 0.1}]

{in → 0.0908861, is → 0.0975829, ψn → 0.0579306, λ → 2.73928,
α → 0.292242, γ → 0.559472, σ → 6.52702, ψf → 0.0648067, φ → 0.0332749}

{in, is, λ, α, γ, σ, φ} =
{0.09088610999999999`, 0.09758293`, 2.7392790529444917`, 0.29224151895052963`,
0.5594718736753528`, 6.5270193175977465`, 0.03327487090959861`}
{0.0908861, 0.0975829, 2.73928, 0.292242, 0.559472, 6.52702, 0.0332749}

Clear[ω, gc]
```

Simulation:

```

FindRoot[
{gc ==  $\left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \left(\frac{\rho + \psi n - gL}{\rho + \psi n + \phi - gL}\right) (\delta \omega)^\sigma - \delta \omega = \delta \left(\frac{1 - \beta n}{1 - \beta f}\right) \left(\frac{s}{1 - s}\right) \left(\frac{1 + \xi f is}{1 + \xi n in}\right) \left(\frac{\alpha}{\gamma}\right),$ 
1 ==  $\gamma \left(\sigma - 1\right) \left(\frac{1}{1 - \beta n}\right) (\rho + \psi n - gL) (1 + \xi n in) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) + \psi n,$ 
1 ==  $\left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\phi}{\phi + \lambda \psi n} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma + \frac{\lambda \psi n}{\phi + \lambda \psi n}\right) (\sigma - 1)$ 
 $\left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right) (\rho + \psi n + \phi - gL) + \alpha \psi f,$ 
RSN ==  $\frac{\psi n \gamma}{1 + (\rho + \psi n - gL) \left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \gamma},$ 
RSF ==  $\frac{\psi f \alpha}{1 + (\rho + \psi n + \phi - gL) \left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right)},$ 
r ==  $\rho + \left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \omega n0 == \left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} +$ 
 $\left(\frac{\lambda \psi n}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) (\delta \omega)^{\sigma - 1}\right)^{\frac{1}{\sigma - 1}},$ 
cn0 ==  $\omega n0 \text{ In0}, \text{In0} == \text{ain0} + \text{iin0} + 1 + \text{RDn0}, \text{ain0} == \left(\frac{1}{1 - \beta n}\right) (\rho - gL) (1 + \xi n in) \gamma,$ 
iin0 ==  $\xi n in \psi n \gamma, \text{RDn0} == \left(\frac{\beta n}{1 - \beta n}\right) (1 + \xi n in) \psi n \gamma, \omega s0 == \frac{\omega n0}{\omega}, \text{cs0} == \omega s0 \text{ Is0},$ 
Is0 ==  $\text{ais0} + \text{iis0} + 1 + \text{RDs0}, \text{ais0} == \left(\frac{1}{1 - \beta f}\right) (\rho - gL) (1 + \xi f is) \alpha,$ 
iis0 ==  $\xi f is \psi f \alpha, \text{RDs0} == \left(\frac{\beta f}{1 - \beta f}\right) (1 + \xi f is) \psi f \alpha,$ 
Un ==  $\frac{1}{\rho - gL} \left(\text{Log}[\text{cn0}] + \frac{gc}{\rho - gL}\right), \text{Us} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cs0}] + \frac{gc}{\rho - gL}\right)\},$ 
{ω, 5}, {ψn, 1}, {ψf, 0.1}, {r, 0.1}, {gc, 0.1}, {RSN, 0.1},
{RSF, 0.1}, {ωn0, 0.1}, {ωs0, 0.1}, {In0, 0.1},
{ain0, 0.1}, {iin0, 0.1}, {RDn0, 0.1},
{Is0, 0.1}, {ais0, 0.1}, {iis0, 0.1}, {RDs0, 0.1},
{cn0, 0.1}, {cs0, 0.1}, {Un, 0.1}, {Us, 0.1}]

{ω → 5.49254, ψn → 0.0579306, ψf → 0.0648067, r → 0.06823,
gc → 0.01823, RSN → 0.026, RSF → 0.013, ωn0 → 0.890991, ωs0 → 0.162218,
In0 → 1.21415, ain0 → 0.0938467, iin0 → 0.00147284, RDn0 → 0.11883,
Is0 → 1.05102, ais0 → 0.0248042, iis0 → 0.000924072, RDs0 → 0.0252905,
cn0 → 1.0818, cs0 → 0.170495, Un → 16.5927, Us → -35.3082}

```

```
{gc1, wn01, ws01, In01, ain01, iin01, RDn01, Is01, ais01, iis01, RDs01, cn01, cs01, Un1,
  Us1} = {0.018229999999999993`, 0.8909911114729104`, 0.1622184996610693`,
  1.214149741244697`, 0.09384674672405943`, 0.0014728352260883792`,
  0.11883015929454935`, 1.0510187805541615`, 0.024804161345699297`,
  0.0009240721433115749`, 0.025290547065150746`, 1.0817966274461595`,
  0.1704946896971027`, 16.59274872462314`, -35.30821563285789`}
{0.01823, 0.890991, 0.162218, 1.21415, 0.0938467, 0.00147284, 0.11883, 1.05102,
  0.0248042, 0.000924072, 0.0252905, 1.0818, 0.170495, 16.5927, -35.3082}
```

The effects of monetary policy

```
Clear[in]
```

```
{in} = {0}
```

```
{0}
```



```

FindRoot[
{gc ==  $\left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \left(\frac{\rho + \psi n - gL}{\rho + \psi n + \phi - gL}\right) (\delta \omega)^\sigma - \delta \omega = \delta \left(\frac{1 - \beta n}{1 - \beta f}\right) \left(\frac{s}{1 - s}\right) \left(\frac{1 + \xi f is}{1 + \xi n in}\right) \left(\frac{\alpha}{\gamma}\right),$ 
1 ==  $\gamma \left((\sigma - 1) \left(\frac{1}{1 - \beta n}\right) (\rho + \psi n - gL) (1 + \xi n in) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) + \psi n\right),$ 
1 ==  $\left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\phi}{\phi + \lambda \psi n} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma + \frac{\lambda \psi n}{\phi + \lambda \psi n}\right) (\sigma - 1)$ 
 $\left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right) (\rho + \psi n + \phi - gL) + \alpha \psi f,$ 
RSN ==  $\frac{\psi n \gamma}{1 + (\rho + \psi n - gL) \left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \gamma},$ 
RSF ==  $\frac{\psi f \alpha}{1 + (\rho + \psi n + \phi - gL) \left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right)},$ 
r ==  $\rho + \left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \omega n0 == \left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} +$ 
 $\left(\frac{\lambda \psi n}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) (\delta \omega)^{\sigma - 1}\right)^{\frac{1}{\sigma - 1}},$ 
cn0 ==  $\omega n0 \ln0, \ln0 == \text{ain0} + \text{iin0} + 1 + \text{RDn0}, \text{ain0} == \left(\frac{1}{1 - \beta n}\right) (\rho - gL) (1 + \xi n in) \gamma,$ 
iin0 ==  $\xi n in \psi n \gamma, \text{RDn0} == \left(\frac{\beta n}{1 - \beta n}\right) (1 + \xi n in) \psi n \gamma, \omega s0 == \frac{\omega n0}{\omega}, \text{cs0} == \omega s0 \text{Is0},$ 
Is0 ==  $\text{ais0} + \text{iis0} + 1 + \text{RDs0}, \text{ais0} == \left(\frac{1}{1 - \beta f}\right) (\rho - gL) (1 + \xi f is) \alpha,$ 
iis0 ==  $\xi f is \psi f \alpha, \text{RDs0} == \left(\frac{\beta f}{1 - \beta f}\right) (1 + \xi f is) \psi f \alpha,$ 
Un ==  $\frac{1}{\rho - gL} \left(\text{Log}[\text{cn0}] + \frac{gc}{\rho - gL}\right), \text{Us} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cs0}] + \frac{gc}{\rho - gL}\right)\},$ 
{ $\omega, 5$ }, { $\psi n, 1$ }, { $\psi f, 0.1$ }, { $r, 0.1$ }, { $gc, 0.1$ }, { $\text{RSN}, 0.1$ },
{ $\text{RSF}, 0.1$ }, { $\omega n0, 0.1$ }, { $\omega s0, 0.1$ }, { $\ln0, 0.1$ },
{ $\text{ain0}, 0.1$ }, { $\text{iin0}, 0.1$ }, { $\text{RDn0}, 0.1$ },
{ $\text{Is0}, 0.1$ }, { $\text{ais0}, 0.1$ }, { $\text{iis0}, 0.1$ }, { $\text{RDs0}, 0.1$ },
{ $\text{cn0}, 0.1$ }, { $\text{cs0}, 0.1$ }, { $\text{Un}, 0.1$ }, { $\text{Us}, 0.1$ }]

{ $\omega \rightarrow 5.48912, \psi n \rightarrow 0.0625057, \psi f \rightarrow 0.0713674, r \rightarrow 0.0696697,$ 
 $gc \rightarrow 0.0196697, \text{RSN} \rightarrow 0.0280349, \text{RSF} \rightarrow 0.0143194, \omega n0 \rightarrow 0.890345,$ 
 $\omega s0 \rightarrow 0.162202, \ln0 \rightarrow 1.21241, \text{ain0} \rightarrow 0.0897674, \text{iin0} \rightarrow 0., \text{RDn0} \rightarrow 0.122642,$ 
 $\text{Is0} \rightarrow 1.05367, \text{ais0} \rightarrow 0.0248042, \text{iis0} \rightarrow 0.00101762, \text{RDs0} \rightarrow 0.0278508,$ 
 $\text{cn0} \rightarrow 1.07946, \text{cs0} \rightarrow 0.170908, \text{Un} \rightarrow 17.6681, \text{Us} \rightarrow -34.1043$ }

```

```
{gcfn, wn0fn, ws0fn, In0fn, ain0fn, iin0fn, RDn0fn, Is0fn, ais0fn, iis0fn, RDs0fn,
  cn0fn, cs0fn, Unfn, Usfn} = {0.019669709889045664`, 0.8903448934883498`,
  0.16220171693976773`, 1.2124089766156765`, 0.08976744001045511`,
  0., 0.12264153660522133`, 1.053672612132977`, 0.024804161345699297`,
  0.00101762039650276`, 0.0278508303907748`, 1.0794621411492036`,
  0.17090750678037878`, 17.66805731273416`, -34.10429281275697`}
{0.0196697, 0.890345, 0.162202, 1.21241, 0.0897674, 0., 0.122642, 1.05367,
  0.0248042, 0.00101762, 0.0278508, 1.07946, 0.170908, 17.6681, -34.1043}
```

```
{Δgcfn, Δlnwn0fn, Δlnwns0fn, ΔlnIn0fn, ΔlnIs0fn, Δlnain0fn, Δlnais0fn,
  Δlniin0fn, Δlniis0fn, ΔlnRDn0fn, ΔlnRDs0fn, Δlncn0fn, Δlncs0fn} =
  {(gcfn - gc1) 100, (Log[wn0fn] - Log[wn01]) 100, (Log[ws0fn] - Log[ws01]) 100,
  (Log[In0fn] - Log[In01]) 100, (Log[Is0fn] - Log[Is01]) 100,
  (Log[ain0fn] - Log[ain01]) 100, (Log[ais0fn] - Log[ais01]) 100,
  (Log[iin0fn] - Log[iin01]) 100, (Log[iis0fn] - Log[iis01]) 100,
  (Log[RDn0fn] - Log[RDn01]) 100, (Log[RDs0fn] - Log[RDs01]) 100,
  (Log[cn0fn] - Log[cn01]) 100, (Log[cs0fn] - Log[cs01]) 100}
{0.143971, -0.0725543, -0.0103463, -0.143476, 0.252183, -4.44408,
  0., Indeterminate, 9.64321, 3.15705, 9.64321, -0.21603, 0.241836}
```

```
ΔUnfn = (Exp[(ρ - gL) Unfn - (ρ - gL) Un1] - 1) 100
3.90231
```

```
ΔUsfn = (Exp[(ρ - gL) Usfn - (ρ - gL) Us1] - 1) 100
4.37914
```

```
{in} = {0.090886109999999999`}
{0.0908861}
```

```
Clear[is]
```

```
{is} = {0}
{0}
```

```

FindRoot[
{gc ==  $\left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \left(\frac{\rho + \psi n - gL}{\rho + \psi n + \phi - gL}\right) (\delta \omega)^\sigma - \delta \omega = \delta \left(\frac{1 - \beta n}{1 - \beta f}\right) \left(\frac{s}{1 - s}\right) \left(\frac{1 + \xi f is}{1 + \xi n in}\right) \left(\frac{\alpha}{\gamma}\right),$ 
1 ==  $\gamma \left((\sigma - 1) \left(\frac{1}{1 - \beta n}\right) (\rho + \psi n - gL) (1 + \xi n in) \left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) + \psi n\right),$ 
1 ==  $\left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\phi}{\phi + \lambda \psi n} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma + \frac{\lambda \psi n}{\phi + \lambda \psi n}\right) (\sigma - 1)$ 
 $\left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right) (\rho + \psi n + \phi - gL) + \alpha \psi f,$ 
RSN ==  $\frac{\psi n \gamma}{1 + (\rho + \psi n - gL) \left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \gamma},$ 
RSF ==  $\frac{\psi f \alpha}{1 + (\rho + \psi n + \phi - gL) \left(\left(\frac{1}{1 - \beta n}\right) (1 + \xi n in) \omega \gamma \left(\frac{1 - s}{s}\right) + \left(\frac{1}{1 - \beta f}\right) (1 + \xi f is) \alpha\right)},$ 
r ==  $\rho + \left(\frac{\lambda - 1}{\sigma - 1}\right) \psi n, \omega n0 == \left(\left(\frac{\lambda \psi n}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} +$ 
 $\left(\frac{\lambda \psi n}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1} (\delta \omega)^{\sigma - 1} + \left(\frac{\phi}{\lambda \psi n + \phi}\right) \left(\frac{\psi f}{\lambda \psi n + \psi f}\right) (\delta \omega)^{\sigma - 1}\right)^{\frac{1}{\sigma - 1}},$ 
cn0 ==  $\omega n0 \ln0, \ln0 == \text{ain0} + \text{iin0} + 1 + \text{RDn0}, \text{ain0} == \left(\frac{1}{1 - \beta n}\right) (\rho - gL) (1 + \xi n in) \gamma,$ 
iin0 ==  $\xi n in \psi n \gamma, \text{RDn0} == \left(\frac{\beta n}{1 - \beta n}\right) (1 + \xi n in) \psi n \gamma, \omega s0 == \frac{\omega n0}{\omega}, \text{cs0} == \omega s0 \text{Is0},$ 
Is0 ==  $\text{ais0} + \text{iis0} + 1 + \text{RDS0}, \text{ais0} == \left(\frac{1}{1 - \beta f}\right) (\rho - gL) (1 + \xi f is) \alpha,$ 
iis0 ==  $\xi f is \psi f \alpha, \text{RDS0} == \left(\frac{\beta f}{1 - \beta f}\right) (1 + \xi f is) \psi f \alpha,$ 
Un ==  $\frac{1}{\rho - gL} \left(\text{Log}[\text{cn0}] + \frac{gc}{\rho - gL}\right), \text{Us} == \frac{1}{\rho - gL} \left(\text{Log}[\text{cs0}] + \frac{gc}{\rho - gL}\right)\},$ 
{ $\omega, 5$ }, { $\psi n, 1$ }, { $\psi f, 0.1$ }, { $r, 0.1$ }, { $gc, 0.1$ }, { $\text{RSN}, 0.1$ },
{ $\text{RSF}, 0.1$ }, { $\omega n0, 0.1$ }, { $\omega s0, 0.1$ }, { $\ln0, 0.1$ },
{ $\text{ain0}, 0.1$ }, { $\text{iin0}, 0.1$ }, { $\text{RDn0}, 0.1$ },
{ $\text{Is0}, 0.1$ }, { $\text{ais0}, 0.1$ }, { $\text{iis0}, 0.1$ }, { $\text{RDS0}, 0.1$ },
{ $\text{cn0}, 0.1$ }, { $\text{cs0}, 0.1$ }, { $\text{Un}, 0.1$ }, { $\text{Us}, 0.1$ }]

{ $\omega \rightarrow 5.483, \psi n \rightarrow 0.0582499, \psi f \rightarrow 0.0659725, r \rightarrow 0.0683305,$ 
 $gc \rightarrow 0.0183305, \text{RSN} \rightarrow 0.0261256, \text{RSF} \rightarrow 0.0132667, \omega n0 \rightarrow 0.890546,$ 
 $\omega s0 \rightarrow 0.16242, \ln0 \rightarrow 1.21481, \text{ain0} \rightarrow 0.0938467, \text{iin0} \rightarrow 0.00148095,$ 
 $\text{RDn0} \rightarrow 0.119485, \text{Is0} \rightarrow 1.0482, \text{ais0} \rightarrow 0.0236502, \text{iis0} \rightarrow 0., \text{RDS0} \rightarrow 0.0245478,$ 
 $\text{cn0} \rightarrow 1.08185, \text{cs0} \rightarrow 0.170248, \text{Un} \rightarrow 16.6733, \text{Us} \rightarrow -35.2697$ }

```

```

{gcfs, wn0fs, ws0fs, In0fs, ain0fs, iin0fs, RDn0fs,
 Is0fs, ais0fs, iis0fs, RDS0fs, cn0fs, cs0fs, Unfs, Usfs} =
{0.018330457932271293`, 0.890545894057624`, 0.1624195036176193`,
 1.2148126809087447`, 0.09384674672405943`, 0.001480951407184878`,
 0.1194849827775005`, 1.0481979952591685`, 0.02365023188446647`,
 0., 0.024547763374701888`, 1.0818464450324172`,
 0.17024779808297782`, 16.673307762740095`, -35.26965628522425`}
{0.0183305, 0.890546, 0.16242, 1.21481, 0.0938467, 0.00148095, 0.119485,
 1.0482, 0.0236502, 0., 0.0245478, 1.08185, 0.170248, 16.6733, -35.2697}

{Δgcfs, Δlnwn0fs, Δlnwns0fs, ΔlnIn0fs, ΔlnIs0fs, Δlnain0fs, Δlnais0fs,
 Δlniin0fs, Δlniis0fs, ΔlnRDn0fs, ΔlnRDS0fs, Δlncn0fs, Δlncs0fs} =
{(gcfs - gc1) 100, (Log[wn0fs] - Log[wn01]) 100, (Log[ws0fs] - Log[ws01]) 100,
 (Log[In0fs] - Log[In01]) 100, (Log[Is0fs] - Log[Is01]) 100,
 (Log[ain0fs] - Log[ain01]) 100, (Log[ais0fs] - Log[ais01]) 100,
 (Log[iin0fs] - Log[iin01]) 100, (Log[iis0fs] - Log[iis01]) 100,
 (Log[RDn0fs] - Log[RDn01]) 100, (Log[RDS0fs] - Log[RDS01]) 100,
 (Log[cn0fs] - Log[cn01]) 100, (Log[cs0fs] - Log[cs01]) 100}
{0.0100458, -0.0499813, 0.123833, 0.0545862, -0.268747, 0., -4.76385,
 0.549546, Indeterminate, 0.549546, -2.98099, 0.00460497, -0.144914}

ΔUnfs = (Exp[(ρ - gL) Unfs - (ρ - gL) Un1] - 1) 100
0.287202

ΔUsfs = (Exp[(ρ - gL) Usfs - (ρ - gL) Us1] - 1) 100
0.137366

Quit[]

```