Global Economy Equilibrium Scenario Builder

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Public Capital

Government Consumption and Taxes

What Are We Developing?

- A modular framework rather than a single model
- Scenario builder based on a DSGE core
- Cover a wide spectrum of real and financial economy aspects, less emphasis on deep disaggregation
- Pragmatic features
- Balanced growth path
- Ease of operation and judgmental adjustments

Current Stage

- Work in progress, under continuous development
- Robust core engine
- A number of prototypes
- Would like to hear feedback about the GPMN member preferences

Key Modules

- Demography
- Households
- Production
- Non-Commodity Exports
- Commodities
- Monetary Policy
- Fiscal Policy

Demography

- Total population
- Working age population
- Labor force (labor participation)

Outside the demography module:

- Per-worker labor supply (e.g. per-worker hours worked)

Total Population

Global Population Trend Component

$$\Delta \log nn_t^{gg} = \rho_{nn^{gg}} \Delta \log nn_{t-1}^{gg} + (1 - \rho_{nn^{gg}}) \Delta \log \kappa_{nn}$$

$$\kappa_{nn} = \frac{nn_{\mathrm{ss}}^{gg}}{nn_{\mathrm{ss}-1}^{gg}}$$

Area/Country Total Population

$$nn_t = nr_t \cdot nn_t^{gg}$$

$$\log(nr_t) = \rho_{nr} \log nr_{t-1} + (1 - \rho_{nr}) \log nr_{\mathrm{ss}}$$

Labor Market Population

Working age population

$$\frac{nw_t}{nn_t} = \rho_{nw} \frac{nw_{t-1}}{nn_{t-1}} + (1 - \rho_{nw}) \, \kappa_{nw} + \epsilon_{nw,t}$$

$$\kappa_{nw} = \frac{nw_{\text{ss}}}{nn_{\text{ss}}}$$

Labor force (participation rate)

$$\frac{nf_t}{nw_t} = \rho_{nf} \frac{nf_{t-1}}{nw_{t-1}} + (1 - \rho_{nf}) \, \kappa_{nf} + \epsilon_{nf,t}$$

$$\kappa_{nf} = \frac{nf_{\text{ss}}}{nw_{\text{ss}}}$$

Households

- Representative household with a growing number of members
- Current income effect
- Net worth effect

Choices Made by Households

- Demand consumption goods
- Demand for investment goods and capital accumulation
- Utilization of capital
- Labor supply
- Demand for (bank) deposits
- Demand for (bank) loans

Lifetime Utility Function

Representative household with a growing number of members

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \left(\log \frac{ch_t - ch_t^{\mathrm{ref}}}{nn_t} - \frac{1}{1+\eta} \cdot {nh_t}^{\eta} + \nu_1 \cdot \log \frac{netw_t}{pch_t \cdot nn_t} \right) nn_t$$

Nominal net worth

$$netw_t = pkh_t \cdot kh_t + bd_t - bl_t$$

Point of reference in household consumption

$$ch_t^{\mathrm{ref}} = \chi \cdot \frac{curr_t}{pch_t}$$

$$curr_t = w_t \cdot nh_t \cdot nf_t - txl1_t$$

Variable	Description
ch_t	Household consumption
ch_t^{ref}	Point of reference in household consumption
nf_t	Labor force
nh_t	Per-worker labor supply (e.g. per-worker hours worked)
$netw_t$	Nominal net worth of households
$curr_t$	Nominal current income of households
$txl1_t$	Net lump-sum taxes (transfers) of type 1

Budget Constraint

$$bd_t - bl_t = rbd_{t-1} \cdot bd_{t-1} - rbl_{t-1} \cdot bl_{t-1}$$
$$+ w_t \cdot nh_t \cdot nf_t + puk_t \cdot u_t \cdot k_t + zy_t + zb_t$$
$$- pch_t \cdot ch_t - pih_t \cdot ih_t$$
$$- txl1_t - txl2_t - adj_t$$

Lagrange multiplier associated with the budget constraint is denoted by vh_t (shadow value of nominal household wealth)

Variable	Description
bd_t	Bank deposits
bl_t	Bank loans
w_t	Nominal wage rate
zy_t	Profits from producers
zb_t	Profits from financial sector
jh_t	Adjustment costs faced by households
$txl1_t$	Type 1 net lump-sum taxes (transfers)
$txl2_t$	Type 2 net lump-sum taxes (transfers)

Household Adjustment Costs

- Investment adjustment costs
- Reference point in capital accumulation
- Cost of utilization of capital

$$jh_t = \frac{1}{2}\, \xi_{ih} \cdot pih_t \cdot ih_t \left(\Delta \log ih_t - \log \kappa_{ih}\right)^2$$

$$+ \frac{1}{2}\, \xi_{k} \cdot pkh_t \cdot kh_t \left(\log kh_t - \log kh_t^{\mathrm{ref}}\right)^2$$

$$+ py_t \cdot kh_t \cdot \left(v_0 \cdot u_t\right)^{v_1}$$

Point of reference in capital accumulation

$$kh_t^{\mathrm{ref}} = \mathrm{E}_t\left[kh_{t+1} \cdot {\kappa_{kh}}^{-1}\right]$$

Steady-state adjustment constants

$$\kappa_{ih} = \frac{ih_{\mathrm{ss}}}{ih_{\mathrm{ss}-1}} \qquad \kappa_{kh} = \frac{kh_{\mathrm{ss}}}{kh_{\mathrm{ss}-1}}$$

Capital Accumulation

$$kh_t = (1 - \delta)\, kh_{t-1} + ih_t$$

Lagrange multiplier associated with the capital accumulation constraint is denoted by pkh_t (shadow price of capital)

Variable	Description
kh_t	Stock of production capital
ih_t	Investment in production capital

Finance Contraint

Sufficient amount of means of payment needs to be held proportional to gross expenditures (consumption, investment, trade in capital)

$$bd_t = \phi\Big(pch_t \cdot ch_t + pih_t \cdot ih_t + \phi_k \cdot pkh_t \cdot kh_t\Big)$$

Real Wage Rigidities

Real wages are sluggish in their response to changes in optimal flexible wage rate; no expliciti microfoundations

$$\log \frac{w_t}{pch_t} = \rho_w \ \log\left(\kappa_w \cdot \frac{w_{t-1}}{pch_{t-1}}\right) + (1-\rho_w) \ \log \frac{w0_t}{pch_t} + \epsilon_{w,t}$$

Steady-state adjustment constant

$$\kappa_w = \frac{w_{\mathrm{ss}} \cdot pch_{\mathrm{ss}-1}}{w_{\mathrm{ss}-1} \cdot pch_{\mathrm{ss}}}$$

Variable	Description
$w0_t$	Optimal flexible nominal wage rate as if optimized by households
w_t	Actual nominal wage rate

Production

- Technology choice production function

- Several pairwise stages of production
- Input factors
    - Labor
    - Intermediate imports
    - Commodity inputs
    - Capital
- Real flexibilities to flatten the marginal cost schedule
    - Variable utilization of capital
    - Roundabout production

- Sticky prices

Productivity

Global productivity component

$$\Delta \log a_t^{gg} = \rho_a \, \Delta \log a_{t-1}^{gg} + (1 - \rho_a) \log \kappa_a$$

$$\kappa_a = \frac{a_{\mathrm{ss}}^{gg}}{a_{\mathrm{ss}-1}^{gg}}$$

Area/Country relative productivity component

$$\log ar_t = \rho_{ar} \;\log ar_{t-1} + (1 - \rho_a r) \;\log ar_{\mathrm{ss}}$$

Area/Country productivity

$$a_t = aa_t^{gg} \cdot ar_t$$

Technology Choice Production Function

Short-run CES technology

$$y_t = F\left(ak_t \cdot k_t,\ an_t \cdot n_t\right)$$

subject to a long-run technology frontier

$$G(ak_t,\ an_t) = a_t$$

with adjustment costs

$$\frac{1}{2}\,\xi \cdot py_t \cdot y_t \left(\log\frac{ak_t}{an_t} - \log\frac{ak_{t-1}}{an_{t-1}}\right)^2$$

Leontief-Cobb-Douglas Case

Short-run Leontief

$$y_t = ak_t \cdot k_t$$
$$y_t = an_t \cdot n_t$$

Long-run Cobb-Douglas

$$ak_t{}^{\gamma} \cdot an_t{}^{1-\gamma} = a_t$$

Without adjustment costs, this is perfectly equivalent (up to a scale constant) to

$$y_t = a_t \cdot k_t{}^{\gamma} \cdot n_t{}^{1-\gamma}$$

Production Stages

Combine imports from other areas

$$m_t = F_4\left(m_t^1, \ldots, m_t^A\right)$$

$$m_t = mm_t + mch_t + mih_t + mcg_t + mih_t + mxx_t$$

Combine non-commodity variable factors

$$y3_t = F_3\left[mm_t,\ \ (nh_t - \gamma_{n0} \cdot nh_{\mathrm{ss}}) \cdot nf_t\right]$$

Combine variable factors with capital

$$y2_t = F_2\Big(ukh_t,\ kg_t,\ y3_t\Big)$$

$$ukh_t = u_t \cdot kh_t$$

Add dependence on commodity inputs

$$y1_t = F_1\Big(y2_t,\ mq_t\Big)$$

Add a roundabout production layer and sticky prices

$$y_t - z_t = F_0(y1_t,\ z_t)$$

$$y_t = ych_t + yih_t + ycg_t + yig_t + yxx_t$$

Sticky Prices

Maximize profits

$$py_t \cdot y_t \ \left(1 + jp_t\right) - py0_t \cdot y0_t$$

with the price adjustment costs given by

$$jp_t = \frac{1}{2}\, \xi_{py} \left(\Delta \log py_t - \Delta \log py_t^{\mathrm{ref}}\right)^2$$

Point of reference in price setting

$$\Delta \log py_t^{\mathrm{ref}} = \zeta_{py} \Delta \log py_{t-1} + (1 - \zeta_{py}) \log \kappa_{py}$$

$$\kappa_{py} = \frac{py_{\mathrm{ss}}}{py_{\mathrm{ss}-1}}$$

Production Sector Total Profits

$$zy_t = py_t \cdot y0_t \ \left(1 - jy_t\right) - pm_t \cdot mm_t - w_t \cdot nh_t \cdot nf_t - puk_t \cdot uk_t -$$

Final Goods Assembly

$$ch = F\left(ych_t,\ mch_t\right)$$

Monetary Policy

- Inflation targeting reaction function
- Exchange rate peg
- Inflation targeting with exchange rate management

Fiscal

- Government consumpiton and investment
- Government debt placed locally
- Lump-sum taxes
- Crowding-in in the short run
- Crowding-out in the long run

Fiscal Budget Constraing

$$dg_t = rg_{t-1} \cdot dg_{t-1} + pcg_t \cdot cg_t + pig_t \cdot ig_t - txl1_t - txl2_t$$

Public Capital

$$kg_t = (1 - \delta)\, kg_{t-1} + ig_t$$

Target level for public capital

$$kg_t^{\text{tar}} = \psi \cdot kh_t$$

Investment rule

$$\Delta \log ig_t = \log \kappa_{ig} + \tau_{ig} \left(\log kg_t - kg_t^{\text{tar}} \right)$$

$$\kappa_{ig} = \frac{ig_{\text{ss}}}{ig_{\text{ss}-1}}$$

Government Consumption and Taxes

- Stabilizing mechanism to keep debt at a target level as a ratio to nominal GDP

$$\frac{dg_t}{ngdp_t}$$

- A wide range of mechanisms to stabilize debt

<<[banking.md]