INTRODUCTION TO ESCAP MACROECONOMIC MODEL

Dawn Holland
National Institute of Economic and Social Research

Side Event to UNESCAP Virtual Conference: Towards post-COVID-19 resilient economies 19 November 2020, Bangkok, Thailand

THE ESCAP MACROECONOMIC MODEL

- Developed by the Macroeconomic Policy and Analysis Section at ESCAP to support the design of economic recovery packages for countries in the Asia and Pacific region
- A complete global model:
  - 46 individual full country models for the Asia and Pacific region
  - Smaller models of 9 key trading partners and 4 major regions
  - Models are linked together via trade, remittances, financial and energy markets
- Founded on a standard macroeconomic framework, with additional channels to capture interactions with key social and environmental channels.
- Runs in Eviews, with most behavioural relationships specified in an error-correction framework to distinguish short-term and long-term dynamics
KEY ACTORS AND FEATURES OF THE MODEL

- **Households:**
  - Consume
  - Save
  - Supply labour

- **Firms:**
  - Produce output
  - Hire labour
  - Invest

- **Government:**
  - Tax
  - Spend
  - Monetary policy

- **Poverty:** Depends on income and post-tax inequality

- **Emissions:** Depend on output, efficiency of production, and the energy mix

- **Global linkages:** Via trade, remittances, financial markets, emissions and energy markets

ECONOMIC INDICATORS: MODELLING GDP

- **GDP is driven by demand in the short-term**
  - Sum of consumption, investment, net trade:
    \[ YER = PCR + GCR + ITR + SCR + XTR - MTR \]

- **GDP is driven by supply in the long-term**
  - Labour, capital, energy, technology, climate damage:
    \[ YFT = f(K, L, E, T, CLIMATE) \]
AGGREGATE DEMAND: PRIVATE CONSUMPTION

- Household consumption (PCR) per capita (POPT) depends on:
  - Real personal disposable income (RPDI)
  - Financial inclusion (FINC)
  - Inflation ‘surprise’ (INFL – INFL*)

\[
\Delta \log(PCR_t) = \phi_0 - \beta [\log(PCR_{t-1}) - \log(RPDI_{t-1}) - \delta_0 FINC_{t-1}] \\
+ \phi_1 \Delta \log(RPDI_t) + (1 - \phi_1) \Delta \log(POP_t) + \delta_1 [INFL_t - INFL^*_{t-1}]
\]

AGGREGATE DEMAND: PRIVATE INVESTMENT

- Private sector investment (IPR) depends on:
  - Potential output (YFT)
  - User cost of capital (USER)
  - Financial inclusion (FINC)
  - Gross domestic income (short-term) (GDI)
  - Lagged dependent variable allows for persistence to capture cyclical nature of investment

\[
\Delta \log(IPR_t) = \phi_0 - \beta [\log(IPR_{t-1}) - \log(YFT_{t-1}) - \delta_1 USER_{t-1} - \\
\delta_2 FINC_{t-1}] + \phi_1 \Delta \log(GDI_t) + \phi_2 \Delta \log(IPR_{t-1}) + \phi_3 \Delta USER_{t-1}
\]
AGGREGATE DEMAND: PUBLIC CONSUMPTION

• Government consumption (GCR) depends on:
  • Spending on health (EXPH)
    • 75% by default
  • Spending on environmental protection (EXPE)
    • 50% by default
  • Other government consumption (OGC)

AGGREGATE DEMAND: PUBLIC INVESTMENT

• Government investment (IGR) depends on:
  • Spending on health (EXPH)
    • 25% by default
  • Spending on environmental protection (EXPE)
    • 50% by default
  • Other government investment (OGI)
AGGREGATE DEMAND: EXPORTS

Exports (XTR) depend on:
- Country-specific external demand (WDR)
- Relative (non-commodity) export prices (XTDNO$/CXUD)
- External demand and global export prices are derived from a global trade matrix to capture bilateral sensitivities between countries

\[ 
\Delta \log (XTR_t) = \Delta \log (WDR_t) + \phi_2 \Delta \log \left( \frac{XTDNO$}{CXUD} \right)_{t-1}
\]

AGGREGATE DEMAND: IMPORTS

Imports (MTR) depend on:
- Domestic demand (PCR+ITR+GCR+XTR)
  - Speed of pass-through allowed to differ across components of domestic demand
- An output gap (YFT/YER)
- Relative price of imported goods (CMUD*EXR/YED)
- Oil imports

\[ 
\Delta \log (MTR_t) = \varphi_0 - \beta \left[ \log (MTR_{t-1}) - \log (DD)_{t-1} - \log \left( \frac{YER}{YFT} \right)_{t-1} - \delta_1 \log \left( \frac{CMUD * EXR}{YED} \right)_{t-1} - 0.25 \times OMS \times \log (OILC)_{t-1} \right] + \varphi_1 \Delta \log (XTR_t) + \varphi_2 \Delta \log (PCR_t) + \varphi_3 \Delta \log (IPR_t) + \varphi_4 \Delta \log (GCR + IGR)_{t-1}
\]
An underlying production function describes the potential output of the economy:

\[ YFT = f(K, L, E, T, CLIMATE) \]

- Capital input is determined by the accumulated investment, with a rate of depreciation that depends on global CO2 emissions
- Potential labour input depends on demographics and labour force participation
- Total energy input depends on output, energy prices and energy efficiency; the energy mix depends on relative prices of oil, gas, coal and renewables
- Trend productivity growth depends on health expenditure; inequality; and air pollution
- Climate damages are exogenous, but linked in scenarios to spending on infrastructure resilience
RECONCILING SUPPLY AND DEMAND

- Deviations of actual output from potential output set in motion adjustment processes that bring the economy back to potential in the long run.
- For example, the gap between supply and demand (‘output gap’) feeds back through prices
- Higher prices:
  - Slows consumption
  - Worsens net trade balance

GOVERNMENT SECTOR

- The model has an expanded fiscal module, to allow a range of policy scenarios to be studied
- Fiscal policy channels include:
  - Spending on social protection
  - Spending on health
  - Spending on environmental protection
  - Fossil fuel subsidies
  - Carbon tax
  - Income tax
  - Corporate tax
  - Indirect tax
  - Taxes on international transactions
  - Commodity revenue
- The fiscal deficit flows onto the government debt stock, and debt service payments flow back onto the fiscal balance
GOVERNMENT SECTOR

- A ‘solvency’ condition, or fiscal rule, can be imposed to avoid “Ponzi games”, so that debt cannot continue to rise without bounds.
- When the rule is active, income and corporate tax rates rise to revert the deficit to a specified target.
- The rule can be turned off to assess where debt is headed if a policy package is financed fully via an increase in debt.
- We use this rule to determine the share of a fiscal package that is financed by taxes as opposed to debt.

GOVERNMENT SECTOR

- A country risk premium is linked to the ratio of government debt to GDP.
- Equation is designed so that countries with higher risk premia to start with are more sensitive to any rise in debt:

\[
PREM_t = PREM_{t-1} (1 + 0.03(GDNRATIO_{t-1} - GDNRATIO_{t-2}))
\]

- The risk premium feeds into borrowing costs, squeezing out investment, puts pressure on the exchange rate and pushes up inflation.
EMISSIONS AND AIR POLLUTION

- CO₂ emissions depend on the quantity of coal, oil and gas consumed:

\[ CO₂ = 96 \times COAL_C + 57 \times GASC + 67.4 \times OILC \]

- CO₂ emissions feed into government revenue via carbon taxes and subsidies, and global emissions impact the rate of depreciation
- Air pollution (PM₂.₅) depends on the shares of coal and oil in total energy consumption, and feeds back into trend productivity growth to reflect the relationship between pollution and health

POVERTY

- Poverty model is based on an assumption that income approximately follows a lognormal distribution
- We calculate the cumulative density function of log income, evaluated at the poverty benchmarks of $1.90/day and $5.50/day.
- Requires an estimate of inequality (standard deviation of log income) and mean income (approximated to track consumption per capita)

\[ \text{Headcount} = \text{Lognorm. dist}\{\text{Benchmark, MeanLI, SDLI}\} \times 100 \]
INEQUALITY

- The standard deviation of log income, needed to calibrate poverty, is derived from the GINI coefficient based on disposable income.
- The GINI depends on a relative redistribution parameter, which is linked to government spending on social protection, and a financial inclusion index, which we proxy with the share of the population with a bank account.
- In addition to poverty, the GINI feeds into potential output.

SCENARIO 1: SOCIAL SERVICES PACKAGE
TOWARDS UNIVERSAL HEALTHCARE AND A SOCIAL PROTECTION FLOOR

- Social protection spending
- Fiscal balance
- Real personal disposable income
- Income distribution and inequality
- Government spending on health
- Public consumption
- Public investment/capital
- Trend productivity
- Private investment in health
- Capital stock
- Imports
- GDP
- Potential output
- Poverty
- Government debt
SCENARIO 1: SOCIAL SERVICES PACKAGE
ILLUSTRATIVE IMPACTS ON ASIA AND PACIFIC REGION

SCENARIO 2: DIGITAL ACCESS PACKAGE
TOWARDS UNIVERSAL DIGITAL ACCESS AND UPPER-SECONDARY EDUCATION FOR ALL
SCENARIO 2: DIGITAL ACCESS PACKAGE
ILLUSTRATIVE IMPACTS ON ASIA AND PACIFIC REGION

Impact on GDP

Impact on Potential Output

Impact on Household spending

Impact on Unemployment rate

Impact on Poverty ($5.50/day)

Impact on Inequality

SCENARIO 3: GREEN DEVELOPMENT PACKAGE
UNIVERSAL ELECTRICITY AND CLEAN COOKING; DOUBLE ENERGY EFFICIENCY GAINS; CLIMATE RESILIENT INFRASTRUCTURE; STRENGTHEN BIODIVERSITY; PRICE CARBON

Clean energy and energy efficiency

Climate resilient infrastructure

Public investment

Energy efficiency

Renewable energy price

Air pollution

Public investment

Climate resilient infrastructure

Public investment

Energy efficiency

Renewable energy price

Air pollution

Biodiversity

Public spending

CO2 emissions

Energy mix

Inflation

GDP

Potential output

Emissions

Government debt
SCENARIO 3: GREEN DEVELOPMENT PACKAGE
ILLUSTRATIVE IMPACTS ON ASIA AND PACIFIC REGION

COMBINED SCENARIO: BUILD FORWARD BETTER

- The combined BFB scenario brings the social services, digital access and green development packages together
- Together they can be expected to deliver:
  - Lower poverty
  - Reduced income inequality
  - Lower carbon emissions
  - Better air quality
  - Fewer lives lost from climate shocks
  - Stronger economic activity
  - A rise in productivity
  - A rise in interregional trade

- But... the magnitude of impacts depends on access to finance and the financial market response to rising levels of government debt
SCENARIO 1: SOCIAL SERVICES PACKAGE
IMPACTS DEPEND ON FINANCING CHOICES AND REACTION OF FINANCIAL MARKETS

100% debt financing, fixed risk premia

Impact on Poverty ($5.50/day)

Impact on Govt debt (% GDP)

100% debt financing, varying risk premia

Impact on Poverty ($5.50/day)

Impact on Govt debt (% GDP)

50% debt financing, 50% tax financing

Impact on Poverty ($5.50/day)

Impact on Govt debt (% GDP)

COMBINED SCENARIO: BUILD FORWARD BETTER
ILLUSTRATIVE IMPACTS WITH “FULL” AND “AFFORDABLE” COSTINGS

Impact on Potential Output

Impact on Exports

Impact on TFP growth

Impact on Lives lost from climate shocks

Impact on CO2 emissions

Impact on Air pollution (PM2.5)

Impact on Poverty ($5.50/day)

Impact on Inequality
FINAL COMMENTS

- Like all models this is still a work in progress
- Powerful tool that ESCAP will be able to use for a wide range of policy studies
- In addition to Building Forward Better scenarios, we are applying it for stress testing and debt sustainability analysis
- Plenty more applications can be developed for the future...

THANK YOU!