Module 2

Macroeconomic Forecasting: UN/DESA's World Economic Forecasting Model (WEFM)

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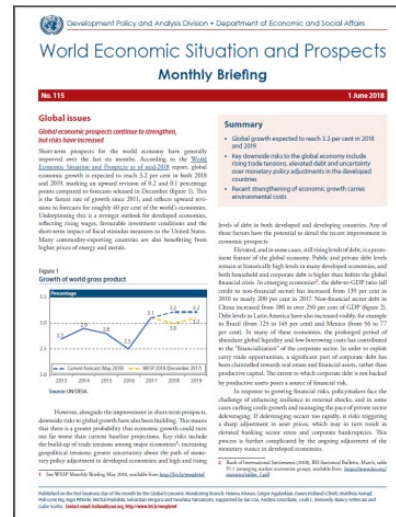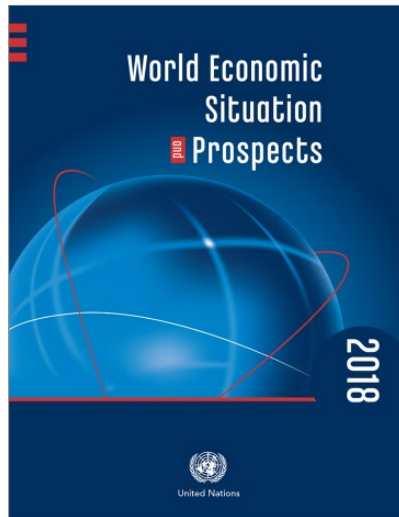# Global Economic Monitoring Branch What do we do?

- Monitor global economic developments and prospects from the country level (179 countries)

- Assess policy options from a sustainable development perspective, including social and environmental dimensions

Global Economic Monitoring Branch What do we do?

- Our macroeconomic forecasts and analyses are reflected in several UN publications

Global Economic Monitoring Branch How do we make forecasts?

- Statistical monitoring and analysis

- World Economic Forecasting Model

- Collaboration with 5 UN Regional Commissions, UNCTAD, ILO, UNWTO

- Project LINK

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- Even complex models are inevitably a gross oversimplification of reality

- Models will only deliver a pre-programmed response

Creating a model-based forecast

- Four key components:

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    - Equations based on economic theory and/or statistical analysis of past behaviour

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    - Tax/spending changes, Monetary policy, external assumptions
  - Model
    - Equations based on economic theory and/or statistical analysis of past behaviour
  - Other judgements

What makes a good forecast?

- Good data

- Good model

- Good judgement

- **How would you rank their importance?**

Good data

- What sources are available?
  - Often trade-off between data quality and data timeliness
- Models should be constructed using the highest quality data available
- Forecasts should make use of most recent data available
- Frequencies may need reconciliation

Good model

- What is the question?
- Short-term forecasting of a single indicator often best with simple data-based model (nowcasting)
- Medium-term projections benefit from theoretical underpinning
- Scenario studies rely on theoretical underpinning

Good judgement

- Specialist knowledge

- Identify shift in behaviour

- Adjust for deficiencies in model or data

- Interventions to allow for future events (e.g. announced tax changes)

- Experience and intuition….

- **Is forecasting an art or a science?**

Imposing judgement on a model

- Exogenous settings (ignore equation(s))
- Add-factor settings (allow model to run)
- Set exogenous variables
  - Policy instruments (eg tax rates, interest rates)
  - External assumptions (for small country, rest of world can sometimes be treated as exogenous)
  - May include trend productivity/commodity prices/key ratios

Forecasting approaches in international organisations

- IMF
  - 'Country-desk' approach – GDP growth error corrects to medium-term trend after 2-3 years
  - Simple models used for consistency of identities
  - Separate DSGE models for policy analysis

- World Bank
  - Country experts apply forecasts to a common econometric modelling framework

- OECD
  - 'Country-desk' approach, with sophisticated spreadsheet linked to common econometric model
  - NiGEM for policy analysis

The UN/DESA forecasting model

- What does UN/DESA want from a model?
  - To produce a globally consistent plausible baseline forecast for 176 countries for several years
  - Simple, efficient tool that can give insight into GDP, inflation, unemployment, current account, fiscal balance etc. under different scenarios
  - Adaptable to address specific questions as needed
  - Able to link to other sustainable development indicators via satellite models
- Structural econometric model adopted (runs in EViews)

Structural econometric models

- Cons
  - Lack theoretical elegance of DSGE models
    - Based on macro rather than micro foundations
    - Subject to aggregation problems
  - Lack short-term forecasting efficiency of VAR
- Pros
  - Large-scale capacity to link 176 countries
  - Compromise between data-based and theory-based models
  - Solution methods more adaptable than DSGE
    - Allows rapid introduction of model extensions to address new issues as they arise

UN/DESA's Model: WEFM

- Some history:
  - WEFM is a descendent of the Project LINK model
  - Project LINK started by Klein and others in late 1960's
  - Originally based on:
    - Expertise of 100 economists from 60 countries and several international organizations (Judgement)
    - LINK global modelling system of 80 individual country models, linked together through trade (Models)
  - Since 2006: LINK system gradually evolved towards World Economic Forecasting Model (WEFM)

UN's World Economic Forecasting Model (WEFM)

- Common theoretical structure
  - Dynamics and key elasticities estimated for each country (within tight boundaries)

- Forecasting philosophy
  - Country monitors and Project LINK experts add judgement to model projections
  - WEFM country models linked via trade matrix that reconciles global export and import volumes and export and import prices
  - WEFM also used for scenario/policy analysis

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WEFM Model Overview (see paper)

- 176 individual country models

- Global linkages reconcile export and import volumes and prices

- Models have roughly 60 equations with 15-20 key behavioural relationships.

- Simple framework that nonetheless captures country-specific behaviour

- Designed for both forecasting and scenario studies

- Theoretical structure with econometrically estimated parameters and dynamics

- Short-term behaviour linked to ROW demand, oil price sensitivity, exchange rate sensitivity, policy, etc.

- Medium term: GDP approaches 'capacity'; inflation may approach a 'target'; productivity approaches 'trend'; current account, gov't debt, unemployment rate all stabilising

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Core economic actors

- Households
  - Consume
  - Supply Labour

- Firms
  - Produce
  - Employ labour
  - Invest

- Governments
  - Tax
  - Spend
  - Borrow

- External sector
  - Export
  - Import
  - Compete (non-oil trade)

Modelling GDP

- GDP is driven by demand in the short-term
  - Sum of consumption, investment, net trade

YER = PCR + GCR + ITR + SCR + XTR - MTR

- Driven by supply in the long-term

$$YFT_t = f\left(K_t, L_t, T_t\right)$$

Aggregate Supply

- Underlying generic 'production function' describes the capacity of the economy
  - **Steady-state assumption**: Capacity evolves with potential labour input (labour force) and trend productivity (technology)
  - To allow for market imperfections in external sector, explicit link to export growth

$$\Delta \log(YFT_t) = \alpha \big[\Delta \log(LFN_t) + \Delta \log(YFIT\_TREND)\big] + \big(1 - \alpha\big)\Delta \log(XTR_t)$$

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Aggregate Demand

- Household consumption
  - Liquidity constrained households depend on current disposable income
  - Unconstrained maintain constant consumption per capita
  - In short-term households can respond to an inflation 'surprise'

$$\Delta \log(PCR_t) = \varphi_0 - \beta \left[\log(PCR_{t-1}) - \log(RPDI_{t-1}) \right]$$
$$+ \varphi_1 \Delta \log(RPDI_t) + (1 - \varphi_1) \Delta \log(POP_t) + \delta_1 \left[INFL_t - INFL^e_{t-1} \right]$$

Aggregate Demand

- Government consumption
  - Policy variable should be exogenous
  - Can also model in line with potential output and term-of-trade adjusted income

$$\Delta \log(GCR_t) = \varphi_1 \Delta \log(YFT_t) + \left(1 - \varphi_1\right)\Delta \log(GDI_t)$$

Aggregate Demand

- Investment
  - Simple accelerator model links investment to terms-of-trade adjusted GDP
  - Lagged dependent variable allows for persistence to capture cyclical nature of investment

$$\Delta \log(ITR_t) = \varphi_0 - \beta \left[\log(ITR_{t-1}) - \log(GDI_{t-1}) \right] + \varphi_1 \Delta \log(GDI_t)$$
$$+ \varphi_2 \Delta \log(ITR_{t-1})$$

Aggregate Demand

- Exports
  - Depend on external demand and competitiveness

    $$XTR_{i,t} = \left(WDR_{i,t}\right)\left(\frac{XTDNO_{i,t}}{CXUD_{i,t}}\right)^{d1}$$

  - Both are 'global' variables, derived from a global trade matrix to capture bilateral sensitivities.
    - External demand is weighted average of imports in the other 175 countries in model
    - Competitiveness is export prices (non-oil) relative to weighted average of export prices from other 175 countries in model

Aggregate Demand

- Imports
  - Depend on domestic demand and relative price of imports
    - Speed of pass-through of the components of total final expenditure allowed to differ across components
    - Oil price excluded from relative price

$$\Delta \log(MTR_t) = \varphi_0 - \beta \left[\begin{array}{c} \log(MTR_{t-1}) - \alpha_1 \log(WER_{t-1}) \\ - \alpha_2 \log\left(\dfrac{MTDNO_{t-1} * EXR_{t-1}}{YED_{t-1}} \right) \end{array} \right] + \varphi_1 \Delta \log(XTR_t)$$

$$+ \varphi_2 \Delta \log(PCR_t) + \varphi_3 \Delta \log(ITR_t) + +\varphi_4 \Delta \log(GCR_t)$$

Reconciling supply and demand

- Gap between supply and demand ('output gap') feeds back through prices

- Higher prices:
  - Slows consumption
  - Worsens net trade balance
  - Raises interest rates which strengthens exchange rate

- **Relies on market forces to act as 'automatic stabiliser. Is this always appropriate?**

Modelling the labour market

- Current vintage of WEFM adopts an Okun-style relationship that links the unemployment rate to GDP growth, simplest labour market model

$$\Delta URX_t = \alpha_1 \Delta URX_{t-1} + \alpha_2 \Delta \log(YER)_t + \alpha_3 \Delta \log(YER)_{t-2} + \alpha_0$$

Supply-side labour market models

- Specify production function, and derive factor demands by setting marginal product equal to marginal cost (profit maximization)

  - With CES function this implies:
  - $\log\left(\frac{LNN_t}{YER_t}\right) = a_1 - \sigma log\left(\frac{W_t}{P_t}\right) - (1-\sigma)YFIT\_TREND$

  - Cointegrating relationship also forms firm side of wage bargain and core price equation
  - Nexus of 3 equations determines long-run URX

Policy channels

- Fiscal policy channels
    - single source of tax revenue
    - 3 categories of expenditure
        - Government consumption (national accounts)
        - Government interest payments
        - Other public spending (residual)

- Monetary policy channels
    - Exchange rate is primary instrument
    - Interest rates can follow a 'Taylor-type' Central Bank policy rule, and exchange rate follows

How does tax impact the labour market?

- In WEFM
    1. Change in tax rate impacts real personal disposable income
    2. Change in real personal disposable income impacts household consumption
    3. Household consumption impacts GDP, investment and imports
    4. GDP impacts unemployment, and second round effects….

- Missing channels: Tax changes can directly impact investment, prices, imports, exports, employment depending on type of tax

How does government spending impact the labour market?

- In WEFM
  1. Change in government spending impacts GDP, investment, imports, fiscal balance
  2. GDP impacts unemployment, and second round effects

- Missing channels: Government spending can directly impact consumption or employment…

How does tax impact spending?

- In WEFM
  1. No direct impact, unless potential output changes

- Missing channels: Solvency condition

Solvency condition

- Government deficit flows onto Debt
- Debt serviced through interest payments
- Without a 'solvency' condition, there is no penalty for running a large deficit
  - Sustainable borrowing today should entail higher taxes or lower spending in the future to repay debt
- Not imposed in models we'll work with this afternoon

- **Watch response of debt stock!**

How do interest rates impact the labour market?

- In WEFM

  1. Interest rate change impacts exchange rate
  2. Exchange rate impacts net trade and inflation
  3. Net trade and inflation impact GDP
  4. GDP impacts unemployment, and second round effects….

- Missing channels: Direct impact of interest rate on investment. Pass through is very slow

How do interest rates impact the fiscal balance?

- In WEFM
    1. Interest rate change impacts debt service payments
    2. Fiscal deficit flows onto debt stock
    3. Without solvency condition, feedback stops here

- Missing channels: Solvency condition

Forecasting study and policy study
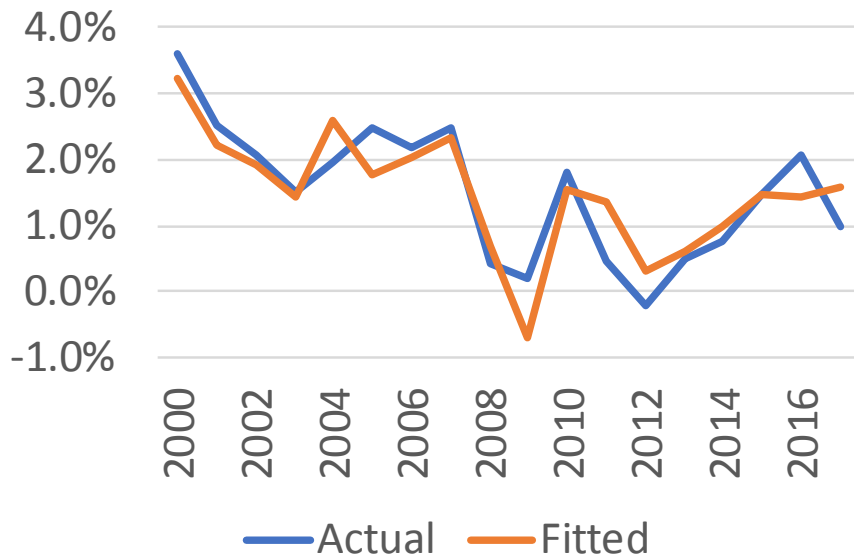
Steps to a model-based forecast

- Collect most recent data
  - Basic data provided
- Estimate model as needed
  - Model provided
- Use high-frequency data for 'nowcasting'
  - Annual database may be augmented by quarterly/monthly/even daily data to estimate key variables for 2017
  - MIDAS estimation example

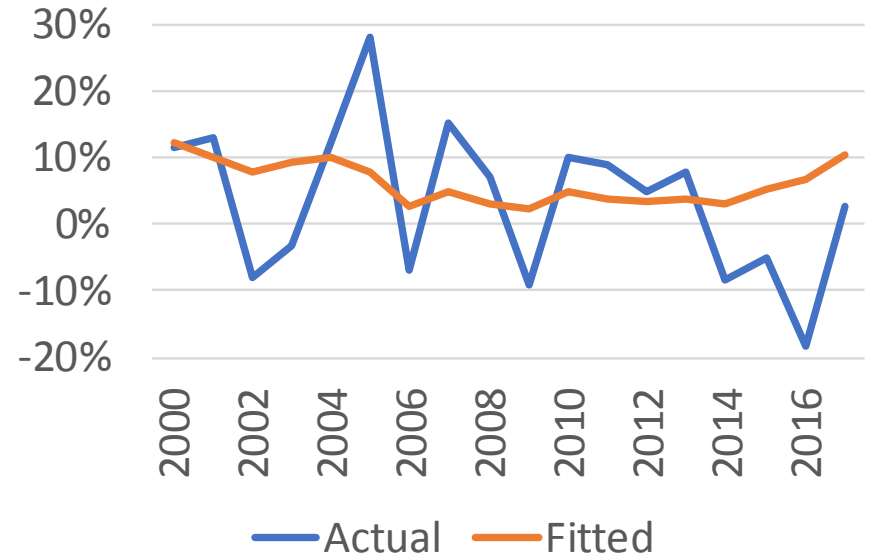# Steps to a model-based forecast

- Set exogenous inputs
  - Policy assumptions
    - Government consumption
    - Tax rate
    - Interest rate/Exchange rate
  - Oil price
- Assess recent accuracy of model and set add factors on equations where necessary
- Produce forecast and fine tune settings

Not all models are created equal
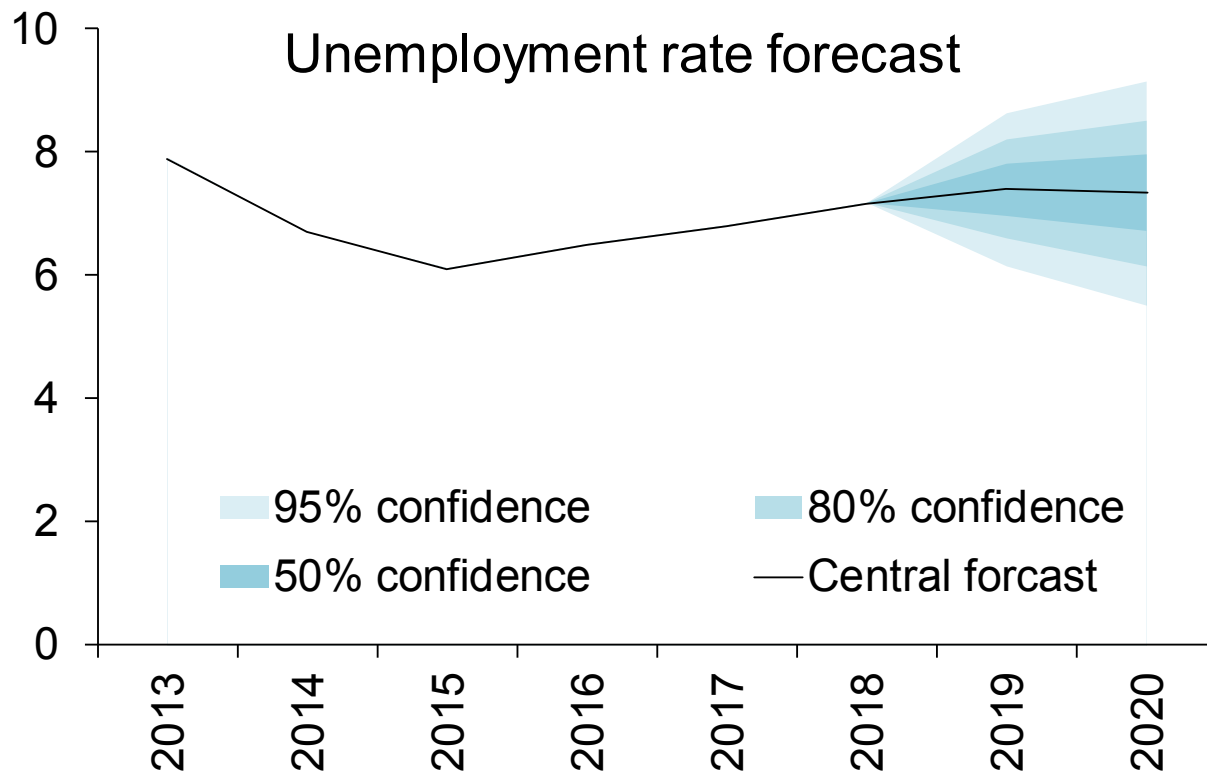

France - Private consumption

Guyana - Private consumption

Steps to a model-based forecast

- Assess accuracy of forecast
  - Stochastic forecast to assess confidence intervals

Unemployment rate forecast

Legend:
- 95% confidence
- 80% confidence
- 50% confidence
- Central forcast

Stochastic forecasts

- Forecast baseline produces point estimates for GDP growth etc.

- These point estimates are subject to a degree of error

- Stochastic forecasts can help us assess the confidence bounds around our point estimates

Stochastic forecasts

- Assess the conditional forecast accuracy of the model

- ***Conditional*** on all the exogenous inputs into the model

- Uses historical errors from the model equations to assess the accuracy of the model going forward

- 1000 different scenarios are run

Policy Study – Shock

- What is a shock?

- A shock is any deviation from the baseline projection for a variable **that is driven by factors exogenous to the model**

- Identifying the source of your shock is the first step to designing a scenario
  - This can sometimes be complex

- How would you design a shock to GDP?

Designing a shock to GDP

- Does it make sense to shock an identity directly?

- If not, what component of GDP is driving the shock?

- Say it comes from a shock to consumption

  - Is this because income has changed?

  - If not, we may have an exogenous shock to household behaviour, driven eg by a change in preferences or forthcoming tax on savings….

  - If so, is the income shock exogenous, or driven by inflation or a change to the tax rate?.... etc….

Policy Study - Shock

- External shock occurs
  - For example, a sharp slowdown in China reduces demand for exports to China
- Exports fall
  - GDP falls
    - Employment falls
    - Output gap opens and prices fall
      - Interest rates fall….
    - Government deficit deteriorates
    - Current account balance deteriorates

Policy Study – Fiscal response

- Increase government consumption spending
  - Government deficit deteriorates
  - GDP rises
    - Employment rises
    - Output gap closes and prices rise
      - Interest rates rise…
    - Government deficit improves…

Policy Study – Monetary response

- Cut interest rates
  - Exchange rate depreciates
    - Net trade improves
    - Inflation rises
  - Investment rises
    - Output gap closes (slowly…)
    - Inflation rises