Office for Budget Responsibility

The OBR macroeconomic model

December 2016

Tom Pybus, OBR

Plan

1. Background to the forecast process and model
2. Examples of model equations
3. The macro model and the economic forecast
4. Small model
5. Summary

Office for Budget Responsibility

1. Background: forecast process

- Economic forecast is produced entirely 'in-house'
- Economy team made up of 6 economists, each responsible for particular area of the forecast
- Iterative process with several "rounds" of the forecast
- Meetings with the Budget Responsibility Committee in advance of each round to discuss key forecast judgements
- Key "determinants" from economy forecast are distributed to fiscal forecasters
- Also discuss the general economic outlook with other economic forecasters e.g. Bank of England, NIESR.

Office for Budget Responsibility

1. Background: macroeconomic model

- We use a large-scale macroeconomic model as the 'vehicle' for the economic forecast:
  - Model is a computational tool – important role for judgement, particularly given breaks
  - Use a range of approaches and models to inform the forecast
  - Also use a 4 equation model for simulations/alternative scenarios
  - Some elements of the forecast are determined outside the model entirely e.g. potential output

Office for Budget Responsibility

1. Model structure

- Simplified representation of the economic activity described and recorded in the National Accounts
- Large-scale macro-econometric time series model:
  - Aggregate model – explain total household spending rather than behaviour of individual household types;
  - 500+ variables, split across 16 groups;
  - Relatively loose theoretical structure
  - Focus on the expenditure and income measures of GDP – no industry split (with exception of North-sea sector)

Office for Budget Responsibility

1. Model structure

- Structure and content of the model reflects use as a vehicle for forecasting the public finances:
  - Detailed treatment of public sector
  - Detailed treatment of income and expenditure elements of nominal GDP given importance for tax receipts e.g.:
    - Nominal consumer spending – VAT receipts
    - Nominal investment – corporation tax receipts
    - Total wages and salaries – income tax receipts
    - Total profits – corporation tax receipts
  - Flexibility to impose forecast judgements

Office for Budget Responsibility

1. Model structure

- Equations in the model represent three different types of relationship:
  - **Accounting identities** : identities and definitions in the National Accounts (e.g. GDP=C+I+G+X-M)
  - **Behavioural/econometric equations:** derived from theory and usually taking an error correction formulation
  - **Technical relationships:** includes calibrated relationships and stylised forecasting assumptions e.g. ratio of pension contributions to total wages and salaries

Office for Budget Responsibility

1. Model structure

No.	Group
1	Consumption
2	Inventories
3	Investment
4	Labour market
5	Exports
6	Imports
7	Prices and wages
8	North sea
9	Public expenditure
10	Public sector receipts

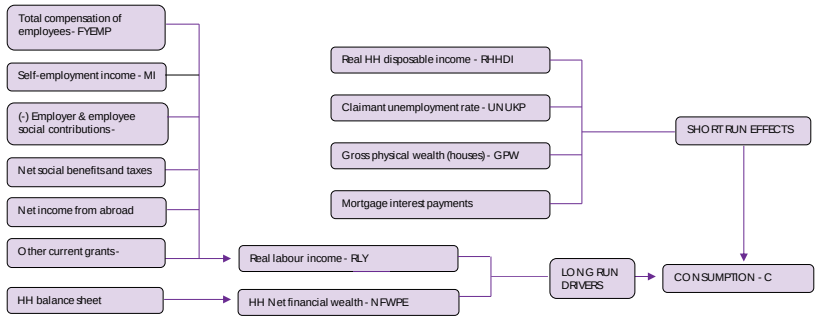
No.	Group
11	Balance of payments
12	Public sector totals
13	
14	Domestic financial sector
15	Income account
16	GDP
17	Financial account and balance sheet

Office for Budget Responsibility

2. Example: **consumption**

- Consumption is determined in the long run by current and expected lifetime resources, represented by real labour income and financial wealth
- Additional short-run dynamics from real disposable income, unemployment, interest rates and mortgage payments

$$\Delta C_t = \varphi_1 \Delta C_{t-1} + \sum_{i=0}^{2} \alpha_i \Delta RHHDI_{t-i} + \varphi_2 \Delta RPW_t - \varphi_3 \Delta U_t - \varphi_4 \Delta RS_t - \varphi_5 \Delta MORTR_{t-1}$$
$$- \varphi_6 (C_{t-1} - \alpha_1 RLY_{t-1} - \alpha_2 RFW_{t-1}) + dummies \ldots.$$



Budget Responsibility

2. Example: **consumption**

- Long run (static) solution:

$$C = 0.96(RLY) + 0.04(RFW) + constant$$

- Elasticity of consumption with respect to a 1% increase in:

	Q1	Long-run
Real labour income	0.12%	0.96%
Real financial wealth	0.01%	0.04%
Real housing wealth	0.11%	0.00%
Nominal interest rate[1]	-0.0005%	0.00%
Real HH disposable income	0.24%	0.00%
Unemployment rate (claimant count)	-0.01%	0.00%
Real value of mortgages	-0.22%	0.00%

[1]Semi-elasticity

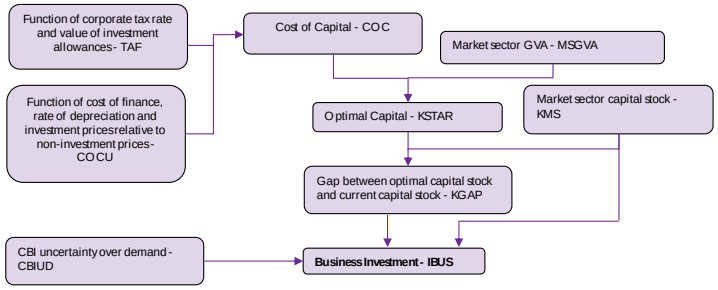
Office for Budget Responsibility

2. Example: **business investment**

- Business investment is determined according to the capital accumulation identity
- Optimal capital stock in turn based on relationship with output and the cost of capital i.e. first-order profit maximising condition of firm, CES production function

$$\Delta IBUS_t = \sum_{i=3}^{4} \alpha_i \Delta IBUS_{t-i} + \varphi_1 \Delta MSGVA_{t-1} - \varphi_2 \, CBIUD - \varphi_3 (IBUS_{t-1} - \alpha_1 KMS_{t-2} - \alpha_2 (KMS_{t-2} - KSTAR_{t-2})) + dummies \ldots.$$

$$KSTAR = MSGVA - 0.4(COC) + constant$$



2. Example: **business investment**

- Long run (static) solution:

$$IBUS = (MSGVA) - 0.4(COC) + constant$$

- Elasticity of business investment with respect to a 1% increase in:

	Q1	Long-run
Market sector GVA	1.04%	1.00%
Cost of capital	0.00%	-0.40%

3. The macro model and the forecast

- Model is a computational tool – **central role for judgement**, particularly given structural breaks:
  - Interpretation of residuals from the behavioural equations
  - Forecast judgement often informed by auxiliary models
  - Comparable episodes/long-run trends
  - External 'conditioning' assumptions e.g. interest rates/oil prices
- Some elements of forecast are **determined entirely outside** the model e.g. aggregate supply/potential output
- **Use a range of approaches and models** to inform the forecast
- Weight placed on different approaches may vary with forecast horizon

Office for Budget Responsibility

3. The macro model and the forecast: GDP

- Utilise a range of different approaches in forecasting GDP:
  a. **Top-down models** based on survey indicators e.g. CIPS/PMI
  b. **Expenditure composition** i.e. GDP=C+I+G+(X-M)
  c. **Supply-side/potential output**: GDP growth ultimately constrained by productivity/labour force growth
- All approaches valid, but will place more weight on different approaches at different horizons:
  - Forecast for next quarter: most weight on top-down models
  - Forecast for next 2-3 years: led by expenditure components
  - Medium-term (i.e. 4-5 years): largely driven by potential output assumptions

Office for Budget Responsibility

3. The macro model and the forecast: GDP

- Forecasts of short-term GDP growth at quarters t and t+1 informed by a range of top-down models:
  - **'Bridge'- type models** – monthly ONS data by industry
  - **Principal component model** – using range of indicators including consumer confidence, claimant count, retail sales, index of production etc…..
  - **Survey indicators** – mapping from CIPS/CBI indicators
  - **Simple AR benchmark**
  - **Allowance for "special events"** (e.g. Olympics, bank-holidays, weather)
- Top-down models supplemented by bottom-up view of expenditure components of GDP

Office for Budget Responsibility

3. The macro model and the forecast: output gap

•Output gap estimates play a central role in the forecast:

- Five-year forecast
- Identification of cyclical vs structural budget balance

•Range of models/techniques:

- Cyclical indicator methods
- Univariate methods i.e. filters
- Multivariate methods
- Production function: Cobb-Douglas production function

•Central estimate also informed by other relevant factors – e.g. changes in the unemployment rate relative to the NAIRU

Office for Budget Responsibility

3. The macro model and the forecast: output gap

Assume a general structural economic relationship, that contains the output gap as an unobserved variable - such as the Phillips curve below:

$$\pi_t = \beta_1 \pi^e_{t+1} + (1-\beta_1)\pi^e_{t-1_t} + c_{t-j} + \varepsilon_{3,t}$$

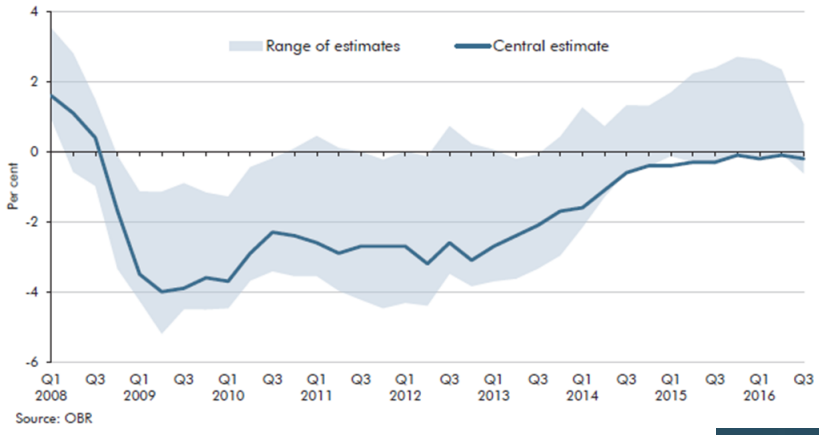
- We can take account of this structural relationship in the objective function of the filter

$$\sum_{t=1}^{T} \left(\frac{1}{\sigma_1^2}(c_t)^2 + \frac{1}{\sigma_2^2}\left(\Delta y^*_{t+1} - \Delta y^*_t\right)^2 + \frac{1}{\sigma_3^2}\left(\varepsilon_{3,t}\right)^2 \right)$$

So the filter also aims to achieve the best fit of the Phillips curve (or any other equation we like)

3. The macro model and the forecast: output gap

Output gap estimates (November 2016)



Source: OBR

Office for **Budget Responsibility**

4. The OBR small model

•Scale/structure of large macroeconomic model makes it less suitable for scenario analysis:

- No endogenous monetary policy
- Scale makes it difficult to trace through relationships/interdependencies

•Use a four-equation 'small' model for scenario analysis, including scenarios published in our *Economic and Fiscal Outlook*

•Model parameters are largely calibrated

Office for Budget Responsibility

4. The OBR small model

• Four equations include an IS relationship, Phillips Curve, Taylor rule and an uncovered interest parity condition

$$y_t = \beta_y y_{t-j} + \beta_r z_{t-j} + \beta_{er} \Delta er_{t-j} + \mu_t .$$

$$\pi_t = \varsigma \pi_{t-j} + (1-\varsigma)\pi^* + \lambda_y y_{t-j} + \lambda_e \Delta e_{t-j} + \varepsilon_t .$$

$$i_t = (1-\psi)\bar{i}_t + (1-\psi)\gamma_y y_{t+j|t} + (1-\psi)\gamma_\pi \left(\pi_{t+j|t} - \pi^*\right) + \psi i_{t-1} .$$

$$\Delta er_t = (e_t - e_{t-1}) + \pi_t - \pi_t^f$$

• Extended model allows for credit spread term in "effective" interest rate

Office for Budget Responsibility

5. Summary

- OBR use a large-scale macroeconomic model for the economic forecast
- Nature of the model reflects the purpose for which we use it.
- Judgement plays a key role in the forecast
- Use a range of other models to inform the forecast
- Small model for scenario analysis

Office for **Budget Responsibility**