The Bank of England's forecasting platform

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8 March 2018

The forecast process: key features

▶ Each quarter, the Bank publishes an *Inflation Report*, including 'fan charts' that depict

> the **MPC's best collective judgement** *about the most likely paths for inflation, output and unemployment, and the uncertainties surrounding those central projections.*

▶ Forecasts are
  ▶ Owned by the MPC
  ▶ Conditional on the paths for the interest rate, the exchange rate, government spending
  ▶ Ultimately determined by judgement, not models

▶ Forecasting platform
  ▶ Collection of models and tools
  ▶ Supports staff in facilitating MPC discussions

Key elements of forecast platform design

- Single model cannot perform well in all roles
  - "Essentially, all models are wrong, but some are useful." George Box (1987)

- Central model to 'organise' the forecast
  - Provides baseline framework for consistency of analysis
  - Guiding principles: Theoretical consistency, tractability, flexibility
  - ⇒ COMPASS: Medium-scale new-Keynesian open-economy DSGE model

- Use a suite of models
  - Help cope with misspecification of central model
    - Structural and reduced-form models, ranging from single-equation models to alternative versions of COMPASS (e.g. COMPASS with energy)
  - Provide cross checks on analysis from central model
    - Recent effort to revamp suite of state-of-the-art forecasting/nowcasting models

COMPASS flows and sectors schematic
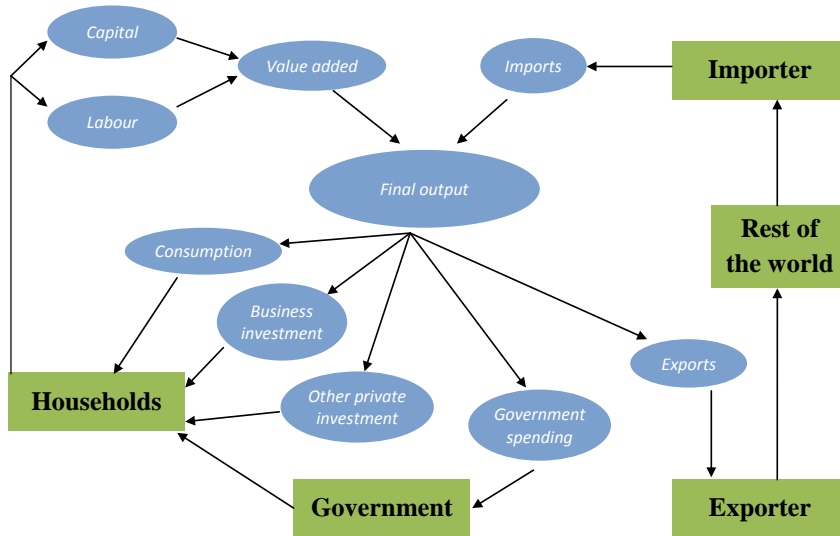
Key behavioural equations and parameters

- Phillips curves for prices of value-added, consumption, import, exports and labour
  - Price adjustment costs (Calvo in the current version of COMPASS)
  - Indexation parameters and share of firms that follow rule-of-thumb pricing
  - Elasticity of labour supply
- Euler equations for consumption and investment
  - Investment adjustment cost parameter (Tobin's q)
  - External habits and share of rule-of-thumb consumers
- The world
  - Exogenous to UK economy
  - SVAR of world GDP, world prices and world interest rates
- Export demand
  - Price elasticity of export demand
- Import demand, which arises from the cost minimisation of final goods producers
- UIP condition

⟩ Households   ⟩ Firms   ⟩ Trends

Monetary and fiscal policy

- Monetary policy follows a reaction function responding to output gap and CPI inflation, with interest rate smoothing

- Simple articulation of fiscal policy
    - Government spending modelled as stochastic process around trend
    - Lump sum taxes levied on unconstrained households: implies a form of Ricardian equivalence
    - Assume budget balanced each period for simplicity

- Forecasts conditioned on implications of announced fiscal plans and measure of market expectations of Bank Rate

Estimation

- Model is estimated on first differences for all I(1) variables

- Bayesian estimation methods
  - Combine prior information on the parameters with information about the relevant data series

- Data sample 1993Q1–2016Q4 for following variables
  - Real GDP, consumption, (business) investment, government spending, exports & imports
  - CPI, import prices, export prices
  - nominal exchange rate, "shadow" Bank Rate
  - Total hours worked, wages (AWE)
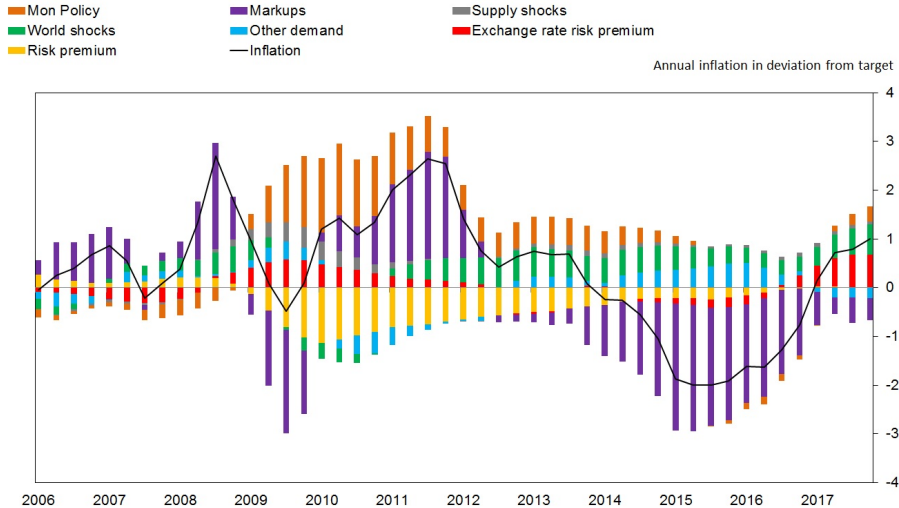 - World demand, world export prices

Policy Analysis in COMPASS

Responses to a 50bp increase in the policy rate
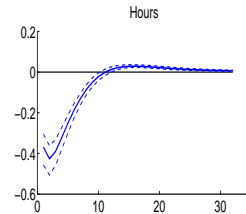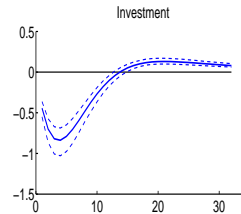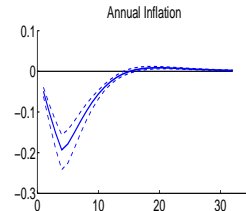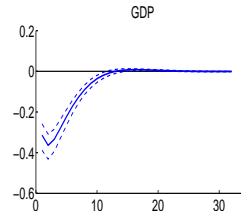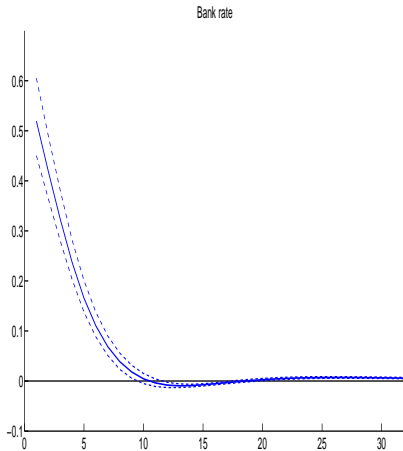
Policy Analysis in COMPASS

Stochastic Simulations in COMPASS

- COMPASS simulations used to assess if the private sector perceived the ZLB as a binding constraint on policy

Stochastic Simulations in COMPASS

- COMPASS simulations used to assess if the private sector perceived the ZLB as a binding constraint on policy

- Compared deflation probabilities from COMPASS with deflation probability measure from professional forecasters and financial markets

  - Professional forecasters and financial markets identify 2009 and 2015 as periods of heightened deflation risk
  - Model simulations produced with no ZLB also identify 2009 and 2015, while model with an ZLB also picks up 2012-2013
  - While 2009 and 2015 deflation risk is mainly driven by weak inflation outlook, the 2012-2013 is driven by presence of the ZLB

- COMPASS sims suggest the private sector did not perceive the ZLB to pose a significant constraint on policy
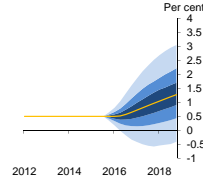
- Haberis, Masolo, Reinold (forthcoming IJCB)
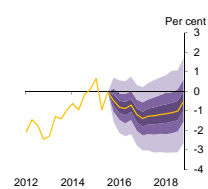
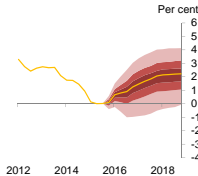# Stochastic Simulations in COMPASS
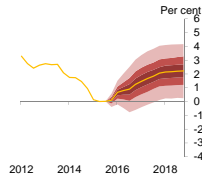
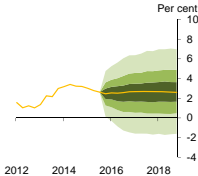(a) CPI inflation, No ELB
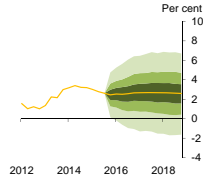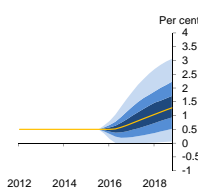
(b) GDP growth, No ELB

(c) Bank Rate, No ELB
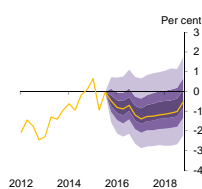
(d) Real rate, No ELB

(e) CPI inflation, 0% ELB

(f) GDP growth, 0% ELB

(g) Bank Rate, 0%ELB

(h) Real rate, 0% ELB

Core COMPASS with myopic households

- ▶ COMPASS is also a laboratory.

- ▶ The assumption of full information rational expectations is often questioned by the Monetary Policy Committee.
  - ▶ MPC tend to believe model's responses are too front-loaded
  - ▶ The forward guidance puzzle suggests that indeed the role of expectations in the distant future is too strong
  - ▶ In the "natural experiment" of Brexit, consumers responded much less than expected.

- ▶ We have experimented with behavioural assumptions:
  - ▶ COMPASS with adaptive expectations for all variables but the exchange rate
  - ▶ Gabaix (2016)-style behavioral (stripped down version of) COMPASS

Core COMPASS with myopic households

COMPASS: other development in train

- ► COMPASS with energy
  - ▸ Dynamic general equilibrium model that includes a wide range of potential channels through which energy price shocks may affect the economy
  - ▸ Households consume ofinal energy goods (petrol and utilities) separately from other goods and services
  - ▸ The production of energy and the way that energy enters the production processes of other non-energy goods and services is modelled explicitly.

- ► Time-varying COMPASS (Kapetanios, Masolo, Petrova, Waldron 2017)
  - ▸ Investigate structural change through the lense of COMPASS
  - ▸ Bayesian local likelihood methods (Galvao, Giraitis, Kapetanios and Petrova, 2017)
  - ▸ Gradual shift to a monetary policy regime characterised by a marked increase in the responsiveness of monetary policy to inflation alongside a decrease in the level of trend inflation down to the 2% target level.

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- COMPASS with financial frictions

Suite of models

- ▶ Set of empirical models to cross-check the MPC's forecast.
    - ▶ BVAR, Dynamic factor model, etc

- ▶ We are working on a DSGE-VAR for COMPASS (Del Negro and Schorfheide 2004)

- ▶ Exploring various models for Brexit
    - ▶ class of infinite-horizon nonlinear dynamic economic models in which preferences, technology and laws of motion for exogenous variables can change over time deterministically or stochastically (Maliar *et al.*, 2015)
    - ▶ Bilbiie-Ghironi-Melitz (2012) type models to capture the endogenous firm entry/exit dynamics.

- ▶ Other modelling approaches
    - ▶ Advanced Analytics Division working on agent-based models

Additional slides

Households

- Share ω_o of households can access the financial markets and are able to save and borrow
    - choose how much to consume/invest/work/hold money to maximse their utility subject to the budget constraint
    - Key frictions they face:
        - external habits
        - wage rigidities *à la* Calvo
        - investment adjustment costs
- Share of households $1 - \omega_o$ do not access financial markets
    - consume their labour income plus a transfer from the goverment
    - take wage set by the optimising households as given
    - supply the same amount of labour as optimising households

▸ back

Firms

- ► There are 5 types of firms in COMPASS: final output producers, value-added producers, importers, exporters and retailers.

- ► All monopolistically competitive, bar the retailers.

- ► In the current version of COMPASS, we model price rigidities according to Calvo (1983).

- ► In addition to indexation, we also have a (small) share of firms in each sector that do rule-of-thumb pricing (Galì and Gertler, 1999)

- ► Retailers are perfectively competitive firms with different technologies applying to each separate sector, giving rise to different trend growth rates for consumption, investment, government and trade

▸ back

Trends

- Model includes a permanent labour augmenting productivity shock
    - Expenditure, wages and GDP are all treated as I(1) and cointegrated

- Simple CRS retail sector incorporates determinstic technology trends that can vary by expenditure component
    - Real great ratios and relative prices are trended (trend stationary)

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