Seðlabanki Íslands

Central Bank of Iceland's macromodel

Revision with model consistent expectations

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Introduction

QMM

- Handbook, database and necessary model files available at the Bank's homepage
- Several institutes analysing the Icelandic economy have started using the model
  - Ministry of Finance, Landsbanki, ASÍ and IMF
- A balanced-growth compatible version of QMM is currently under construction and will be available shortly

QMM

- New version of QMM
  - Re-estimation with additional data from 2005-6
  - Revisions and updates
  - Forward-looking (model consistent) expectations
- Although the new version includes rational expectations a version with backward-looking (adaptive) expectations is also included in the handbook

Overview of QMM structure

QMM: Structure and size

- QMM is basically an empirically estimated error-correction model
  - Structure, explanatory variables and model properties are, however, not only based on empirical fit but also on the overall structure and properties of the model
- Number of variables: 152
  - Endogenous variables: 107
    - Behavioural (30), technical (22), definitions (29) og identities (26)
  - Exogenous variables: 45
- QMM database
  - Quarterly data from 1990 for almost all variables and stretching back to the early 1970s for almost half of the variables

QMM: Level of aggregation

- QMM is a relatively simple, medium sized model of the Icelandic economy
  - Highly aggregated but sufficiently detailed to describe the most important parts of the macrostructure of the economy
  - Simple enough to manage the model and its database and to have sufficient understanding of its short and long-run properties
  - A drawback is that information of the finer details of the economy is lost
  - For the Central Bank, however, the key importance is that the model describes the main transmission channels of monetary policy in line with modern macroeconomic literature and research

QMM: Main sectors

- Financial system
  - Interst rates , asset prices and wealth
- Demand and production
  - Expenditure, net trade and potential output
- Labour market
  - Wages, productivity and employment
- Price setting
  - Prices of different expenditure items and inflation
- Public sector
  - Taxes, expenditure and net borrowing
- Household income accounts

Monetary policy in QMM

The monetary policy rule in QMM

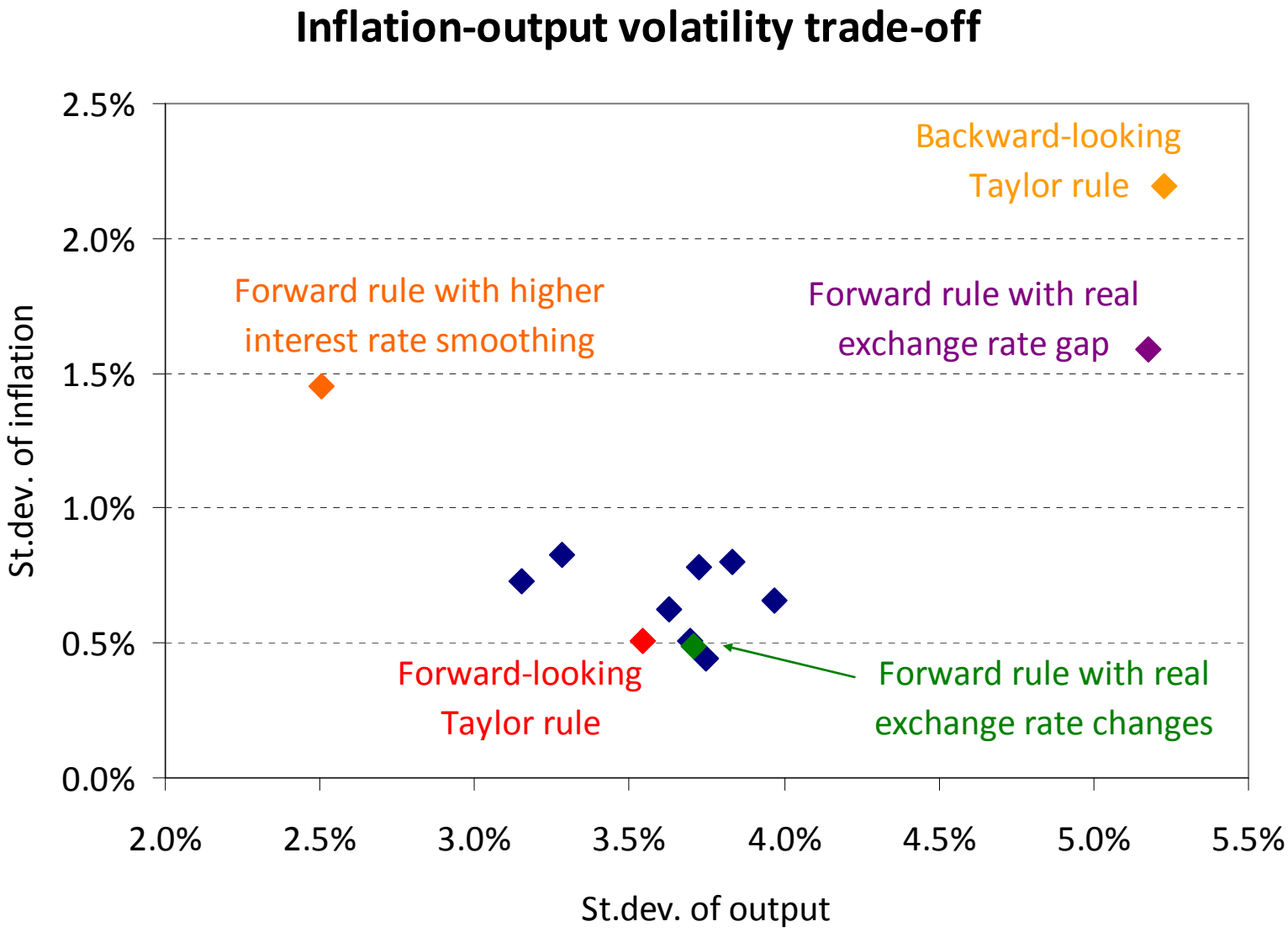
- QMM assumes that monetary policy of the Central Bank is set in terms of a forward-looking Taylor rule
- The rule and its parameters were chosen from a large set of alternative policy rules
  - Chosen such as to minimise the variability of inflation and output

$$RS_t = 0.6RS_{t-1} + 0.4\left[(RRN_t + IT_t) + 1.5(INF_{t+4} - IT_t) + 0.5GAPAV_t\right]$$

where:

RS	Short-term interest rate (4.1).
RRN	Real neutral interest rate (exogenous).
IT	Central Bank of Iceland 2.5% inflation target (exogenous).
INF	Four-quarter CPI inflation rate (7.15).
$GAPAV$	Annual average of output gap (5.44).

New policy rule improves trade-off



Other main changes in QMM

Long-term interest rates in QMM

- Long-term interest rates are determined by the expectations hypothesis but allowing the long rate to move more closely with the current short rate than is consistent with theory

$$RL_t = \underset{(2195.5)}{0.189}\,(RS_t + TERM_t) + (1 - 0.189)\,[RL_{t+1} + (RS_t - RS_{t+20})/20 + (TERM_{t+1} - TERM_t)] \quad (4.5)$$

Estimation method	GMM
Adjusted R^2	0.842
Equation standard error	0.58%
Coefficient restrictions (F-test)	0.00 [0.99]
J-test for over-identifying restrictions (χ^2-test)	6.03 [0.74]
Normality test (χ^2-test)	1.02 [0.60]
Sample period	1998:Q1-2003:Q4 ($T = 24$)

$$RL_t = 0.189 RS_t + (1 - 0.189) \sum_{j=0}^{19} RS_{t+j}/20 + TERM_t$$

Long-term interest rates in QMM

- Long-term real interst rates are given by the Fisher relation

$$RLV_t = (RL_t - INFE_t) - PRISK_t$$

- Long-term inflation expectations (break-even inflation expectations) are given as the expected inflation rate over the next 5 years

$$INFE_t = \frac{1}{20} \sum_{j=0}^{19} INF_{t+j}$$

Exchange rates in QMM

- The real exchange rate is given by the UIP relation where the real exchange rate depends on its expected value and the risk-adjusted real interest rate differential
  - But allows for backward-looking expectations by some investors

$$rex_t = \alpha_{rex} rex_{t-1} + \beta_{rex} rex^e_{t+1} + (1 - \alpha_{rex} - \beta_{rex}) rexeq_t + rid_t$$

$$rex^e_{t+1} = \gamma_{rex} rex_{t-1} + \phi_{rex} rex_{t+1} + (1 - \gamma_{rex} - \phi_{rex}) rexeq_t$$

$$\begin{aligned}(rex_t - rexeq_t) \quad = \quad & (\alpha_{rex} + \beta_{rex}\gamma_{rex})(rex_{t-1} - rexeq_t) \\ & + \beta_{rex}\phi_{rex}(rex_{t+1} - rexeq_t) + rid_t\end{aligned}$$

Exchange rates in QMM

$$(rex_t - rexeq_t) = \underset{(5.7)}{0.552}(rex_{t-1} - rexeq_t) + \underset{(4.8)}{0.435}(rex_{t+1} - rexeq_t) + rid_t \quad (4.16)$$

Estimation method	GMM
Adjusted R^2	0.904
Equation standard error	2.67%
Coefficient restrictions (F-test)	0.05 [0.83]
J-test for over-identifying restrictions (χ^2-test)	1.73 [0.42]
Normality test (χ^2-test)	16.7 [0.00]
Sample period	1997:Q1-2007:Q4 ($T = 44$)

- The nominal exchange rate is then derived from the real exchange rate and relative price levels

Inflation in QMM

- Year-on-year inflation is determined by a forward-looking Phillips curve
  - Allows for backward-looking expectations by some agents and short-run supply shocks from the real exchange rate and real unit labour costs

$$\begin{aligned}\Delta_4 cpi_t &= \underset{(13.8)}{0.625}\Delta_4 cpi_{t-1} + \underset{(3.8)}{0.178}\Delta_4 cpi_{t+8} \\ &+(1-0.625-0.178)\log(1+IT_t) + \underset{(3.8)}{0.111}\Delta_4 rexm_{t-1} \\ &+\underset{(2.4)}{0.077}\Delta_4(ulct_{t-4} - cpi_{t-4}) + \underset{(2.6)}{0.083}GAPAV_{t-1}\end{aligned} \tag{7.1}$$

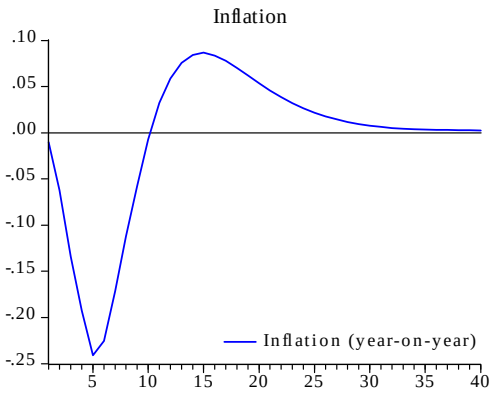
Estimation method	GMM
Adjusted R^2	0.883
Equation standard error	0.69%
Dynamic homogeneity (F-test)	1.17 [0.29]
J-test for over-identifying restrictions (χ^2-test)	1.26 [0.26]
Normality test (χ^2-test)	0.18 [0.91]
Sample period	1994:Q1-2006:Q3 ($T = 51$)

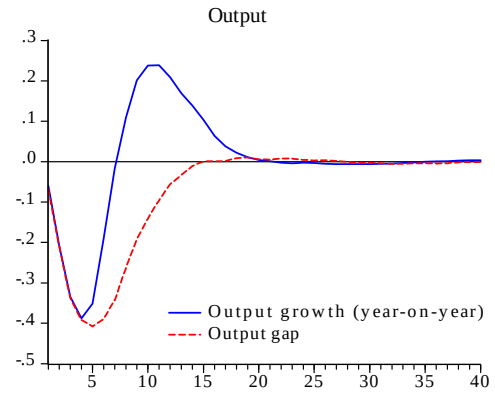
Other changes in QMM

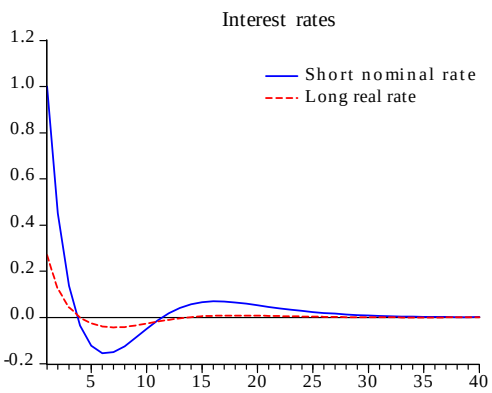
- All empirical equations have been re-estimated with data up to 2006
  - The consumption equation uses new data on disposable income from Statistics Iceland instead of the previous in-house version
  - No other major changes to empirical equations
  - A number of equations have, however, been revised to improve the overall properties of the model – especially to reduce the number of imaginary roots in the system and the resulting oscillatory behaviour found in previous versions
- A number of technical relations have been revised in light of new data

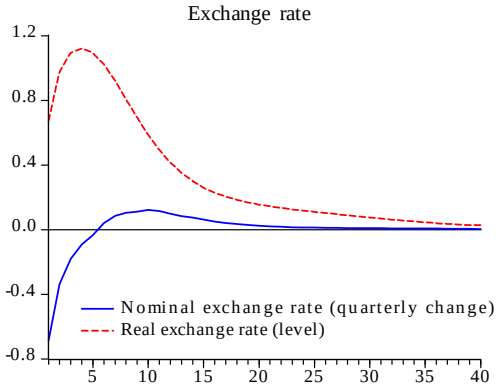
Model properties

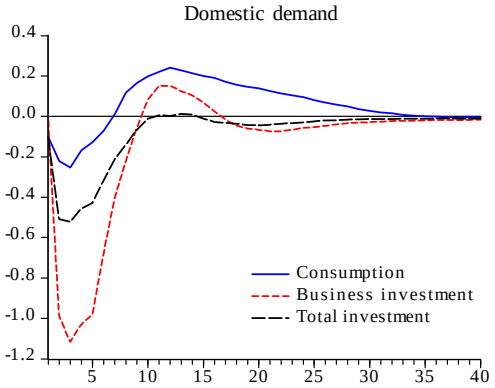
Monetary policy shock

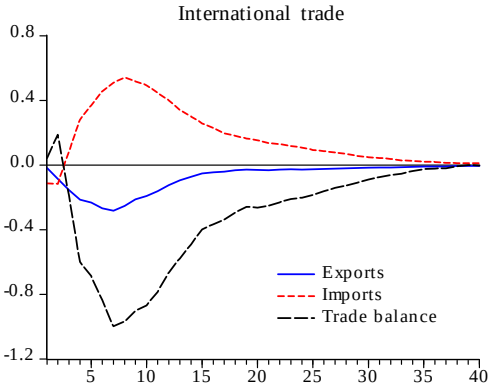


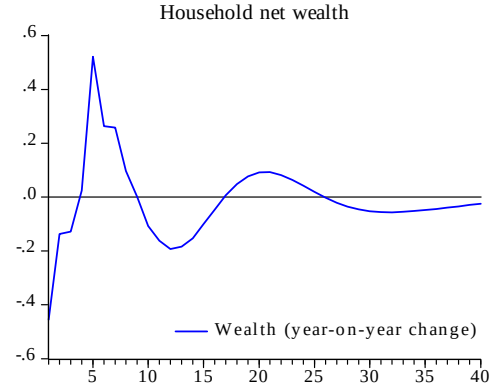


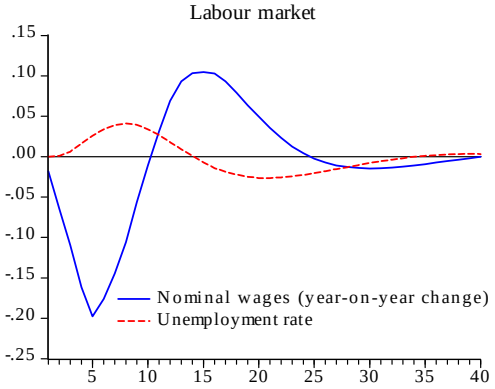








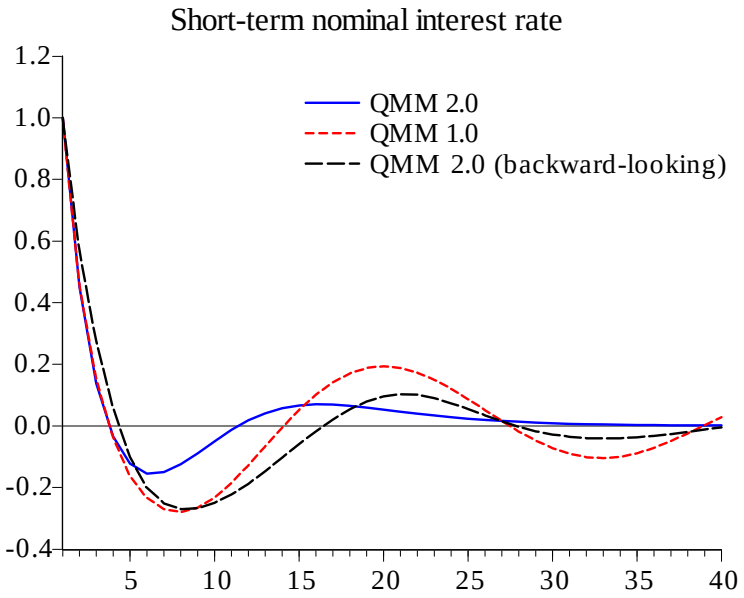


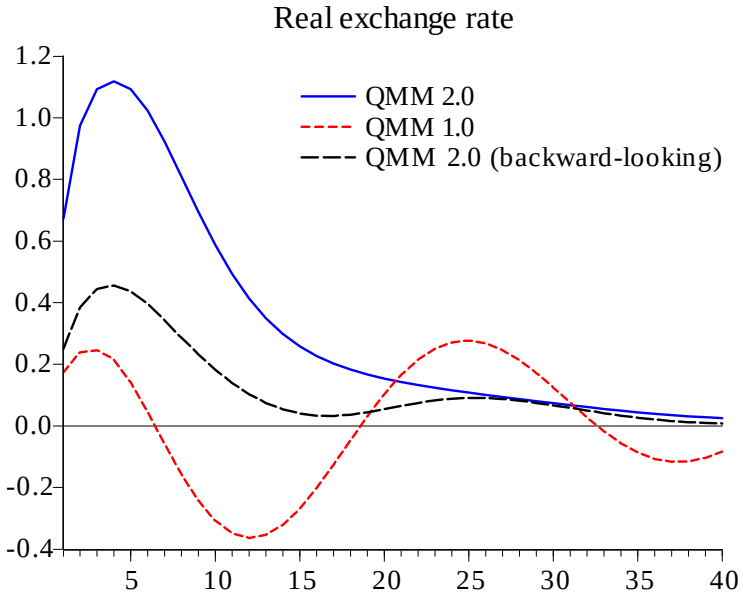


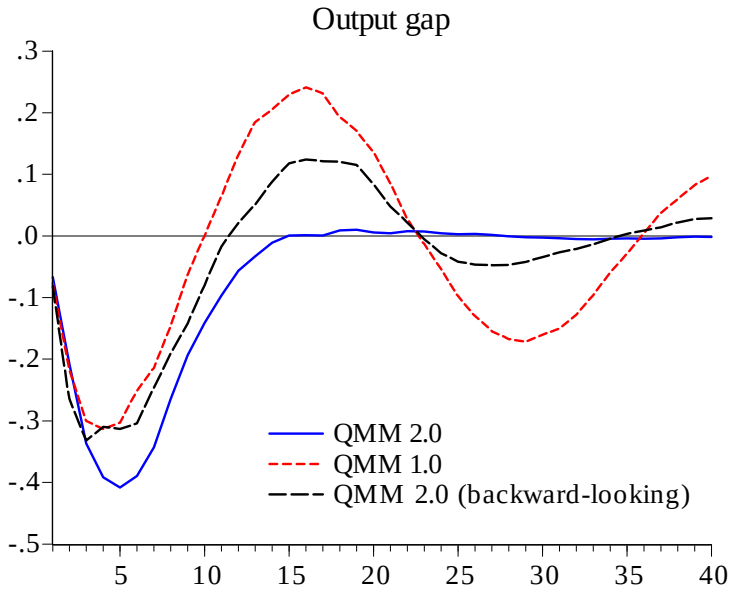
Monetary policy shock:

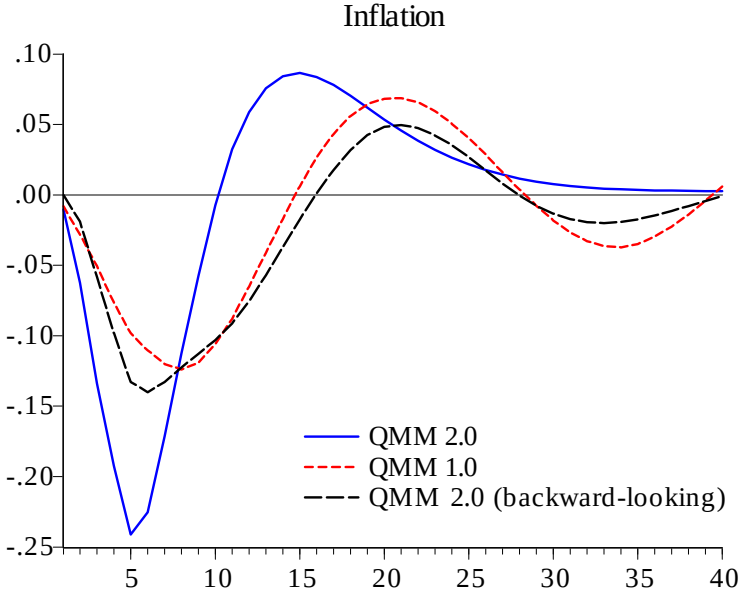
Unanticipated 1% rise in policy rate for 1 quarter; but follows Taylor rule after that

Comparison of policy shock in QMM 1.0

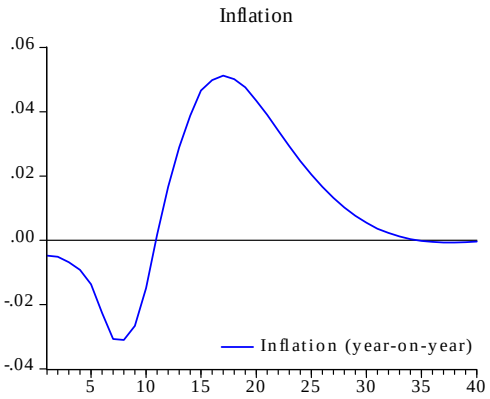


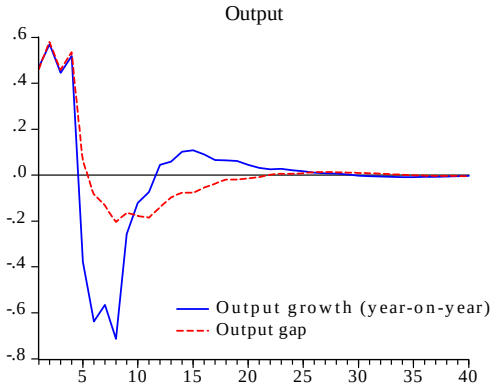


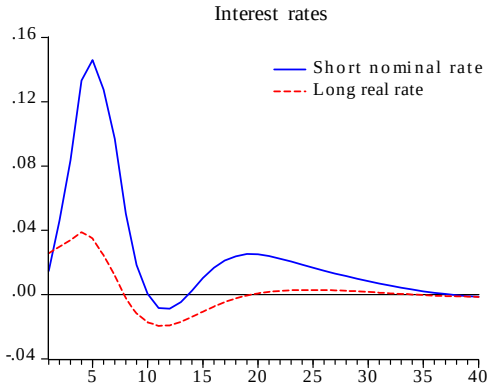


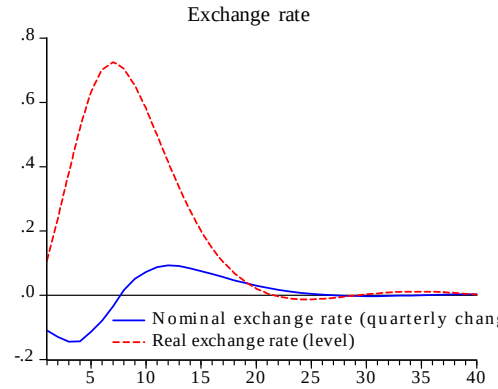


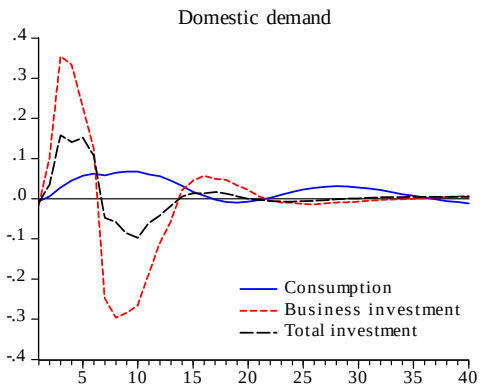
Government expenditure shock

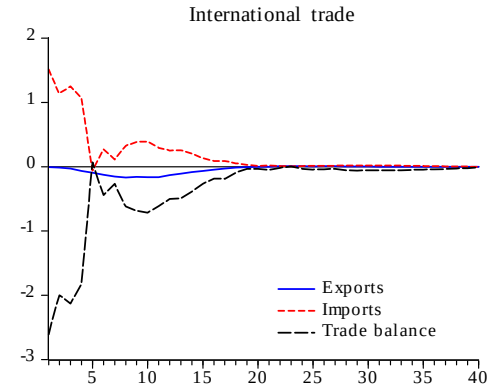


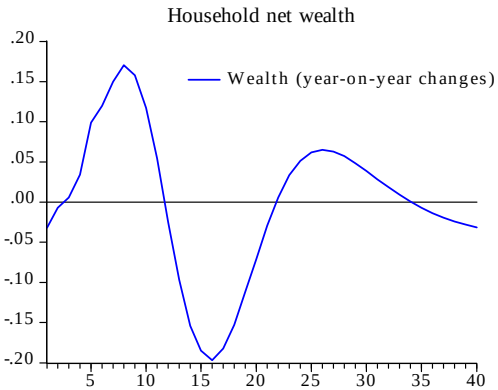


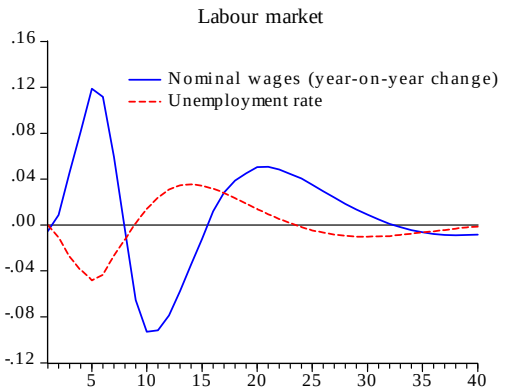








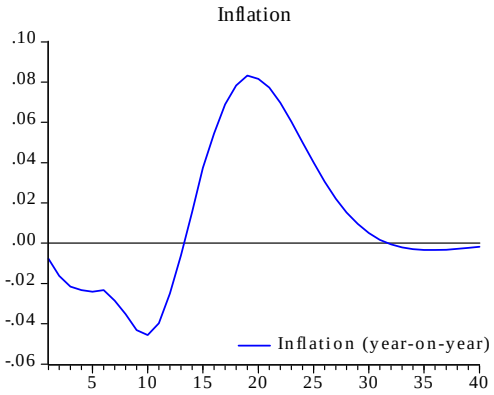


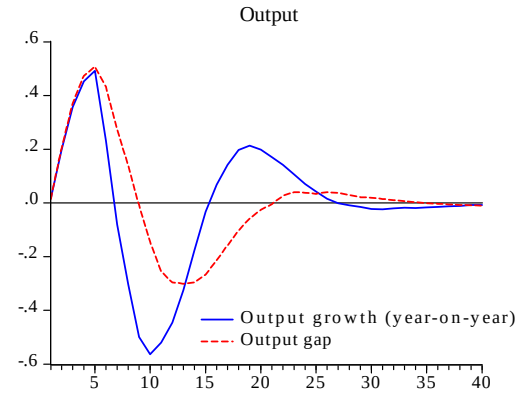


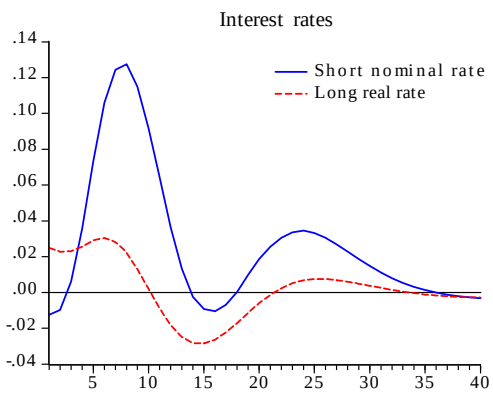
Government expenditure shock:

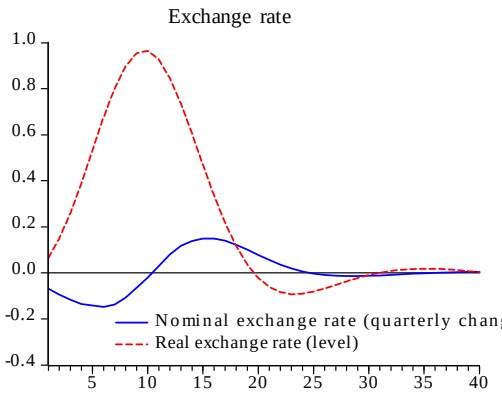
Unanticipated rise government consumption equivalent to 1% of nominal GDP for 1 year

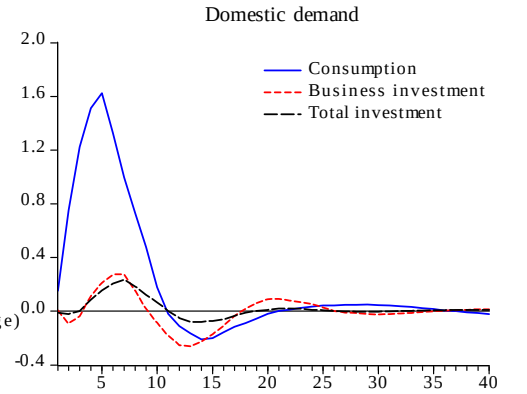
Income tax shock

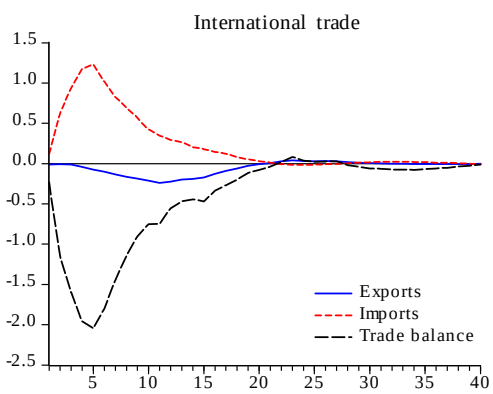


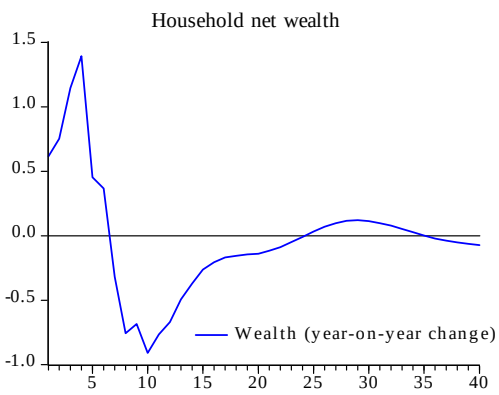


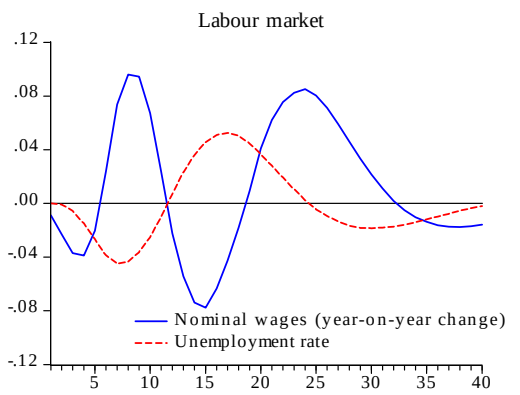










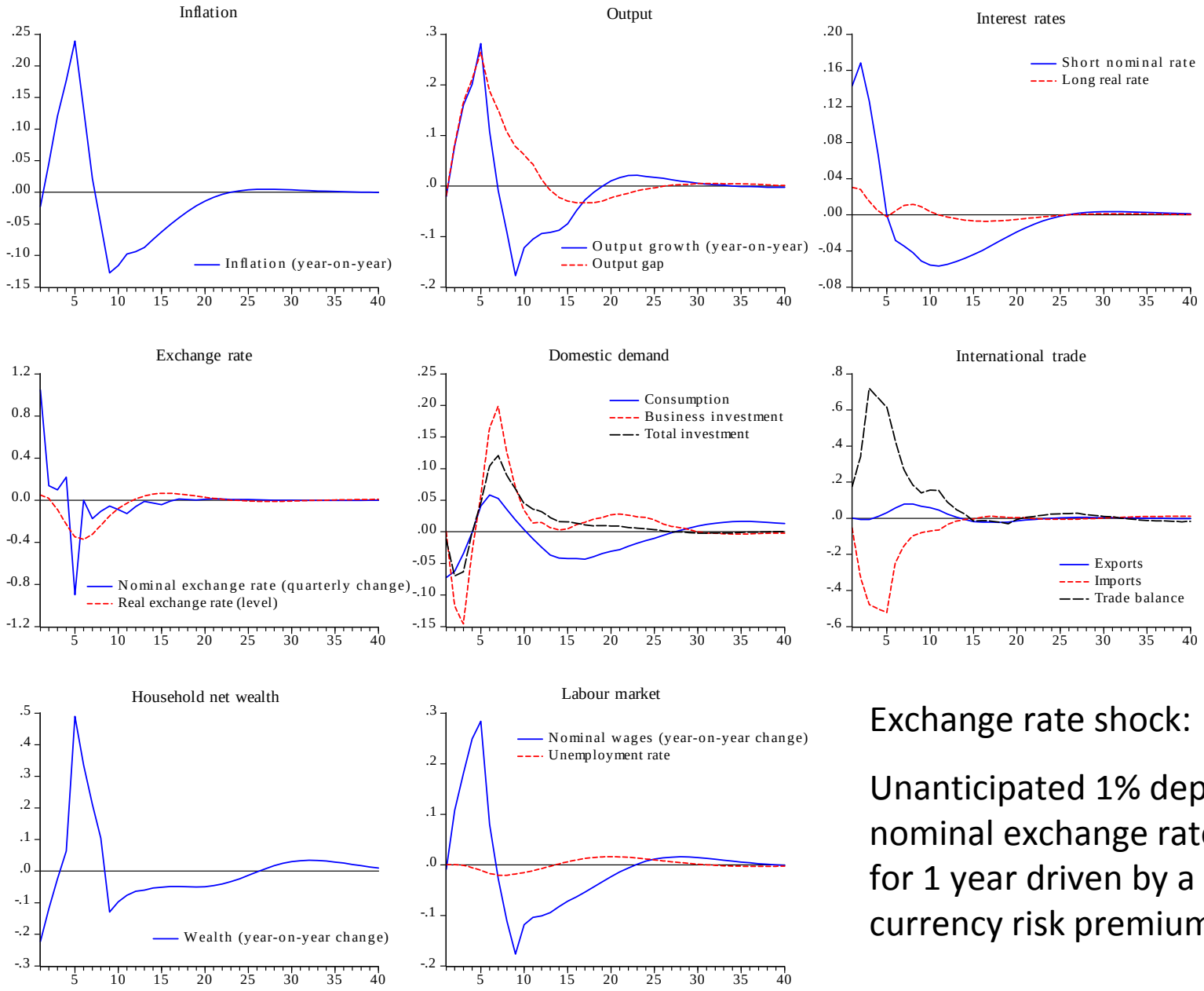


Income tax shock:

Unanticipated fall in income tax rate equivalent to 1% of nominal GDP for 1 year

Amounts to a 1⅔% cut in tax rate

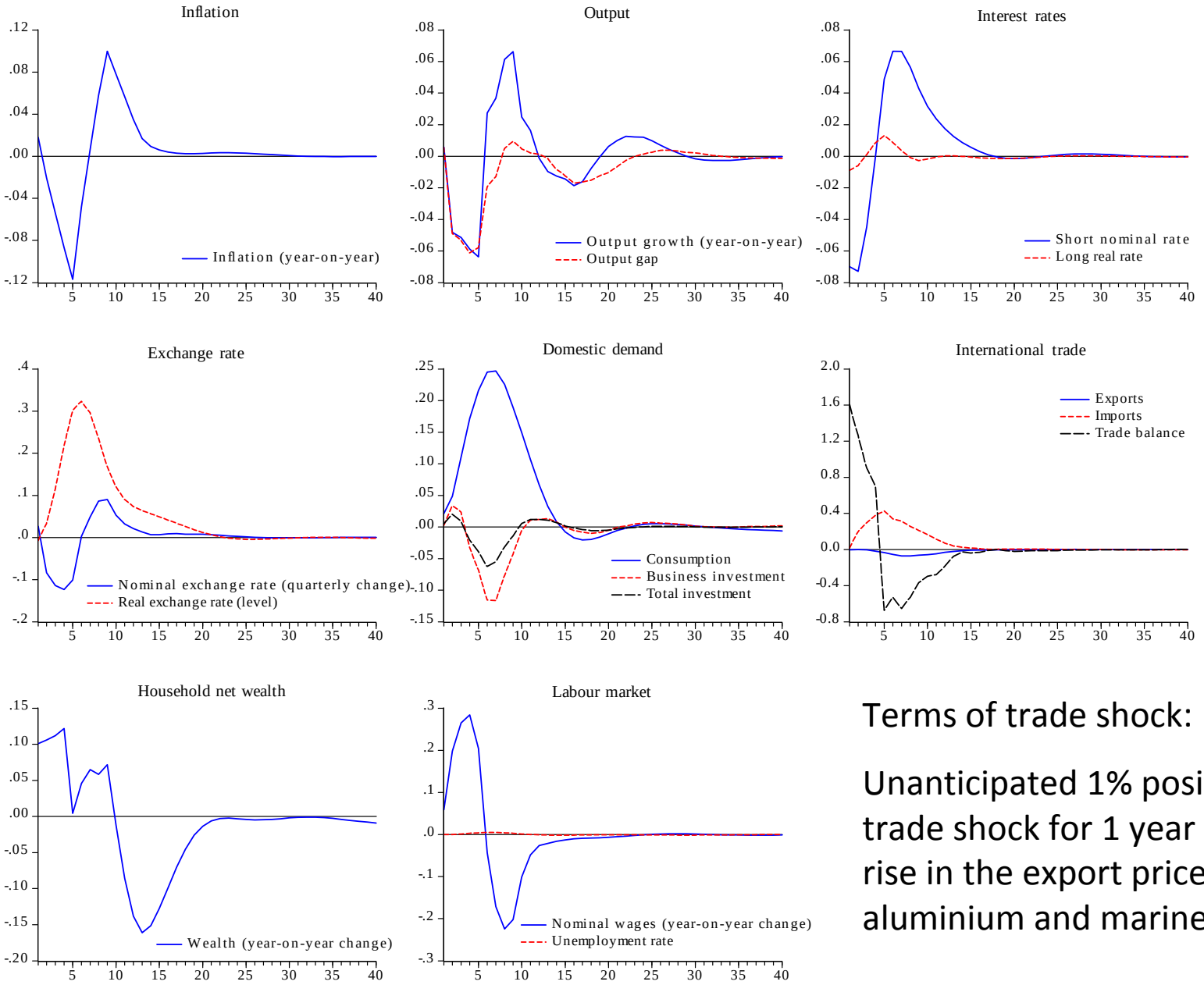
Exchange rate shock



Exchange rate shock:

Unanticipated 1% depreciation of nominal exchange rate that lasts for 1 year driven by a rise in the currency risk premium

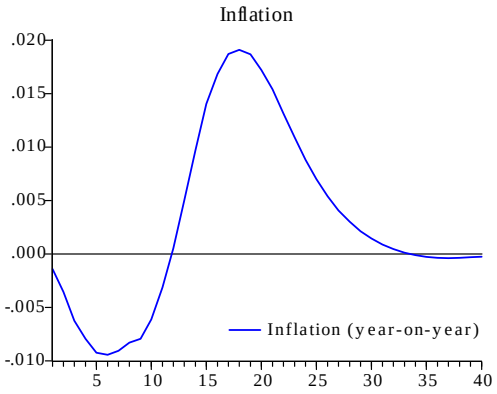
Terms of trade shock

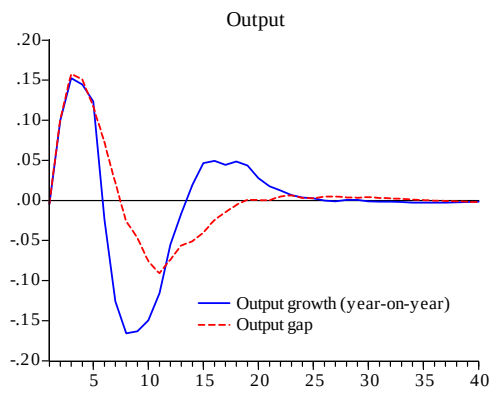


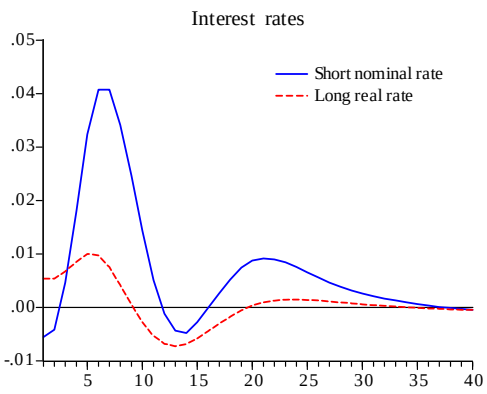
Terms of trade shock:

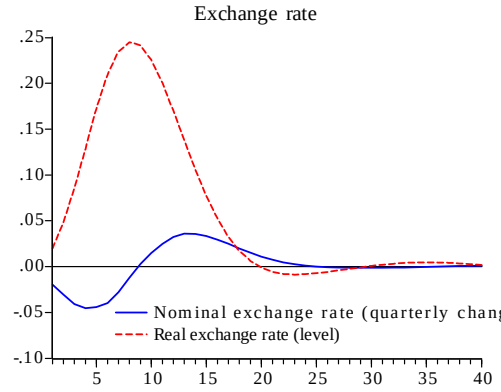
Unanticipated 1% positive terms of trade shock for 1 year driven by a rise in the export price of aluminium and marine products

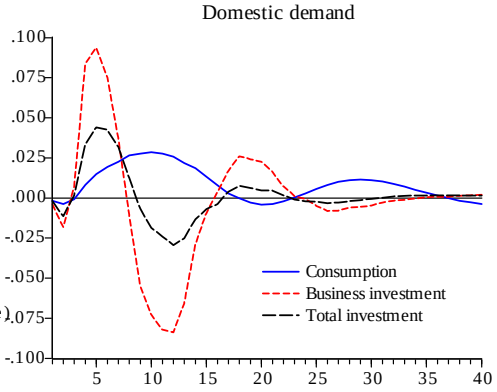
World demand shock

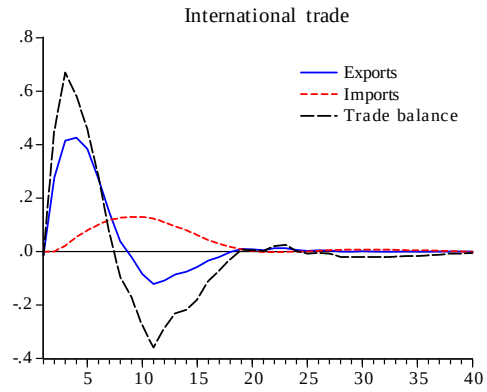


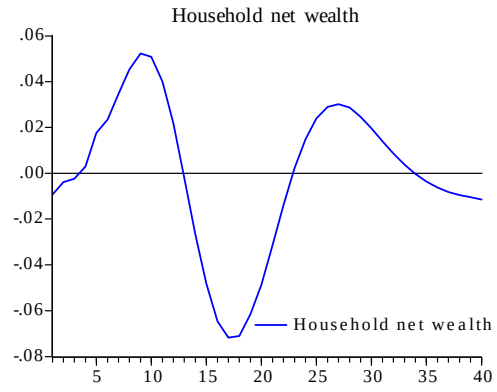


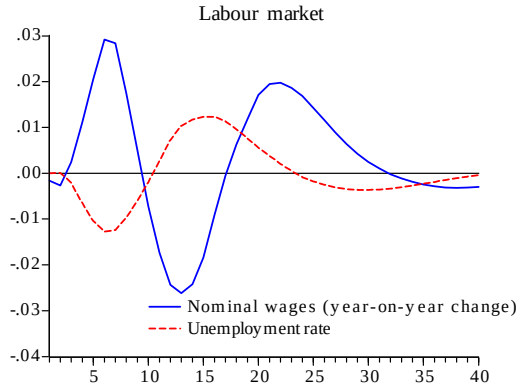








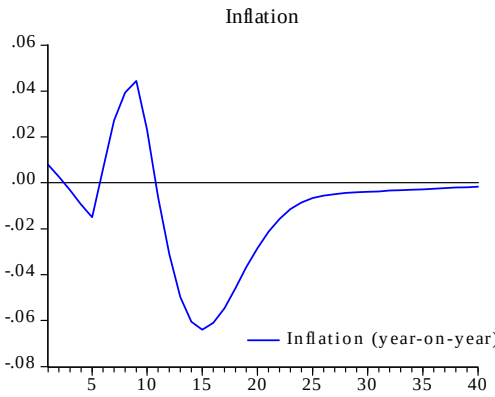


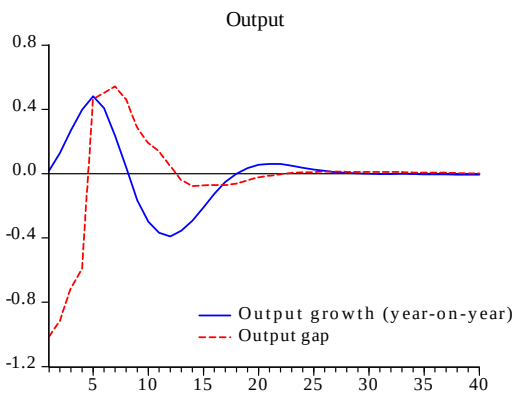


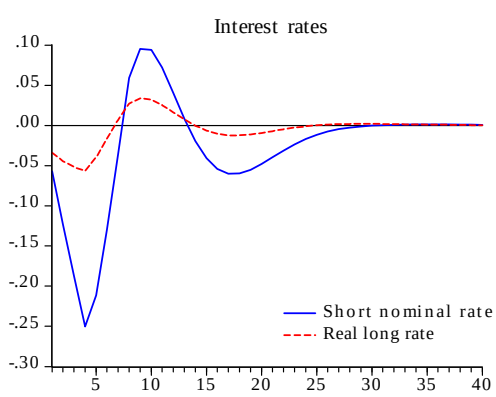
World demand shock:

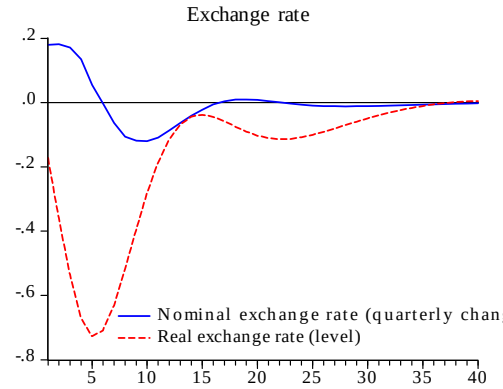
Unanticipated 1% increase in world output and trade for 1 year

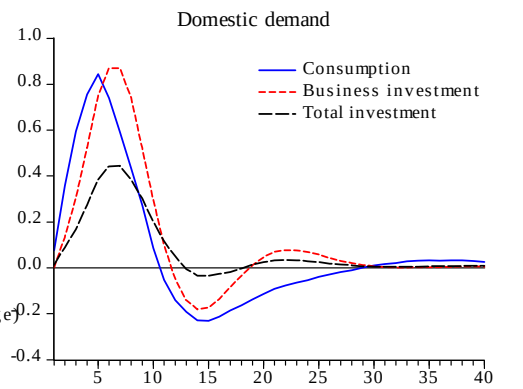
Productivity shock

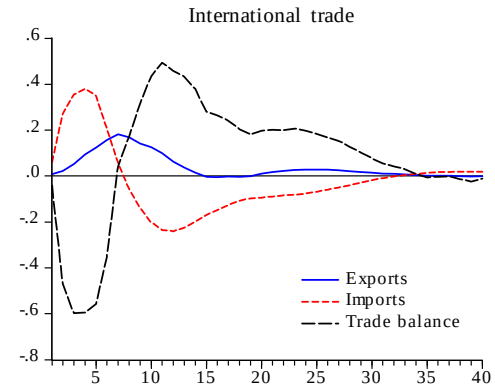


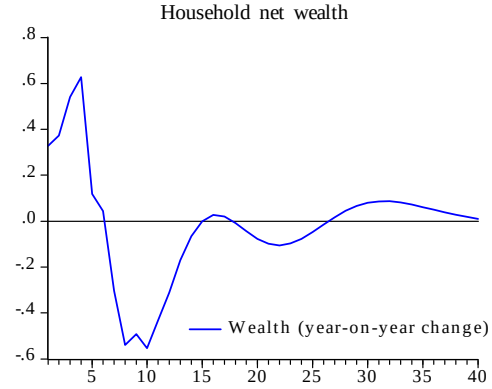


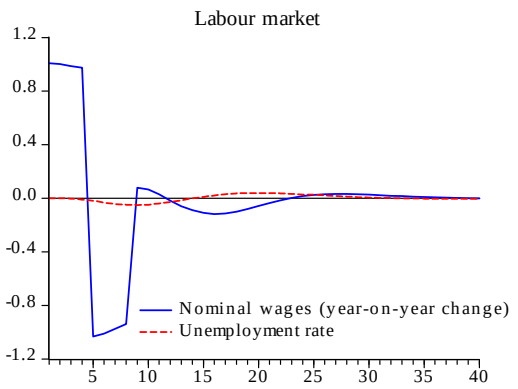












Productivity shock:

Unanticipated 1% increase in the level of labour productivity for 1 year