A Small Semi-structural Model for Thailand:
Construction and Applications
Modelling and Forecasting Team
Bank of Thailand
17 December 2008
Outline

- Motivation
- Model Construction
  - Bayesian estimation
- Model Structure
- Model Properties and Applications
  - Simulations
  - Policy analysis
  - Forecasting
- Conclusion
- Issues for discussions
1. **Construct a small-size model to supplement BOTMM/DSGE**
   - Comprehensive: capture the dynamics of major macroeconomic variables
   - Simple and tractable

2. **Semi-structural: a good blend between theories and empirics**

3. **Sufficiently versatile for a wide range of practical applications**
   - Policy/shock analyses
   - Forecasting
   - Constructing fan charts from joint distributions of assumptions
Model Construction

Model Structure

New Consensus in Macroeconomics

<table>
<thead>
<tr>
<th>New Keynesian</th>
<th>RBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Nominal and real rigidities</td>
<td></td>
</tr>
<tr>
<td>- AD in determining short-run output</td>
<td></td>
</tr>
</tbody>
</table>
- General equilibrium
- S-side determined equilibrium output

Stylized Facts

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
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<tbody>
<tr>
<td>International evidence</td>
</tr>
</tbody>
</table>

Bayesian estimation of parameters

Small Model

Data

Data on the Thai economy (2000-2008)

Data on 10 major trading partners* (2000-2008)

* US, Japan, Euro-area, China, Singapore, Malaysia, Korea, Taiwan, Indonesia, Philippines
Model Structure

9 behavioural equations (6 domestic + 3 foreign) + 5 identities

- **IS (Output gap equation)**
  \[ y_{\text{gap}} = \beta_1 y_{\text{gap},t-1} + \beta_2 y_{\text{gap},t+1} - \beta_3 (r_t - r^*) - \beta_4^* (z_t - z^*) + \beta_5 y_{\text{gap}} + \epsilon^y_t \]

- **AS (Phillips curve)**
  \[ \pi_t^Q = \delta_1 \pi_{t+4}^A + \delta_3 \pi_{t-1}^A + \delta_2 y_{\text{gap}} + (1 - \delta_1 - \delta_3) (\pi_t^f - \Delta e_t) + \epsilon^\pi_t \]

- **Exchange rate equation**
  \[ z_t = z_t^e + \gamma_2 (r_t - r^f_t - \text{risk})/4 + \gamma_3 c_{\text{a}} + \epsilon_t^z \]

- **Monetary policy rule (reaction function)**
  \[ i_t = \alpha_1 i_{t-1} + (1 - \alpha_1) (r^* + \pi_{t+1}^Q + \alpha_2 (\pi_{t+4}^A - \pi^*) + \alpha_3 y_{\text{gap}}) + \epsilon_t^i \]

- **Current account**
  \[ c_{\text{a}} = \eta_1 (z_{t-1} - z_t) - \eta_2 y_{\text{gap}} + \eta_3 y_{\text{gap}} + \epsilon_t^{\text{ca}} \]

- **Exchange rate expectations**
  \[ z_t^e = \lambda z_{t+1} + (1 - \lambda) z_{t-1} + \epsilon_t^{zx} \]

- **Identities**
  \[ \Delta e_t = (z_t - z_{t-1}) + \pi_t^f - \pi_t \]
  \[ r_t = i_t - \pi_{t+1}^Q \]
  \[ \pi_t^A = (\pi_t^Q + \pi_{t-1}^Q + \pi_{t-2}^Q + \pi_{t-3}^Q)/4 \]
Bayesian estimation is a bridge between calibration (specification of priors) and maximum likelihood (confronting the model with data)

**The Bayes formula**

\[ p(\theta|Y, M) = \frac{L(Y|\theta, M) p(\theta|M)}{p(Y|M)} \]

**Why Bayesian?**

- Able to cope with some shortcomings of calibration and maximum likelihood analysis
- By allowing the consideration of priors, it avoids the posterior distribution peaking at strange points where the likelihood peaks.
- The inclusion of priors helps identifying parameters
- Bayesian estimation explicitly addresses model misspecification by including shocks - observation errors in the structural equations
- Allows model comparisons based on fit

**Estimation Procedure**

- Priors on parameters (\(\theta\))
- Model (M)
- Data (Y)
- Combine likelihood function with a prior density for structural parameters
- Posterior modes
- Sampling algorithm (Metropolis-Hastings)
- Posterior distribution of parameters
Model Properties and Applications

✓ Simulation results
  - Output and inflation shocks

✓ Policy analysis
  - Shocks to policy variables: policy rate and exchange rate
  - Policy shock:
    - Anticipated and unanticipated
    - Temporary and prolonged

✓ Forecasting
  - based on MPC December 08 assumptions and current data
Model Properties: Simulation
Shock propagation: 1% shock to ygap equation

**ygap**

<table>
<thead>
<tr>
<th>ey</th>
<th>Q1-4</th>
<th>Q5-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>ygap</td>
<td>0.57</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

**Inflation (q-o-q annualized)**

<table>
<thead>
<tr>
<th>ey</th>
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</thead>
<tbody>
<tr>
<td>p</td>
<td>0.06</td>
<td>0.00</td>
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</table>

**Policy rate**

<table>
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<tr>
<th>ey</th>
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<tbody>
<tr>
<td>id</td>
<td>0.25</td>
<td>0.06</td>
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</table>

**Real ER**

<table>
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<tr>
<th>ey</th>
<th>Q1-4</th>
<th>Q5-8</th>
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<tbody>
<tr>
<td>z</td>
<td>0.71</td>
<td>1.04</td>
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</table>
Model Properties: Simulation
Shock propagation: 1% shock to inflation equation

Inflation (q-o-q annualized)

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<th>ep</th>
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<td>p</td>
<td>0.55</td>
<td>0.05</td>
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Policy rate

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</thead>
<tbody>
<tr>
<td>id</td>
<td>0.18</td>
<td>0.04</td>
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</table>

Real ER

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<tr>
<th>ep</th>
<th>Q1-4</th>
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</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>0.48</td>
<td>0.69</td>
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</tbody>
</table>

ygap

<table>
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</thead>
<tbody>
<tr>
<td>ygap</td>
<td>-0.07</td>
<td>-0.15</td>
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</table>
Model Properties: Policy Analysis
Policy rate and exchange rate

1% increase in  
<table>
<thead>
<tr>
<th></th>
<th>Output gap deviation from steady state (%)</th>
<th></th>
<th>Inflation deviation from steady state (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Q1-Q4</td>
<td>Average Q5-Q8</td>
<td>Average Q1-Q4</td>
</tr>
<tr>
<td>Policy rate*</td>
<td>-0.12</td>
<td>-0.03</td>
<td>-0.15</td>
</tr>
<tr>
<td>REER**</td>
<td>-0.13</td>
<td>-0.19</td>
<td>-0.52</td>
</tr>
</tbody>
</table>

* Without exchange rate movements ** without interest rate movements
Model Properties: Policy Analysis
Anticipated and unanticipated 1% increase in interest rate

<table>
<thead>
<tr>
<th>1% Policy rate shock (at t = 1)</th>
<th>Output gap deviation from steady state (%)</th>
<th>Inflation deviation from steady state (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Q1-Q4</td>
<td>Average Q5-Q8</td>
</tr>
<tr>
<td>Anticipated</td>
<td>-0.10</td>
<td>-0.06</td>
</tr>
<tr>
<td>Unanticipated</td>
<td>-0.23</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Inflation (q-o-q annualized)

ygap

-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0
3 2 7 12 17 22 27 32 37

-1.4
-1.2
-1.0
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0
3 2 7 12 17 22 27 32 37

unanticipated
anticipated

Inflation deviation from steady state (%)
Temporary and prolonged policy rate shock of 1%

Model Properties: Policy Analysis
Temporary and prolonged policy rate shocks

![Graphs showing the effects of temporary and permanent policy rate shocks on ygap (output gap) and inflation (q-o-q annualized).](image)
Model Properties: Forecasting
Forecasting procedure

Assumptions

<table>
<thead>
<tr>
<th>Variables/shocks</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varepsilon_{y\text{gap}}$</td>
<td>Government Consumption &amp; Public Investment</td>
</tr>
<tr>
<td>$\varepsilon_{y\text{gap}}$</td>
<td>Dubai oil price, farm price, Non-fuel commodity price, minimum wage</td>
</tr>
<tr>
<td>yfgap</td>
<td>Trading partners GDP</td>
</tr>
<tr>
<td>$\pi^f$</td>
<td>Trading partners CPI</td>
</tr>
</tbody>
</table>

- Actual data 2000Q1-2008Q3
- Central Forecasts 2008Q4-2010Q3
- Historical forecast errors + distribution of assumptions
- Model Properties: Forecasting
- Forecasting procedure
Model Forecasts without judgments

GDP growth
(with 90% confidence interval)

Inflation (y-o-y)
(with 90% confidence interval)

Note:
- Keeping domestic and foreign policy rates constant
- Based on Dec08 (as of 1 Dec 08) assumptions
Conclusion

- The purpose of a Small Semi-structural Model:
  - supplement large-scale models (BOTMM and DSGE) in the monetary policy process
    - Simulation (shock propagation)
    - Policy analysis
    - Forecasting
- Bayesian estimation technique was employed in the model parameterization
- Further development to forecasting process
  - Improve assumption conversion process
  - Incorporate joint distributions of assumptions
  - Incorporate judgments into the fan charts
Issues for discussion

- What is your view on the **forecasting procedure**? Please suggest how it could be improved.
- How should **judgment** play a role in forecasting? If so, at what stage?
- Despite the growing popularity of the **Bayesian technique** in the literature, would you have any reservations with regard to using this technique in modelling?
- Suggestions on **model specification**.