BOKDSGE: A DSGE Model for the Korean Economy

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Outline

1. Background
2. Model structure & parameter values
3. Model experiment
4. Current status
1. Background

- main macro forecasting model: BOK04
  - Keynesian type simultaneous equation model
    (81 endogenous variables; 26 exogenous variables)

- develop a DSGE model, suitable for
  - forecasts/projections and policy analysis
  - risk and uncertainty assessment
  - communication
2. Model structure...

- typical SOE structure
2. Model structure ...

A. Household

\[
\max \quad U = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[ \ln \left( \tilde{C}(h)_t - b \cdot \tilde{C}(h)_{t-1} \right) - \chi_1 \frac{N(h)_{t+\nu}}{1+\nu} + \chi_2 \ln \left( \frac{M(h)_{t+1}}{\tilde{P}_t} \right) \right] \right\}
\]

s.t.

\[
\tilde{C}(h)_t + \tilde{I}(h)_t + \frac{b(h)_{t+1}}{R_t} + \frac{s_t b(h)_{t+1}^*}{R_t \phi_B(t)} + m(h)_{t+1}
\]

\[
= w(h)_t \left[ 1 - \frac{\phi_w}{2} \left\{ \frac{w(h)_t}{w(h)_{t-1}} \frac{\tilde{\pi}_t}{w(h)_{t-2} \tilde{\pi}_t} \left( \frac{\tilde{\pi}_t}{\tilde{\pi}_{t-1}} - 1 \right) \right\}^2 \right] N(h)_t
\]

\[
+ R^K_t K(h)_t + \frac{b(h)_t}{(1 + g_y) \tilde{\pi}_t} + \frac{s_t b(h)_t^*}{(1 + g_y) \tilde{\pi}_t} + \frac{m(h)_t}{(1 + g_y) \tilde{\pi}_t} - T(h)_t + \Pi(h)_t
\]

- featuring habit formation; money-in-utility function; and CES type of composite goods and price index
2. Model structure ...

B. Firms (monopolistic competition)

production technology

\[ Y_t(j) = \exp(z_t) \cdot \left[ N_t(j)(1 + g_y)^t \right]^\alpha \cdot K_t(j)^{1-\alpha} \]

profit maximization:

\[
\max_{\{P_t(j)\}_t=0} E_0 \sum_{t=0}^\infty \left( \frac{D_{0,t}}{\tilde{P}_t} \right) P_t(j) \left[ \frac{P_t(j)}{P_t} \right]^{-\psi_p} Y_t \left\{ 1 - \frac{\phi_P}{2} \left( \frac{P_t(j)/P_{t-1}(j)}{P_{t-1}/P_{t-2}} - 1 \right)^2 \right\} \\
-\tilde{P}_t mc_t(j) \left[ \frac{P_t(j)}{P_t} \right]^{-\psi_p} Y_t \]

where

\[ mc_t(j) = \left( \frac{1}{e^{x_i}} \right) \left( \frac{w_t}{\alpha} \right)^\alpha \left( \frac{r^K_t}{1-\alpha} \right)^{1-\alpha} \]
law of motion on capital:

\[(1 + g_Y)K(h)_{t+1} = (1 - \delta)K(h)_t + e^\phi_l \left[1 - \frac{\phi_l}{2} \left(1 + g_Y \tilde{I}(h)_t \right) - 1 \right]^2 \tilde{I}(h)_t \]

where \( \tilde{I}(h)_t = \left[ \theta I_t(h)^{\frac{\gamma-1}{\gamma}} + (1 - \theta)I^*_t(h)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}} \)

- featuring labor augmenting technological progress; rigidities on wage and prices (Rotemberg, 1982); and quadratic adjustment costs on capital accumulation
2. Model structure ...

C. Central Bank: monetary reaction function

\[
\frac{R_t}{\bar{R}} = \left( \frac{R_{t-1}}{\bar{R}} \right)^{\rho_{\pi}} \left( \frac{\tilde{\pi}_t}{\bar{\pi}} \right)^{\rho_{\pi}} \left( \frac{Y_t}{\bar{Y}} \right)^{\rho_Y} \exp(\hat{R}_t)
\]

D. External Sector

interest rate parity condition:

\[
\frac{R_t}{R_t^*} = E_t \left[ \left\{ \frac{s_{t+1}}{s_t} \right\} \left\{ \frac{\phi_B(t)}{1 + \phi_B'(t)} \right\} \right]
\]

where \( \phi_B(t) = \exp \left[ -\phi_B \left( \frac{s_t B^*_{t+1}}{p_t Y_t} \right) \right] \)
2. Model structure ...

E. Equilibrium

- market clearing: goods market, labor market, capital market, money market, bond market, and external (stock-flow) balance

- balanced growth equilibrium path

- symmetric equilibrium, consisting of Korea and its Trading Partners
2. ... and parameter values

- **pragmatic approach** in setting parameter values
  
  - **goal**: mimic Korean macro dynamics
  
  - **strategy**: incorporate various evidence including “Great ratios”, VAR impulse responses, and inflation target
  
  - **tools**: historical data, IV estimation, method of moments, MLE with Kalman Filter
    
    - MATLAB with DYNARE (v3.0)
2. ... and parameter values

- classify parameters into 5 groups: \( \Omega_1, \Omega_2, \Omega_3, \Omega_4, \Omega_5 \)

<table>
<thead>
<tr>
<th>group</th>
<th>coverage (examples)</th>
<th>tools</th>
<th>metric</th>
</tr>
</thead>
</table>
| \( \Omega_1 \) (8) | • data driven  
• depreciation rate  
• discount rate  
• inflation target  
• potential growth rate | historical date (SNA) |    |
| \( \Omega_2 \) (3) | • monetary policy reaction function parameters | IV estimation |    |
2. ... and parameter values

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<tr>
<th>group</th>
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| $\Omega_3$ (8) | - long-run steady state  
  - great ratios  
  - adjustment costs  
  - preferences | calibration (method of moments) | $|\triangle(\Omega_3)|$ of 8 relevant variables |
| $\Omega_4$ (8) | - short-run dynamics  
  - habit formation  
  - elasticities | pseudo-calibration (MM) | $[\triangle(\Omega_4) I \triangle(\Omega_4)']$ of 10 horizon GDP & Cons. dynamics |
| $\Omega_5$ (14) | - exogenous shock parameters | MLE with Kalman filter | likelihood of 7 time series |

1. $\triangle(\Omega) = \text{data driven statistics} - \text{Model}(\Omega)$
2. □: sequential iteration of $\Omega_5 \rightarrow \Omega_4 \rightarrow \Omega_3$
   (convergence critical values: $|\Omega_3| < d_1$ and $|\Omega_4| < d_2$)
2. ... and parameter values

- dynamic properties compared with the data counterpart

<table>
<thead>
<tr>
<th>(in percent)</th>
<th>Consumption to GDP</th>
<th>Government Expenditure to GDP</th>
<th>Fixed Capital Formation to GDP</th>
<th>Export to GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>52.2</td>
<td>12.2</td>
<td>29.4</td>
<td>47.4</td>
</tr>
<tr>
<td>Model</td>
<td>56.5</td>
<td>12.4</td>
<td>28.9</td>
<td>40.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Net Export to GDP</th>
<th>Inflation Rate</th>
<th>Nominal Interest Rate</th>
<th>Money/GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>6.3</td>
<td>2.75</td>
<td>4.28</td>
<td>7.76</td>
</tr>
<tr>
<td>Model</td>
<td>2.2</td>
<td>2.56</td>
<td>4.00</td>
<td>7.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>C</th>
<th>I</th>
<th>Exp.</th>
<th>Imp.</th>
<th>Inflation</th>
<th>Ex. Rate</th>
<th>Int. Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficient with GDP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>...</td>
<td>0.64</td>
<td>0.61</td>
<td>0.36</td>
<td>0.61</td>
<td>-0.14</td>
<td>-0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>Model</td>
<td>...</td>
<td>0.53</td>
<td>0.65</td>
<td>0.95</td>
<td>0.65</td>
<td>0.24</td>
<td>-0.03</td>
<td>0.13</td>
</tr>
</tbody>
</table>

| First-order Autocorrelation Coefficient |
| Data                   | 0.59  | 0.89  | 0.10  | 0.79  | 0.67  | 0.10      | 0.78     | 0.77      |
| Model                  | 0.55  | 0.89  | 0.88  | 0.69  | 0.88  | 0.21      | 0.70     | 0.80      |
2. ... and parameter values

- impulse responses: comparison with VAR counterpart

**impulse responses to monetary policy shock**

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**< GDP >**

- BOKDSGE
- VAR

---

**< Consumption >**

- BOKDSGE
- VAR
3. Model experiment

➢ “back-out” realizations of the economic shocks ...

- < Productivity Shock >
- < Export and Capital Adjustment Cost Shocks >
- < Fiscal Policy Shock >
- < Monetary Policy Shock >
3. Model experiment

< Foreign Price Shock >

... and execute medium-term baseline forecasts

< Foreign Interest Rate Shock >
4. Current status

- completed:
  - analytical model structure
  - systematic estimation and update of the parameter values
  - analyzing conjunctural issues: stagflation, expectation shocks in line with the algorithm of Fujiwara & Kang (2008)

- in progress:
  - integration with the current forecasting system
  - optimal monetary policy: interest rate path

- future tasks:
  - Bayesian estimation of the parameter values
  - uncertainty and risk assessment
  - model extension: global model, stochastic growth