Outline

1. Thailand's Macroeconomic Modeling
2. FPO Macroeconomic Model
3. NESDB Macroeconomic Model
4. BOT Macroeconomic Model
Overview of Thailand’s Macroeconomic Modeling

Purpose of Modeling

- Economic Projections (FPO, NESDB, BOT; rolling release rule)
- Budget preparation (FPO, NESDB, BOT)
- Determining revenue side of the budget (FPO)
- National Economic & Social Development Plan (NESDB)
- Monetary Policy Decision making (BOT)
Policy Implication of UN MDG

Macro models

- Higher World Demand
- Better Infrastructure
- More Private Investment

Higher Econ Growth

- Reduce Poverty?
- Reduce Inequalities?
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Historical Background

FPO Macro Model

In the past
• Financial Programming, quarterly basis
• Short-run forecasting (1-2 years ahead)
• Excel based

At present
• Error Correction Model (ECM), quarterly basis
• Medium-run forecasting (5 years ahead)
• Eviews based
• OLS Estimation with the Error Correction Model (ECM)
• 338 equations, built on GDP demand side identity
  – GDP = C+I+NX
• 338 dependent variables, 135 independent variables, including key macro variables such as
  - Private, public, and external demand
  – Inflation
• Constructed as a system of (linear) equations
FPO Macro model: Structure

- **Private Sector**: RCp, RIp
- **Public Sector**: RCg, Rlg
- **External Sector**: RXgs, Rmgs
- **AD (Demand Side)**
- **AS (Supply Side)**
- **Output Gap**
- **BOP**
- **Fiscal Balance**

**PRICE NOMINAL**

- Capital
- Labor
- Other Factor
FPO Macro model: Structure

➢ Aggregate Demand

Real Block
- RCp
- RI p
- RCg
- RI g
- RXgs
- RMgs

Price Block
- PCp
- PI p
- PCg
- PI g
- PXgs
- PMgs

Nominal Block
- NCp
- NI p
- NCg
- NI g
- NXgs
- NMgs

RGDP × PGDP = NGDP

FPO Macroeconomic Model
FPO Macro Model: Data

- Time series (Quarterly)
- Secondary data
- Sources: Bank of Thailand, NESDB, Ministry of Finance, Ministry of Commerce, Ministry of Tourism and sports, private sources, etc.
- Key challenges: large number of data and discrepancy in fiscal data
Macro Model: Forecasting techniques

• Conduct key assumption forecasts
  – Dubai oil prices, Trading partners economies, no. of tourists, government expenditure, policy rate, exchange rates

• Cross check the economic forecasts with the results from supplementary models, consensus, and expert views
Macro Model: Software Platform & key challenges

Software Platform: Eviews
Key challenges:

• Ability to forecast esp. external demand
• No explanation for structural change
Supplementary models

• Indicators model
  – Attempt to ‘nowcast’ the SNA variables especially private consumption and investment
  – Simple regression and pattern observation

• CGE model
  - Income distribution analysis
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Economic Projection at NESDB

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NESDB’s Functions and Responsibilities

1. To formulate the 5-year National Plans and other proposals before submitting to the cabinet for consideration.

2. To study and analyze the national economic and social condition for development planning, and recommend related policy issues to the government.

3. To monitor and evaluate the performance of the National Plan and some major development programs and projects.

4. To coordinate with all agencies concerned in implementation of the development plan.

5. To appraise and evaluate development programs/projects of public agencies.

6. To undertake any assignments by the government.

Impact analysis
NESDB and Economic Projections

- Long-term projection
- Potential GDP (subjected to strong assumptions)
- Medium-term and short-term projection (guideline for formulating development plan & development strategy)
- Medium Term Macroeconomic Frameworks (Trends and targets)
- Short Term Projection (Time series/ Econometric estimations)
Contents of the economic report

• Current economic conditions
• Outlook for remaining of the year
• Yearly GDP projection
  (Quarterly GDP forecast is part of yearly GDP projection)
• Policy guidelines

☐ Release to the public (release on the same date with actual QGDP. Scheduled on February, May, August, November of every year)
☐ Submit to cabinet for consideration
NESDB and Economic Projections

Annual GDP forecast

- Forecast economic growth (focuses mainly on expenditure side)
- Current account balance
- Inflation

- Update on quarterly basis (Assumptions & databases, revise if necessary)
- Requires quarterly forecast

- Projection in the range of 1% in February and May
- Projection range will be reduced to 0.5% in August
- Point estimate in November (the projection for following year will be also released)
Tools for Quarterly and Yearly Economic Projection

Short-term Projection

- Current Quarter Model: CQM
  Time series model in the tradition of Lawrence Klein that are purely reliance on time series and econometric estimation

- Quarterly Financial Model: QFM
  The macro econometric models with greater reliance on economic theory.

Medium- and Long-term Projection

- Computable General Equilibrium (CGE) model that are long-run structural model based on Neoclassical growth theory
Adjust Annual forecast (CGE + Fin. Programming)

CQM’s forecast (2 quarters)

Current Quarter Model (CQM)

High frequency data (Monthly)

Comparison

QFM’s forecast (4 quarters)

Quarterly Financial Model (QFM)

Assumptions & exogenous variables (Quarterly)

Beginning

Annual forecast is the mixtures of CQM and QFM forecast
### Yearly GDP Projection

<table>
<thead>
<tr>
<th>Release date</th>
<th>Actual</th>
<th>CQM forecast</th>
<th>QFM forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>23rd February</td>
<td>Q4 of previous year</td>
<td>Q1</td>
<td>Q2-Q4</td>
</tr>
<tr>
<td>March-April</td>
<td>Q4 of previous year</td>
<td>Q1,Q2</td>
<td>Q3-Q4</td>
</tr>
<tr>
<td>25th May</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3-Q4</td>
</tr>
<tr>
<td>June-July</td>
<td>Q1</td>
<td>Q2-Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>August</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>September-July</td>
<td>Q2</td>
<td>Q3-Q4</td>
<td>-</td>
</tr>
<tr>
<td>November</td>
<td>Q3</td>
<td>Q4</td>
<td>-</td>
</tr>
<tr>
<td>December-January</td>
<td>Q3</td>
<td>Q4 - Q1 (next year)</td>
<td>-</td>
</tr>
</tbody>
</table>
CQM is first developed at the University of Pennsylvania by Noble Laureate Lawrence R. Klein

**Concept**

- Utilize high but different frequencies information (indicator variables) to estimate immediate future values of GDP both on demand and supply sides
- The estimates are made on the basis of bridge equations that link high frequency data (indicator variables) to low frequency data (NIPA).
- The procedure is first to predict the future value of high frequency data (indicator variables) by using time-series analysis (ARMA process) and then estimate future values of NIPA by using bridge equations.
- The estimate values of GDP will be updated on the rolling basis, when new piece of information or new figure for one of indicator variable become available (not late than 15th of each month).
On June 15: Monthly indicators as of April 31 become available

1. Forecast indicator variables by using ARMA equation
2. Transform from monthly indicators to quarterly indicators
3. Use bridge equations to estimate NIPA variables

**Monthly indicators**
(Indicator variables)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

Bridge Equation

\[ Q_{\text{NIPA}} = a + bQx \]

**NIPA**

<table>
<thead>
<tr>
<th>A</th>
<th>E</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>E</td>
<td>E</td>
</tr>
</tbody>
</table>

A = Actual value
P = Projected value
E = Estimated value
<table>
<thead>
<tr>
<th>NIPA</th>
<th>Monthly Indicators</th>
<th>Price Deflator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private Consumption Expenditure</strong></td>
<td>Value added tax, Retail Sales Index, Import of Consumer Goods</td>
<td>CPI</td>
</tr>
<tr>
<td><strong>Government Expenditure</strong></td>
<td>Exogenous</td>
<td>Exogenous</td>
</tr>
<tr>
<td><strong>Gross Fixed Capital Formation</strong></td>
<td>Construction area permitted (lag terms)</td>
<td>Construction price index</td>
</tr>
<tr>
<td></td>
<td>Cement consumption</td>
<td></td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Commercial car sales, Import volume index of capital goods</td>
<td>PPI of capital equipment</td>
</tr>
<tr>
<td><strong>Machinery and Equipment</strong></td>
<td>Import volume index of capital goods</td>
<td></td>
</tr>
<tr>
<td><strong>Exports of Goods</strong></td>
<td>Export of goods (BOP)</td>
<td>Unit value of exports</td>
</tr>
<tr>
<td><strong>Exports of Services</strong></td>
<td>Receipts of services income and transfer (BOP)</td>
<td>Weighted avg. of CPIs</td>
</tr>
<tr>
<td><strong>Imports of Goods</strong></td>
<td>Imports of goods (BOP)</td>
<td>Unit value of imports</td>
</tr>
<tr>
<td><strong>Imports of Services</strong></td>
<td>Payments of services income and transfer (BOP)</td>
<td>Nominal imports of goods</td>
</tr>
</tbody>
</table>
2. Quarterly Financial Model: QFM

- QFM can be classified as a macro econometric models.
- QFM comprise of 29 endogenous aggregate variables and 28 exogenous aggregate variables.
- QFM forecast is used to reconcile with CQM forecast and to form annual projection.
- QFM is also used for analyzing shocks in financial sector
List of Endogenous Variables

- $C_p^t = \text{Private consumption expenditures}$
- $\text{CAD} = \text{Current account deficit}$
- $\text{CF}_t = \text{Net capital inflows}$
- $\text{EX} = \text{Aggregate exports}$
- $\text{GR}_t = \text{Total government revenue}$
- $\text{GS}_t = \text{Government surplus}$
- $I_p^t = \text{Private investment}$
- $\text{IM}_i = \text{Import classified by commodity groups}$, where $i=1,2,3,\ldots,10$
- $\text{IM} = \text{Aggregate imports}$
- $M^s = \text{Money Supply}$
- $\text{MB} = \text{Money base}$
- $\text{NFA} = \text{Net foreign asset}$
- $\text{NES} = \text{Net exports of services}$
- $\text{PXD}_i = \text{Relative price of export to domestic price index (classified by commodity groups)}$, where $i=1,2,3,\ldots,10$
- $\text{Ptd} = \text{Consumer price index}$
- $\text{PIMDi} = \text{Relative price of import to domestic price index (classified by commodity groups)}$, where $i=1,2,3,\ldots,10$
- $\text{rd} = \text{Domestic interest rate (MLR)}$
- $\text{St} = \text{Saving}$
- $\text{TAXt} = \text{Government tax revenue}$
- $X_i = \text{Exports classified by commodity groups}$, where $i=1,2,3,\ldots,10$
- $\text{VAT} = \text{Value added and business tax revenue}$
- $\text{Yt} = \text{Gross domestic product}$
- $\text{YA} = \text{GDP from agriculture sector}$
- $\text{YC} = \text{GDP from}$
- $\text{YE} = \text{GDP from electricity and water supply}$
- $\text{YM} = \text{GDP from industrial sector}$
- $\text{Yother} = \text{GDP from other sectors}$
- $\text{YD} = \text{Disposable income}$
- $\text{YD}_{er} = \text{Disposable income in USD}$
List of Exogenous Variables

- Ctg = Public consumption expenditures
- CONP = Claims on nonfinancial public enterprise (collected since January 1995)
- CREDIT = Export credit (USD)
- DISt = Statistical discrepancies
- et = Bilateral exchange rate (baht/USD)
- EOS = errors and omission portions in balance of payments
- Get = total government expenditure
- GRWTHUS = Growth of US GDP
- Itg = Public capital formation expenditures real
- NCOG = Net claims on Government by bank of Thailand
- Pid = Domestic price index classified by commodity groups, where i=1,2,3,…9
- PtE = Price expectation in period t (adaptive)
- Ptf = Foreign price index (USCPI)
- Ptm = Import price index
- PtX = Export price index
- PtYA = Price index of agriculture sector
- PtYC = Price index of construction
- PtYE = Price of electricity and water supply
- PtYA = Price index of industrial sector
- PtmI = Import price index classified by commodity groups, where i=1,2,3,…10
- PXi = Export price index classified by commodity groups, where i=1,2,3,…10
- ri = Interbank rate
- rf = Foreign interest rate (LIBOR)
- Qi = Time trend of export i classified by commodity groups, where i=1,2,3,…9
- Qie = Expected export i (time trend of export i classified by commodity groups classified), where i=1,2,3,…10
- Qt = Output capacity (time trend of aggregate exports)
- Ytf = world gross domestic products (USGDP)
- Yte = Expected output (time trend of Yt)
Ramsey-Cass-Koopmans Dynamic General Equilibrium Model

- Base on Neoclassical growth theory of the Ramsey-Cass-Koopmans type
- Captures both macro (intertemporal) and micro (intratemporal) efficiencies
- Mostlty used for analyzing of economic shocks, i.e. oil shock and agricultural TFP shock

- It is a dynamic CGE model for a small open-economy
- Single household, 12 production sectors, one government
- Solve for 100 period horizon with totally 36,988 single equations
- Can be divided into five blocks, households, firms, foreign trade, within period equilibrium conditions and steady-state terminal conditions.

- Calibrate to Thailand’s Social Accounting Matrix
- The model is solved for time path of economic variables by using General Algebraic Modeling System (GAMS)
Analytical tools for economic projections: no single tool suit for all purposes

- For NESDB, CQM is the most available efficient tool for short-run estimation (times & resources)
- Nevertheless, structural model such as QFM and CGEM are needed (for the purpose of both reconciliation and longer-term projection)
- Under some certain conditions (shocks to the variables that cannot be included in time series model, structural models (i.e. CGE models) are useful
Experiences

**Key success factors**
- Technical skills
- Understanding of economic structures and economic conditions
- Databases, models & assumptions

**Problems**
- Strong and abrupt shocks reduce precision of CQM forecasts
- Fast changes in global condition made it more difficult to update exogenous variables in QFM and thus reduce its precision.
- Judgments rise with projection horizon
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Bank of Thailand
Macroeconomic Models
Economic Forecasting and Policy Formulation Process

1. Nowcasting

2. Assumptions on World Economy, Public Spending and Prices

3. Bot's Core Economic

4. Probability Distribution of Forecasts (Fan Chart)

Monetary Policy

Assessment of Risks

Economic Forecasts (Baseline)
(2) Key assumptions

**World Economy**
- Trading partners GDP growth and inflation rates
- JPY, EUR, and Regional FX rates
- US Fed funds rate

**Public Sector Expenditure**
- Consumption
- Investment

**Prices**
- Dubai crude oil price
- Domestic retail petroleum prices
- Non-fuel world commodity prices

**Endogenous**
- Policy interest rate
- Thai Baht
### BOT’s Macroeconomic Models

**Comparison between 2 core models**

<table>
<thead>
<tr>
<th>Concept/ Estimation</th>
<th>BOT Macroeconometric Model (BOTMM)</th>
<th>Monetary Policy Model (MPM): DSGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conception/ Estimation</strong></td>
<td>OLS Estimation with Error correction mechanism (ECM)</td>
<td>DSGE model type</td>
</tr>
</tbody>
</table>
| **Pros** | Balance between Data and Economic theory  
GDP components (Bottom up)  
Easy to understand | Small model, based on theory and capture overall structure of the economy  
Policy simulation - interest rate path from Taylor’s rule |
| **Limitations** | Lucas critique  
Big model | Linearity in some relationship |
• OLS estimation with error correction mechanism, using quarterly data between 1993Q1-2015Q1
• 94 Behavioral Equations + 76 Identities
• 4 Blocks
  – Real Sector: GDP components e.g. C, I, G, X, M
  – Public Sector: Nominal public expenditure and revenue
  – External Sector: Exchange rate, current account, and capital flows
  – Monetary Sector: Interest rate, consumer credit and corporate credit
• Price indices and inflation expectations
  – Key prices: Headline and core CPI, Producer price index, GDP components’ deflators
  – Inflation expectation = f(Inflation(t), Inflation(t-1), Inflation(t+4))
• Output gap
BOT’s Monetary Policy Model (MPM): DSGE

- Expected inflation
- Foreign inflation
- Expected output gap
- Output gap
- Foreign output gap
- Expected exchange rate
- Exchange rate
- Foreign interest rate
- Interest rate

- Philip curve
- Euler’s equation
- UIP

Blue = endogenous
Gray = exogenous
Red = expectations
Skewness and width of fan charts:

- Reflects the MPC’s risk assessment on the economic and inflation projections

- Illustrates the probability distributions for the forecasts and degree of confidence in the forecasts

- A skewed distribution arises when the risks to the forecasts are more
Thank you