Developing Analytical Models for Public Debt Management:

Notes from Turkish Experience

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Outline

- Why an in-house Model?
- Deterministic vs Stochastic Models
  - Deterministic Model: Stress Testing and Scenario Analyses
  - Stochastic Model: Turkish Debt Simulation Model (TDSM)
- Use of Models in Decision Making
- Resources and Challenges in Model Development
Why an in-house Model?
Why an in-house Model?

An off-the-shelf model (commercial software)

- Theoretically provides
  - Professionalism
  - Efficiency in model implementation
- Requires low internal support
- May prove to be
  - Less flexible
  - Restrictive in maintenance and development
  - More expensive (in general)
Why an in-house Model?

An in-house model

- Requires institutional capacity
  - Programming skills
  - Software platform
  - IT support

- Provides
  - Customized solutions (particularly important for a developing country)
  - Independence in terms of development and maintenance
  - Lower cost (in general)
Why an In-house Model?

- A choice between off-the-shelf and in-house models depends on
  - User specific needs
  - Institutional capacity
  - Cost concerns

- Turkish Treasury chose to develop an in-house model because of its need for flexibility and sophisticated institutional capacity
Deterministic vs Stochastic Models
Deterministic vs Stochastic Models

- **Deterministic Models**
  - Simple
  - Limited number of scenarios
  - May not able to sufficiently capture the dynamics of the ‘system’
  - Easy to build, interpret, and communicate

- **Stochastic Models**
  - Complex
  - Better replication of the ‘system’
  - Hundreds/thousands scenarios
  - Harder to build, interpret, and communicate
Deterministic vs Stochastic Models

- Not necessarily substitutes for each other
- Approaches similar in essence
- Choice should be based on
  - Available resources
  - Degree of detail needed
  - Other country specific circumstances
- It is also possible to employ deterministic and stochastic models as complementary tools
  - Turkish Case
Deterministic Model: Spreadsheet Model

- Simple MS Excel-based model
- Used to perform
  - Scenario analyses and stress tests:
    - Financing requirement and debt stock projections under the baseline scenario
    - Effects of changes in macro-fiscal variables
    - Scenarios are built by means of expert judgement, market analysis etc.
    - Accounting approach is also used for debt accumulation
Stochastic Model: Turkish Debt Simulation Model (TDSM)

Objective

- Assess the sensitivity of public debt to market movements
- Help quantify the costs and risks associated with alternative financing strategies:
  - Provide assistance in developing the strategic guidelines
Stochastic Model: Turkish Debt Simulation Model

Cost-at-Risk Simulation Framework

- Macroeconomic Scenario Generation
- Debt Database
- Alternative Strategies
- Cash Flow Modelling and Borrowing Requirement
- Expected cost & risk of alternative strategy
Stochastic Model: Turkish Debt Simulation Model

Model Building: The Conceptual Model

- Decision Horizon: 5 years
- Granularity: quarterly
- Instruments: A representative selection
- Choice of Cost and Risk Metrics
- Choice of Debt Structure Metrics (Key Portfolio Indicators)
Stochastic Approach: Turkish Debt Simulation Model


- Cost Metric: Accrued interest on debt plus changes in debt amortization due to FX rate movements
- Risk Metric: Cost-at-risk (C@R) at chosen confidence level
- Platform: MS Visual Basic and Commercial Statistical Softwares
Stochastic Approach: Turkish Debt Simulation Model

TDSM v.2 (2007)

- **Cost Metrics:**
  - Cash-based interest expenditures
  - Level of debt stock

- **Risk Metrics:** Conditional cost-at-risk (C@R)

- **Platform:** Matlab
Stochastic Approach: Turkish Debt Simulation Model

TDSM v.2.1 (2010)

- Modifications based on changing market conditions and instrument set

- Cost Metrics:
  - Cash-based interest expenditures
  - Level of debt stock
  - Level of inflation adjusted debt stock

- Risk Metrics: Conditional cost-at-risk (C@R)

- Platform: Matlab
Use of Model in Decision Making
Use of Models in Decision Making

- TDSM results are used to determine strategic benchmarks for debt and risk management
- Strategic benchmarks aimed at
  - Composition of financing (before 2007)
  - Composition of the debt stock (after 2007)
  - Allows for a holistic approach to cover
  - Outright sales
  - Buy-backs and debt exchanges
  - Derivative instruments
Use of Models in Decision Making

Illustrative Results

Distribution of Interest Payments

Distribution of Debt Stock Projections

Use of Models in Decision Making
Use of Models in Decision Making

Illustrative Results

Interest Payments for Alternative Strategies

Accrued Inflation Adjusted Stock (AIAS) for Alternative Strategies
Use of Models in Decision Making

Strategic Benchmarks

- Reduce liquidity / refinancing risk:
  - Maintain a certain level reserve of cash
  - Increase average maturity to the extent that market conditions allow
  - Decrease the share of debt maturing within 12 months

- Reduce currency risk:
  - Borrow mainly in TL

- Reduce interest rate risk:
  - Use fixed rate instruments as the major source of domestic borrowing
  - Decrease the share of debt which has interest rate re-fixing period less than 12 months
Resources and Challenges in Model Development
Resources and Challenges in Model Development

Resources Needed

- Institutional Capacity
  - Committed and Skilled Staff
  - IT systems

- Financial Resources
  - Training
  - Consulting
  - Software

- Management Support (probably the most important one)
Resources and Challenges in Model Development

Challenges

- In-house modeling
  - Choice of modelling platform
    - Ease of implemention vs. efficiency and speed (Excel vs. some technical computing platform)
  - Capacity building
  - Maintenance

- Input Modeling
  - Lack of long data series
  - Stationarity problems in data
    - Regime changes
    - Financial crises
  - Distributional assumptions
    - Do scenario generation options enough to cope with extreme cases (event risk)?
For more information: