UNCTAD’s Seventh Debt Management Conference

9-11 November 2009

Risk Models and Public Debt Management

by

Mr. Phillip Anderson

Senior Manager

Public Debt Management, World Bank Treasury

The views expressed are those of the author and do not necessarily reflect the views of UNCTAD
Risk Models and Public Debt Management

Phillip Anderson
Senior Manager,
Public Debt Management, World Bank Treasury

UNCTAD Debt Management Conference
Geneva, November 9-11, 2009
“Too large a proportion of mathematical economics are a mere concoction, as imprecise as the initial assumptions they rest on, which allow the author to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols.”

John Maynard Keynes, 1936

“Beware of geeks bearing formulas.”

Warren Buffet, 2008
Outline

- What is a risk model? Why is it useful?
- Models in debt management
- The structure and output of a simple scenario analysis model
- Implementation issues
- Concluding remarks
What is a risk model? How can it be used?

- A simplified representation of a more complex system
- Designed to shed some insights on a problem that one is analyzing
- In the area of public debt management, models can be used to help make decisions about the composition of public debt
- Can provide a clearer picture of the trade-off between cost and risk in the portfolio
  - Requires clear definition of cost and risk
Cost and risk

- Examples of cost measures
  - Nominal interest payments
  - Interest cost adjusted for unrealized capital gains/losses (e.g. FX)
  - Interest cost as a percentage of revenues
  - Total debt as a percentage of GDP

- Risk is defined as the difference between the expected cost (baseline case) and the cost under a specific negative scenario (in a deterministic model)

- Degree of vulnerability to market risk can be measured by a range of metrics
  - Debt maturing within 1 year
  - Average time to maturity
  - Debt with interest rates re-fixing within 1 year
  - Average time to re-fixing
  - Currency mismatch between financial assets and liabilities
  - Etc.

- Different cost and risk measures provide different information - do not rely on one cost and risk measure
Why is a risk model useful?

- Allows analysis of different strategies under alternative scenarios for future interest rates and exchange rates
- Maintain integrity across different scenarios/strategies
  - Apples to apples comparison
- Forces discipline in the process: systematic analysis and examination of possible states of the world
- Gives deeper insight into the trade-offs and supports the identification of options and constraints
**Is a model needed to develop a sound debt management strategy?**

- No, recent examples include
  - Indonesia, Peru, Colombia

- In the above cases, the strategy was initially formulated as broad guidelines based on more qualitative analysis and judgment
  - More domestic debt, longer maturity, etc.

- A natural next step is providing more precision in the form of targets for specific risk indicators – this is supported by a model
  - As extreme risks are reduced, more granularity and higher precision are required
Risk models and the debt management problem

- The debt portfolio is exposed to future changes in market rates – such changes will impact the government’s budget.
  - Central to a risk model is the following identity:
    - Primary balance + Interest payments on debt = Budget balance
    + Amortization of debt = Funding need

- Deterministic scenario analysis
  - Few strategies, few market scenarios

- Stochastic scenario analysis
  - Few strategies, many market scenarios
    - Allows analysis of statistical distributions, requires ability to model the generation of market rates, typically based on historical data
The structure of a risk model

**INPUT**
- Existing debt cash flows
  - Macro Variables
    - Primary fiscal balance
  - Structure of new debt
    - Borrowing strategy
  - Financial variables
    - Exchange rates
    - Interest rates

**ENGINE**
- Cash-flow Simulation

**OUTPUT**
- Cost
- Risk
Cash flow simulation

- Starting point is the cash flow on existing debt
  - High quality and timely data is a requirement
- Decide on the time frame of analysis, e.g. 10 year - the choice of time horizon is critical
- Main outputs from a risk model are cash-flows
  - These can be used to calculate a range of cost and risk indicators
- The cost generated by the base scenario for market rates for a given borrowing strategy will be defined as the **expected cost**
- **Risk** is defined as the deviation from expected cost, when using a deterministic model
Model output example: interest cost/GDP

- **S1: “Status quo”**
  - 70% ext / 30% dom
  - Heavily concessional

- **S2: “Shift to quasi-concessional”**
  - 70% ext / 30% dom
  - Less concessional, reflecting graduation to blend status

- **S3: “Develop domestic market”**
  - 70% ext / 30% dom
  - Rebalance mix of domestic tenors to widen and deepen investor demand

- **S4: “Pessimistic”**
  - 60% ext / 40% dom
  - Less concessional
  - Closure of long-term domestic segment

---

<table>
<thead>
<tr>
<th>Differences from base</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parallel shift</td>
<td>0.21%</td>
<td>0.28%</td>
<td>0.30%</td>
<td>0.33%</td>
</tr>
<tr>
<td>flattening of curve</td>
<td>0.21%</td>
<td>0.28%</td>
<td>0.30%</td>
<td>0.33%</td>
</tr>
<tr>
<td>revaluation of peg</td>
<td>0.31%</td>
<td>0.30%</td>
<td>0.30%</td>
<td>0.25%</td>
</tr>
<tr>
<td>repeat 2008 ER shock</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Combination shock</td>
<td>0.72%</td>
<td>0.77%</td>
<td>0.42%</td>
<td>0.15%</td>
</tr>
</tbody>
</table>
Model output example: debt stock/GDP

- **S1: “Status quo”**
  - 70% ext / 30% dom
  - Heavily concessional

- **S2: “Shift to quasi-concessional”**
  - 70% ext / 30% dom
  - Less concessional, reflecting graduation to blend status

- **S3: “Develop domestic market”**
  - 70% ext / 30% dom
  - Rebalance mix of domestic tenors to widen and deepen investor demand

- **S4: “Pessimistic”**
  - 60% ext / 40% dom
  - Less concessional
  - Closure of long-term domestic segment

### Differences from base

<table>
<thead>
<tr>
<th>Differences from base</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>0.56%</td>
<td>0.73%</td>
<td>0.79%</td>
<td>0.84%</td>
</tr>
<tr>
<td>parallel shift</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flattening of curve</td>
<td>0.56%</td>
<td>0.73%</td>
<td>0.79%</td>
<td>0.84%</td>
</tr>
<tr>
<td>revaluation of peg</td>
<td>16.79%</td>
<td>16.54%</td>
<td>16.52%</td>
<td>16.07%</td>
</tr>
<tr>
<td>repeat 2008 ER shock</td>
<td>2.14%</td>
<td>2.11%</td>
<td>2.07%</td>
<td>2.05%</td>
</tr>
<tr>
<td>Combination shock</td>
<td>3.07%</td>
<td>3.18%</td>
<td>2.28%</td>
<td>1.62%</td>
</tr>
</tbody>
</table>

**Cost-Risk (Max)**

- S1: 
  - 70% ext / 30% dom
  - Heavily concessional

- S2: 
  - 70% ext / 30% dom
  - Less concessional, reflecting graduation to blend status

- S3: 
  - 70% ext / 30% dom
  - Rebalance mix of domestic tenors to widen and deepen investor demand

- S4: 
  - 60% ext / 40% dom
  - Less concessional
  - Closure of long-term domestic segment
The use of model-output

Different borrowing strategies can be analyzed by comparing cost and risk for a range of future scenarios for market rates.

The debt manager should be careful to cover all dimensions of cost and risk.

- Examples:
  - Nominal interest cost versus outstanding debt - where the latter would reflect the effect on the debt of a currency depreciation.
  - Debt maturing in 1 year versus average time to refinancing.

The debt manager should carefully select and use a set of cost and risk indicators to ensure that important risks are not ignored.
Typical experiences from working with risk models

- Not the main basis for decision-making, rather a supplement to experience, sound judgment, etc. – provide additional foundation for making better informed choices
- A scenario analysis model will not provide an “optimal” debt portfolio, but provides information that will allow cost-risk comparisons, and increases knowledge of the options and constraints facing the debt manager
- Clarifies framework for decision-making
- Working with risk models requires a considerable investment in resources, and model development is an ongoing process
- Typically, the incentive structure in a debt office is different from Wall Street
  - Abuse less likely (and no examples of abuse)
  - Rather than abuse, the main risk seems to be that the model is “inaccurate” by not capturing the characteristics of the existing and new debt
Off-the-shelf or in-house-developed model?

- Model development requires
  - Adequate staff and software
  - Time – often trial and error
  - Focus on key person risk

- Buying an off-the-shelf model is tempting, but supply is very limited – and will often imply acquiring a black box
  - Flexibility and ability to adjust model is important, especially if country-specific circumstances needs to be reflected
  - Building and maintaining your own model allows you to obtain a deeper understanding of the dynamics of the debt portfolio

- The MTDS Analytical Tool could provide a starting point
Concluding Remarks

1. A risk model will not tell you how to structure the public debt
   – But it will provide information in a systematic way to help make decisions

2. Use models to analyze the problems and questions that you face
   – Country circumstances vary

3. The modeling process is an art as well as a mathematical exercise, because you are making choices to simplify the real world
   – Repeated experimentation deepens the understanding of the dynamics of the debt portfolio

4. There is no evidence that models used in public debt management are “abused”
   – Problems relate more to poorly specified models and scenarios, and one-dimensional view of risks