Risk Modeling: The Brazilian Experience

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### Motivation

| Cost-Risk Analysis – Long term view |
| Model Description               |
| Connecting the Model to Reality |
| Next Steps                     |
What have we pursued?

Minimize long-term borrowing costs, with maintenance of prudent risk levels; at the same time, seek to contribute to smooth operation of the public bond market.

The role of transparency

- Besides a well established legal and institutional framework, transparency and accountability are also requirements for good governance practices.

- Transparency generates predictability, that reduces market uncertainties about the Debt Managers objectives and actions, contributing for volatility and risk premium reduction.
Federal Debt (FPD) Composition

- Fixed Rate
- Inflation linked
- Floating Rate
- FX-linked
- Other

Jan 04 to Un-un
Motivation

- Brazil walked on thin ice for a long time
  - poor debt structure
  - Very risky and volatile
- Then public debt was improved: **where do we want to go?**
- Benchmark Optimal composition
  - Instrument for risk management and for strategic planning
- How to measure debt management performance?

Guidelines (World Bank and IMF)

- According to their Guidelines, the benchmark could work as a powerful management instrument as it represents the debt structure that the government would like to have, based on its expected risk and cost preferences. Thus, the benchmark could guide the debt administrator in his decisions regarding issuance and risk management.
Motivation

Cost-Risk Analysis – Long term view

- 1st and 2nd phases

Model Description

Connecting the Model to Reality

Next Steps
The process of debt planning in Brazil is in a sophisticated stage...

... but, it is a result of a long process of institutional advances and of a simultaneous development of the technical framework.
1\textsuperscript{st} phase – Central Gov’t ALM

Short-term analysis

- The Annual Borrowing Plan 2002
  - ALM as a tool to map and manage risks of the public debt portfolio
  - ALM: a dynamic analysis of assets and liabilities that takes into consideration the public debt management strategy and the macroeconomic policies enforced by the government
  - the basic premise for outstanding debt insulation is the balancing between the characteristics of assets and liabilities

- Refinancing and market risks are key elements
  - market risk categories: inflation, exchange rate, floating rate, and fixed rate
  - refinancing risk
Integrating assets in the analysis helped identifying opportunities…

1ST phase – Central Gov’t ALM

Asset - Liability Mismatch

Central Government Cashflow

Assets Liabilities
Impact of 1% FX devaluation on Net PS Debt/GDP*

Source: National Treasury

Note: Stress scenario considered of 3 standard deviations over the medium interest and exchange rate observed at 2002, equivalent of an overshooting of 56.6% on exchange rate and an increase of 7.8 on the Selic rate.

*Net Public Sector Debt
Schematic Summary of the CaR Definition

Relative Cost-at-Risk of DPF*

* Considers the 2007 share for Floating and Exchange Rates plus 10 percentage points. The 2008 projected composition is estimated as the midpoint value of the target ranges of the PAF 2008.
Source: National Treasury
Simulating strategies

INPUTS

- Outstanding Debt (bonds and contracts)
- Macroeconomic Scenario: GDP, inflation, fiscal balance
- Financing Strategy
- Financial Variables: interest rate, FX-rate
- Dynamic Analysis

Treasury’s GERIR system

Debt payments flow forecast

Projected results:

- Outstanding
- Maturity
- Profile
- Cost
- Risk
Motivation

Cost-Risk Analysis – Long term view

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Next Steps
Building a Benchmark Model

A Stochastic Finance Approach

- **Stochastic Scenarios – models**
  - Interest rates: Cox, Ingersoll and Ross – CIR
    \[ dJ_t = \alpha (J^* - J_t)dt + \sigma_1 \sqrt{J_t} dZ^1_t \]
  - Inflation: Geometric Brownian Motion
    \[ dI_t = \mu I_t dt + \sigma_3 I_t dZ^3_t \]
  - Exchange Rate: Chan, Karolyi, Longsta and Sanders – CKLS
    \[ dC_t = \beta (C^* - C_t)dt + \sigma_2 C_t dZ^2_t \]

- **Bond Prices**
  - Prices come from CIR
    \[ P(t, T) = A(t, T)e^{-B(t, T)J} \]
  - Nelson-Siegel approach to premium
    \[ P_{premium} = \beta_0 + (\beta_1 + \beta_2 T)e^{-kT} \]
Building a Benchmark Model

Debt’s Carrying Cost
- Define a Carry cost for each type of bond \( y \)

\[
R_t^D = \lambda_{LFT} R_t^{LFT} + \lambda_{LTN} R_t^{LTN} + \lambda_{FX} R_t^{FX} + \lambda_{NTB} R_t^{NTB}
\]

Federal Public Debt (FPD) Dynamics
- Where \( M_t \) is the monetary base, \( prim_t \) is the primary balance

\[
FPD_{t+1} = (FPD_t - \Delta M_t - prim_t)(1 + R_t^D)
\]

Debt Sustainability indicator
- Because the Treasury control FPD, but the Net Public Sector Debt (NPSD) is the relevant indicator, it is hereby described as the following function

\[
NPSD_t = FPD_t + M_t + SelicLiab_t + FXLiab_t - (FXreserves_t + GDPAsset_t + SelicAsset_t) + others
\]
Benchmark model: Searching the optimal composition of the public debt
Benchmark model: Searching the optimal composition of the public debt

Correlation - Single Value Decomposition (SVD)
Connecting the Model to Reality
Development of Debt Management Capability is not necessarily a long process, but it depends on a number of factors.
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Next Steps

Building a more robust macro-structural basis

- Work on other functional forms of key variables
  - Ex: Interest rates: Nelson-Siegel

\[ i_t(\tau) = (\beta_{1t} + \beta_{2t}) \left( \frac{1 - e^{-\frac{-\tau}{\lambda}}}{-\tau} \right) + \beta_{2t} \left( \frac{1 - e^{-\frac{-\tau}{\lambda}}}{-\tau} - e^{-\frac{-\tau}{\lambda}} \right) \]

- Having a macro-based description of key variables behind the model will enhance the debt strategies stories
- Incorporate the transition strategy in the optimization model
  - Long-run stationary optimal debt story VS today’s problem
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