Modeling and Managing Sovereign Risk in a Jumpy World: an Illustrative Application to Brazil

April 2006

Theodore Barnhill
Global and Entrepreneurial Finance Research Institute (GEFRI)

George Washington University

Motivation

- High cost of financial crises
- Need to assess the *probability* of a financial crisis occurring
- Need to assess policy alternatives to manage risk level
- Need for a powerful and flexible modeling approach that can handle:
  - numerous economic and financial risk variables including trends, volatilities, and correlations,
  - important details of a government's asset and liability portfolio, or
  - a simplified government asset and liability structure

Motivation

- An inability of many existing risk models, based on normal distributions, to adequately account for fat tailed distributions

- Periodically observed simultaneous and substantial changes (i.e. Jumps) in numerous risk variables brought on by external or internal shocks such as:
  - Russian and Asian financial crises,
  - floating of the foreign exchange rates,
  - default by Argentina, and
  - political turmoil and uncertainty.

Related Research

Adrogue (2005),

Barnhill and Kopits (2004)

Engle (2002)

Kaminsky, Reinhart, and Vegh (2004)

Mendoza and Oviedo (2005)

Merton (1976)

Conventional Scenario Approach

$$W_0 = PV(Z) - PV(C) - B_0$$

$$= \sum_{t=0}^{\infty} (1+r)^{-t} Z_t - \sum_{t=0}^{\infty} (1+r)^{-t} C_t - \sum_{t=0}^{\infty} (1+r)^{-t} B_t$$

$$z^* \geq \left(\frac{r-g}{1+g} \right) b_{t-1}$$

Portfolio Simulation Approach

- Simulate future financial and economic environment as a set of *correlated* random variables
- Revalue each asset and liability as a function of the simulated environment
- Recalculate the government's risk indicators in the simulated environment,
  - debt to GDP, and
  - net worth to GDP
- Repeat the simulation a large number of times
- Analyze the distribution of simulated government risk indicators to estimate the probability of restricted market access

Scenario/Simulation Model Applied to Brazil

1.

   - Optimistic
   - Base
   - Stress

2.

3.

4.

5.

Table 2: GOB Debt Portfolio Composition as of June 2004

Type of Security	Fraction of total
(Brazil Model used 149 Securities)	
Floating Rate Debt	0.475
Fixed Rate Debt	0.138
Global bonds (USD Denominated)	0.105
Inflation Indexed Debt	0.072
World Bank/IBD/IMF (USD Denominated)	0.059
Exchange Rate Indexed Debt	0.054
Brady Bonds (USD Denominated)	0.050
Inflation Indexed Debt	0.022
Euro Denominated Bonds	0.021
Yen Denominated Bonds	0.004
total	1.000

-
-
-
-
-

Table 1: Alternative Scenarios

Scenario	Optimistic	Base	Stress
Max Tax Rate (% of Nominal GDP)	0.37	0.37	0.37
Target Tax Rate (% of Nominal GDP)	0.36	0.36	0.36
Target Non-Financial Expenditure Rate (% of Nominal GDP)	0.305	0.315	0.325
Target Primary Surplus (% of Nominal GDP)	0.055	0.045	0.035
Maximum Feasible cut in Non-financial Expenditures (% of Nominal GDP)	0.05	0.03	0.01
Expected Nominal GDP Growth Rate (%)	0.1	0.08	0.06
GDP Volatility (%)	0.015	0.025	0.035
Weighting for current GDP Growth rate in calculating the Expected long-run GDP Growth Rate	0.1	0.1	0.1
Assumed Discount rate on Perpetuities (r-g)	0.02	0.04	0.07

Deciles	GOB Debt to GDP Ratio	Percent Change in GDP	Percent Change in Exchange Rate	Percent Change in Selic	Inflation Rate
1	0.517	10.6%	2.2%	1.4%	5.9%
2	0.535	9.4%	6.7%	0.8%	6.1%
3	0.545	8.9%	12.0%	0.5%	5.7%
4	0.551	8.5%	11.7%	0.0%	5.9%
5	0.557	7.9%	14.9%	0.6%	6.3%
6	0.564	7.9%	15.2%	-0.3%	6.1%
7	0.570	7.3%	17.0%	-0.5%	5.9%
8	0.577	7.4%	23.8%	-0.3%	6.3%
9	0.586	6.4%	22.8%	-1.3%	6.0%
10	0.608	5.4%	28.1%	-2.1%	6.1%

	Optimistic	Base (MFPS=8.5%)	Stress (MFPS = 5.5%)	Stress with MFPS = 7.5%
Mean	5.815	1.736	0.243	0.567
Std	0.245	0.234	0.213	0.202
Max	6.574	2.479	0.887	1.185
Min	5.022	0.951	-0.484	-0.128
Percentile Distribution				
0%	5.022	0.951	-0.484	-0.128
1%	5.245	1.197	-0.275	0.089
2%	5.317	1.239	-0.221	0.158
5%	5.414	1.348	-0.135	0.222
10%	5.490	1.423	-0.033	0.287
11%	5.499	1.432	-0.026	0.296
12%	5.511	1.443	-0.013	0.309
13%	5.522	1.454	-0.0008	0.324

Conclusions from Scenario/Simulations

-
-
-
-

Conclusions from Scenario/Simulations

-
-

Brazil Risk Assessment: Jump Process Approach

2.

4.

6.

Brazil Risk Assessment: Jump Process Approach

Strictly for purposes of illustration assume that:

2. **Probability of Optimistic scenario = 10%**
3. **Probability of Base scenario = 80%**
4. **Probability of Stress scenario = 10%.**

Brazil Risk Assessment: Jump Process Approach

3.

5.

7.

Table 8: Simulated GOB "Net Worth" To GDP Ratio As of 6/30/05

	Jump Process (Fat Tailed Distribution)	Base Scenario (Normal Distribution)
Mean	1.9945	1.7363
Std	1.3699	0.2341
Max	6.3892	2.4793
Min	-0.4389	0.9517
Percentile Distribution		
0%	-0.4389	0.9517
1%	-0.0091	1.1972
2%	0.1357	1.2391
3%	0.1701	1.2818
10%	1.1642	1.4234
25%	1.5149	1.5684
50%	1.7432	1.7224
75%	1.9644	1.8805
90%	5.2348	2.0352
95%	5.8260	2.1124
99%	6.1697	2.2570
100%	6.3892	2.4793

Conclusions

- Run higher primary surpluses and reduce Debt to GDP ratio
- Altering the types of securities used to finance the Government
- Pursue monetary and fiscal polices which result in more stable long-term economic growth

Conclusions

- **Deal with many correlated risk variables,**
- **Deal with detailed or simplified portfolios,**
- **Account for periodic structural breaks that greatly increase risk levels,**
- **Be incorporated into broader integrated risk assessments that include the financial sector (e.g. Barnhill and Souto, 2006)**