



# Can We Predict the Next Capital Account Crisis?

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# Predicting Crises Is Challenging

- Many possible explanatory variables to consider
- Very hard to get the timing of crises right
- Nature of crises has evolved over time



# Predicting Crises with Binary Classification Trees (BCTs)

- BCTs work by successively partitioning the data in order to separate crises from non-crises
- BCT starts by comparing all variable\*thresholds to split the data
  - E.g. Current Account/GDP above or below 3 percent
- For each candidate split, it computes a measure of how it improves the “purity” of the data
  - Measure of purity based on product of probabilities of crisis and non-crisis at each node (which depend on relative frequencies, priors and relative misclassification costs)



# Benefits of BCTs

- Can consider a large number of competing variables. Variables with low explanatory power do not interfere with results
- Consider all possible variable\*threshold interactions. This is not possible in standard regressions where possible combinations are orders of magnitude higher than number of observations
- Non-parametric
- Can consider variables with missing values
- BCTs unrelated to standard crisis-prediction tools:
  - At the very least, they provide alternative estimates that can complement other predictions



# Missing Crises vs False Alarms

- We want to err on the side of caution.
- Ready to call crisis prone a node where ratio of crisis/non-crisis twice as high as in the sample
  - Two parameters are used to determine conservativeness: priors and relative misclassification costs
  - Set crisis prior to 20%; cost of missing crisis 2x cost of misclassifying non-crisis
  - Alternatively could set prior to sample frequency (6%); cost of missing crisis 7.7x cost of misclassifying non-crisis



# Data

- Data covers 49 emerging markets:
  - Significant access to private international financial markets;
  - No substantial net foreign asset position; and
  - Are not small (GDP at least 7.5 billion dollars)
- Sample covers 1994-2005



# Dating Capital Account Crises Episodes

- Dating of crises result of concerted effort of the Working Group on Vulnerability Indicators
- Initial candidate episodes chosen based on:
  - Sudden stop indicators, exchange rate pressure (from EWS), sovereign defaults, banking crises (Demirguc-Kunt and Detragiache 1998) and corporate crises (CVU).
- Final selection of episodes made after comments from IMF country desk economists
- Dating based on inception of crises
- Table 1 lists crisis episodes. Appendix provides detailed information on crisis selection



# Vulnerability Indicators

## ■ External sector:

- Reserve coverage (relative to ST/maturing external debt and the current account deficit)
- Current account balance/GDP
- External debt/GDP
- Real exchange rate overvaluation (using only *ex ante* data)
- Exchange rate regime

## ■ Fiscal sector:

- Overall balance
- Primary gap (difference between primary balance and debt-stabilizing primary balance)
- Public debt (in percent of GDP)
- Short-term debt/total debt
- Foreign-currency debt in percent of total debt





# Vulnerability Indicators (cont'd)

## ■ Financial sector:

- Capital adequacy
- Return on assets
- Non-performing loans as a share of total loans
- Growth in private sector credit/GDP
- Share of foreign currency loans
- Financial sector soundness from Boyd, De Nicolo and Al Jalal (2006)

## ■ Corporate sector:

- Default probability (implied by Black-Scholes-Merton formula)
- Interest coverage ratio
- Debt-to-assets ratio
- Real return on assets
- Valuation measure based on the price-to-earnings-ratio.



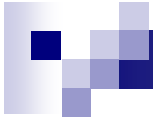
## Vulnerability Indicators (cont'd)

- Macroeconomic Conditions. One-year-ahead WEO forecasts of:
  - Real GDP growth
  - CPI inflation.
- Global Demand Conditions
  - One-year-ahead WEO forecasts of growth in import demand by trading partners
  - Commodity price indices faced by each particular country (constructed by RES Commodities Unit)
- EMBI Spreads

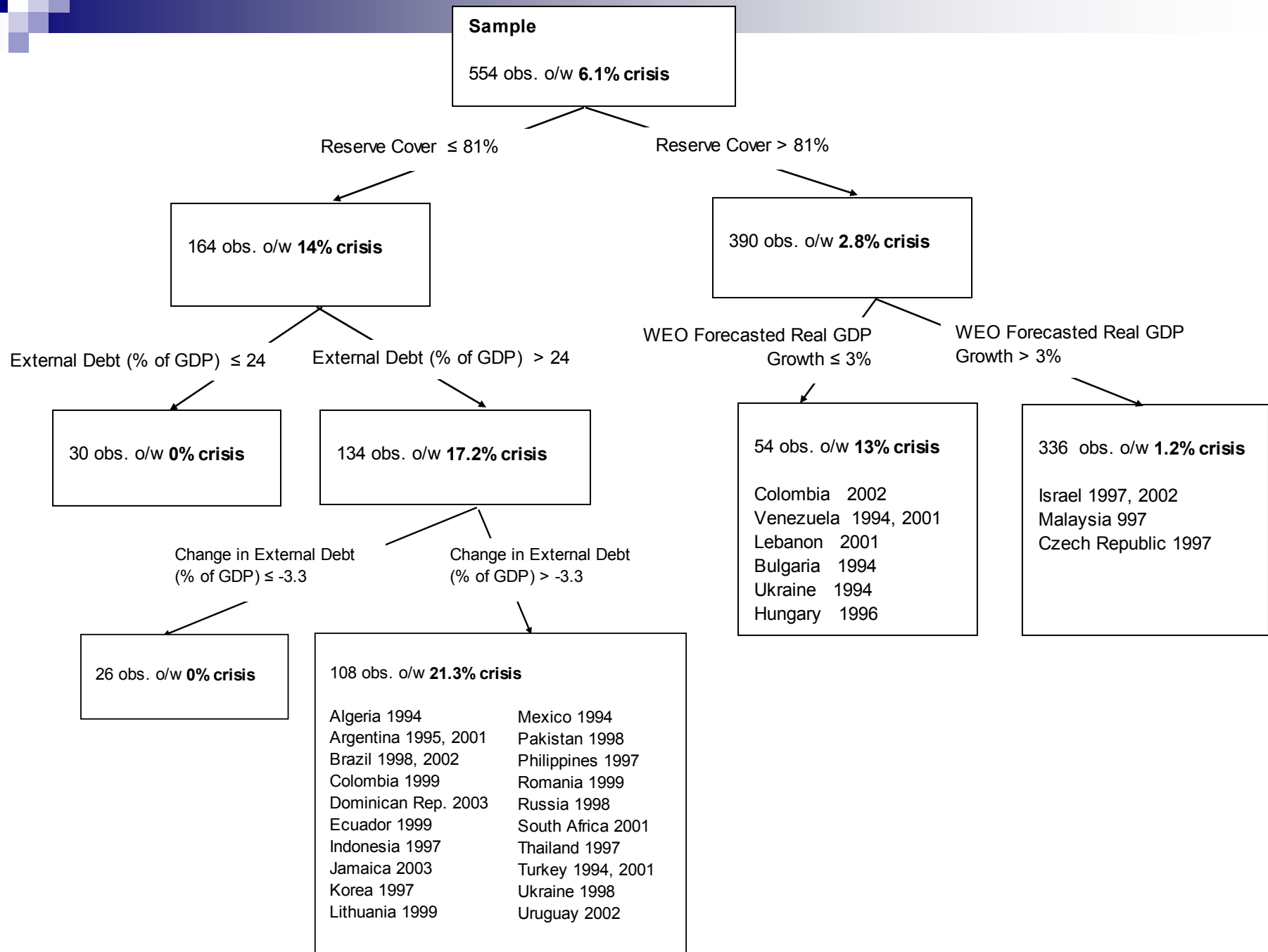


## Vulnerability Indicators (cont'd)

- Country-invariant measures of global conditions not used
  - Given nature of BCT, they often acted as proxies for year dummies
- Due to forecasting nature of exercise, all variables are lagged:
  - For example, use current account balance in 2000 when predicting crisis in 2001



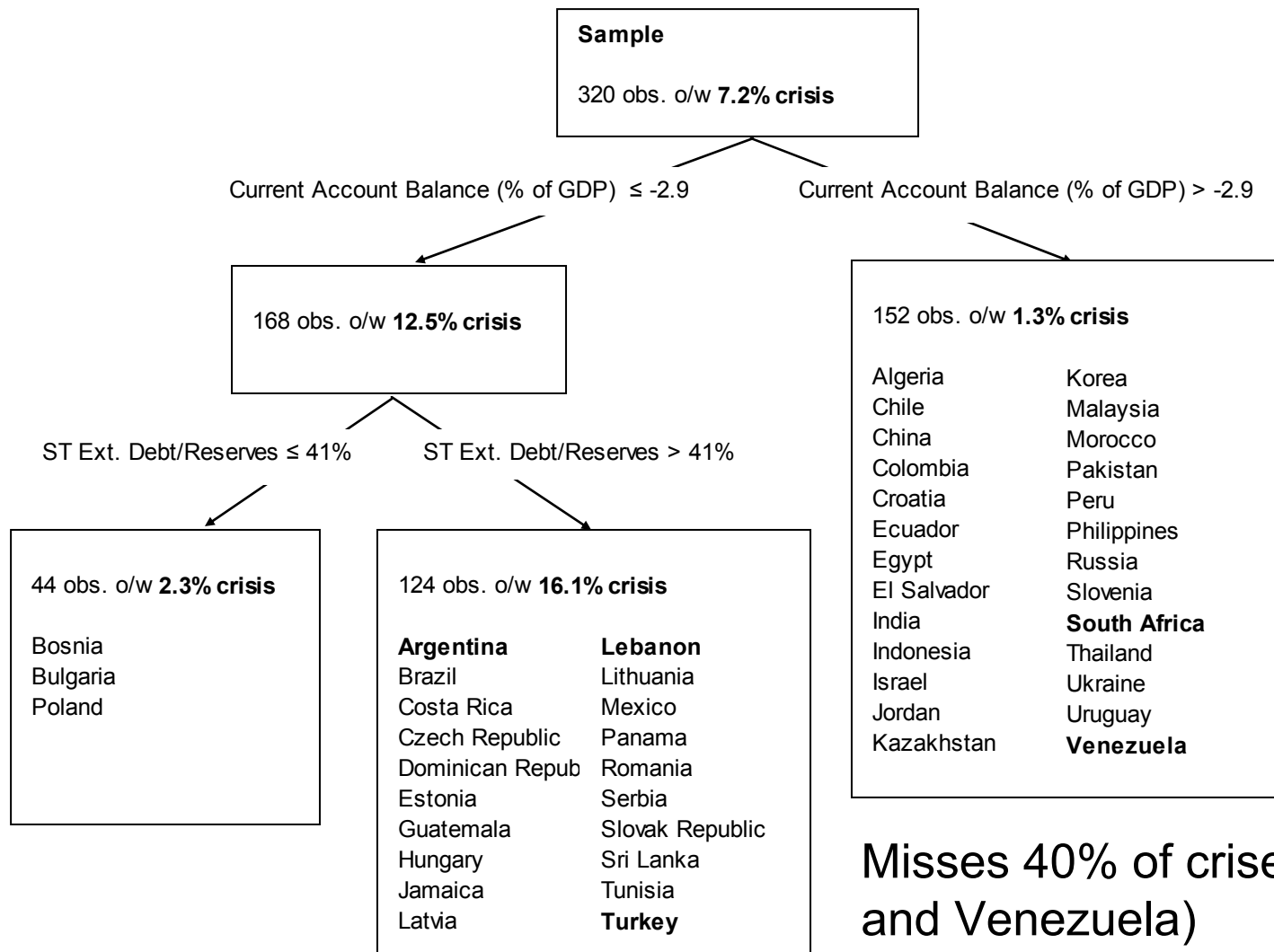
# Baseline Tree





# Out-of-Sample Forecasts

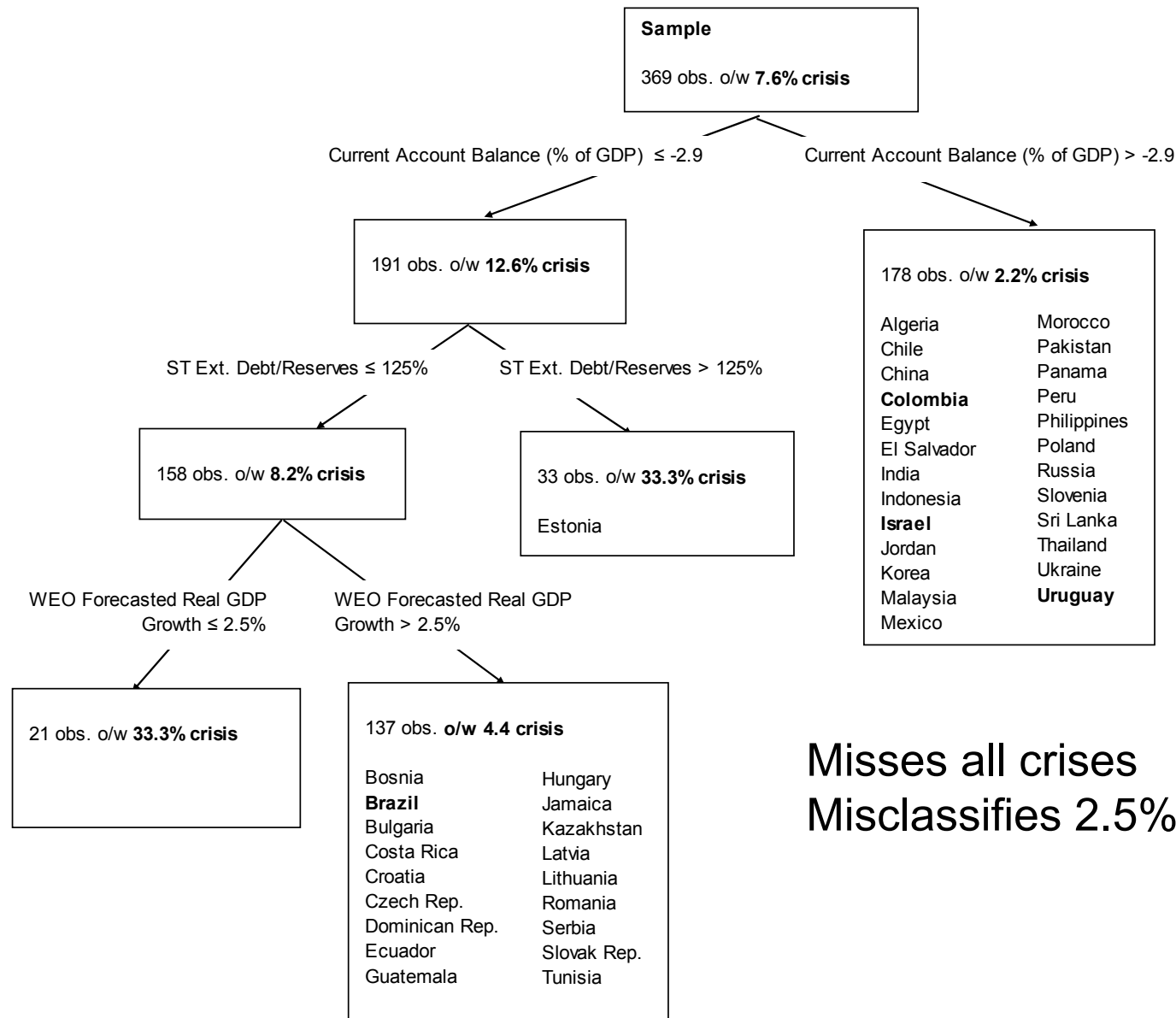
# Using Data Up To 2000 To Predict 2001



Misses 40% of crises (South Africa and Venezuela)

Misclassifies 33% of non-crises

# Using Data Up To 2001 To Predict 2002



Misses all crises  
Misclassifies 2.5% of non-crises

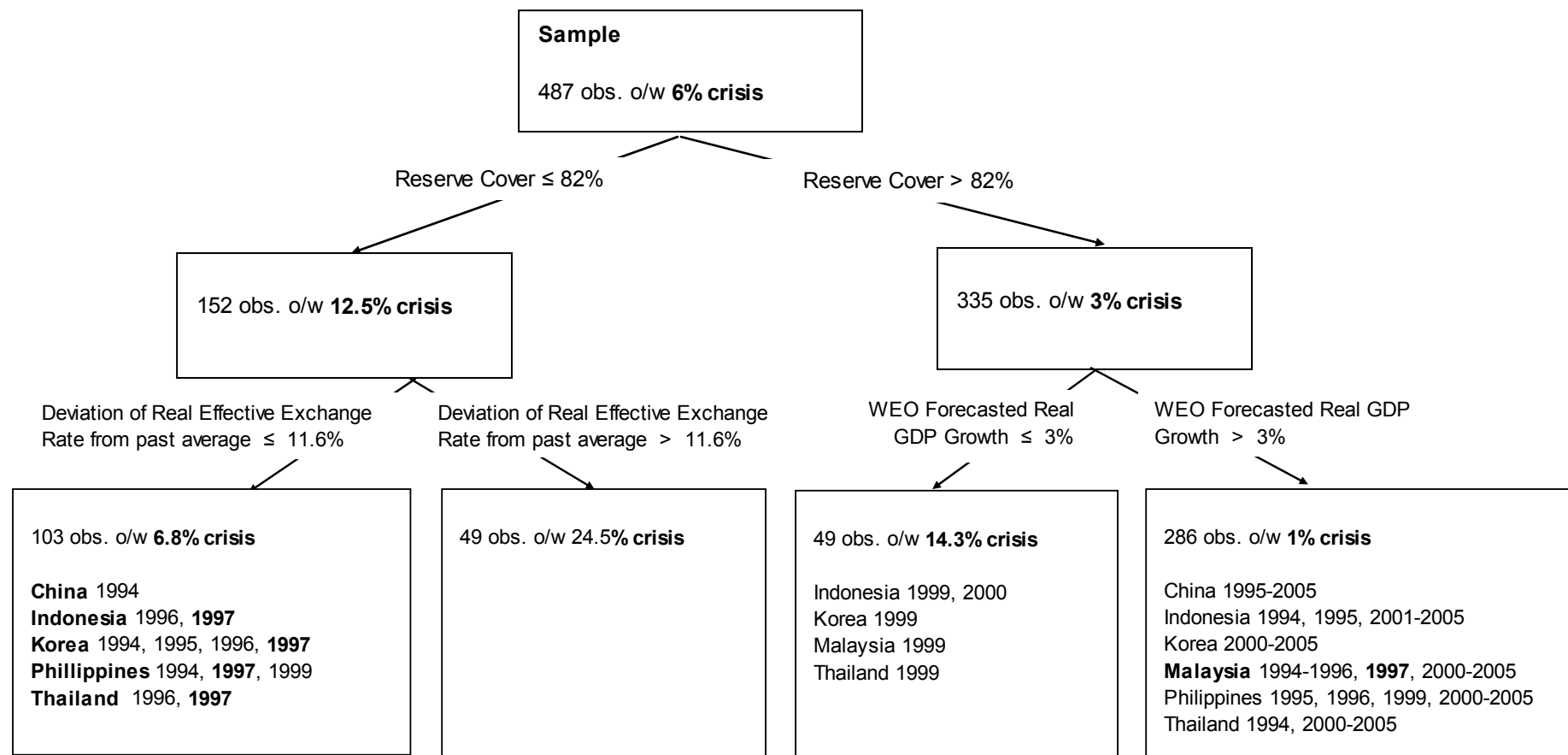




## Using Data Up To 2002 To Predict 2003

- We predict both crises (Dominican Republic and Jamaica), misclassify only 16 percent of non-crisis observations

# Using Data Excluding East Asia to Predict East Asia



Misses all 5 crises and misclassifies 7.5% of non-crises

Top split alone would have missed only Malaysia 97 and misclassified 13% of non-crises



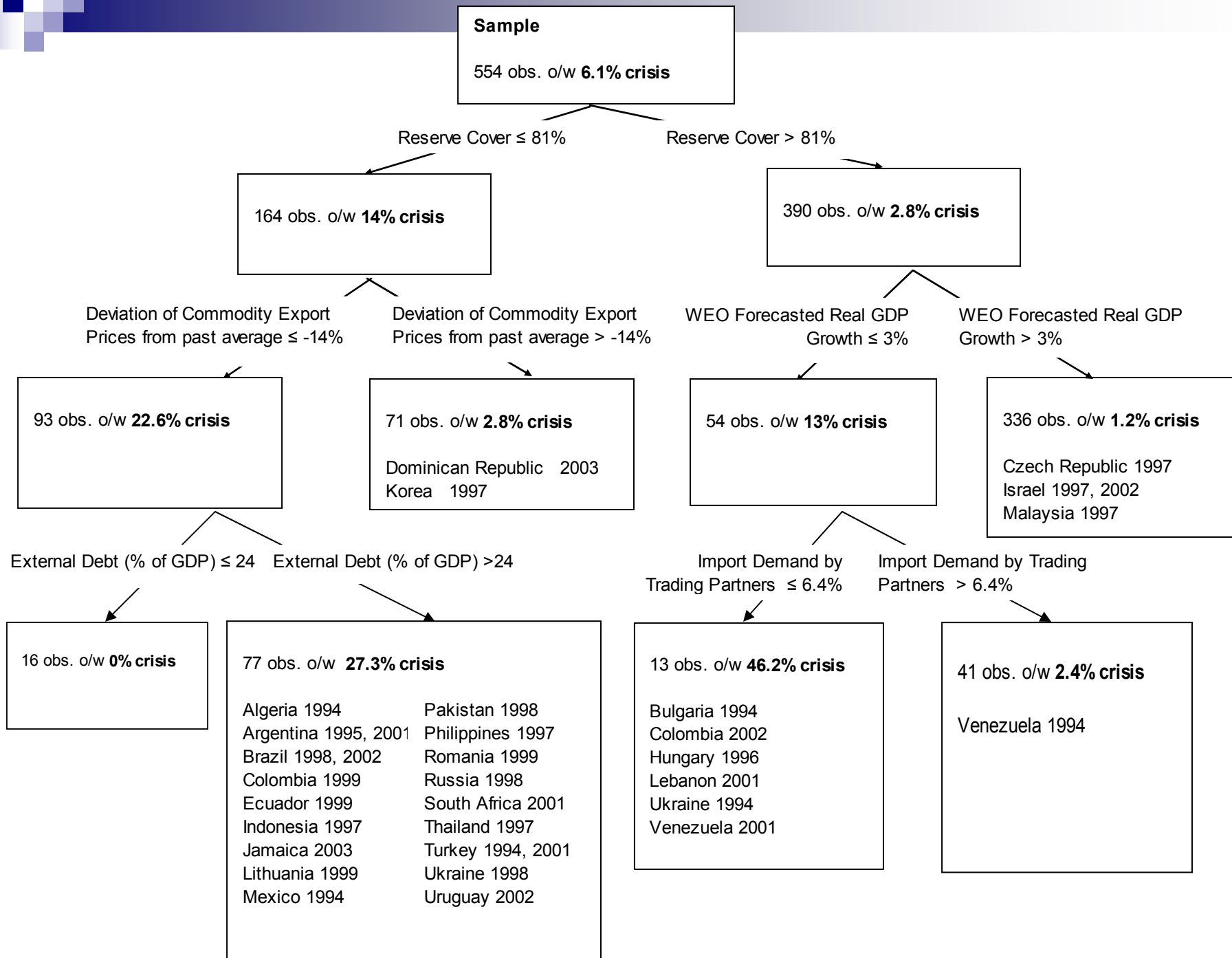
# RandomForests


- Estimates 1000 trees based on bootstrapped samples. In each split, it only considers 3 randomly chosen indicators. Predictions from each tree are averaged out.
- Performance similar to that of forecasting trees:
  - 2001: Predicts the same crises but has more false-alarms
  - 2002: Predicts the crisis in Brazil while still missing others, misclassifies 25% of non-crisis
  - 2003: Misses one of the crises and has more false-alarms
  - East Asia: Predicts Korea while still missing others. Misclassifies 29% of non-crisis.



# Global Conditions vs Country-Specific Indicators

- It would be interesting to get a sense of extent to which benign global environment compensates for country vulnerabilities
- We include contemporary global condition variables (commodity prices and import demand). No longer a forecasting exercise!





# Baseline Tree + Contemporary Global Conditions

- Taken at face-value:
  - Deviation of commodity prices from past average of 14% does as much harm for low reserve cover countries as having external debt above 24% of GDP
- We should also be cautious when trying to separate global and country-specific crisis determinants:
  - If global conditions deteriorate, a number of improvements in country indicators (e.g. more reserves, less short-term debt) could be reversed



# Conclusions

- Can we predict the next capital account crises?
  - If it were not for 2002, our performance would have been excellent
- How do our estimates compare with previous Early Warning Systems (EWS)?
  - In-sample we do better
  - Out-of-sample comparison difficult since crises definitions different and EWS uses monthly data
  - But out-of-sample performance comparable (and 2002 aside, our performance seems preferable)



# Conclusions

- Traditional macro/external variable seem to have more explanatory power than financial sector variables
  - There are limitations in our methodology and some financial sector variables had limited coverage
  - Maybe macro/external variables are better at explaining whether crisis occurs, but financial indicators may be more relevant for how disruptive crisis will be
- Role of reserve cover identified in our estimates supports view that world is a safer place now
  - Reserve accumulation often higher than threshold in our estimates