SAMBA: Stochastic Analytical Model with a Bayesian Approach

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The views expressed here are those of the authors and do not necessarily reflect those of the Banco Central do Brasil (BCB)
• Introduction
• Model overview
• Estimation
• Model properties
• Conclusion
Introduction

• Dynamic stochastic general equilibrium (DSGE) models: advances in modeling and estimation techniques => greater empirical coherence

• SAMBA is a DSGE model:
  – Built and estimated for the Brazilian economy
  – To be used as part of the macroeconomic modeling framework of the BCB, providing support for policy analysis and forecasting.
Model Overview

• Microfounded model developed for the inflation targeting period (started in mid-1999)
• Small open economy (OEM) model, which borrowed many insights from:
  – Christiano, Eichenbaum and Evans (2005), Smets and Wouters (2003, 2007) – closed economy models
Model Overview

- SAMBA combines standard DSGE model features:
  - Nominal rigidities: price and wage rigidities
  - Real frictions: habit persistence in consumption, adjustment cost in investment, exports and imports
  - Monetary policy: Taylor rule

with...
Important features of the Brazilian economy:

- Fiscal rule: target for the primary surplus
- Part of the CPI is comprised of regulated or administered prices: Follow a backward-looking rule
- Imports are inputs used to produce differentiated sectoral goods (most of imports in Brazil are inputs used in the production process)
- Fraction of imports are financed abroad
- Fraction of households are financially constrained
Model Overview
Agents and Flow of Goods/Services

- Importing Firms
- Government
- Rule-of-Thumb Households
- Optimizing Households
- Domestic Input Producers
- Intermediate Goods Producers
- Importing Firms
- Labor
- Capital
- Private Cons. Goods
- Investment Goods
- Export Goods
- Government Cons. Goods
- Government
- Final Goods Assemblers

M

ROW

C

I

X

G

ROW
Model Overview

- Private aggregate demand components (C, I, X, M) depend on:
  - Past values
  - Expected values (C, I)
  - Shocks: specific and productivity
  - Driving forces
Model Overview
Main Drivers of Aggregate Demand

- Potential Output
  - Labor
  - Wage
  - Net tax
- Inflation Target
  - Inflation
- Nominal Int. Rate
  - Disposable Income
    - C of RoT
    - C of Opt.
- Real Int. Rate
- Rental Rate of K
- Relative Prices
  - World Income
  - Domestic Costs
  - Foreign Prices
  - Dom. Input Prices
- Country Risk Premium
- Foreign Int. Rate
- Foreign Inv. Risk Aversion

Domestic Production
- Domestic Costs
- Relative Prices
- Relative Input Prices

GDP

- C
- I
- G
- X
- M
- NFA
Model Overview Pricing

- Two layers of price rigidity

- Wage (Rigidity)
- Rental Rate of Capital
- Import Prices (Rigidity)

Input Prices

- Sectoral differentiated goods with different degrees of price rigidity

Pricing to market
Model Overview

• Phillips curves for the prices of the sectoral goods: C, I, G, X, M
  – Price rigidity à la Calvo
  – Backward-looking indexation
  – Inflation depend on:
    • Past and expected inflation (hybrid specification)
    • Shock
    • Marginal costs (driving forces):
      – Wages, rental rate of capital, import prices, productivity
Model Overview

• Pricing in the consumption goods sector
  – Freely-set or market prices (70% of the CPI): standard setup
  – Regulated or administered prices (30% of the CPI): prices regulated by the government or regulatory agency – in the model, they follow a rule capturing actual behavior:
    • Prices are adjusted by the rule once a year
    • Price adjustment is based on the past four-quarter changes in CPI inflation (main component), exchange rate, and costs
  □ In comparison to freely-set prices, the responses of administered prices to shocks are:
    • Lagged, weaker and more persistent
Model Overview

• Technology shocks: transitory and permanent
• Monetary authority
  – Forward-looking Taylor rule
• Fiscal authority: Rule to capture regime in place
  – Pursues a target for public sector primary surplus
  – Instrument: Government consumption
  – Target also reacts to deviations of the government debt from the steady state
  – Government debt is affected by the policy rate
Estimation

• Bayesian estimation
  – Prior distribution + likelihood from the data

• Sample period: 1999Q3 – 2010Q2 (44 obs.)

• Data (observables):
  – 18 domestic variables
  – 5 foreign variables

• Data treatment
  – Trend variables: first log-difference
  – Stationary variables: demeaned
Estimation

- Shocks: 17 domestic and 6 foreign shocks
- Total number of parameters: 118
  - 81 are estimated: 33 are structural and 48 are shock-related parameters
  - 37 are calibrated
- Posterior distributions
  - Data was informative: it played an important role in determining the estimates for large part of the parameters
Estimation

Prior and posterior distributions of selected parameters
Model Properties
IRF to a Monetary Policy Shock

Real GDP
Private Consumption
Government Consumption
Investment
Exports
Imports
4-Q Inflation
Real Exchange Rate
Nom. Interest Rate (annualized)

CPI
Free
Admin.
Model Properties
IRF to a Wage Markup Shock

- Real GDP
- Private Consumption
- Government Consumption
- Investment
- Exports
- Imports
- 4-Q Inflation
- Real Exchange Rate
- Nom. Interest Rate (annualized)

CPI, Free, Admin.
Model Properties
IRF to a Real Exchange Rate Shock

- Real GDP
- Private Consumption
- Government Consumption
- Investment
- Exports
- Imports
- 4-Q Inflation
- Real Exchange Rate
- Nom. Interest Rate (annualized)
Model Properties
IRF to a Government Cons. Shock

- Real GDP
- Private Consumption
- Government Consumption
- Investment
- Exports
- Imports
- 4-Q Inflation
- Real Exchange Rate
- Nom. Interest Rate (annualized)
Model Properties
Forecasting Performance

Root Mean Squared Errors (RMSE) of forecasts

4-Q CPI Inflation
GDP Growth (y-o-y)
Selic rate (quarterly)
Model Properties
Forecasting Exercises

• Data up to 2004Q4
• Data up to 2008Q4
• Unconditional forecasts
• Made in a mechanical way
• Necessary combination with specialists’ forecasts for
  – foreign variables
  – domestic variables in the short run
• Thorough assessment only after the model is tested in real time for some period of time
Conclusions

• Model has reasonable properties
  – Impulse response functions: well behaved and consistent with available evidence
  – Forecasting: mechanical exercises are encouraging, but too early to tell

• Model can be a useful tool for policy analysis (construction of scenarios, assessment of the impact of shocks, etc.) and forecasting

• Additional tool in the suite of models used by the BCB: small- and medium-sized semi-structural models, VAR models
Conclusions

• Next step: Inclusion of financial intermediation in the model
  – To broaden range of issues to be dealt with, including financial regulatory issues
  – Necessary a consensus framework
  – As Gertler and Kiyotaki (2010) points out: Earlier literature on financial frictions treated financial intermediaries largely as a veil
• Much more details can be found in the BCB Working Paper no. 239.

Thank you for your attention!