



XIII Seminário Anual de Metas para a Inflação

SAMBA: Stochastic Analytical Model with a Bayesian Approach

**Marcos R. de Castro, Solange N. Gouvea, André Minella,
Rafael C. Santos, Nelson F. Souza-Sobrinho**

Research Department

Rio de Janeiro, May 12-13, 2011



BANCO CENTRAL DO BRASIL



- The views expressed here are those of the authors and do not necessarily reflect those of the Banco Central do Brasil (BCB)

Presentation Outline



- Introduction
- Model overview
- Estimation
- Model properties
- Conclusion



- 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
 - Adolfson, Laséen, Lindé and Vilani (2007, 2008), Christoffel, Coenen, Warne (2008), Medina and Soto (2007), Murchison and Rennison (2006) - OEM

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...

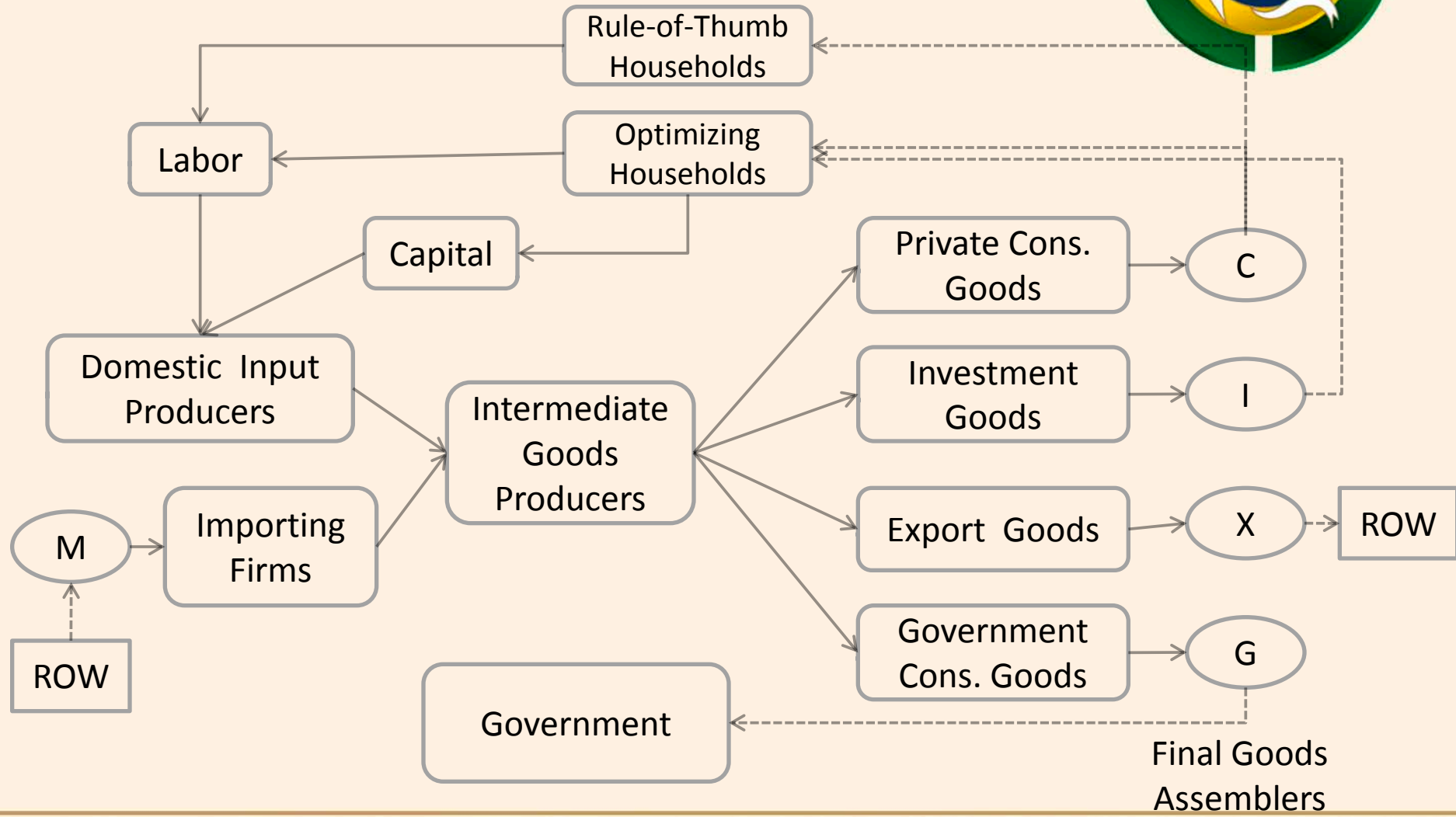


Important features of the Brazilian economy:

- 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

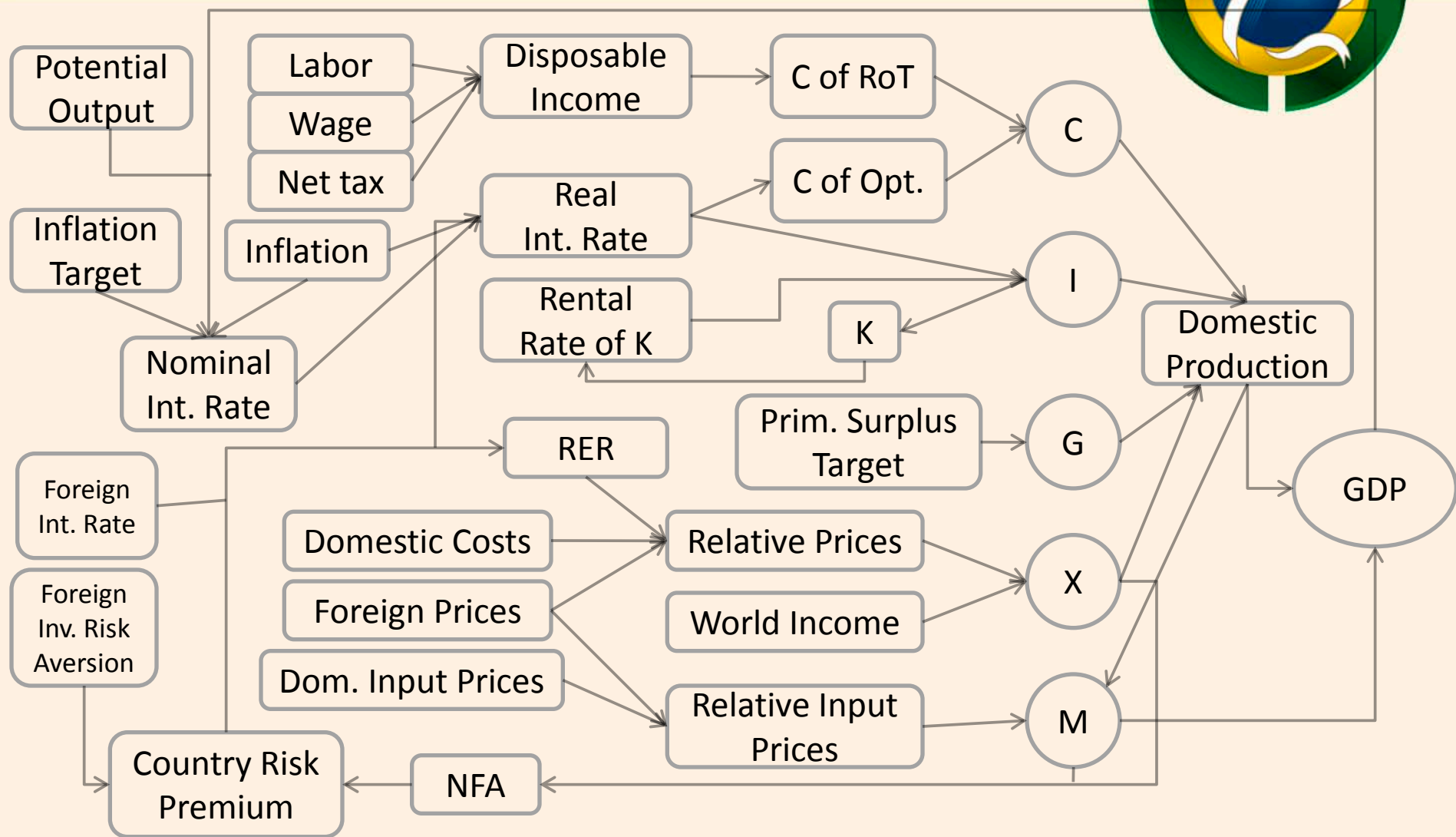




- Private aggregate demand components (C, I, X, M) depend on:
 - Past values
 - Expected values (C, I)
 - Shocks: specific and productivity
 - Driving forces

Model Overview

Main Drivers of Aggregate Demand

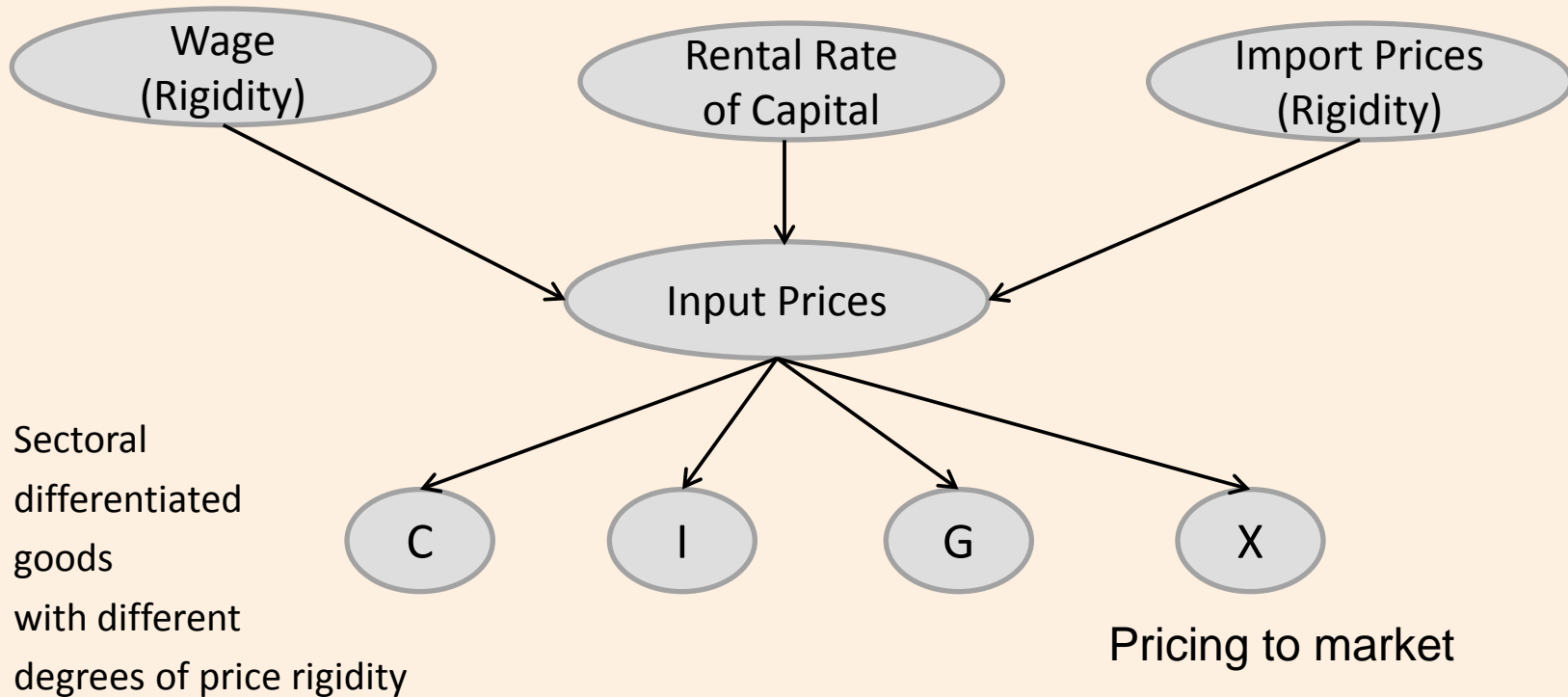


Model Overview

Pricing



- Two layers of price rigidity





- 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



- 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



- 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

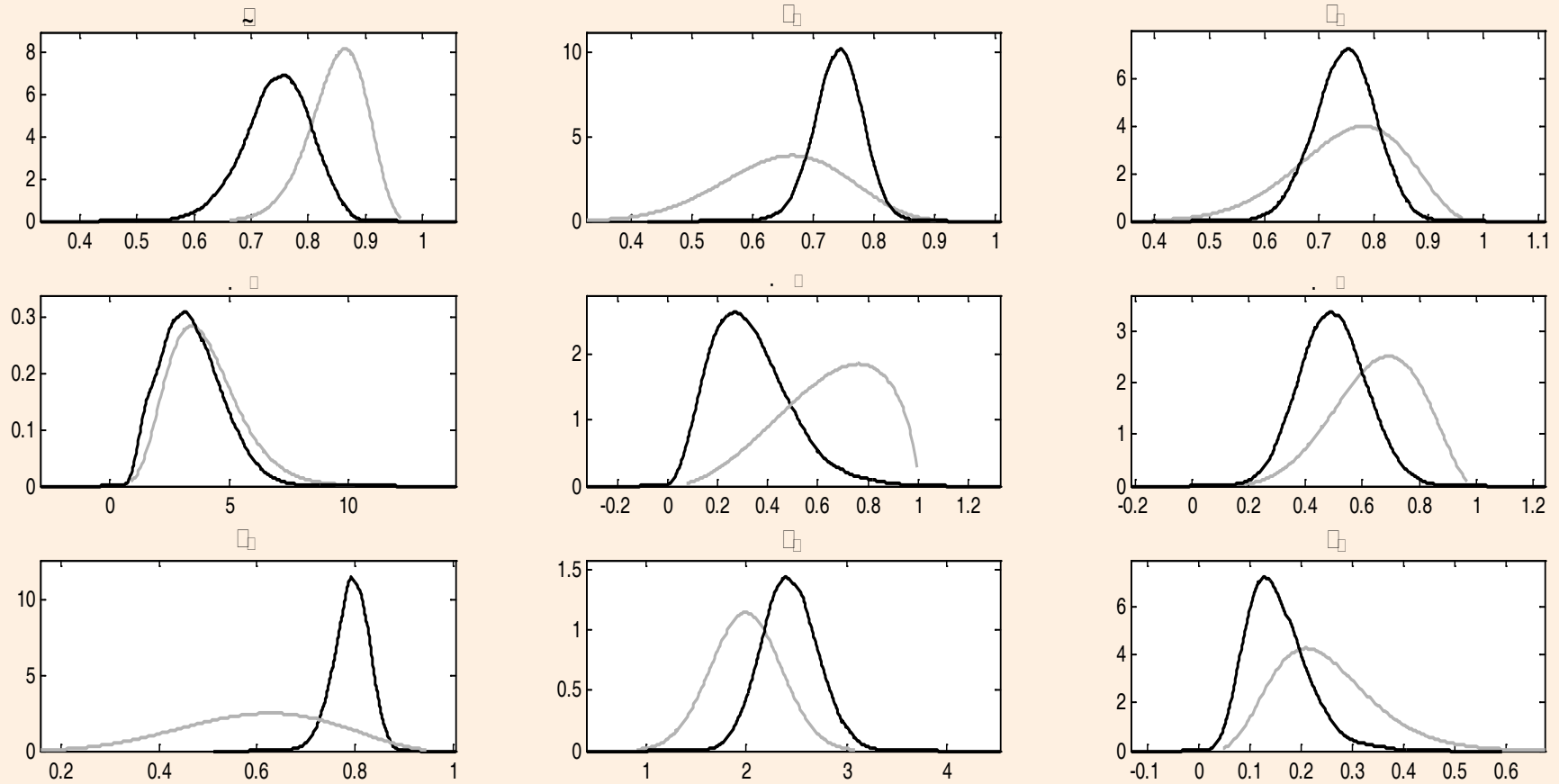


- Shocks: 17 domestic and 6 foreign shocks
- Total number of parameters: 118
 - 81 are estimated: 33 are structural and 48 are shock-related parameters
 - 37 are calibrated
- Posterior distributions
 - Data was informative: it played an important role in determining the estimates for large part of the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

Estimation

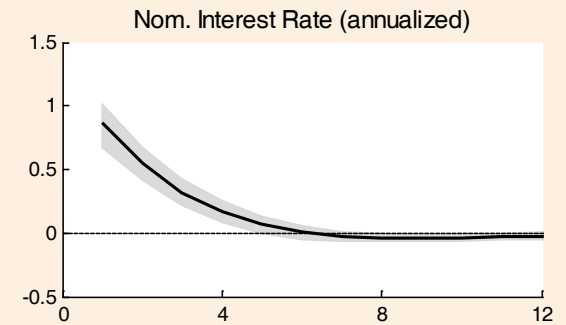
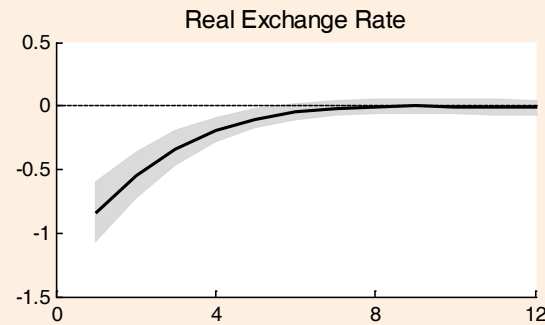
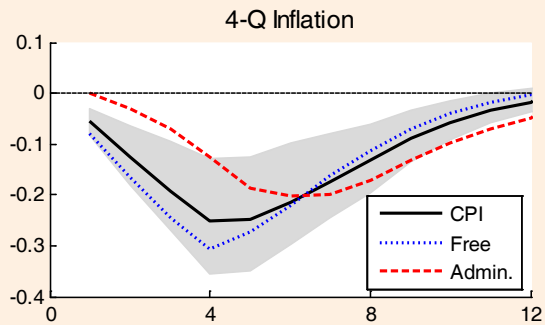
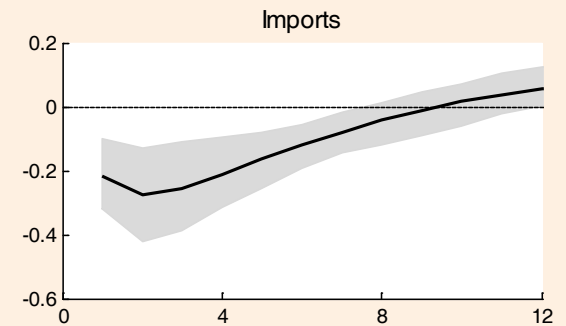
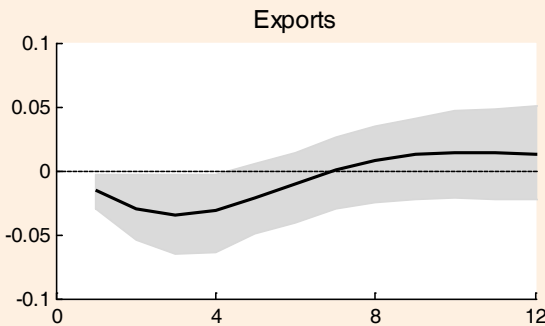
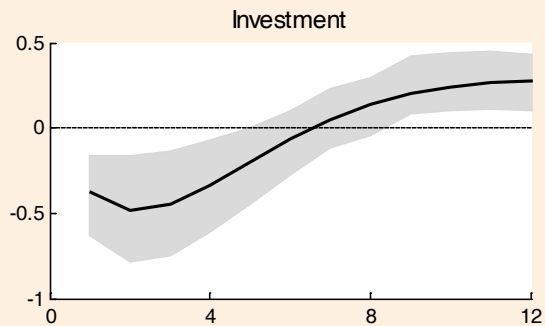
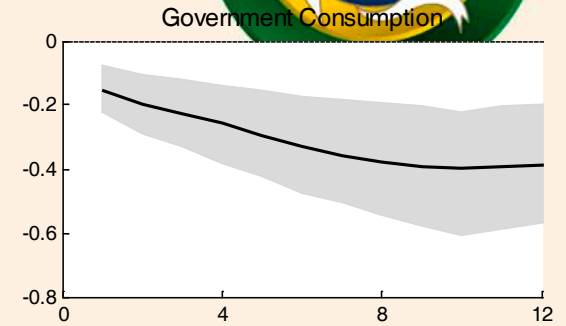
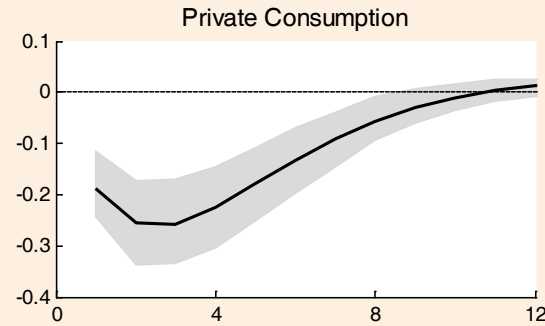
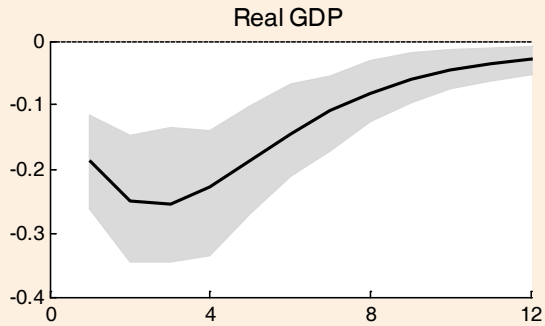


Prior and posterior distributions of selected parameters



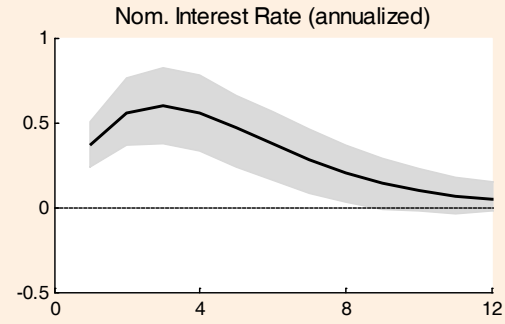
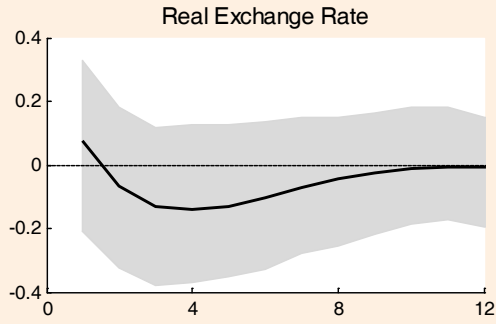
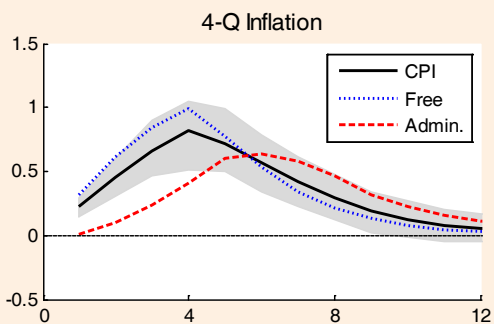
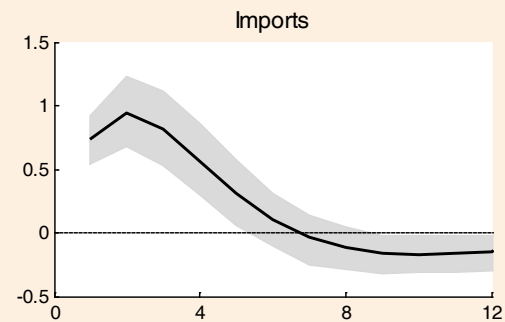
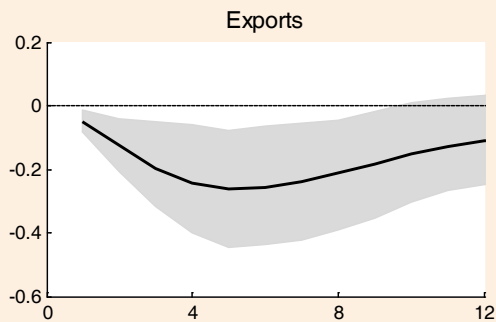
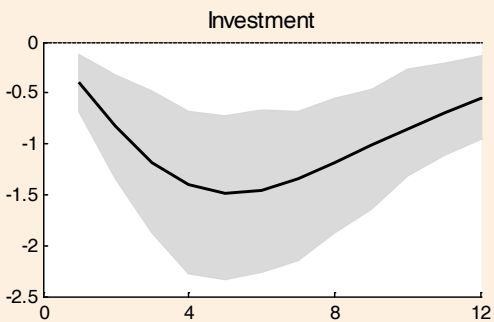
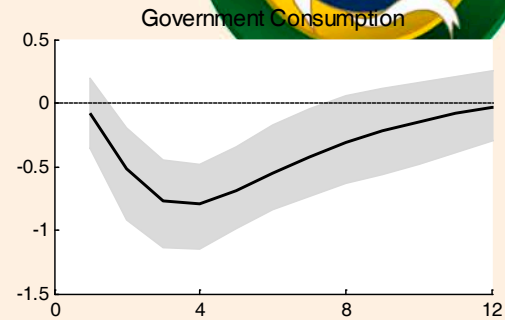
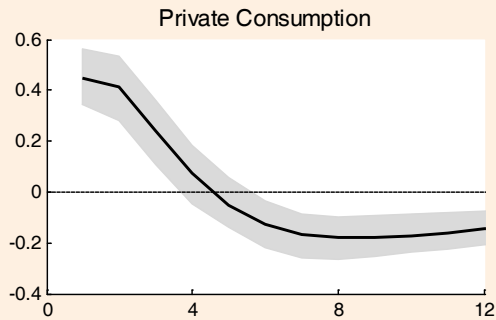
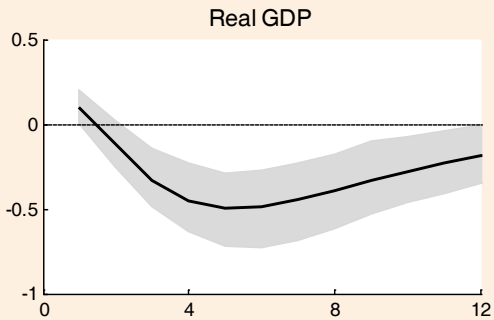
Model Properties

IRF to a Monetary Policy Shock



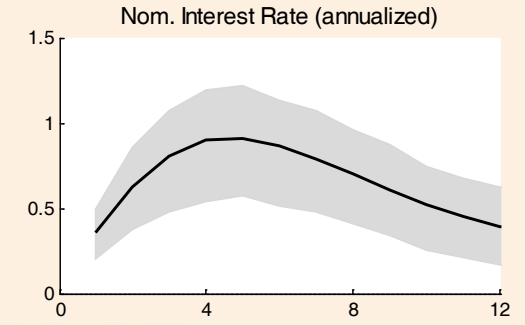
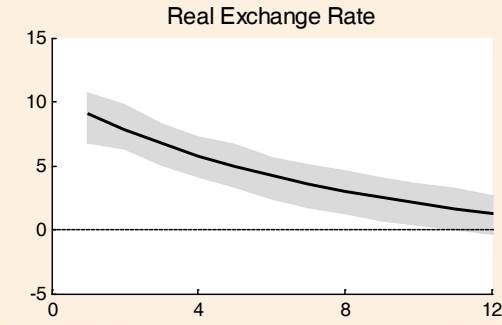
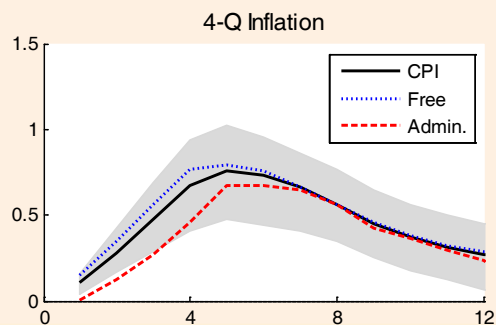
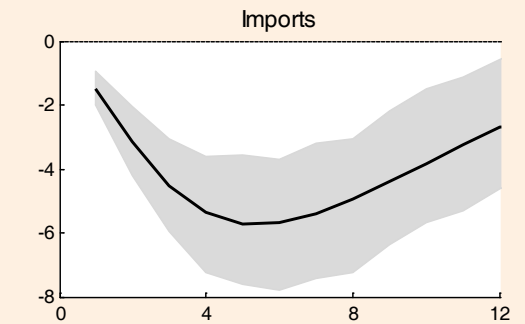
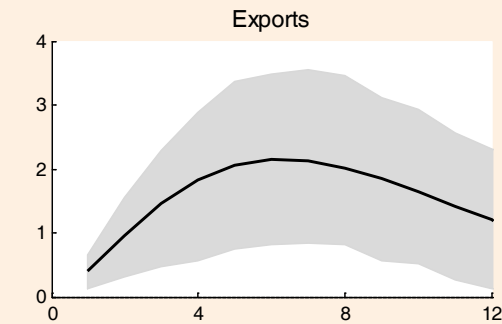
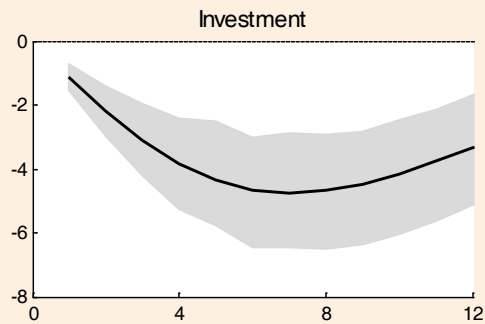
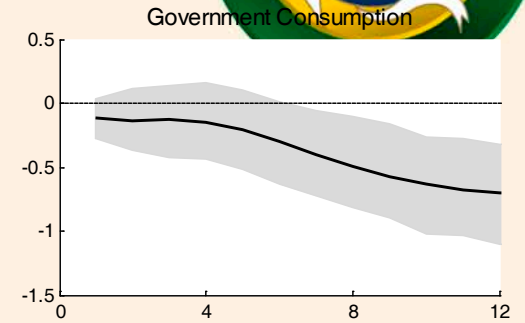
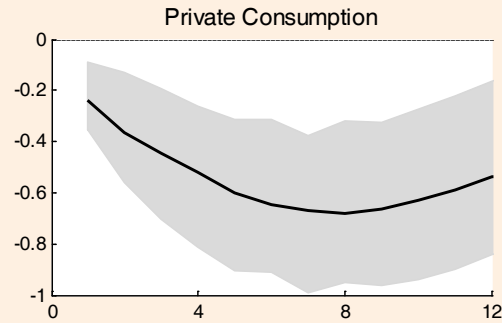
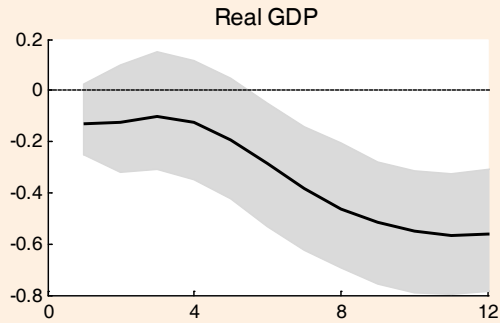
Model Properties

IRF to a Wage Markup Shock



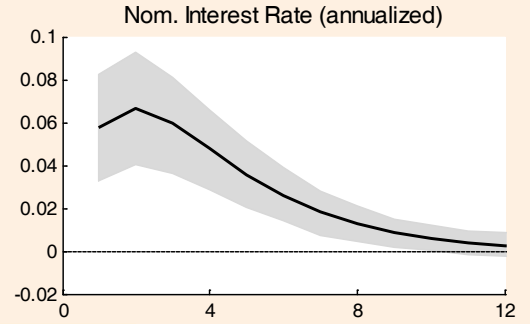
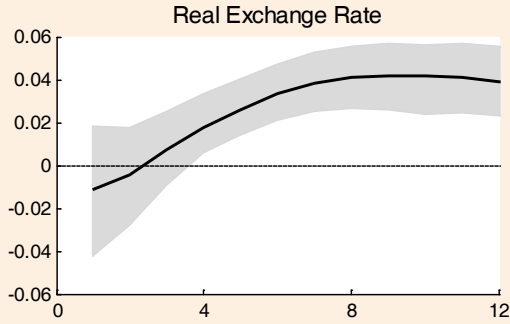
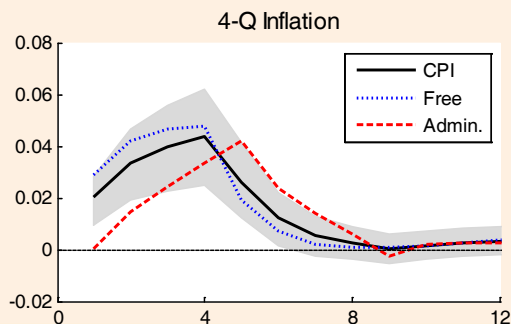
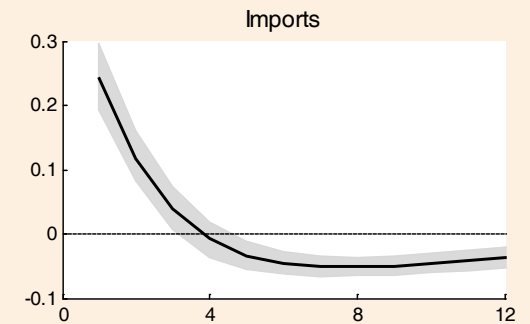
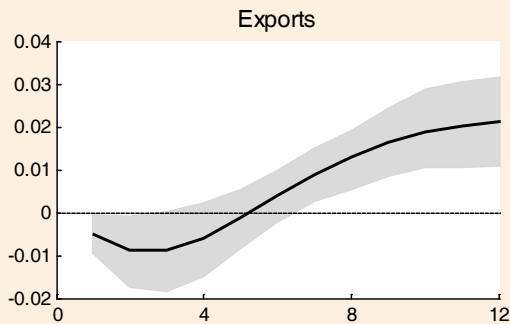
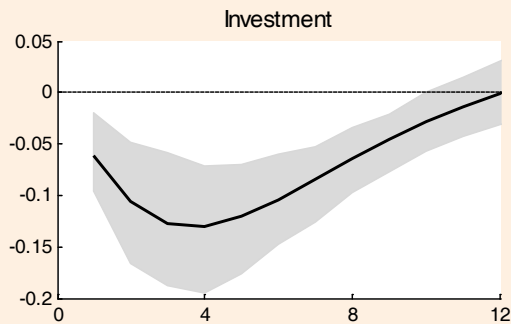
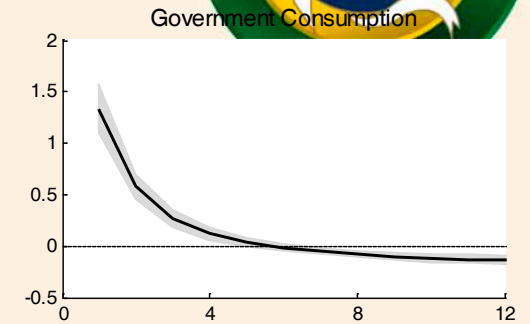
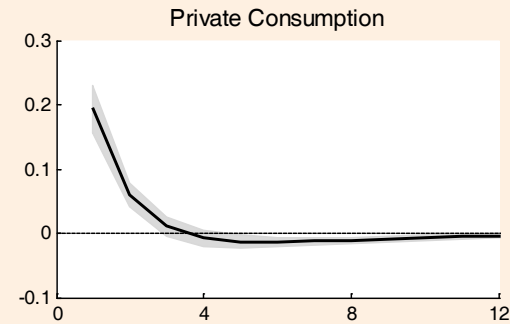
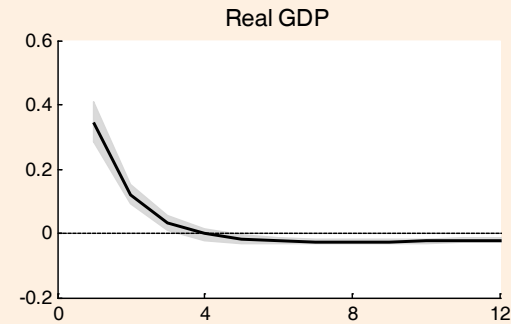
Model Properties

IRF to a Real Exchange Rate Shock



Model Properties

IRF to a Government Cons. Shock



Model Properties

Forecasting Performance

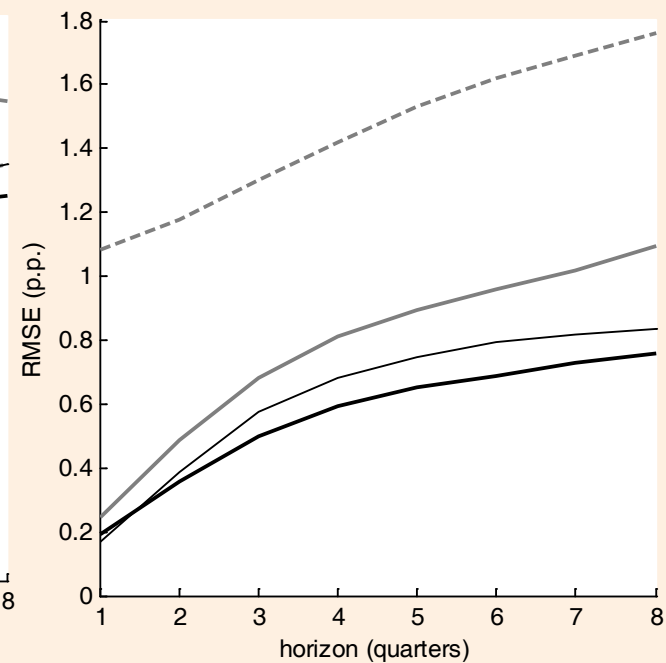
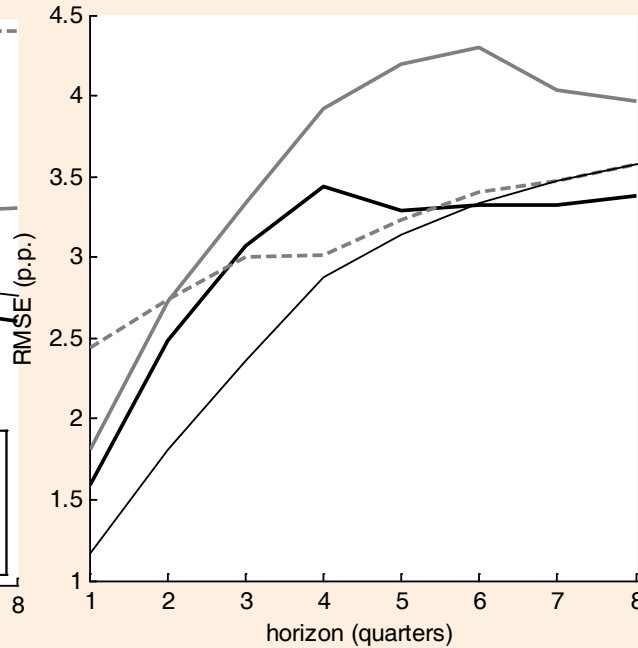
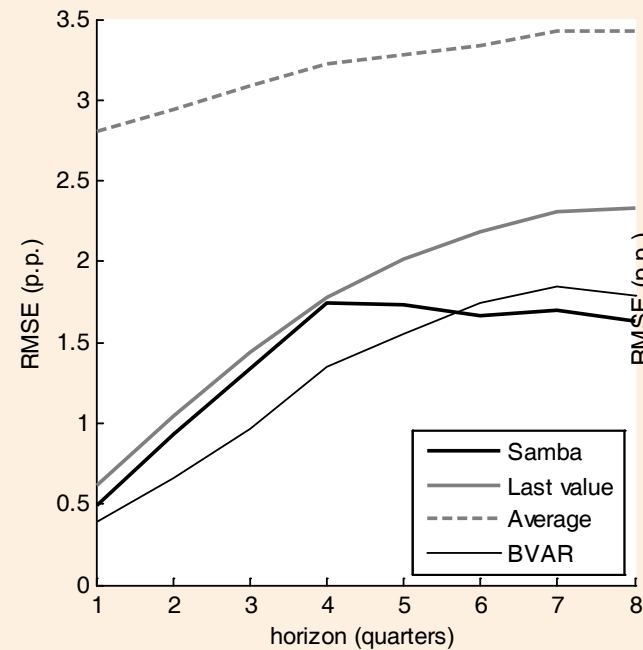


Root Mean Squared Errors (RMSE) of forecasts

4-Q CPI Inflation

GDP Growth (y-o-y)

Selic rate (quarterly)



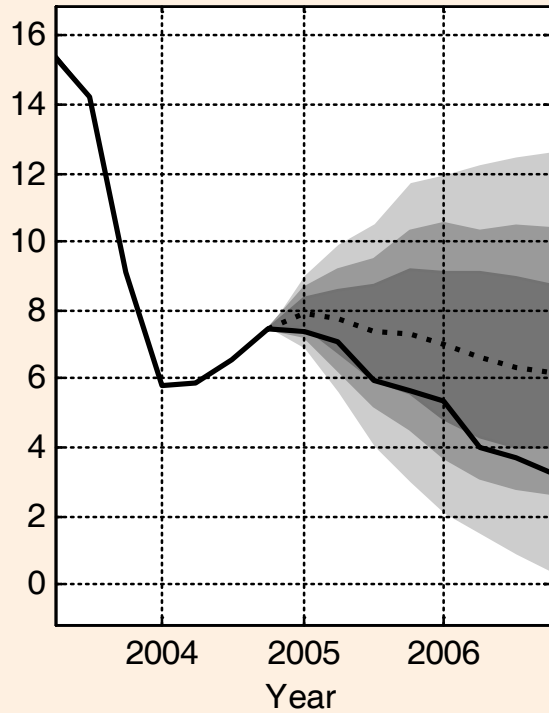
Model Properties

Forecasting Exercises

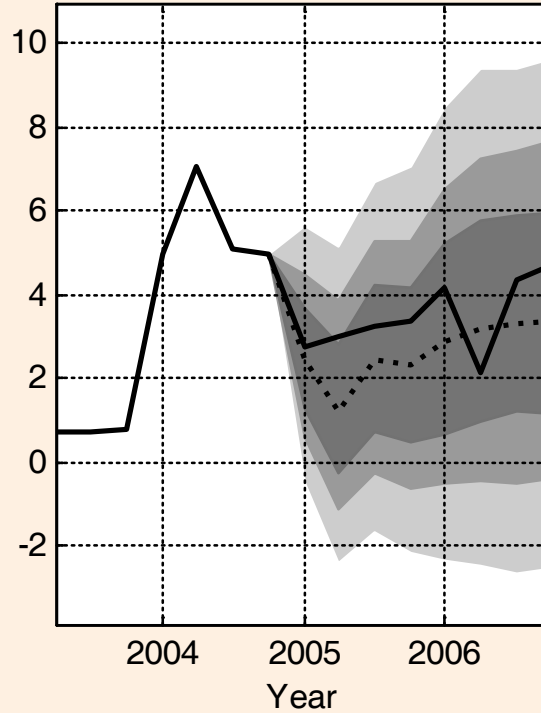


- Data up to 2004Q4

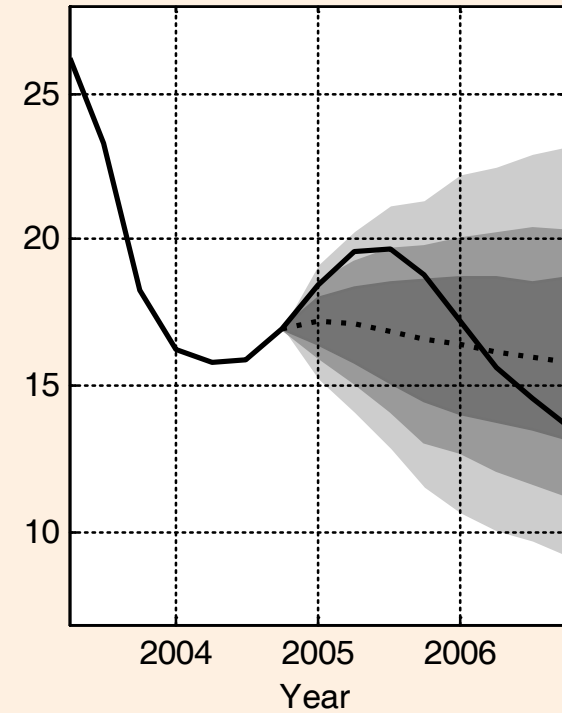
CPI Inflation year-on-year



GDP growth year-on-year



Selic rate (%p.y.)



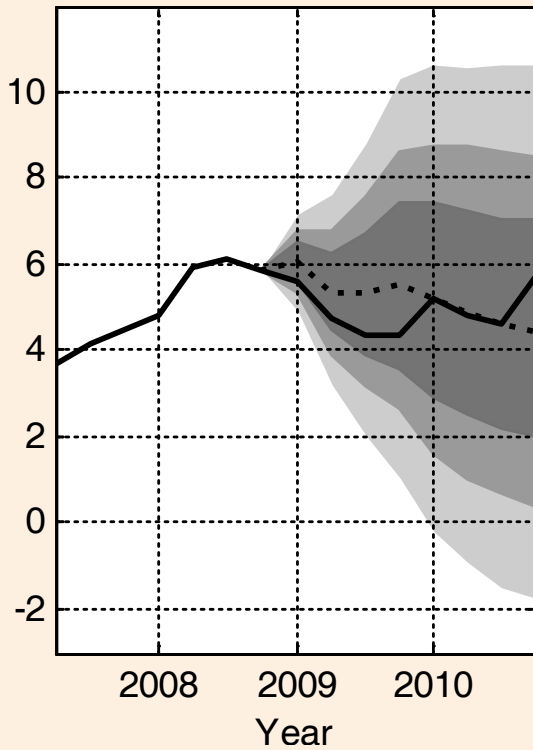
Model Properties

Forecasting Exercises

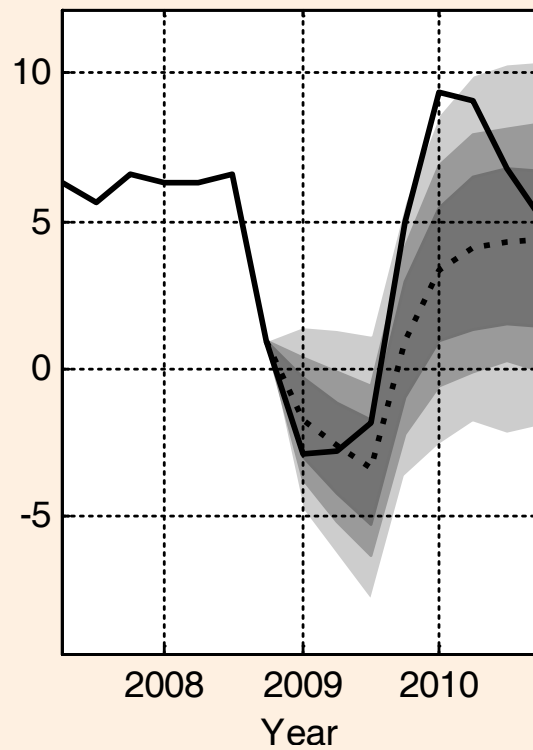


- Data up to 2008Q4

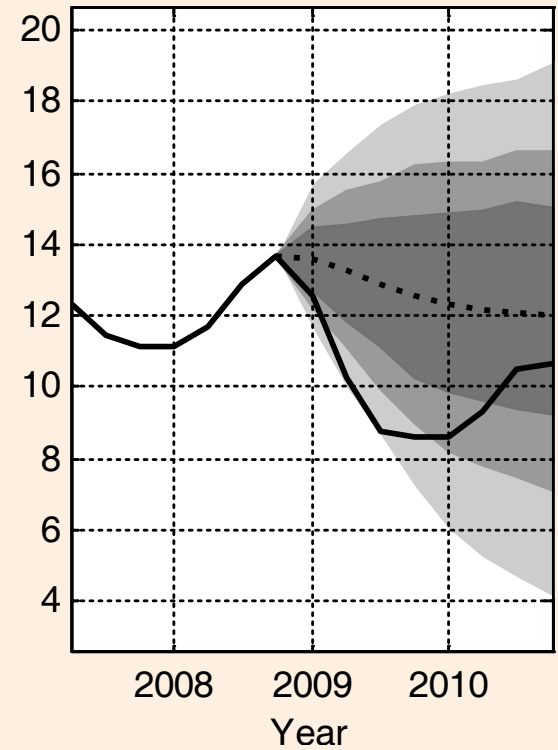
CPI Inflation year-on-year



GDP growth year-on-year



Selic rate (%p.y.)



Model Properties

Forecasting Exercises



- 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



- 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!