The Brazilian Quarterly Real GDP:Temporal Disaggregation and Nowcasting.

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Presentation

Nowcasting Problem

- Economic variables and diferent frequencies:
  - industrial production (PIM), retail survey (PMC) Monthly, 2 months lag ($t+2$);
  - Average Electric Energy Consumption Monthly, 1 month lag ($t+1$);
- GDP frequency: Quarterly with Lag;
- IBC-Br: The Central Bank of Brazil Economic Activity Index;
- IBC-Br frequency: Monthly, 2 months lag ($t+2$);
- IBC-Br : Weaknesses and questions;
- Is there any room for advancement and improvement?

Literature

Article	Theme
Boot, Feibes & Lisma (1965)	Interpolation methods
Denton (1971)	Interpolation methods
Chow & Lin (1971)	Parametric model
Fernandez (1981)	Unit root case
Gregoir (1995)	Dynamic model
Salazar et al. (1997, 1998)	Dynamic model
Santos, Silva & Cardoso (2001)	Dynamic model
Monch & Uhlig (2005)	State-Space (SS) model
Cardoso (1981)	Fisrt brazilian case
Notini et alli. (2012)	SS Coincident index for brazilian GDP

Table : Time evolution of the disaggregation models

Concepts and Definitions

$$y_{l,t} = \sum_{i=1}^{s} c_i y_{h,i}$$

$$Y_l = CY_h$$

$$Y_h = AY_l$$

$$C_{t\times 3t} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$$

First Model

Chow & Lin (1971):

$$Y_l = X_l'\beta + u_l \qquad u_l \sim N(0, V_l)$$

$$Y_h = X_h'\beta + u_h \qquad u_h \sim N(0, V_h)$$

$$u_{h,t} = \rho u_{h,t-1} + \epsilon_t$$
$$\epsilon \sim N(0, \sigma_\epsilon^2)$$

$$\hat{Y}_h = A(X_l'\beta + u_l) \Leftrightarrow \hat{Y}_h = AY_l$$

$$\min_{\beta,\rho} COV(\hat{Y}_h - Y_l)$$

A Disaggregation Model using Kalman Filter

Monch & Uhlig (2005):

$$y^{+} = (0 \quad 0 \quad y^{3} \quad 0 \quad 0 \quad y^{6} \quad 0 \quad 0 \quad y^{9} \ldots)$$

$$y_{l,t}^{+} = \begin{cases} \frac{1}{3}\sum_{i=0}^{2} y_{h,t-i}, & t=3,6,9,\ldots \\ 0, & \text{otherwise} \end{cases}$$

$$y_{l,t}^{+} = H_t \xi_t$$

$$H_t = \begin{cases} [1/3 \ 1/3 \ 1/3 \ 0], & \text{para, } t = 3,6,9,\ldots \\ [0 \ 0 \ 0 \ 0], & \text{otherwise} \end{cases}$$

$$\xi_t = \begin{bmatrix} y_{h,t} \\ y_{h,t-1} \\ y_{h,t-2} \\ u_{h.t} \end{bmatrix} = \begin{bmatrix} \phi & 0 & 0 & \rho \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & \rho \end{bmatrix} \times \begin{bmatrix} y_{h,t-1} \\ y_{h,t-2} \\ y_{h,t-3} \\ u_{h,t-1} \end{bmatrix} + \begin{bmatrix} X'_{h,t}\beta \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} \epsilon_t \\ 0 \\ 0 \\ \epsilon_t \end{bmatrix}$$

State-Space Models for Disaggregation

Nº	Model	Φ	ρ
M1	Static Model in levels with IID residuals	0	0
M2	Static Model in levels with AR(1) residuals (*Chow & Lin (1971)*)	0	free
M3	Static Model in first differences with IID residuals (*Fernandez (1981)*)	0	1
M4	Dynamic Model in levels with IID residuals (*Mitchell et al (2005)*)	free	0
M5	Dynamic Model in first differences with IID residuals	free	1
M6	Dynamic Model in levels with AR(1) residuals (*Santos Silva e Cardoso (2001)*)	free	free

Table 1: Models and Specifications Using State-Space Structure - Source: Mönch & Uhlig (2005) and Author

Methods of Evaluation

In-Sample Criteria

Monch & Uhlig (2005):

$$R^2_{diff} = \frac{Var(\Delta y^+_{t|T})}{Var(\Delta y^+_{t|T}) + Var(\Delta u_{t|T})}$$

Out-of-Sample Criteria

Proietti (2006):

$$MAPE = \frac{1}{T}\sum_{t=1}^{T}\left|\frac{\hat{y^+_t} - y^+_t}{y^+_t}\right|$$

$$RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(\hat{y^+_t} - y^+_t)^2}$$

Variable Selection

- 1st quarter of 2003 to the 4rd quarter of 2012 (Real GDP);
- 54 variables were tested;
- Unit root tests: *ADF*, $MADF_{gls}$, with and without structural breaks - Perron (1989), determinist trend with structural breaks;
- Cross correlation in first difference: Monch & Uhlig (2005), Notini & Issler (2008) and Notini et alli. (2012);
- Causality tests;
- Principal Component Analysis in time series context;

Selected Variables

x_i	Variable	Availability	Unit	Source
1	Capacity Utilization Level (NUCI)	t + 1	index	FGV
2	Present Situation Index (ICI)	t + 1	index	FGV
3	Expectations Index (IE)	t + 1	index	FGV
4	ABCR Heavy Vehicle Traffic on Tollroads	t + 1	thousands	ABCR
5	Average Electric Energy Consumption	t + 1	Mwmed	ONS
6	M1 (deflated by IPCA)	t + 1	millions	BACEN
7	Credit Protection Service (SPC)	t + 1	number of queries	ACSP
8	Agricultural Activity Index	t + 1	index	MF
9	ABPO Corrugated Fiberboard and Cardboard Sales	t + 1	thousand tons	ABPO
10	Cement Production	t + 1	tons	SNIC
11	Inventory levels	t + 1	index	FGV
12	Import Quantum	t + 1	index	FGV
13	Export Quantum	t + 1	index	FGV
14	PMC - Monthly Retail Survey	t + 2	index	IBGE
15	PIM - Monthly Industrial Production	t + 2	index	IBGE
16	IBC-Br - Brazil Central Bank Economic Activity Index	t + 2	index	BACEN

Table 2: Variables Selected

Models Selected

Model	MAPE	RMSE	R^2_{diff}	Description	Variables Used
M(T+2)	0,0018	0,0392	0,7242	M6 - Monch & Uhlig - Table (1)	t+2 and t+1
M1	0,0018	0,0362	0,849	M6 - Monch & Uhlig - Table (1)	t+2 and t+1, replacing ABPO by income tax.
M.IBC-Br	0,0027	0,0596	0,7866	M6 - Monch & Uhlig - Table (1)	t+2 (without IBC-Br) and t+1
M(T+1)	0,0037	0,0704	0,4074	M6 - Monch & Uhlig - Table (1)	t+1
M2	0,0061	0,0119	0,949	Santos, Silva & Cardoso (2001) - Seção (3)	t+2 and t+1
M2.IBC-Br	0,0062	0,0384	0,649	Santos, Silva & Cardoso (2001) - Seção (3)	t+2 (without IBC-Br) and t+1
M3	0,1377	0,5126	0,2119	M5 - Monch & Uhlig - Table (1)	t+2 and t+1
M4	0,0687	0,2898	0,6944	M4 - Monch & Uhlig - Table (1)	t+2 and t+1
M5	0,1456	0,9898	0,2098	M3 - Monch & Uhlig - Table (1)	t+2 and t+1
M6	0,1311	2,1216	0,7013	M2 - Monch & Uhlig - Table (1)	t+2 and t+1
M7	0,1111	1,7996	0,6971	M1 - Monch & Uhlig - Table (1)	t+2 and t+1

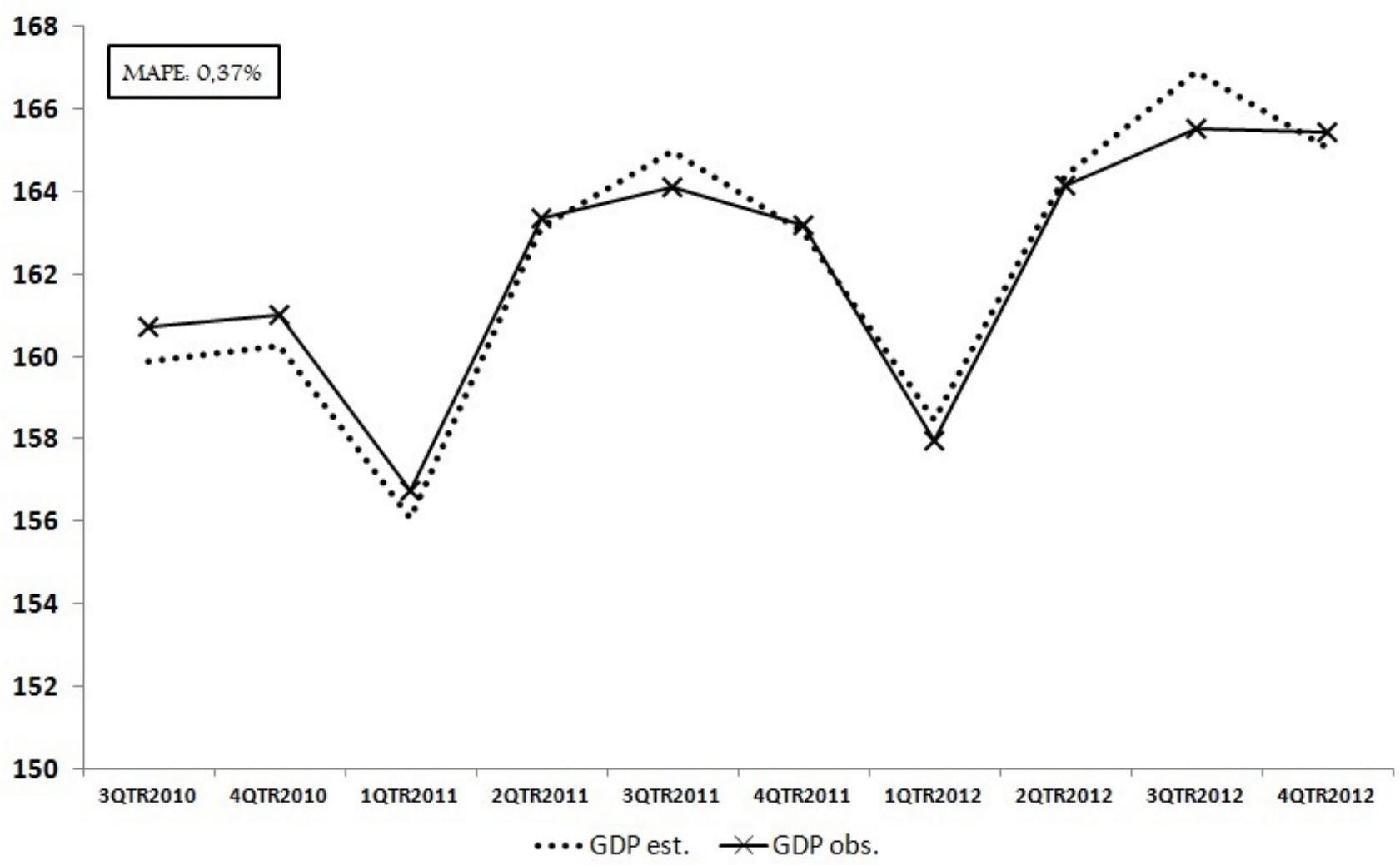
Table 4: Selection of Models

Predictive Ability

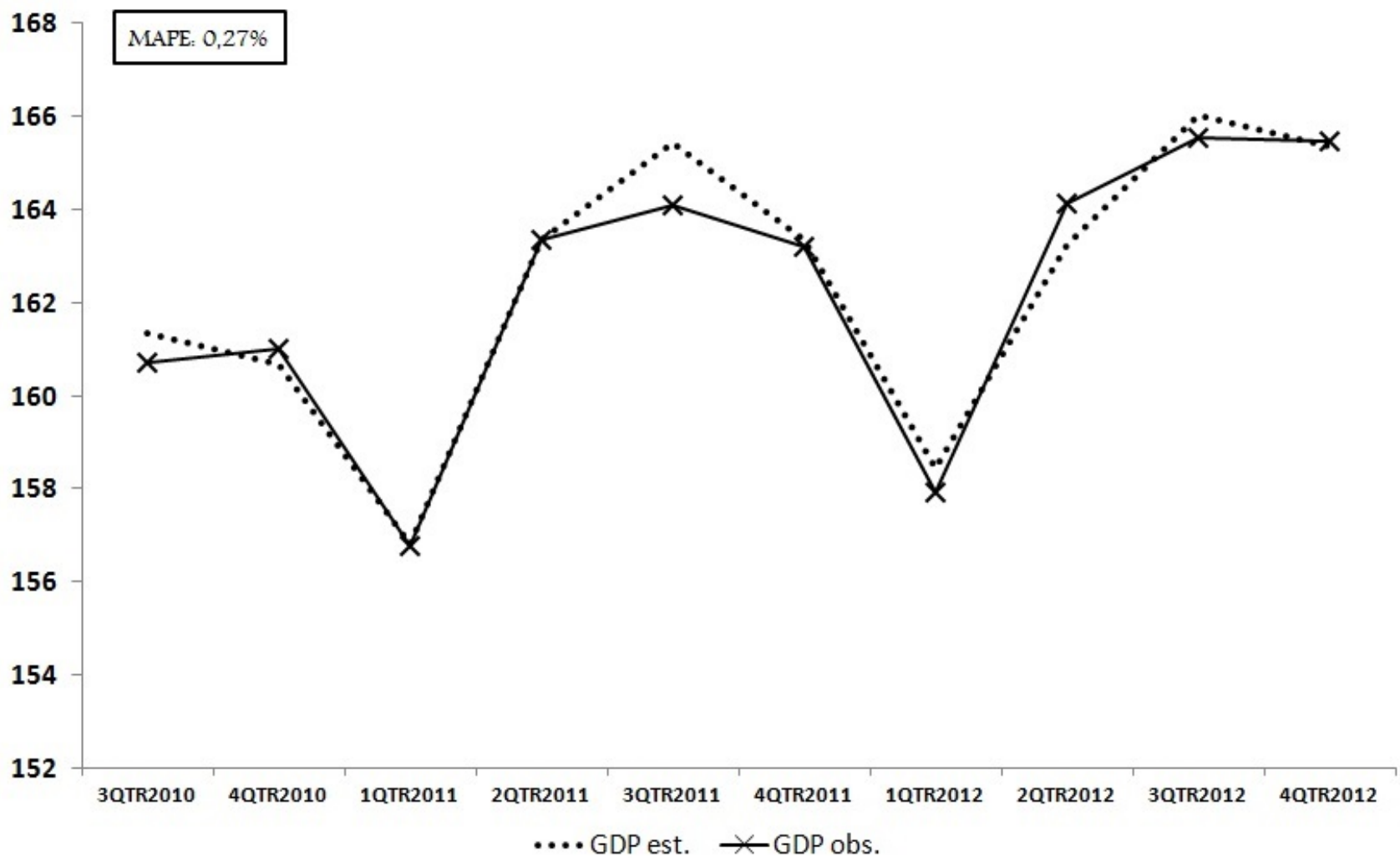
Period	Rate of change (t/t-1) seasonally adjusted.				Forecast Error (GDP - Nowcast)		
	GDP*	IBC-Br	T+1	T+2	IBC-Br	T+1	T+2
2010T3	0,90	0,45	1,54	0,94	0,45	-0,64	-0,05
2010T4	0,87	1,35	0,69	0,76	-0,48	0,18	0,11
2011T1	1,17	1,68	0,81	1,21	-0,50	0,36	-0,04
2011T2	0,44	-0,30	0,81	0,37	0,74	-0,37	0,07
2011T3	-0,04	-0,52	0,78	0,15	0,47	-0,83	-0,20
2011T4	0,34	0,31	-0,08	0,33	0,03	0,42	0,00
2012T1	0,21	0,30	0,21	0,37	-0,09	0,00	-0,17
2012T2	0,43	0,58	0,13	0,10	-0,15	0,31	0,34
2012T3	0,59	1,12	0,35	0,67	-0,53	0,24	-0,08
2012T4	0,56	0,62	0,34	0,74	-0,07	0,22	-0,18
Mean Absolute Error					**0,35**	**0,36**	**0,12**
Mean Square Error					**0,18**	**0,18**	**0,02**

* Using vintage correspondent.

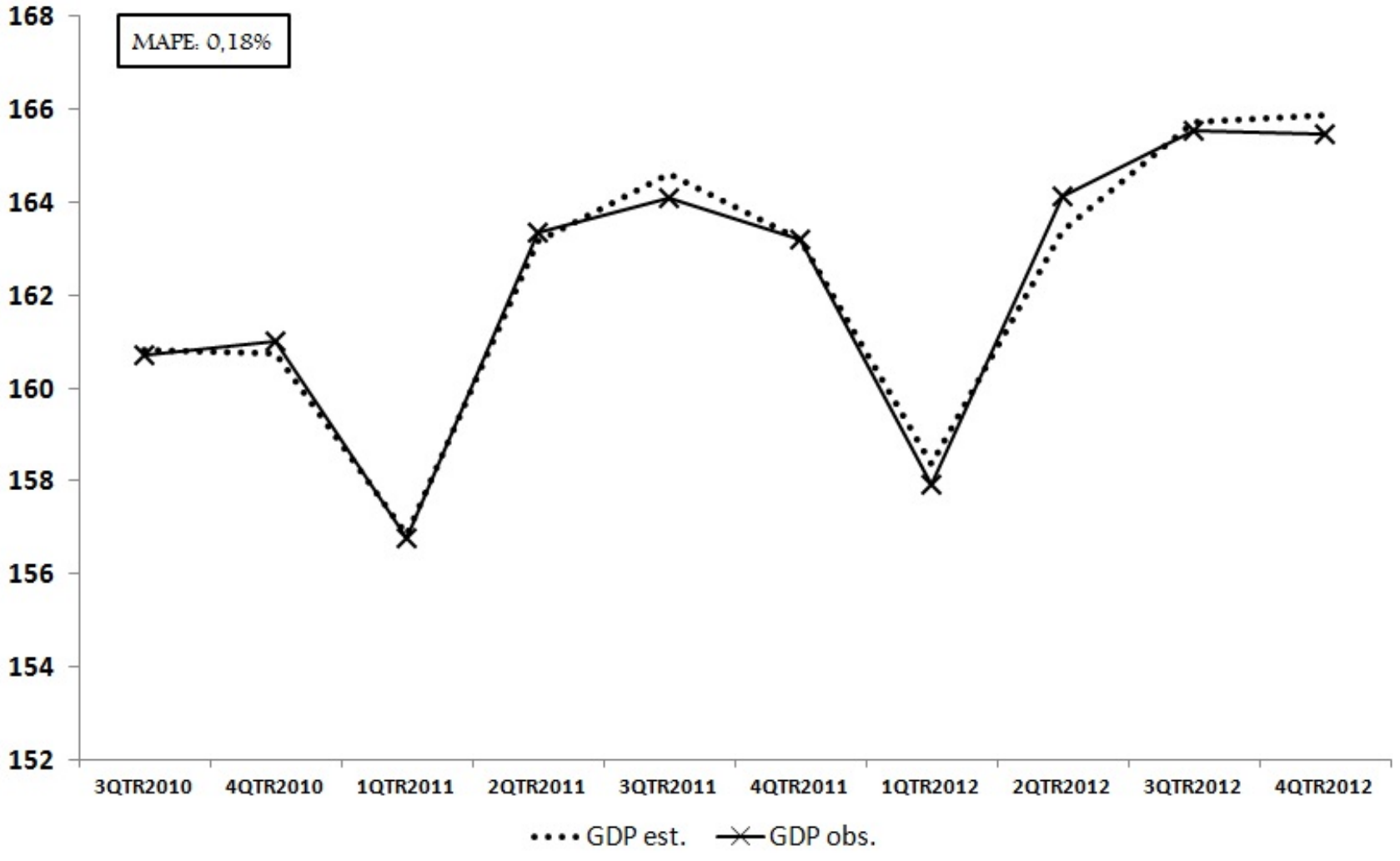
Model t+1


MAPE: 0,37%
168
166
164
162
160
158
156
154
152
150
3QTR2010
4QTR2010
1QTR2011
2QTR2011
3QTR2011
4QTR2011
1QTR2012
2QTR2012
3QTR2012
4QTR2012
GDP est.
GDP obs.

Model t+2 without IBC-Br



Model t+2


MAPE: 0,18%
168
166
164
162
160
158
156
154
152
3QTR2010
4QTR2010
1QTR2011
2QTR2011
3QTR2011
4QTR2011
1QTR2012
2QTR2012
3QTR2012
4QTR2012
GDP est.
GDP obs.

Final Considerations

Main Contribuitions

1. Model (t+1) and GDP disaggregation;
   - Same predictive capacity of the IBC-Br, however with variables t + 1;
   - The quarterly average coincides with the values of real GDP, in this sense it is literally a coincident indicator.
2. Model (t+2) without IBC-Br and Model (t+2);
   - Both models have a better predictive performance than the IBC-Br;
   - The quarterly average coincides with the values of real GDP.

Final Considerations

Research Agenda

1. Possibility of testing variables from the big data context;
2. Use of high-dimensional time series models;
3. Extended temporal sample for the purpose of using predictability tests as presented by Giacomini and White (2006);
4. Study of turning points and economic cycles.

Article Presented:

THE BRAZILIAN QUARTERLY REAL GDP:TEMPORAL DISAGGREGATION AND NOWCASTING.

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THANK YOU ALL.