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 2rd quarter of 2017 (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

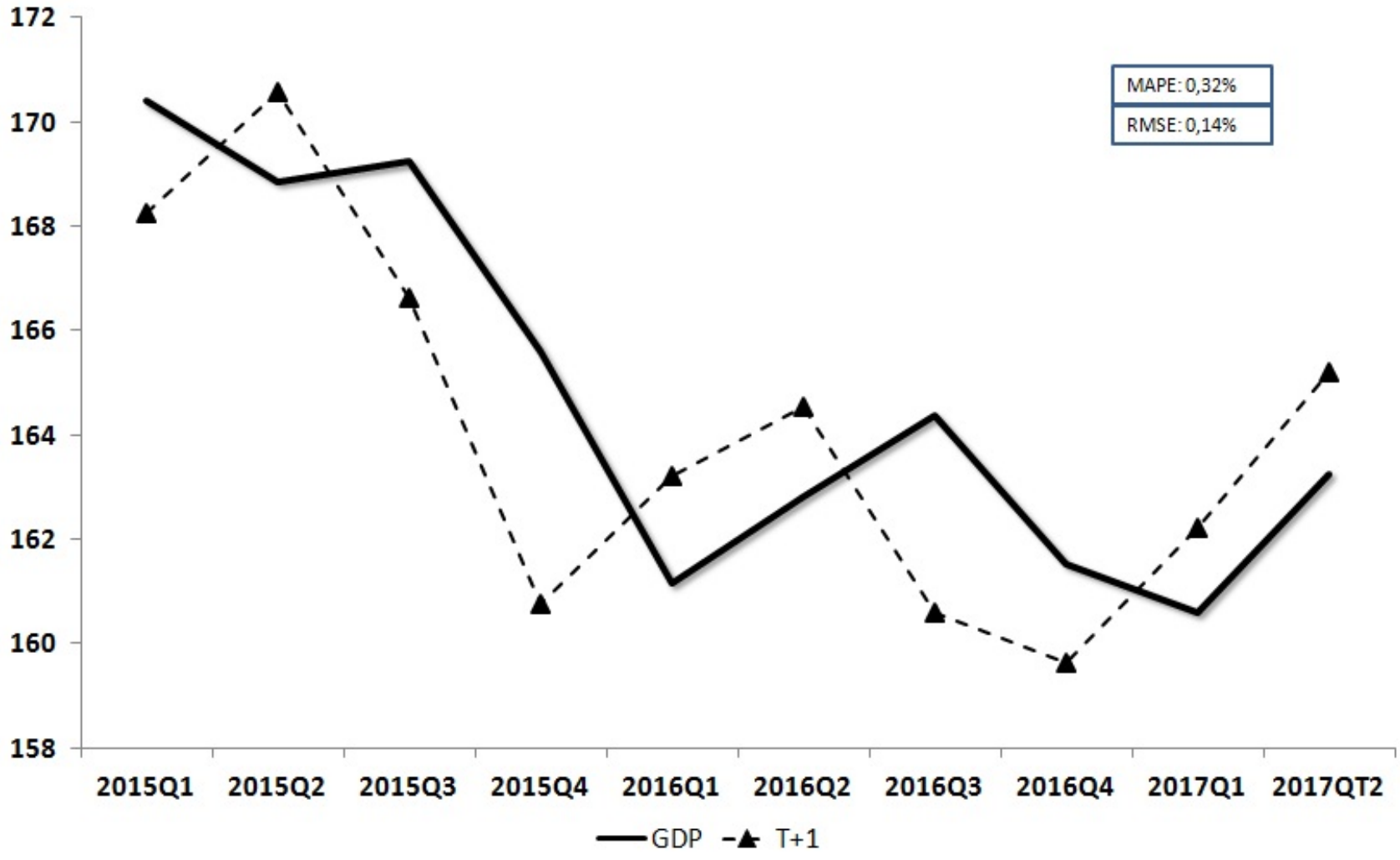
Table 2: Variables Selected

Models Selected

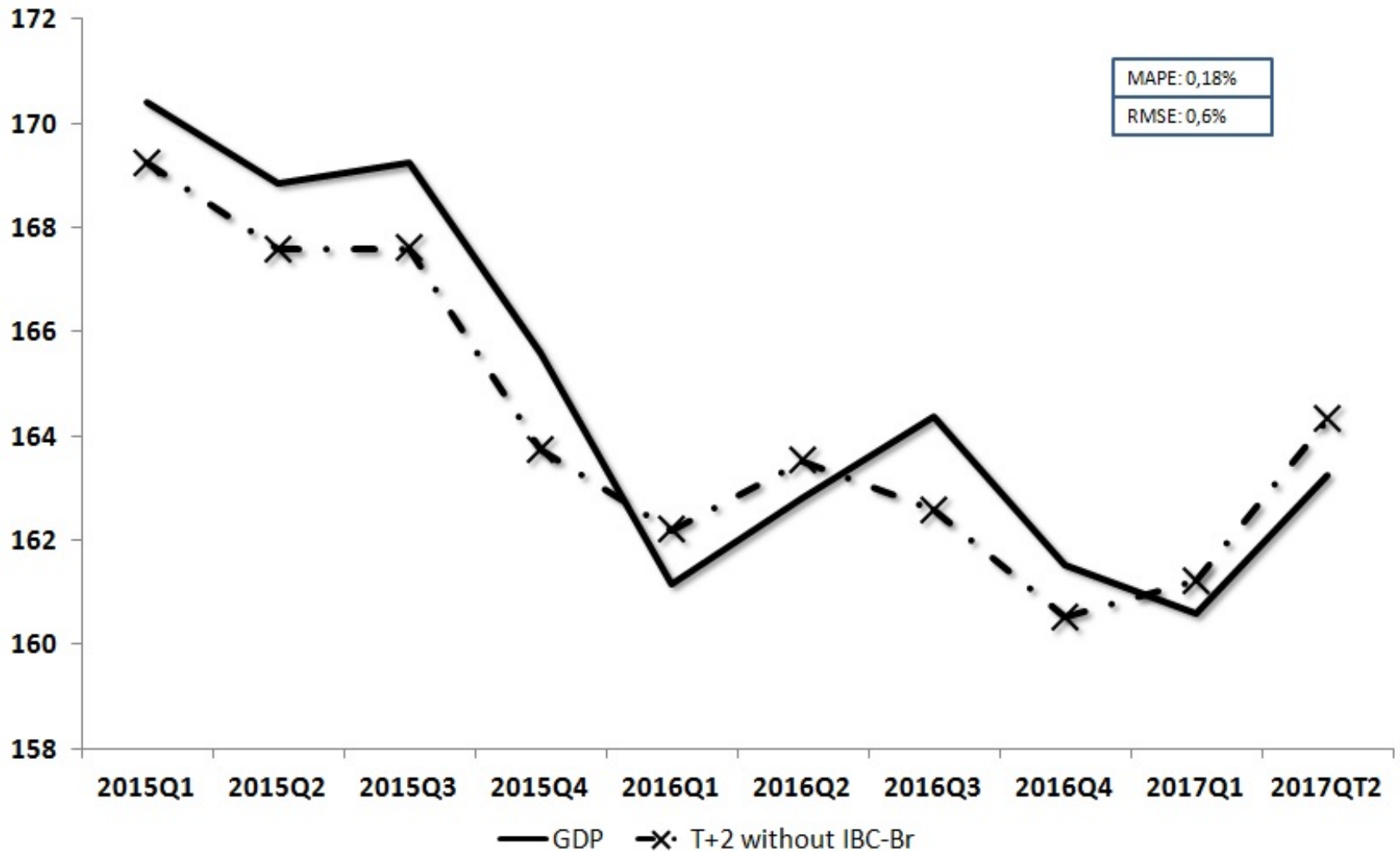
Model	MAPE	RMSE	R^2_{diff}	Description	Variables Used
M(T+2)	0,0018	0,0392	0,7242	M6 - Monch & Uhlig - Table (1)	t+2 and t+1
M1	0,0018	0,0362	0,849	M6 - Monch & Uhlig - Table (1)	t+2 and t+1, replacing ABPO by income tax.
M.IBC-Br	0,0027	0,0596	0,7866	M6 - Monch & Uhlig - Table (1)	t+2 (without IBC-Br) 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

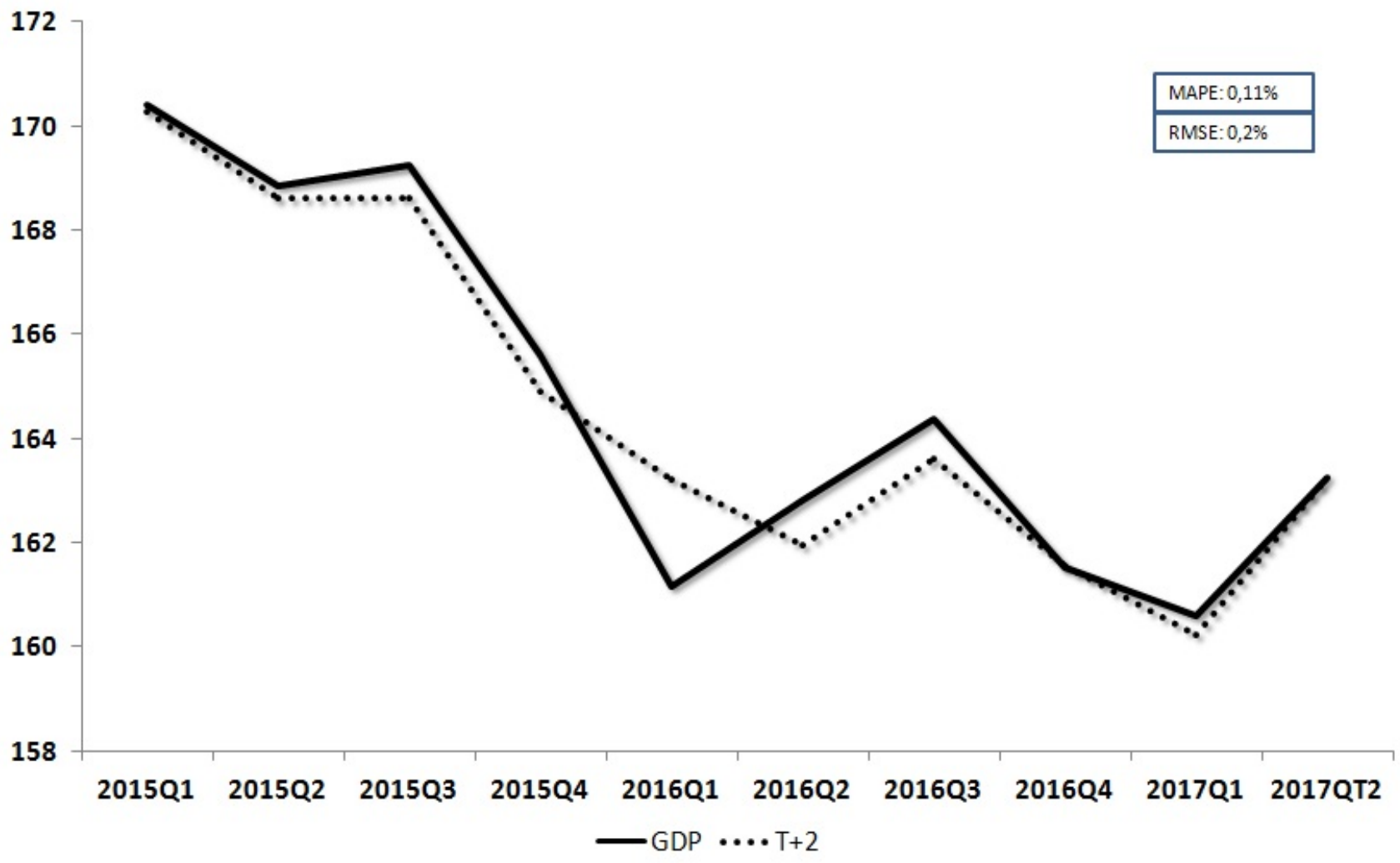
Model t+1


172
170
168
166
164
162
160
158
MAPE: 0,32%
RMSE: 0,14%
2015Q1
2015Q2
2015Q3
2015Q4
2016Q1
2016Q2
2016Q3
2016Q4
2017Q1
2017QT2
GDP
T+1

Model t+2 without IBC-Br



Model t+2


172
170
168
166
164
162
160
158
MAPE: 0,11%
RMSE: 0,2%
2015Q1
2015Q2
2015Q3
2015Q4
2016Q1
2016Q2
2016Q3
2016Q4
2017Q1
2017QT2
GDP
T+2

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
2015Q1	-1,21	-0,86	-1,89	-1,11	-0,34	0,69	-0,10
2015Q2	-2,35	-2,37	-2,50	-2,28	0,01	0,14	-0,07
2015Q3	-1,34	-1,93	-1,84	-1,44	0,59	0,50	0,10
2015Q4	-0,95	-0,81	-0,79	-0,88	-0,14	-0,16	-0,07
2016Q1	-0,94	-1,91	-1,49	-1,31	0,98	0,55	0,37
2016Q2	-0,43	-0,56	-0,77	-0,51	0,13	0,34	0,08
2016Q3	-0,55	-0,61	-0,86	-0,66	0,06	0,31	0,11
2016Q4	-0,54	-0,43	-0,31	-0,49	-0,11	-0,23	-0,05
2017Q1	1,13	1,25	1,28	1,19	-0,13	-0,16	-0,06
2017QT2	0,21	0,39	0,36	0,30	-0,18	-0,15	-0,09
Mean Absolute Error					**0,27**	**0,32**	**0,11**
Mean Square Error					**0,15**	**0,14**	**0,02**

* Using vintage correspondent.

Predictive Ability Tests			
Test	IBC-Br/T+2	IBC-Br/T+2*	IBC-Br/T+1
GW	0,69	0,31	0,04
DM	0,51	0,25	0,03

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.
   - In all models of the nowcasting exercise, we have the monthly estimate of real GDP for the periods prior to nowcasting. (Temporal disaggregation 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:

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THANK YOU ALL.