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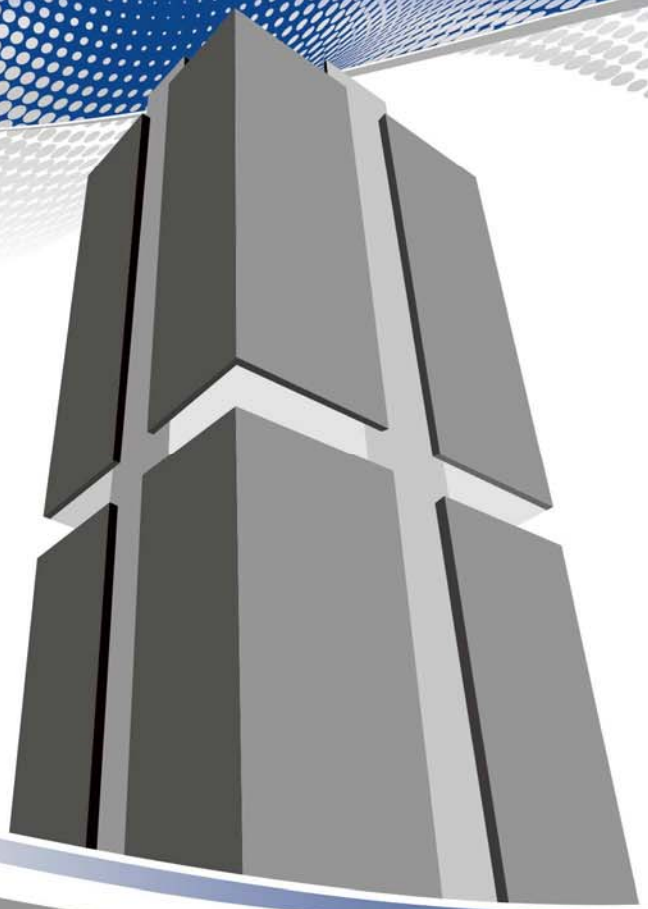


Output Gap and GDP in Brazil: a Real-Time Data Analysis

Rafael Tiecher Cusinato (BCB/Depep)
André Minella (BCB/Depep)
Sabino Pôrto Júnior (UFRGS)

BANCO CENTRAL DO BRASIL

Motivation

- Main economic activity data are revised after first release. Examples in Brazil: GDP, industrial production.

- The recent literature on real-time data analysis has shown that data revisions are relevant.

- And economic agents have to make decisions in real time without the benefits of data revisions.

Motivation

- Croushore and Stark (2000, 2001) organized a real-time data set for the U.S. GDP and found relevant GDP growth revisions.

- Orphanides and van Norden (2002) analyzed the U.S. output gap revisions and found relevant magnitudes of revisions.

- Studies for other countries: Cayen and van Norden (2004, 2005);
  Bernhardsen, Eitrheim, Jore and Røisland (2004, 2005);
  Palis, Ramos and Robitaille (2004).

Objective of the paper

Investigate, in the Brazilian case, the magnitude of data revisions for the

- GDP
- output gap (actual GDP minus potential GDP)

Developing a GDP real-time data set for Brazil

- It is necessary to organize a GDP real-time data set for Brazil.
- Quarterly data with seasonal adjustment.
- Source: publications of the Brazilian Institute of Geography and Statistics (IBGE).
- Sources of data revision:

  a) Increase in the information set available;

  b) Reestimation of seasonal factors;

  c) Methodological changes

The presence of data revisions is a fact and should not be understood as a criticism of the work of the institutions that produce those data.

Developing a GDP real-time data set for Brazil

- **Vintage**: the set of information available for a series at a specific date.
- 50 vintages from 1996Q1 to 2008Q2. Data start in 1990Q1.

Real-Time Data Set for the GDP (quarterly seasonal adjusted data - index number)

	Vintage					
Period	2007:1	2007:2	2007:3	2007:4	2008:1	2008:2
1990:1	88.65	88.65	88.65	88.65	88.65	88.65
1990:2	81.84	81.84	81.84	81.84	81.84	81.84
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2005:1	124.60	124.60	124.80	124.80	124.80	124.90
2005:2	126.80	126.80	127.70	127.80	127.80	127.60
2005:3	126.70	126.70	126.60	126.70	126.70	126.70
2005:4	127.80	127.70	127.70	127.60	127.60	127.60
2006:1	129.40	129.50	129.70	129.50	129.50	129.70
2006:2	128.90	128.80	129.90	130.00	130.00	129.80
2006:3	132.40	132.40	132.20	132.30	132.30	132.30
2006:4	133.80	133.80	134.00	133.90	133.90	134.00
2007:1	134.80	135.00	135.50	135.20	135.20	135.40
2007:2		136.10	137.30	137.30	137.30	137.10
2007:3			139.60	139.80	139.80	139.60
2007:4				142.00	142.00	142.20
2008:1					143.00	143.30
2008:2						145.60

GDP Revision Analysis

GDP growth

- Quarterly GDP compared with the *i*-th previous quarter.

  (Ex.: q-o-q growth, y-o-y growth)

$$\Delta GDP_{n,t} = 100 \cdot log\left(\frac{GDP_{n,t}}{GDP_{n,t-i}}\right) \qquad (1)$$

- *i* -period average GDP compared with the previous period

  (Ex.: four-quarter growth)

$$\Delta GDP_{n,t} = 100 \cdot log\left(\sum_{j=0}^{i-1} GDP_{n,t-j} / \sum_{j=0}^{i-1} GDP_{n,t-i-j}\right) \qquad (2)$$

where:

$GDP_{n,t}$ is the GDP index for period *t* and vintage *n*.

$\Delta GDP_{n,t}$ is the GDP growth for period *t* and vintage *n*.

GDP Revision Analysis

Example: q-o-q GDP growth in 1996Q1 throughout the revisions (%)

GDP Revision Analysis

Computation of GDP growth revisions

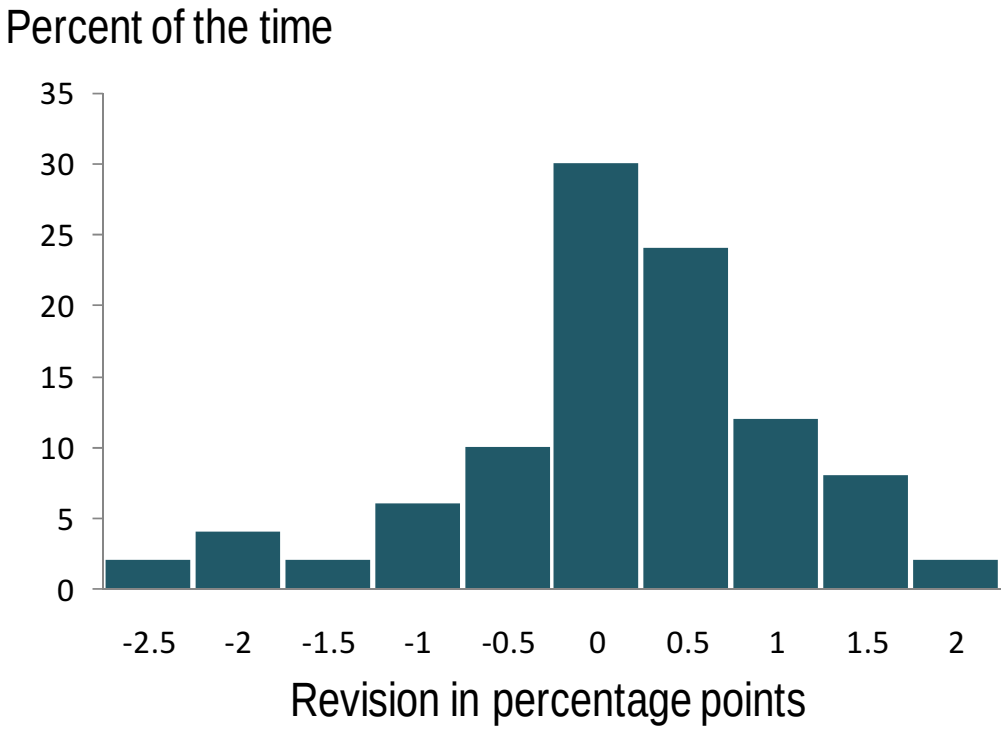
Revision series =

“Final” GDP series (last series available to the researcher)

minus

Real-time GDP series (contains the first release of each period)

GDP Revision Analysis



- Revisions: near zero (between -0.25 p.p. and +0.25 p.p.) only in 30 percent of the time.
- Revisions magnitude: higher than 1 p.p. in 24 percent of the time.

GDP Revision Analysis

Table 4
Revision indicators - GDP growth
(quarter-on-quarter % change) - 1996Q1-2008Q2

Mean Revision	MAR	RMSR	CORR	N/S	OPSIGN	FRLA	AR
0.13	0.67	0.89	0.67	0.79	0.16	0.26	-0.34

Notes: Quarterly seasonally adjusted GDP series.
MAR is the mean absolute revision.
RMSR is the root mean square of revision.
CORR is the correlation of real time and final GDP growth.
N/S is a *proxy* for the noise-to-signal ratio (obtained by the ratio of the RMSR to the standard deviation of the final GDP growth).
OPSIGN is the frequency in which real-time and final GDP growth estimates have opposite signs.
FRLA is the frequency with which the absolue value of the revision is larger than the absolute value of the final GDP growth.
AR is the first-order serial correlation of the revision series.

Important revisions:

- On average, the magnitude of the revision of the quarterly GDP growth is 0.67 p.p.
- In 16 percent of the time, the sign of the quarterly GDP growth is reversed.

GDP Revision Analysis

Table 5
Revision indicators of the GDP growth (percent change in relation to the *i*-th previous quarter) - 1996Q1-2008Q2

GDP growth rate in	MAR/q	N/S	CORR
1 quarter	0.67	0.79	0.67
2 quarters	0.41	0.64	0.80
3 quarters	0.32	0.62	0.82
4 quarters	0.23	0.52	0.89

Notes: Quarterly seasonally adjusted GDP series.
MAR/q is the mean absolute revision divided by the number of quarters under analysis.
N/S is a *proxy* for the noise-to-signal ratio (obtained by the ratio of the RMSR to the standard deviation of the final GDP growth).
CORR is the correlation between real time and final GDP growth.

GDP Revision Analysis

Table 6
Revision indicators of the GDP growth (percent change of average GDP in *i* quarters in relation to the previous *i* quarters)
1996:1-2008:2

Average GDP in	MAR/q	N/S	CORR
1 quarter	0.67	0.79	0.67
2 quarters	0.31	0.58	0.84
3 quarters	0.21	0.48	0.90
4 quarters	0.16	0.48	0.89

Notes: Quarterly seasonally adjusted GDP series.
MAR/q is the mean absolute revision divided by the number of quarters under analysis.
N/S is a *proxy* for the noise-to-signal ratio (obtained by the ratio of the RMSR to the standard deviation of the final GDP growth).
CORR is the correlation between real time and final GDP growth.

- As the aggregation period increases, the revisions magnitude becomes less important.

GDP Revision Analysis

Table 7
GDP growth and methodological change in the 2006Q4 vintage
(quarter-on-quarter % change) - 1996Q1-2006Q4

Revision decomposition in 2006Q4	Mean	Mean Absolute Revision (MAR)
Revision with the previous methodology	0.06	0.53
Additional revision with the new methodology	0.05	0.52
Total revision in 2006Q4 with the new methodology	0.11	0.75

Notes: Quarterly seasonally adjusted GDP series.

Are most of the revisions magnitude due to the new GDP methodology (introduced in 2007)?

- Both the previous revisions and the one stemming from the new methodology were important.

Output Gap

Detrending methods

Hodrick-Prescott (HP)

$$L = \sum_{t=1}^{T}(y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1}(\Delta y_{t+1}^* - \Delta y_t^*)^2$$

Linear Trend (LT)

$$y_t = \alpha + \beta t + e_t$$

Output Gap

Quadratic Trend (QT)

$$y_t = \alpha + \beta_1 t + \beta_2 t^2 + e_t$$

Harvey-Clark Model of Unobserved-Components (HC)

$$y_t = y_t^* + x_t$$

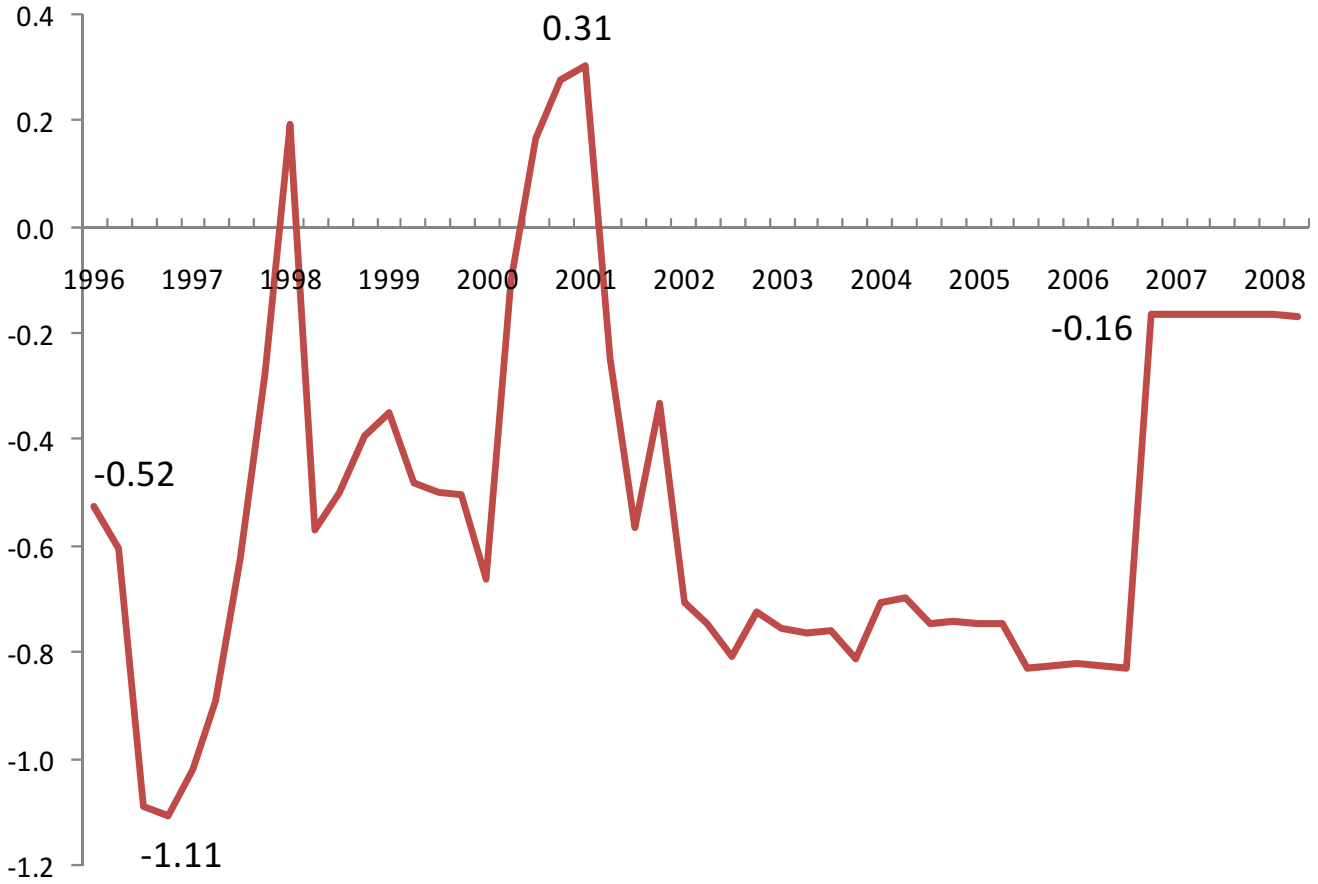
$$y_t^* = \mu_{t-1} + y_{t-1}^* + v_t \qquad v_t \sim i.i.d.N(0, \sigma_v^2)$$

$$\mu_t = \mu_{t-1} + w_t \qquad w_t \sim i.i.d.N(0, \sigma_w^2)$$

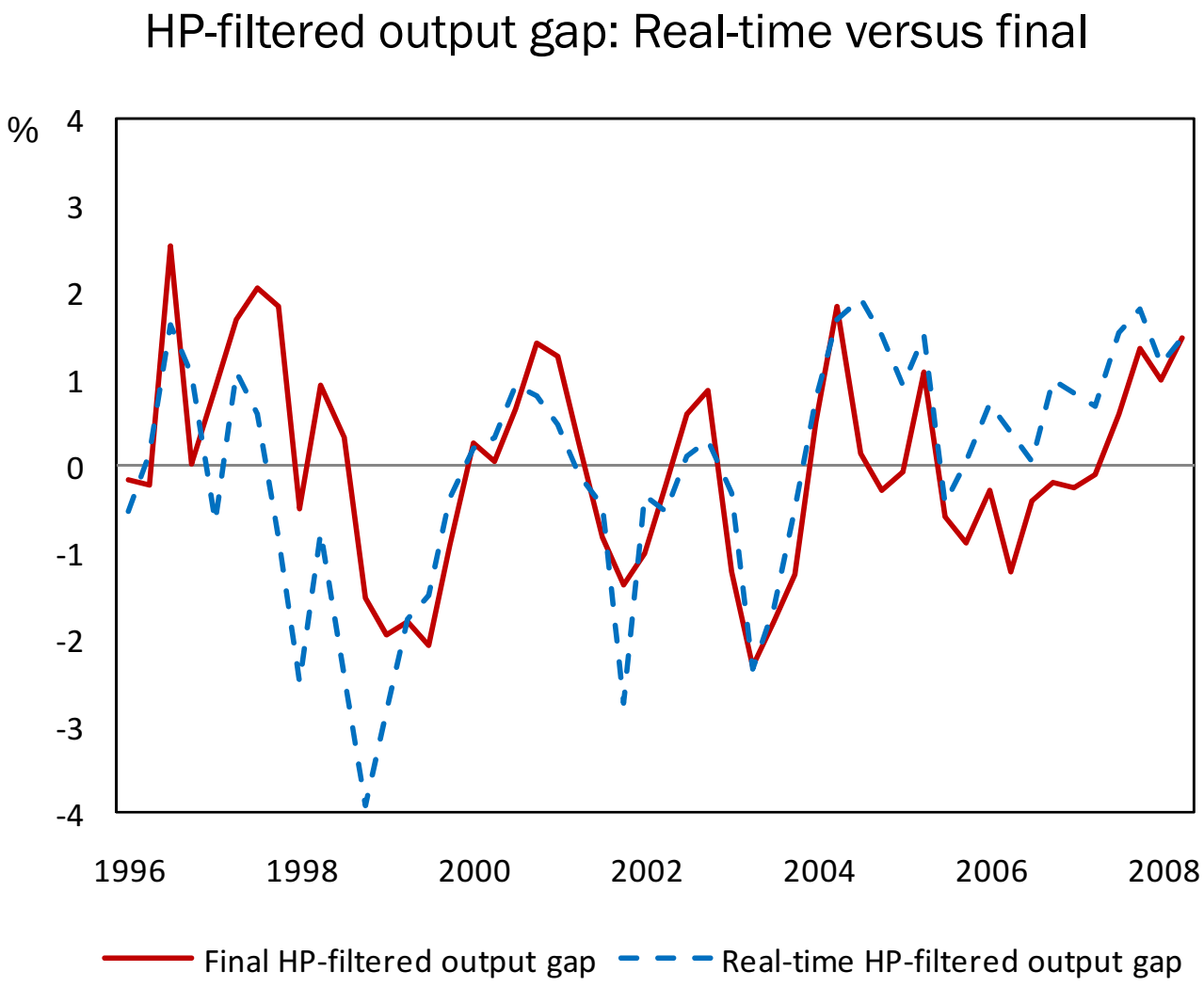
$$x_t = \phi_1 x_{t-1} + \phi_2 x_{t-2} + e_t \qquad e_t \sim i.i.d.N(0, \sigma_e^2)$$

Output Gap Revision Analysis

HP-filtered output gap in 1996Q1 throughout the revisions (% of GDP)

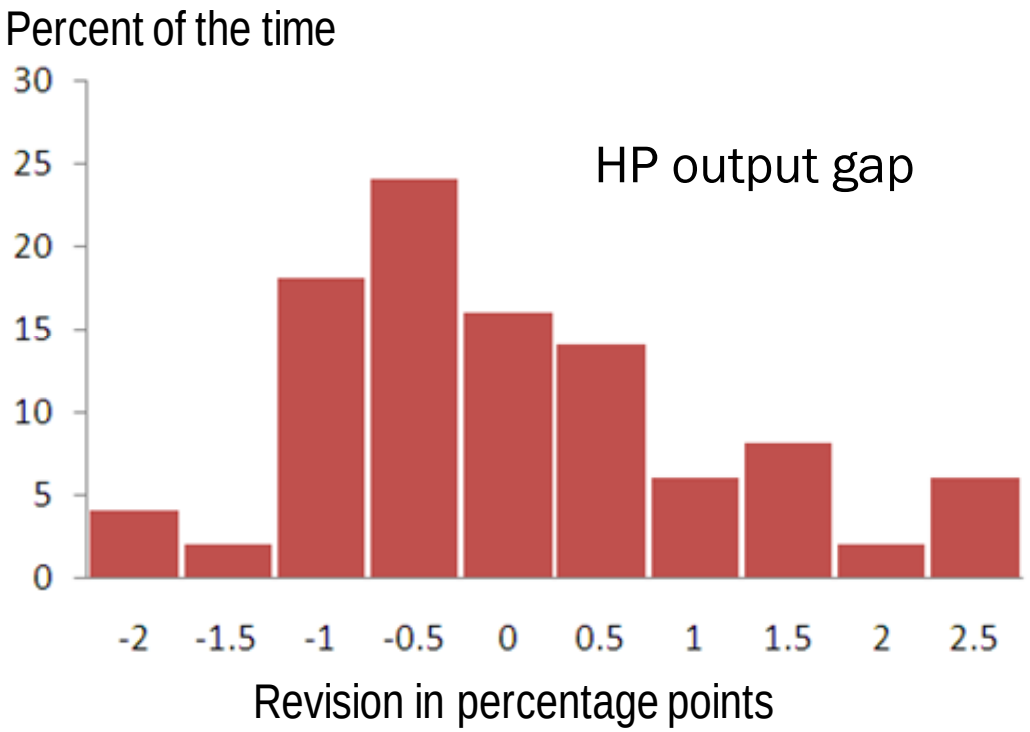


Output Gap Revision Analysis



Output Gap Revision Analysis

Output gap revision = “Final” output gap – Real-time output gap



- Revisions: near zero (between -0.25 p.p. and +0.25 p.p.) only in 15 percent of the time.
- Revision magnitude: higher than 1 p.p. in 32 percent of the time.

Output Gap Revision Analysis

Table 12
Revision Indicators - Output Gap (%)
1996Q1-2008Q2

	Mean Revision	MAR	RMSR	AR	N/S	CORR	OPSIGN
Hodrick-Prescott (HP)	0.04	0.84	1.08	0.63	0.92	0.64	0.30
Linear Trend (LT)	0.40	0.89	1.15	0.47	0.47	0.91	0.14
Quadratic Trend (QT)	0.00	2.26	2.78	0.91	1.25	0.21	0.44
Harvey-Clark (HC)	0.29	0.59	0.78	0.57	1.01	0.71	0.30

Notes: The data sample for the output gap estimation starts in 1990Q1.
MAR is the mean absolute revision.
RMSR is the root mean square revision.
AR is the first-order serial correlation of the revision series.
N/S is a *proxy* for the noise-to-signal ratio (obtained by the ratio of the RMSR to the standard deviation of the final output gap).
CORR is the correlation betw een real-time and final output gap.
OPSIGN is the frequency w hich real-time and final output gap estimates have opposite signs.

Sizeable revisions to the output gap:

- On average, the magnitude of the output gap revision is 0.59–2.26 p.p.
- The sign of the output gap is reversed in 14%–40% of the time.

Output Gap Revision Analysis

Table 13
Revision Indicators - Output Gap (%) - Results of some studies (*)

	RMSR	AR	N/S	CORR	OPSIGN
Hodrick-Prescott (HP)					
Brazil	1.08	0.63	0.92	0.64	0.30
United States	1.83	0.93	1.11	0.49	0.41
Canada	1.85	0.93	1.23	0.38	0.45
Norway	2.13	0.73	1.53	-0.01	0.53
Linear Trend (LT)					
Brazil	1.15	0.47	0.47	0.91	0.14
United States	5.12	0.91	1.32	0.89	0.49
Canada	13.65	0.99	1.48	0.81	0.51
Norway	2.58	0.82	0.79	0.83	0.25
Quadratic Trend (QT)					
Brazil	2.78	0.91	1.25	0.21	0.44
United States	2.91	0.96	1.07	0.58	0.35
Canada	5.12	0.99	1.30	0.60	0.40
Norway	5.66	0.94	1.53	0.33	0.44
Harvey-Clark (HC)					
Brazil	0.78	0.57	1.01	0.71	0.30
United States	1.82	0.92	0.84	0.77	0.34
Canada	2.82	0.92	2.03	-0.19	0.63
Norway	3.15	0.83	1.00	0.22	0.53

Notes: RMSR is the root mean square revision.
N/S is a *proxy* for the noise-to-signal ratio (obtained by the ratio of the RMSR to the standard deviation of the final output gap).
CORR is the correlation betw een real-time and final output gap.
OPSIGN is the frequency w hich real-time and final output gap estimates have opposite signs.
(*) Analysis periods: Brazil: 1996Q1-2008Q2; United States: 1966Q1-1997Q4; Canada: 1972Q1-2003Q4; Norw ay: 1993Q1-2002Q1.

Output Gap Revision Analysis

Two sources of output gap revision:

- Data revision.

- Sample size – regardless of GDP data revision, output gap estimations are revised as new period data are included in the sample estimation.

Output Gap Revision Analysis

Table 14
Decomposition of Output Gap Revision (%)
1996Q1-2008Q2

Methods	Mean	MAR
Hodrick-Prescott (HP)		
Total revision	0.04	0.84
Data revision effect	0.15	0.60
Sample size effect	-0.11	1.02
Linear Trend (LT)		
Total revision	0.40	0.89
Data revision effect	0.38	1.19
Sample size effect	0.02	1.45
Quadratic Trend (QT)		
Total revision	0.00	2.26
Data revision effect	0.52	0.69
Sample size effect	-0.52	2.79
Harvey-Clark (HC)		
Total revision	0.29	0.59
Data revision effect	0.32	0.55
Sample size effect	-0.03	0.28

Notes: The data sample for the output gap estimation starts in 1990Q1.
MAR is the mean absolute revision.

- In general, both data revision effect and sample size effect account for the magnitude of the total revision.
- However, the sample size effect is clearly more important in the QT method, while the data revision effect is more important in the HC method.

Output Gap Revision Analysis

Gross Domestic Product

- The GDP growth revisions are relevant.
- The GDP methodological revision introduced in 2007 is a relevant source of revisions, although accounts only for a part of the revisions.
- When the aggregation period is increased, many revision indicators become more favorable.

Conclusion

Output Gap

- All methods have presented revisions of important magnitude.
- In general, both data revision effects and data sample size effects are important sources of output gap total revisions.
- Although the Brazilian revision indicators of the output gap are, in general, less unfavorable than those reported for other countries, the Brazilian indicators suggest important limitations to the analyzed output gap estimates.

Conclusion

- So, there are important implications for monetary policy analysis, monetary policy rules estimations and inflation forecasts comparisons.

- Our results also suggest that it is important to use a larger set of information to analyze the business cycle state. In principle, the use of a large set of information could reduce the associated risks of series subject to revisions. In fact, central banks usually use a large set of economic activity indicators.

Thank you!

More details of this research can be found in the BCB Working Paper Series, no. 203, 2010