Evaluation and Combination of Core Inflation Measures for Brazil

Francisco Marcos Rodrigues Figueiredo*
Roberta Blass Staub*

Abstract

This article presents the first results obtained in the computation of core inflation indicators for the Brazilian IPCA. Limited influence estimator approach is stressed in the discussion and a symmetric trimmed mean was computed. The obtained indicator presented a downward bias. In order to solve this shortcoming, two alternatives were tested: an asymmetric trimmed mean proposed by Bryan & Cecchetti (2001) for Brazil and a symmetric trimmed mean with the smoothing of series which present infrequent changes (for instance, administered prices). The bootstrapping procedure is also used to choose the optimal trimming with a 13-month centered moving average as benchmark. Impulse response of a bivariate VAR´s with headline inflation and core indicator were performed to verify the *attractor* properties of core inflation suggested by Marques, Neves and Sarmento (2000). Finally, based on a proposal by Cogley (1998), we borrowed the procedure used in forecast combination technique in order to combine the methods mentioned above with other alternatives (exclusion method, double weighting scheme and so on) and verify whether the resulting indicator outperforms the individual measures.

Keywords: Core Inflation, Trimmed Mean and Bootstrapping.

* Research Department of Central Bank of Brazil
The views expressed in this paper do not necessarily reflect those of Central Bank of Brazil

1. Introduction

The objective of this paper is to discuss and compare some results of alternative methodology to calculate core inflation indicators for the Brazilian IPCA[1].

In order to assess the trend component of inflation, Central Banks have developed measures known as core inflation indicators. This tool aims to eliminate or reduce temporary fluctuations from price indices allowing monetary authorities to identify shocks hitting the inflation rate that do not affect the trend inflation. Temporary shocks, despite impacting the headline index, are quickly reversed without affecting expectations and, therefore, do not demand a policy response from the monetary authority.

The first attempts to develop a measure that captures the permanent component of inflation date back to the 70´s decade and consisted of purging the most volatile components from the headline index. Hence, this methodology of core inflation excludes the elements whose short-term behavior mostly differs from the underlying price trends. In general, food and energy are excluded from the core indices on these grounds.

During the 1990´s, the literature presented other methods for compute core. The use of limited influence estimators due to Bryan and Pike (1991) and Bryan and Cecchetti (1994) is an example of alternative methods. The papers of Wynne (1999) and Roger (1998) are excellent examples of surveys that describe several methods for the calculation of core inflation, as well as the advantages and shortcomings of each one.

There has been a surge in the literature about core inflation in recent years, as more countries adopt explicit inflation targeting regimes or single out low and stable inflation rate as the main goal of monetary policy. That growing interest was unequivocally illustrated in the BIS seminar, *Measures of Underlying Inflation and Their Role in the Conduct of Monetary Policy* (BIS, 1999) held in February 1999. In addition, several

Central Banks such as the Bank of England, the Reserve Bank of New Zealand and the Federal Reserve Bank of the United States disclose regularly inflation trend measures. **Table A1** in Appendix shows the different measures of core inflation used by several Central Banks.

Remarkable information from the table mentioned above is that in a sample of 22 Central Banks that regularly disclose core inflation figures, just two of them do not use some indicator based on a kind of exclusion method. A possible explanation to this widespread use is that the public can easily understand this measure.

Regarding Brazil, estimation of core inflation has been a recent topic and has gained importance after the introduction of the inflation targeting regime in July 1999. The first measures of core inflation were published in the beginning of 2000. Since March of that year, *Fundação Getúlio Vargas* (FGV) has been releasing a monthly measure of core inflation for the IPC-Br, using the trimmed mean technique, whose methodology is briefly described in Gonçalves *et al.* (2000). *Instituto de Pesquisa Econômica Aplicada* (IPEA), in its January 2000 Bulletin, presented some preliminary results for the IPCA core inflation using smoothing trimmed mean. The description of the methodologies can be found in Moreira and Carvalho (2000). Furthermore, Monetary Policy Committee (COPOM) has divulged a symmetric trimmed-mean since September 2000. This last indicator is described in the next section.

The outline of this paper is as follows: next section describes a set of alternative core inflation indicators computed. In Section 3, Granger causality tests and impulse responses from a bivariate VAR are analyzed to assess attractor properties. In the fourth section the results of a combination of core inflation indicators are evaluated. Concluding remarks and issues that should be explored follow this.

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[1] IPCA, calculated by the *Instituto Brasileiro de Geografia e Estatística* (IBGE), is a comprehensive statistic measuring price changes to families with monetary income from any sources ranging between 1 and 40 minimum wages and includes nine metropolitan areas of the country, besides the municipality of Goiânia and Brasília.

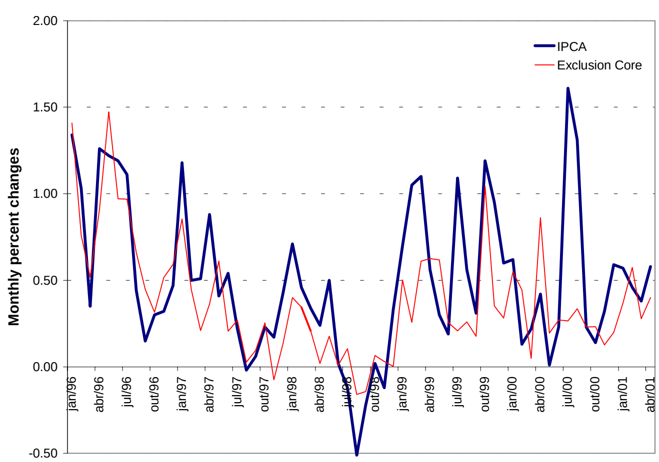
2. Core inflation measures

In this section, the core inflation measures employed along this paper are described. First, a measure based on exclusion of items corresponding to *foods at home* and *administered prices*. Second, the 20% symmetric trimmed mean disclosed by COPOM. The two last indicators are an asymmetric trimmed mean proposed by Bryan and Cecchetti (2001) and a double weighted measure.

2.1 Exclusion measure of core

The first indicator of core inflation is one based on the traditional approach of excluding the items that historically present the highest volatilities. To compute this estimator, the items of *food at home* and *administered prices* are excluded from the headline IPCA. The items whose prices are considered wholly or partially controlled by government are basically public transportation, motor and household fuel and lubricants, land, water and sewage taxes and telephone services. The excluded items amounted approximately 43% of the total basket of the IPCA in April 2001. **Chart 1** shows the core series from January 1996 through April 2001.

Chart 1 - IPCA and exclusion core, Jan/96 through Apr/2001



2.2 A symmetric trimmed-mean with smoothing items

An alternative method for estimating the core is the use of limited influence estimators (LIE). These are order statistics in which the influence of the values located on the tails of the distribution is reduced. The weighted median and trimmed-mean are examples of LIE.

The trimmed mean consists of the computation of the mean of a distribution where tail portions are removed. The weighted median is a particular case of trimmed mean, in which nearly 50% is removed from both tails.

In order to calculate the trimmed mean with $\alpha\%$, the sample of the variations of the IPCA components is ordered $\{x_1, \ldots, x_n\}$ with its respective weights $\{w_1, \ldots, w_n\}$. The symmetric trimmed mean is obtained from:

$$\bar{x}_\alpha = \frac{1}{1-2\frac{\alpha}{100}} \sum_{i \in I_\alpha} w_i x_i$$

where $$I_\alpha = \left\{ i \mid \frac{\alpha}{100} < W_i < (1 - \frac{\alpha}{100}) \right\}$$

I_α is the set of the components to be considered in the computation of the trimmed mean with $\alpha\%$ and W_i is the accumulated weight up to i-th component.

When estimating a trimmed-mean, the choice of the section to be trimmed is not a trivial subject. In this paper, α was chosen in order to minimize the root mean square error (RMSE) relative to a benchmark measure of core inflation, a 13-month centered moving average of the headline inflation rate. Such method is quite frequent in the core inflation literature. Bryan and Cecchetti (2001), for example, use a 24-month centered moving average to compute an optimal trim for the IPCA.

The trimming point chosen was 30%, that is to say the new inflation figure is computed with 40% of central section of the price changes distribution.

The 30% trimmed mean for the IPCA from January 1996 to May 2000 was mostly below the overall inflation as shown in Figueiredo (2001). This underestimation of the inflation path when the tail cuts are symmetric was also noticed by Laflèche (1997), Roger (1998) and Marques et al. (2000). Statistically, this behavior results from a positive asymmetry in the distribution of the changes of the price components.

The asymmetry of the price distribution could be explained by the existence of certain prices that suffer changes from time to time. The discontinuous price changes are larger than the variations of other prices that present more regular behavior, thus leading to a systematic exclusion of the former from the computation of the trimmed mean, causing a downward bias in the core measure.

In the core inflation literature, there are two possible solutions to this shortcoming. First, an asymmetric core inflation could be computed as Bryan and Cecchetti (2001) and Picchetti and Toledo (2001) did.

The methodology used by Bryan and Cecchetti (2001) is summarized in the next subsection. Picchetti and Toledo (2001), using a dynamic factor index indicator as benchmark to minimize the RMSE function, found 30% for the inferior trimmed and 40% for superior trimmed. Both author performed these computations for IPCA.

Another solution suggested by Laflèche (1997) and implemented by Gonçalves *et al.* (2000) for the IPC-Br is the smoothing the series that present less frequent changes.

In this paper, the second approach was chosen. The employed method consists of distributing the price variation of some items for the period and the following eleven months. The smoothed items were the following: communication, electricity, household and motor fuels, household services, public transportation, tobacco products and tuition and other school fees. The observed and smoothed series are showed in Figueiredo (2001). After including the smoothed series in the price components, the new core measure was computed and the optimal trim chosen was 20%.

Chart 2 displays the monthly percent changes for the IPCA and the trimmed mean. This new statistic does not present a downward bias.

Chart 2 - IPCA and 20% trimmed-mean core, Jan/96 through Apr/2001

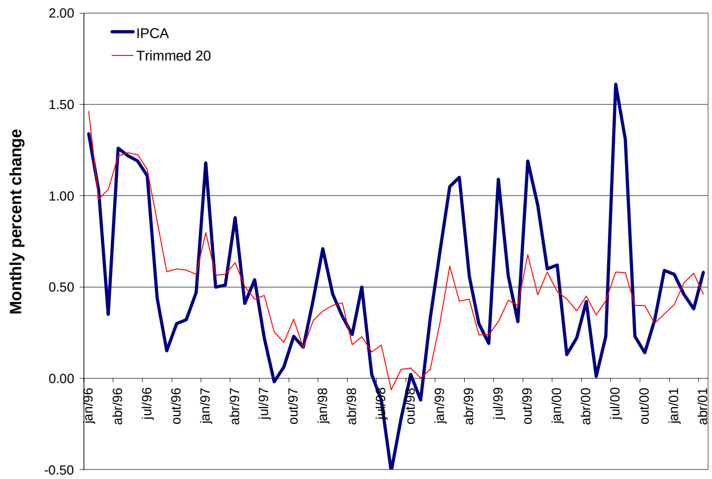


Table A2 in Appendix shows the frequency in which a component is trimmed in the lower and the upper tail. 12 up to 16 items with a frequency trimmed larger than 60% are food. In spite of being smoothed items, motor and household fuel were excluded 74% and 61% of the whole sample period, respectively.

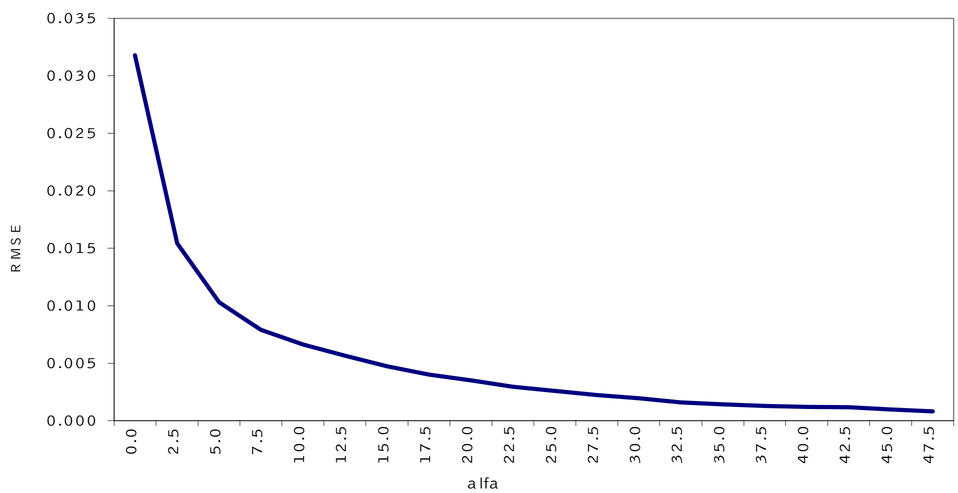
2.2.1 Bootstraping

Another approach to determine the trimming point is to use a bootstrap methodology developed by Efron (1982). The procedure used here is similar to the one applied in Cechetti (1998) and Andrade and O´Brien (2000). First of all, the 13-month centered moving average is substracted from the monthly price variation of each item (totalizing 52 itens). The sample period ranges from January 1996 to October 2000. Consequently, there is a 52 x 58 matrix from which random samples were drawn. Each sample consists of 52 items resulting from a drawn from each line of the matrix.

The goal of this exercise is to find an α (how much of the distribution is excluded from each side) that minimizes the root mean square error (RMSE) of the price variations relatively to the 13-month centered moving average. The RMSE was calculated for each sample with α = 0 to 47.5 (step = 2.5). We used the weights recalculated so as to add to 100. Finally, the bootstrap estimate was reached.

According to Neter et al. (1996), the number of bootstrap samples necessary for evaluating the precision of an estimate depends on each particular application. They suggest to look at the variability of the bootstrap estimate calculated, in this case the RMSE. If the variability stabilizes reasonably, the process should be stopped. Based on this criterion 400 samples for each alpha were drawn. The values of RMSE obtained for α = 0 to 47.5 (step = 2.5) are showed below.

Chart 3 - RMSE for the bootstrapping procedure



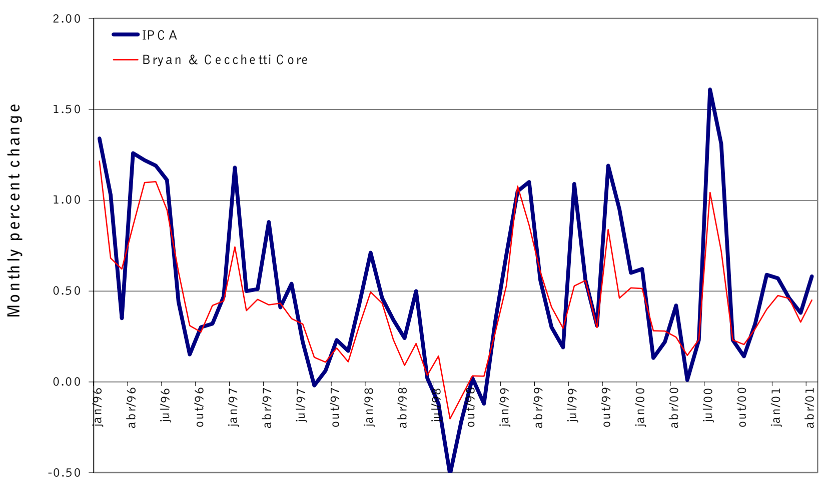
As we can verify, the RMSE decreases as α increases. But it must be taken into consideration that the gain in trimming can be very small, suggesting that to trim more or not does not provide much additional efficiency gain in tracking the trend of inflation. For example, trimming 20% from each side reduces the RMSE in almost 93%.

Thus, the 20%-trimmed mean which was chosen using the historical data was the preferred indicator.

2.3 Bryan & Cecchetti indicator

Bryan and Cecchetti (2001) proposed an unbiased measure of core inflation for the IPCA based on an asymmetric trimmed mean. To do this, they chose the percentile of the distribution of the price changes that on the average represents the headline inflation measured by the IPCA for a sample ranging from August 1994 to May 2000. The value was slight above the 60th percentile. Then the authors built trimmed means centered in the 60th percentile and found out the most efficient indicator in terms of RMSE when compared with a 24-month centered moving average. The most efficient estimator was an 24%-trimmed indicator, being 14,4% in the lower tail and 9,6% in the upper tail. **Chart 4** shows the core measure from January 1996 to April 2001.

Chart 4 - IPCA e Bryan & Cecchetti core, Jan/96 through Apr/2001



2.4 DoubleWeighting Core

A core measure using the double weighting method (π^{dw}) was calculated as well. The methodology used is a combination of methods shown by Laflèche (1997) and Marques et al. (2000). With N price components, the formula is:

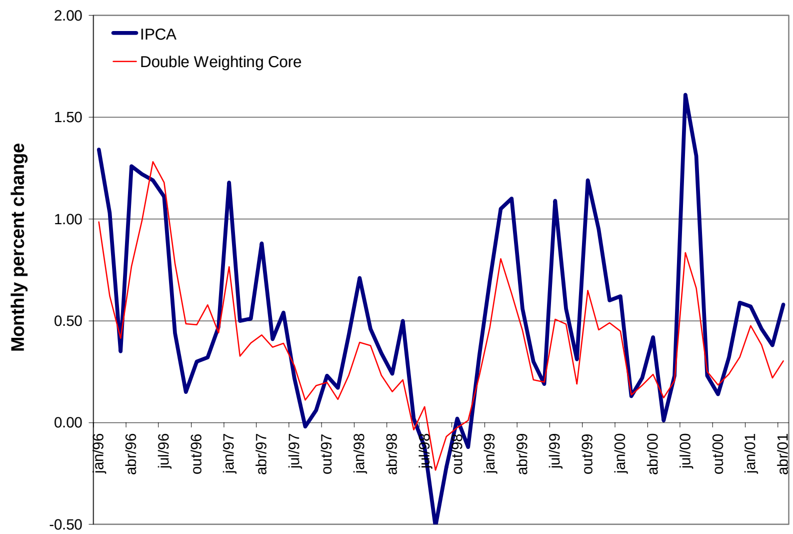
$$\pi_t^{dw} = \frac{\sum_i^N c_i w_i \pi_{it}}{\sum_i^N c_i w_i} \quad \text{with} \quad w_i = \frac{\frac{1}{\sigma_{it}}}{\sum_{i=1}^N \frac{1}{\sigma_{it}}}$$

Where c_i is the expenditure weight for i-th component and w_i is the volatility weight for component i based on the standard deviation of this component in the period t (σ_{it}). This standard deviation is calculated using the volatility of each component in relation to the average variability of the overall IPCA. In order to perform this computation it is required to choose a certain time window (m) as shown in the formulae below. In this paper, it was used a five-month window. **Chart 5** displays the series obtained from this methodology.

$$\text{where } \sigma_{it} = \sqrt{\frac{\sum_{j=t-m+1}^{t} \left[(\pi_{ij} - \pi_j) - \overline{(\pi_{it} - \pi_j)} \right]^2}{m}} \quad \text{for i = 1,2,..., N and}$$

$$\overline{(\pi_{it} - \pi_j)} = \sum_{j=t-m+1}^{t} \frac{(\pi_{ij} - \pi_j)}{m}$$

Chart 5 - IPCA e Double Weight core , Jan/96 through Apr/2001



In the next section, all measures for core inflation are evaluated in according to their capacity to fulfill some desired properties.

3. Evaluation of core estimators

According to the core inflation literature, the procedure to select the appropriate indicator of the core inflation still remains a challenging question. Roger (1998) suggested that a good measure of core inflation should satisfy four properties: timeliness, robustness, unbiasedness, and verifiability. Furthermore, Wynne (1999) added to this list the following conditions: forward looking nature, theoretical basis and easy understanding by the public.

Marques *et al.* (2000) assert that the above conditions are vague and little selective despite being important. Besides, some conditions seem to be just pre-requisites. In order to overcome these questions some authors evaluate core inflation indicators by means of some statistical properties.

A basic test is to verify if the core inflation indicator shows lower variability than the headline index. Intuitively, a measure of core inflation should be less volatile than the headline inflation, because this statistic seeks to retain only lasting movements in prices excluding transient noise. According to the standard deviations figures in **Table 1**, the four indicators present lower volatilities than the headline index.

Other method to compare is to compute a RMSE of each measure and a core inflation reference (a centered moving average). According to Wynne (2001), this procedure tests the ability of a potential core estimator to track trend inflation.

In this paper, using a 13-month and a 24-month centered moving average of the IPCA, all of indicators presented lower RMSE than the headline index. This result means that using whichever core measure evaluated, the Central Bank can improve upon the high-frequency signal to assess the IPCA trend. Furthermore, the 20%-trimmed mean indicator performed better than the other, producing an efficiency gain of 52% (13-month) and 54% (24-month) over the monthly change of the IPCA. The efficiency gains from the other methods are similar (ranging 32% to 34% for a 13-month moving average).

Table 1 - Statistics of core inflation indicators - Jan/96 to Apr/2001

Statistics	IPCA	Exclusion	Trimmed 20	B & C	Double weight
Acumul. Change	37.22	27.19	35.43	30.94	27.19
Standard-deviation	0.44	0.34	0.31	0.30	0.27
RMSE*	0.40	0.27	0.19	0.26	0.27
RMSE**	0.36	0.29	0.17	0.26	0.27

* The benchmark is a 13-month centered moving average of IPCA

** The benchmark is a 24-month centered moving average of IPCA

In order to systematize a set of required properties, Marques *et al.* (2000) introduced statistical conditions that have to be met by any core inflation indicator. The first condition is the existence of stable long-run relationship between core measure and inflation. Also, the trend measure should behave as an *attractor* of the inflation, in the sense that, in the long run, inflation tends to converge to the measure. However, this condition should not apply in the opposite direction, that is, the core measure should not be *attracted* by inflation. Thus, it is expected that, under normal conditions, when inflation is above the core, it tends to drop in the future.

If the attraction condition applies, changes in the core precede temporarily changes in the inflation headline and the converse is not true. Thus, a granger causality test might be performed between core inflation and the headline index in both directions to assess these features.

The results of the traditional Granger causality tests are valid only if the series are stationary. To verify if the core inflation series are stationary Augmented Dickey-Fuller tests were used. Statistical tests results are shown in **Table 2** below, the unit root hypothesis are rejected in a significance level of 1% for each indicator except to the double weighted core that the null hypothesis is rejected in a level of 5%.

Table 2 - Augmented Dickey-Fuller Tests

Index	Lags	Intercept	Trend	ADF statistic
IPCA	0	yes	no	-4.64*
Exclusion	0	yes	no	-4.06*
Trimmed 20	5	yes	no	-3.88*
B&C	0	yes	no	-4.06*
Double	0	yes	no	-3.53**

* Unit root hypothesis rejected for 1% level of significance

* Unit root hypothesis rejected for 5% level of significance

Granger causality tests were applied to assess the attraction conditions described earlier. The results obtained are showed in **Table 3**.

Based on the levels of significance of an F test, the indicator suggested by Bryan and Cecchetti outperformed the other attending both hypotheses with one and two lags: the core statistic is not Granger-caused by the IPCA and Granger-causes the IPCA.

For the 20% trimmed mean core, considering one lag in the model, the null hypothesis that the indicator does not cause inflation is not rejected, but with two lags the null hypothesis is rejected. Changing the model specification we have the desired properties. The other condition is satisfied for both lags.

For the double weighted indicator, the tests show that the hypotheses of not Granger causality are not rejected in both directions.

Table 3 - Granger causality tests

Index	Null hypothesis	Lags	F statistic
Exclusion	IPCA does not causes Exclusion	1	4.95**
		2	2.94***
	Exclusion does not causes IPCA	1	0.13
		2	1.65
Trimmed 20	IPCA does not causes Trimmed 20	1	0.00
		2	0.95
	Trimmed 20 does not causes IPCA	1	2.45
		2	3.88**
B&C	IPCA does not causes Trimmed 20	1	0.02
		2	1.15
	Trimmed 20 does not causes IPCA	1	5.01*
		2	4.72*
Double	IPCA does not causes Double	1	0.22
		2	0.57
	Double does not causes IPCA	1	0.54
		2	1.13

* Null hypothesis rejected for 1% level of significance
** Null hypothesis rejected for 5% level of significance
*** Null hypothesis rejected for 10% level of significance

At last, the exclusion core indicator performed poorly. This indicator does not cause the IPCA and is caused by the IPCA for both lags.

In order to verify the impact of changes in the core measure to headline inflation, impulse responses of a bivariate vector autoregression with the monthly changes of the IPCA and each core indicator were estimated. The lag length of VAR is selected using the Akaike Information Criteria.

The diagonal graphs of impulse responses give the amount of persistence contained in the core measure and in headline inflation. The most important part for the impulse response graphs are those displayed on the off diagonal. The upper right graph gives the impact on the core inflation measure from a standard-deviation shock in the headline inflation. As discussed above, it is expected that the core inflation will not react systematically to changes in inflation. Meanwhile, the lower left chart shows the headline inflation response to one standard-deviation shock in core measure. The attractor properties of core measure would lead to a significant positive impact in the first months that vanishes after some periods.

The four sets of graphs show similar results, however a couple of points are worth to remark. The impulse response of the exclusion core for a shock in the IPCA is significantly positive in the first two periods. This pattern suggests time precedence for the IPCA in relation to core statistics.

When the upper left graph of the three sets of impulse are compared, the persistence of Trimmed 20 core seems to be larger than the other. This behavior is the consequence of the smoothing procedure used in this approach.

4. Core indicator combination

The need for an accurate and reliable measure of core inflation is practically a consensus among Central Banks authorities, mainly in those countries that follow an inflation targeting regime for monetary policy. Not only the core permits detecting particular movements in prices, but it also helps Central Banks communicate with the public in a more transparent way. However, there is some vagueness related to the best method for the calculation of such indicator.

The best choice for the core measure depends on its objective. If the Central Bank objective is to anchor expectations, the core inflation estimation should be disclosed to the public. In this context, an alternative to enhance credibility should be a verifiable and timely computed measure, easily understandable by the public in general. On the other hand, if the core is used as an intermediate target, for instance, the Central Bank can choose an indicator calculated by more sophisticated methods.

According to Laflèche (1997), as an accurate measure of trend inflation is a controversial subject, a preferred procedure should be to use a set of available core indicators provided by distinct methods. When this group points to the same direction, it should be considered a reliable instrument for monetary policy decisions. However, if the estimates conflict, larger attention is required to examine the reasons of the divergence and to ensure which road the monetary policy must follow.

Cogley (1998) goes further in this line and suggests that the alternative measures of core inflation could be combined in a weighted average with the aim of assessing the different information on trend inflation contained in different methods. Banco de La Republica from Colombia, for example, discloses the average of four core inflation measures.

In order to verify if a combination of core measures produces a better indicator for tracking trend inflation, a simple arithmetic average and a weighted average whose weights were defined on inverse of the variability of each measure were computed and evaluated. Both RMSE for 13- and 24-month moving averages for the two ways of combinations display results worse than 20%-trimmed mean. This outcome is possible due to the employment of biased indicators of core inflation in the set of core inflation measures.

5. Conclusion

In this paper, a set of core inflation indicators were estimated and evaluated. All estimators seem to reveal the trend of inflation better than the headline inflation does. However, the symmetric 20%-trimmed mean with smoothed items and the asymmetric indicator proposed by Bryan and Cecchetti (2001) performed better. Based on the causality tests, this two indicators help to anticipate the changes of the headline inflation.

Using an approach suggested by Cogley (1998), a combination of the indicators were computed and this new indicator does not improve the capacity of revealing the persistent movement of inflation given by centered moving averages.

The further research on core inflation includes the computation of trimmed mean with smoothed sub items rather than items and the evaluation of the predictive capacity of core inflation statistics for different forecast horizons.

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Appendix

Table A1 - Core inflation measures used by Central Banks

Country	Core measure
Australia	CPI less mortgage interest payments, government controlled prices and energy prices
Belgium	CPI less potatoes, fruit and vegetables
Canada	CPI less indirect taxes, food and energy items
Chile	CPI excluding perishable goods and energy
Colombia	An average of four measures (CPI excluding food and three limited influence estimator)
Czech	CPI less fees and controlled and regulated prices
Finland	CPI less housing capital costs, indirect taxes, and government subsidies
France	CPI less change in taxes, energy prices, food prices and regulated prices
Greece	CPI less food and fuel
Israel	CPI less govenrment goods, housing, fruit and vegetables
Japan	CPI less fresh foods
Netherlands	CPI less vegetables, fruit, and energy
New Zealand	CPI less commodity prices, government controlled prices, interest and credit charges
Norway	CPI less electricity prices and indirect taxes
Phillipines	A statistical trend line
Poland	A set of three measures (CPI less officialy controled prices, CPI less prices with highest volatilities and a 15% trimmed-mean)
Portugal	10% trimmed mean of the CPI
Singapore	CPI less cost of private road transportation and accommodation
Spain	CPI less mortgage interest payments
Sweden	CPI less housing mortgage interest and effects of taxes and subsidies
United Kingdom	Retail price index less mortgage interest payment
United States	CPI less food and energy items weighted median (FRB of Cleveland)

Source: Bryan & Cecchetti (1999), and several Central Banks publications

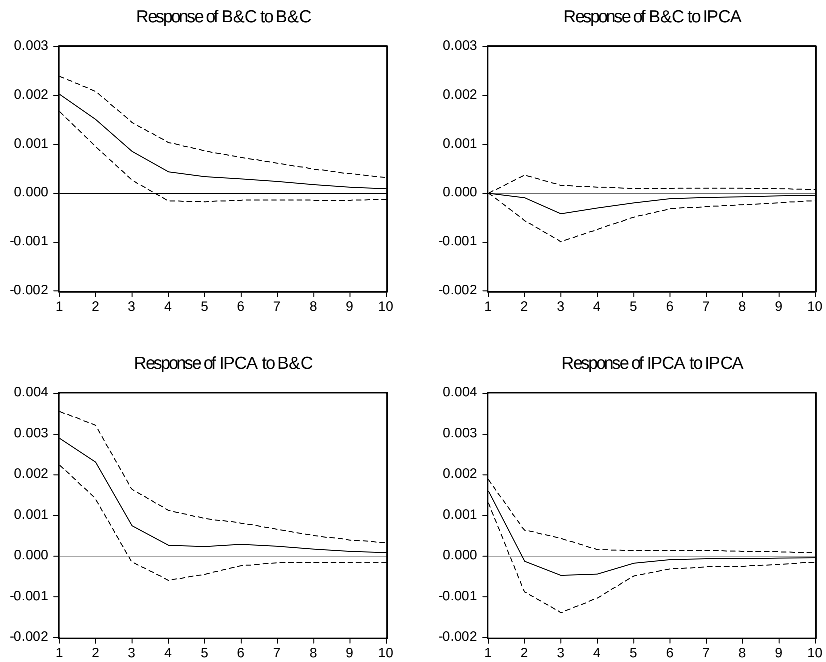
Table A2 - The trimmed frequency - January/1996 through January/2001

Items	Inferior	Superior	Total
More frequent trimmed			
Potatoes	52.46	39.34	91.80
Vegetables	52.46	37.70	90.16
Fish	45.90	40.98	86.89
Cereals	45.90	36.07	81.97
Fruits	62.30	18.03	80.33
Sugar and sweets	42.62	32.79	75.41
Fats and oils	54.10	21.31	75.41
Household fuel	**1.64**	**72.13**	**73.77**
Poultry and eggs	40.98	31.15	72.13
Meat	36.07	34.43	70.49
Dairy products	39.34	29.51	68.85
Flour and prepared flour mixes	42.62	21.31	63.93
Television, sound equipment	45.90	16.39	62.30
Motor fuel	**4.92**	**55.74**	**60.66**
Bedding and bath clothes	36.07	24.59	60.66
Beverages	44.26	16.39	60.66
Less frequent trimmed			
Maintanance and repair commodities	14.75	14.75	29.51
Decorator items	16.39	13.11	29.51
Tuition, other school fees and childcare	**0.00**	**27.87**	**27.87**
Reading materials	16.39	9.84	26.23
Vehicles	14.75	8.20	22.95
Personal care services	16.39	6.56	22.95
Hospital and other medical care services	14.75	6.56	21.31
Prepared food	9.84	9.84	19.67
Professional services	13.11	3.28	16.39
Domestic services	**3.28**	**4.92**	**8.20**

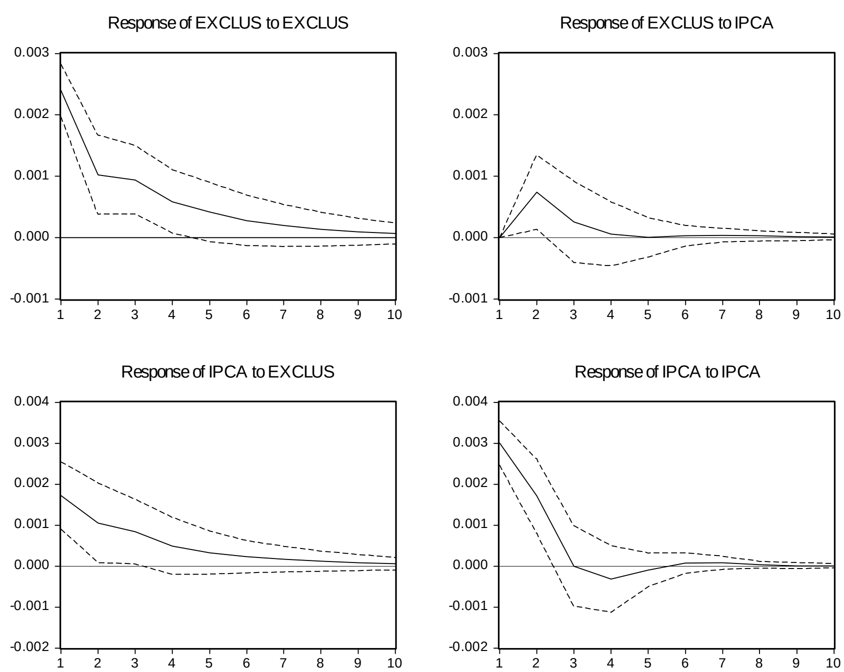
Obs. The smoothed items are in boldface.

Impulse responses from a bivariate VAR

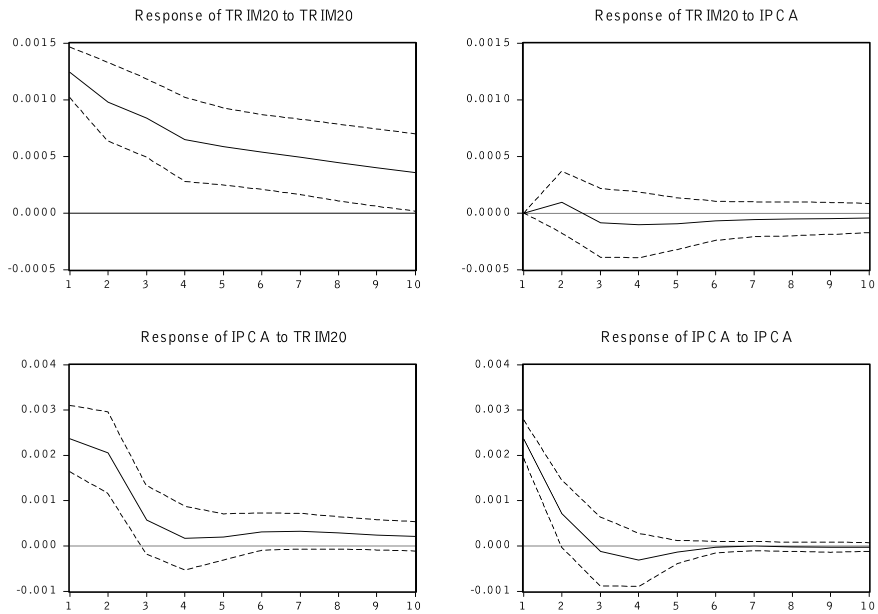
IPCA e B&C core - Response to One S.D. Innovations ± 2 S.E.



IPCA and Exclusion Core - Response to One S.D. Innovations ± 2 S.E.



IPCA and Trim 20 - Response to One S.D. Innovations ± 2 S.E.



IPCA and Double Weight - Response to One S.D. Innovations ± 2 S.E.