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Evaluating Core Inflation Measures for Brazil[1]

Francisco Marcos Rodrigues Figueiredo[*]

Abstract

This article presents a brief survey about core inflation and shows the first results obtained in the computation of such indicator for the Brazilian IPCA for the period from January/1996 to May/2000. The performance of five alternative measures of core inflation (exclusion method, symmetric trimmed mean, symmetric trimmed mean with smoothed series, weighted median and double weighted indicator) is evaluated and compared. The preliminary results show that the double weighted measure and the 20% trimmed mean with smoothed series performed better.

[1] Author thanks Fábio Araújo and Marta Baltar for technical support. The views expressed in this paper are my own and do not necessarily reflect those of Central Bank of Brazil.

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Evaluating Core Inflation Measures for Brazil

1. Introduction

The objective of this paper is to present a brief review about core inflation and show the first results obtained in calculating such indicator for the Brazilian IPCA. This index, calculated by the Brazilian Institute of Geography and Statistics (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.

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. 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.

The outline of this paper is as follows: The first section discusses the concept of core inflation. Section 2 describes the alternatives to measure the core and the required properties that a core measure should fulfill. In Section 3, some measures are computed and evaluated. Concluding remarks follow this.

2. The Core Inflation Concept

Bryan & Cecchetti (1996) assert that core inflation does not present a clear definition. According to Roger (1998), such concept tends to be better defined in terms of the particular method that is being used to estimate the measure than the own phenomenon that the measure tries to capture. However, the same author verifies that any measure of core inflation endeavors to capture the persistent and generalized components of inflation. These components are usually associated to demand pressures over the productive capacity, permanent shocks in relative prices and changes in inflation

expectations, leaving out supply shocks. Thus, core inflation is directly associated with the concept of trend inflation. In addition, Quah & Vahey (1995) define core inflation as the component of inflation that does not have impact on real output in the medium and long run.

Core inflation is an important tool for monetary policy as it helps monetary authorities to identify shocks hitting the inflation rate that do not affect the core. Among those are the temporary supply shocks like the ones resulting from climate factors (ubiquitous for fresh food) or from seasonal patterns (widespread for clothing and beef). Temporary shocks, despite moving the headline index, are quickly reversed without affecting expectations and, therefore, do not justify a policy response from the monetary authority.

In 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, *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, Schechtman and Barros (2000). The *Instituto de Pesquisa Econômica Aplicada* (IPEA), in its January 2000 Bulletin, presented some preliminary results for the IPCA core inflation using the methodologies of smoothing trimmed means, and the methodologies of extracting the common trends of the components of the index and the common trends of the several inflation indices. The description of the methodologies can be found in Moreira and Carvalho (2000) and Fiorêncio and Moreira (2000). Additionally, Picchetti and Toledo (2000) measure core inflation for the IPCA and the IPC-FIPE based on trimmed means and dynamic factor index while Pinto (2000) defends the use of the median as indicator of the underlying inflation.

3. Measures of Core Inflation

Roger (1998), based on the two broad conceptions of inflation (persistence and generalization), classifies the core measures as persistent inflation measures or generalized inflation measures. The distinction between them is not clear-cut, and there are certain alternatives based on hybrid or combined approaches.

3.1 Generalized Inflation Measures

The generalized inflation approach focuses on the degree of generalization in price changes at a disaggregated level. Therefore these measures deal with the cross-section distribution of the price components.

In chronological terms, the 1970's witnessed the first attempts to measure underlying inflation, with the most volatile components being purged from the headline index. Hence, 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. Several Central Banks report core inflation based on this approach as can be seen in **Table 1** below.

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. Bryan and Cecchetti (1994) introduced such approaches in the discussion of core inflation.

Table 1 - 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
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 government 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
Philippines	A statistical trend line
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
United States	CPI less food and energy items

Source: Bryan & Cecchetti (1999), MAS (1998) and Banco de la Republica (2000).

The economic intuition supporting this methodology is based on the menu costs model with asymmetric shocks presented in Ball and Mankiw (1995) as discussed in Bryan and Cecchetti (1994) and Bakhshi and Yates (1999).

The statistical argument for using these methods is that the changes in price components do not follow a normal distribution. Actually, several papers verify that the distribution of the component changes of the indices is asymmetric to the right and it contains excess of kurtosis. Bryan and Cecchetti (1994), Marques *et al.* (2000), Roger (1997), Shiratsuka (1997), Bakhshi and Yates (1999), Deustche Bundesbank (2000) and Pichetti and Toledo (2000) found evidences of excess of kurtosis and skewness for consumer price indices in the USA, Portugal, New Zealand, Japan, UK , German and Brazil, respectively. In this context, the sample mean is no longer the best estimator for the population mean and an estimator which is robust to extreme values should be used.

In order to prevent the loss of relevant information when using the exclusion method, the Bank of Canada (Laflèche, 1997) suggested a different core measure based on component volatility. In this measure, the effect of volatile components on the overall index is reduced by using weights that are linked to the price variability of individual components in the basket. The higher volatility in the component, the lower the weight. The new weights can be simply obtained by the ratio between the standard deviations of the individual component and the overall index, as in Marques *et al.* (2000), or combining the expenditure weight in the basket with the volatility weight (double weighting method), as in Laflèche (1997) and Deutsche Bundesbank (2000).

3.2 Other Approaches

In reference to the persistent inflation measures that emphasize the behavior of the inflation itself, there are some smoothing methods. This approach can range from simple moving averages, smoothing filters, to the fitting of trend lines such as the Hodrick-Prescott filter.

Some other measures of core inflation attempt to use characteristics of the two former approaches, exploring the behavior of the price index components in time. The dynamic factor index (Bryan & Cecchetti, 1994) is an example of this approach in which the constituents of the price index are filtered to obtain an unobserved common stochastic component.

An alternative approach due to Quah & Vahey (1995) is the structural vector autoregression (SVAR). Their measure is constructed by placing long-run constraints in a bivariate VAR with output and inflation. The main advantage of this approach is that it has a clear economic interpretation. Economic agents are assumed to incorporate core inflation into their actions. Thus core inflation has no long-run impact on output. Gartner & Wehinger (1998), Blix (1995) and Claus (1997) have proposed extensions of this model.

Table 2 summarizes the methods used for the core inflation calculation.

Table 2 – Approaches to core inflation measurement

		Time perspective	
		Cross-section	**Time series**
Raw data	**Individual Price changes**	Exclusion Limited influence estimator Volatility and double weighted index	Dynamic factor index
	Headline inflation Rate		Moving averages Filtered series Exponentially smoothed series
	Price data plus other Variables		SVAR measures

Source: Wynne(1999).

3.3 Desired Characteristics of a Core Measure

According to the literature, the procedure to select the appropriate indicator of the core inflation still remains a challenging question. There are several approaches to choose the measure of core inflation. Bryan & Cecchetti (1994, 1999), for example, compare the behavior of the potential trend inflation measures with a benchmark measure for inflation and verify the relationship between the core measures and money growth. Lafléchè (1997) tests the information content in the indicators in order to forecast future values for headline inflation.

Roger (1997) suggested that a good measure of core inflation should satisfy four properties: timeliness, robustness, unbiasedness, and verifiability. Furthermore, Wynne (1999) enlarged this list to six conditions:

a. The first condition for the choice of the core inflation is being timely computable. Almost all the measures satisfy this point, except for the measures based on symmetrical (centered) filters. In spite of being calculated in real time, Hodrick-Prescott filter is not appropriate as core inflation because it presents end-sample problems.

b. The second criterion is that the measure should have a forward-looking nature. Most of the alternatives do not present such character inherently, except the measures based on structural VAR. However, some methods possess some accuracy power to predict future inflation.

c. The next condition is the ability that the measure has to explain past inflation. In general, it can be said that all measures satisfy this approach, except the index of dynamic factor, which has not been much explored in the literature yet.

d. The fourth criterion is that the measure should be easily understandable by the public. Wynne (1999) questioned whether the public could easily understand some of the sophisticated measures. Rigorously, the only easily understood measure is the one built by the exclusion method. This can explain the massive use of such indicator by Central Banks.

e. In the communication between Central Banks and the public, a core measure should be definitive in the sense that past figures do not change when new observations are available. Measures using econometrics procedures such as Kalman filters and VAR do not satisfy this fifth requirement. Wynne (1999) suggests that robustness of core inflation estimation should be studied when new observations are included.

f. The last criterion is that the measure should have a theoretical basis. Wynne (1999) and Marques *et al.* (2000) assert that the core measure should be based on money neutrality. The only measure that strictly satisfies this condition is the one based on SVAR methods.

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, Marques *et al.* (2000) introduce statistical conditions that have to be met by any core inflation indicator.

A stable long-run relationship between core measure and inflation is the first necessary condition. Also, the tendency 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. In the next section such *attractor* conditions are tested for alternative core inflation measures.

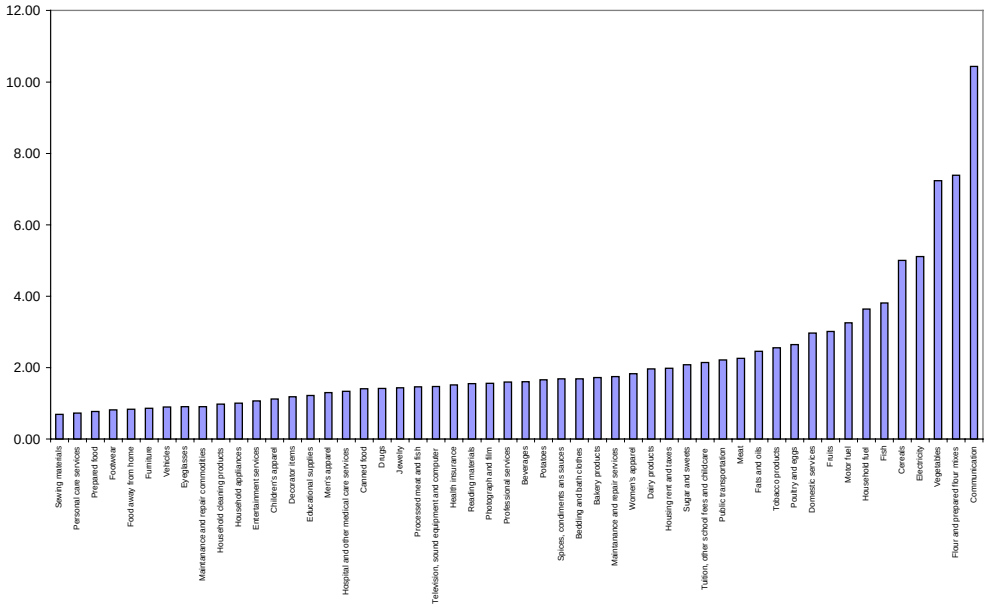
4. Computation of Core Inflation Measures

In this section, preliminary results concerning the construction of core inflation indicators for Brazil are shown. The results are obtained using generalized inflation measures that deal with the cross-section distribution of price changes.

4.1 Exclusion Method Core

Graph 1 exhibits the standard deviations of the 52 components of IPCA from January 1995 to May 2000. This sample was used to perform the computation of the core indicators. Previous data was not considered because of a change in the price dynamics which occurred with the Real Plan (July 1994), as pointed out by Fiorencio & Moreira (2000).

Chart 1 - Standard Deviation of CPI Components, Jan 1995 - May 2000



The first core measure was computed following the exclusion method. The excluded items total approximately 45% of the overall index and are presented, with the respective weights, in **Table 3**. Comparing **Table 3** and **Chart 1**, we can notice that mostly the excluded prices are the ones with larger volatilities.

Table 3 – Eliminated Items in Exclusion Core

Excluded items	Average Weight
Total	**44.95**
Cereals	1.32
Potatoes	0.62
Vegetables	0.25
Fruits	0.89
Meat	2.83
Fish	0.36
Poultry and eggs	1.29
Dairy products	1.67
Rent of residence	8.09
Real-state tax	0.25
Water and sewer	1.06
Gas	0.61
Electricity	1.78
Apparel	8.99
Public transportation	5.29
Motor fuel	3.82
Tobacco products	1.56
Tuition, other school and child care	3.01
Communication	1.28

4.2 Trimmed-mean and Weighted Median

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

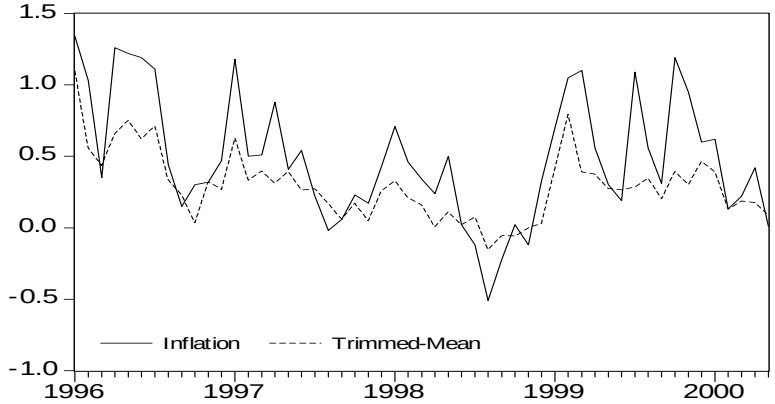
I_α is the set of the components to be considered in the computation of the trimmed mean with $\alpha\%$ and W_i is the accumulated weight up to *i*-th component.

The weighted median indicator was computed setting $\alpha = 50$. The results are showed and evaluated in section 4.4.

When estimating a trimmed-mean, the choice of the section to be trimmed is not a trivial subject. In this example, 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. The optimal trim was 30%.

The 30% trimmed mean (Trimmed 30) for the IPCA from January 1996 to May 2000 is mostly below the overall inflation as shown in **Chart 2**. This underestimation of the inflation path when the tail cuts are symmetric was also noticed by Laflèche (1997), Roger (1997) and Marques et al. (2000). Statistically, this behavior results from a positive asymmetry in the distribution of the changes of the price components.

Chart 2 – 30% Symmetric Trimmed-Mean

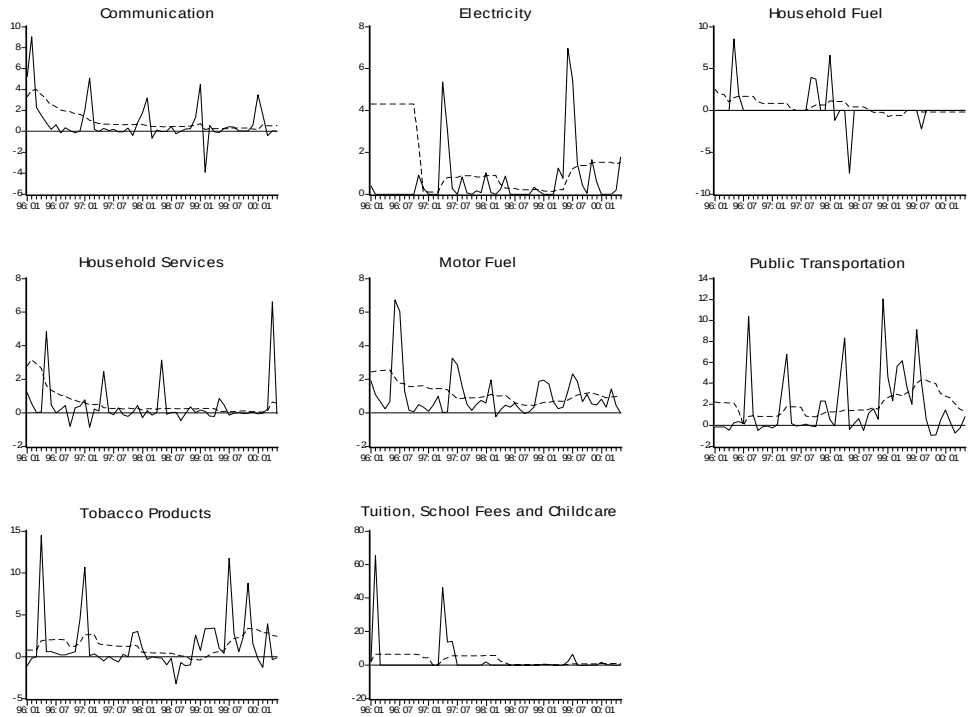


A way to deal with this restriction is the computation of asymmetric trimmed means that take into account the degree of asymmetry of the price distribution as found in Roger (1997). Bahkshi & Yates (1999) argue that this is not a straightforward task because the asymmetry of the distribution is not observed and can change in time.

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. A solution used in this paper was to smooth the series that present less frequent changes.

The smoothing method consists of distributing the price variation 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 **Chart 3** below.

Chart 3 - Smoothed Series Included in the Trimmed-Mean, Jan 1996 – Jan 2000



After including the smoothed series in the price components, the new core measure was computed and the optimal trim chosen was 20% (Trimmed 20). **Chart 4** displays the RMSE values using three sample periods (January 1996/May 2000; January 1997/May 2000 and January 1998/May 2000). In addition, **Table 4** shows the optimal trims for these different sample periods and using distinct centered moving average as benchmark indicators.

Chart 4 – Efficiency of Trimmed Mean (13-month)

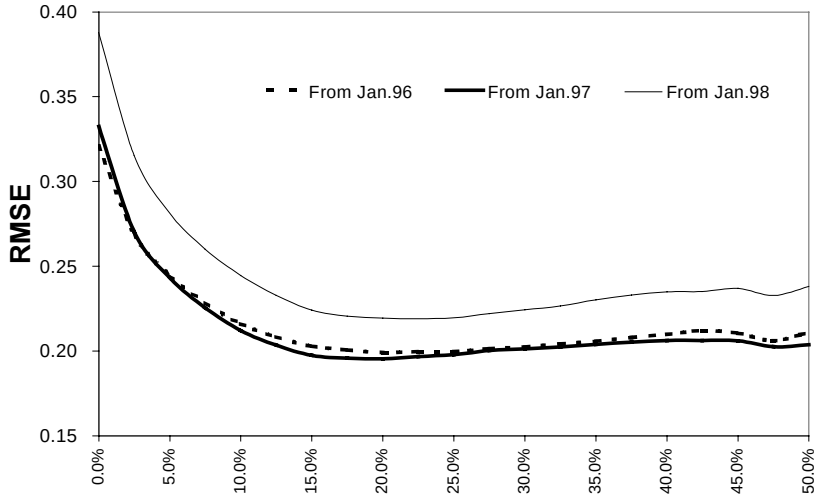
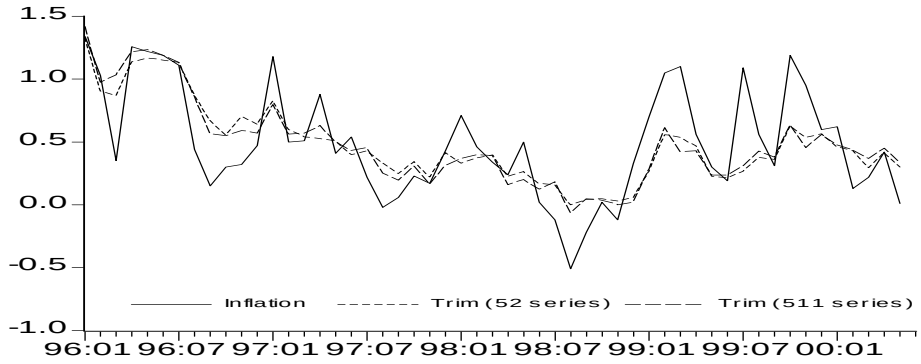


Table 4 - Optimal Trims

Period	Moving Average		
	7-month	13-month	17-month
From Jan/96	17.5	20.0	20.0
From Jan/97	10.0	20.0	20.0
From Jan/98	10.0	22.5	25.0

One of the critics to this approach is the non-robustness to changes in the aggregation level. In order to address this question, the trimmed mean with α = 20% using the IPCA lowest aggregation level (511 series) was estimated. **Chart 5** shows that the difference between the two alternatives is not substantial.

Chart 5 – 20% Trimmed Means with Different Levels of Aggregation



4.3 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 Lafléchè (1997) and Marques et al. (2000). With N price components, the formula is:

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

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 six–period window.

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

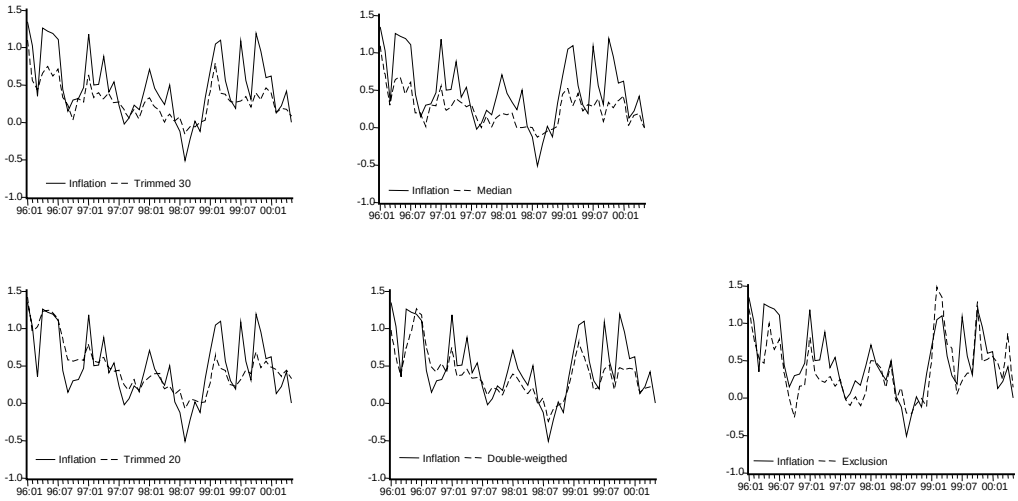
$$\left(\overline{\pi_{it} - \pi_j}\right) = \sum_{j=t-m+1}^{t} \frac{\left(\pi_{ij} - \pi_j\right)}{m}$$

4.4 Preliminary Results

Chart 6 presents the measures obtained using the five methods described in the last subsection – exclusion, trimmed 30, trimmed 20, weighted-median and double-weighted - and **Table 5** shows the descriptive statistics for each of these measures.

Table 5 stresses that the different core measures reduced the standard deviation of the inflation. In the case of the exclusion method the reduction is very small. It is worth noticing that the average and median of trimmed-mean with smoothed series is approximately equal to the inflation statistics, while the measure of central tendency for the trimmed without smoothing and weighted median are substantially smaller than the inflation statistics.

Chart 6 – Core Inflation Measures, Jan 1996 - May 2000



A RMSE in relation to a 13-month centered average of inflation is computed for three periods in order to compare the performance of the core inflation. The Trimmed 20 presented the best results followed by the double-weighted measure (**Table 6**).

Table 5 – Descriptive Statistics of Core Measures, Jan 1996 – May 2000

Statistics	IPCA	Double-Weight	Exclusion	Weighted Median	Trimmed-Mean 20	Trimmed-Mean 30
Mean	0.49	0.38	0.37	0.25	0.48	0.29
Median	0.43	0.36	0.32	0.23	0.43	0.27
Std. Dev.	0.43	0.30	0.41	0.24	0.37	0.24

Table 6 – RSME of Core Inflation Measures

Period	Methods				
	Double-weight	Exclusion	Weighted Median	Trimmed-Mean 20	Trimmed-Mean 30
From Jan/96	0.2588	0.4189	0.4734	0.1992	0.4490
From Jan/97	0.2259	0.3973	0.3640	0.1955	0.3545
From Jan/98	0.2558	0.4407	0.4131	0.2194	0.3997

An additional point is to evaluate the relationship between the core inflation and money growth. A measure of inflation that disregards the transient components should be more related to changes in monetary aggregate than the headline inflation. In order to assess this property, the contemporaneous correlations between money growth (M2) and core indicators are performed for one, two, three and six month variations. The double-weighting core performs better than the other alternative measures. However, the Trimmed 20 and weighted median present a higher correlation than the headline except for the 3-month period (**Table 7**).

Table 7 – Contemporaneous Correlation Between Money Growth and Core Indicators, Jan 1996 – May 2000

Method	1-month	2-month	3-month	6-month
IPCA	0.286	0.456	0.579	0.769
Double-Weighting	**0.351**	**0.486**	**0.583**	**0.810**
Exclusion	0.195	0.278	0.372	0.602
Weighted Median	**0.341**	**0.462**	0.560	0.731
Trimmed 20	**0.329**	**0.462**	0.550	**0.774**
Trimmed 30	**0.287**	0.433	0.530	0.741

An equation suggested by Cogley (1998) was estimated for each core candidate aimed at testing the *attractor* properties stated by Marques et al. (2000). The equation is the following:

$$(\pi_{t+h} - \pi_t) = \alpha_h + \beta_h(\pi_t - \pi_t^c) + \varepsilon_{t+h}$$

where π_{t+h} is the inflation value in *h* periods ahead and π_t^c is a measure of core inflation in period *t*.

According to Cogley (1998) if the core inflation is a proxy to expected inflation in the medium and long-run, it is possible to write $\pi_t^c = E_t\pi_{t+h}$ for a suitably long forecast horizon h.

In order to satisfy the equality shown above in the *attractor* equation, the coefficient α_h should be zero to assure that $(\pi_{t+h} - \pi_t)$ and $(\pi_t - \pi_t^c)$ are zero mean. As $(\pi_t - \pi_t^c)$ measures the short-lived inflation components, β_h should be equal to –1. If the value of β_h were negative and lower than the unity in absolute value, the core measure overestimates the inflation rate. Likewise, if the value of β_h were negative and higher than the unity in absolute value, the core measure would underestimate the inflation rate.

Table 8 below shows the estimated β for horizons from 1 through 8 periods. The results shows that the Trimmed 30, weighted median and double-weighted measures present a negative bias while the exclusion method overestimates the inflation in most periods. Although the Trimmed 20 presents the best outcomes concerning the bias level, the Trimmed 30, weighted median and double-weighted outperformed the former in accounting for changes in the future inflation (**Table 9**).

Table 8 – β estimates from *Attraction* Regressions

H (months)	Trimmed 20	Trimmed 30	Exclusion	Weighted Median	Double-Weight
1	-0.583	-0.781	-0.170	-0.657	-0.680
2	-0.806	-1.069	-0.389	-1.062	-0.971
3	-0.847	-1.125	-0.218	-1.191	-1.002
4	-1.119	-1.570	-0.588	-1.546	-1.495
5	-1.138	-1.723	-0.915	-1.636	-1.683
6	-1.152	-1.740	-0.839	-1.719	-1.762
7	-1.182	-1.768	-0.889	-1.676	-1.944
8	-0.928	-1.546	-1.128	-1.385	-1.649
Average	**-0.969**	**-1.415**	**-0.642**	**-1.359**	**-1.398**

The results shown above are far to be conclusive. Trimmed 20 presented the best performance in tracking the inflation trend benchmark (13-month centered moving average) and the bias level, but concerning the relation between the core measures and money growth, the double-weighted indicator outperformed the others. Subsequent inflation changes are better accounted by Trimmed 30 and weighted median. A clear result of this exercise is that the exclusion method performed poorly.

Table 9 – R^2 from *Attraction* Regressions

H (months)	Trimmed 20	Trimmed 30	Exclusion	Weighted Median	Double-Weight
1	0.186	0.276	0.016	0.214	0.168
2	0.222	0.324	0.048	0.351	0.214
3	0.231	0.337	0.014	0.414	0.215
4	0.298	0.492	0.073	0.527	0.362
5	0.308	0.594	0.177	0.590	0.459
6	0.315	0.602	0.148	0.650	0.501
7	0.300	0.562	0.155	0.562	0.552
8	0.208	0.466	0.300	0.419	0.416

5. Concluding Remarks

The need for an accurate and reliable measure of core inflation is practically a consensus among central banks authorities, mainly in those countries which follow an inflation targeting regime for monetary policy. Not only the core permits detecting particular movements in prices, but it also helps central bank 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 tendency is a controversial subject, the most correct procedure is to use a set of available 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.

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