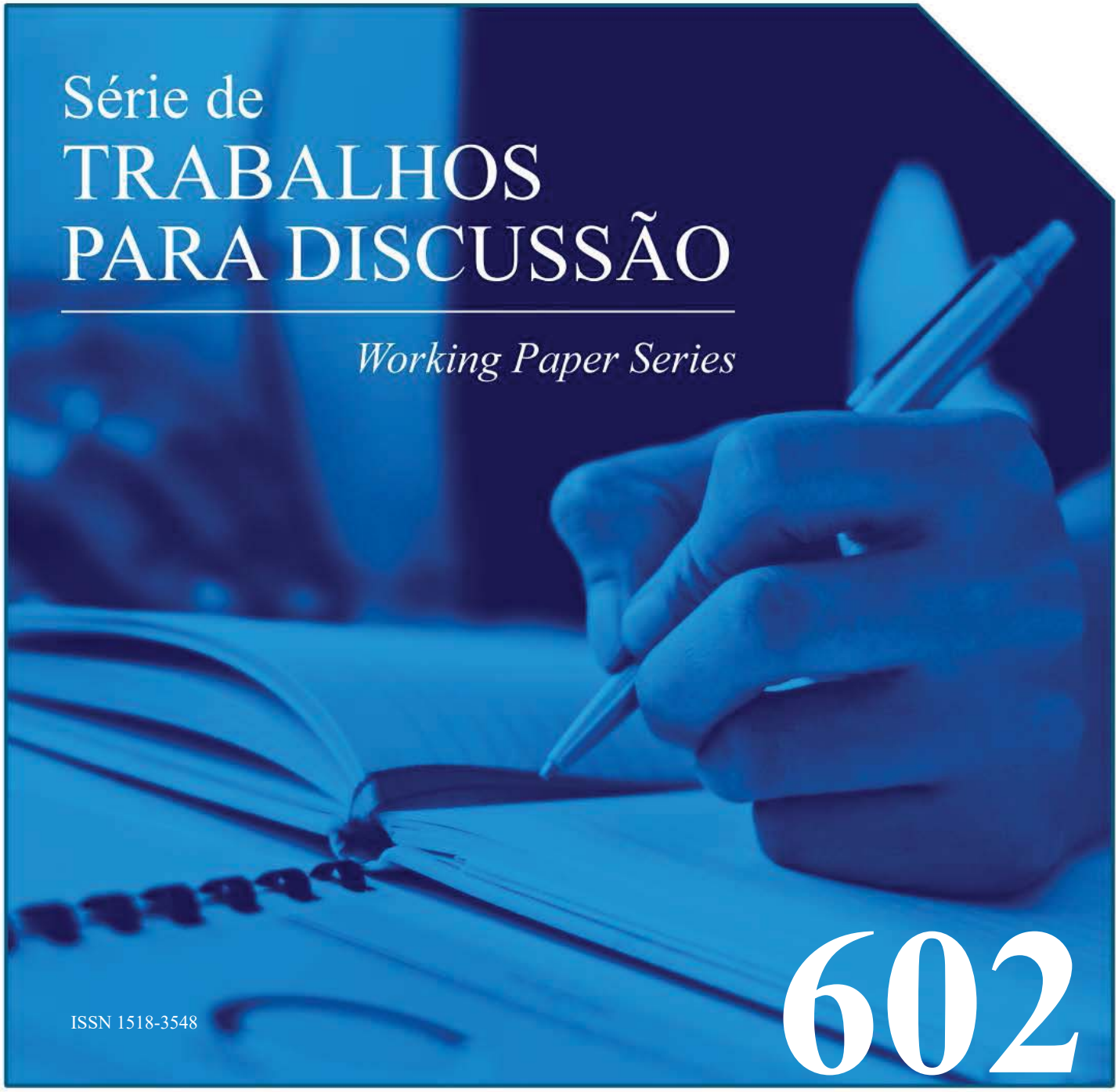

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Core Inflation in Brazil: past and present

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Non-technical summary

Core inflation plays a crucial role in enabling central banks to make well-informed monetary policy decisions. In particular, during shock episodes, such as the Covid-19 pandemic and its aftermath, a more detailed assessment of underlying inflation becomes extremely important. It is no coincidence core inflation measures have gained more prominence in monetary policy and even in popular media around the world.

Given the significance of core inflation measures, it is not surprising there is already a substantial body of literature on this subject. However, it is noteworthy no comprehensive survey on core inflation measures exists for Brazil. The main contribution of this paper is to compile academic articles and BCB publications, summarizing the key themes of this growing literature. Another contribution is to provide a unified approach, applied to assess the current set of official measures used by the BCB.

The literature survey revealed some peculiar aspects: i) Among the most commonly used criteria for evaluating core inflation measures are their ability to capture the trend of inflation, their forecasting capability, and the absence of bias and low variability; ii) a significant portion of the literature focuses on alternative proposals to the BCB's "official" measures, either due to changes in specifications or different methodologies; iii) generally, with a few exceptions, core measures are not successful as predictors of inflation; and iv) there is no consensus on a preferred individual measure.

Based on the theoretical findings and practical insights, the article further provides a unified approach to evaluating core inflation measures. This approach is applied to assess the current set of official measures used by the BCB. The results reveal: i) the overall strong performance of the average of the five measures; ii) the complementary nature of the measures in various aspects, supporting the adoption of different measures by the BCB; iii) better relative performance of the P55 and DP measures; and iv) the relatively weaker forecasting performance of core measures compared to the IPCA itself.

Sumário não-técnico

Os núcleos de inflação desempenham um papel crucial para permitir que os bancos centrais tomem decisões de política monetária bem-informadas. Em particular, nos episódios de choques, como foi o caso no período de pandemia da Covid-19 e de seus desdobramentos, uma avaliação mais minuciosa da inflação subjacente torna-se de suma importância. Não à toa, os núcleos de inflação ganharam maior destaque na política monetária e até mesmo na mídia popular ao redor do mundo.

Apesar de já haver uma literatura substancial sobre o tema, vale ressaltar que não existe um levantamento abrangente sobre as medidas de núcleo de inflação para o Brasil. Portanto, a principal contribuição do estudo foi compilar artigos acadêmicos e publicações do BCB, resumindo os principais temas dessa literatura crescente. Outra contribuição é fornecer uma abordagem unificada, aplicada para avaliar o atual conjunto de medidas oficiais usadas pelo BCB.

O estudo bibliográfico revela alguns aspectos peculiares: i) entre os critérios mais utilizados para avaliação dos núcleos se destacam a habilidade de captar a tendência da inflação, a capacidade de previsão da inflação e a ausência de viés e baixa variabilidade; ii) boa parte da literatura se concentra em propostas alternativas às “oficiais” do BCB, seja por mudanças de especificações como por uso de metodologias diferentes; iii) em geral, com algumas exceções, os núcleos não são bem-sucedidos como previsores da inflação; e iv) não há consenso sobre uma medida individual preferida.

Com base nos achados teóricos e na prática, o artigo oferece ainda uma abordagem unificada para avaliar os núcleos de inflação. Esta abordagem é aplicada para avaliar o conjunto atual de cinco medidas de núcleo e a sua média. Os resultados revelam: i) o desempenho geral forte da média das cinco medidas; ii) a natureza complementar das medidas em vários aspectos, apoiando a adoção de diferentes medidas pelo BCB; iii) o desempenho relativamente melhor das medidas P55 e DP; iv) o desempenho de previsão relativamente mais fraco das medidas, em comparação com o próprio IPCA.

Core Inflation in Brazil: past and present[1]

Vicente da Gama Machado*

Abstract

Since the adoption of inflation targeting in Brazil, the literature on core inflation has significantly expanded; however, a comprehensive survey has been lacking. This paper aims at filling this gap by providing a thorough overview of the academic developments and a historical guide to the core inflation measures employed by the Central Bank of Brazil (BCB). Additionally, the paper introduces a unified approach to evaluate the performance of core measures, which is then used to assess the set of official measures currently monitored by the BCB. This approach emphasizes the complementary nature of individual measures and demonstrates the overall favorable relative performance of the core average.

Keywords: Core inflation, Monetary Policy, Survey

JEL Classification: C32, E31, E32, E52

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1. Introduction

Central banks, as well as economic agents in general, consistently seek a clearer and more stable representation of the underlying inflation trend, which should reflect long-term changes in the general price level of goods and services. Typically, this is achieved through the use of core inflation indicators.

Core inflation measures play a crucial role in enabling central banks to make well-informed monetary policy decisions. Particularly during periods of significant deviations from its trend, as witnessed in the aftermath of the Covid crisis, a more precise assessment of underlying inflation becomes of paramount importance. In such contexts, where economies experienced substantial shocks not only in headline inflation but also in relative prices, core inflation measures have gained greater prominence in policy debates and even in popular media.[2]

Given the significance of core inflation measures, it is not surprising there is already a substantial body of literature on this subject. However, it is noteworthy no comprehensive survey on core inflation measures exists for Brazil. While Figueiredo (2001) and da Silva Filho and Figueiredo (2014a) have compiled the set of measures used by the Central Bank of Brazil (BCB) during specific time periods, this paper takes a different approach by surveying both academic articles and BCB publications to present the main themes in this growing literature. As a result, this survey is aimed at serving as an updated guide to core inflation in Brazil, catering to academic researchers and the Central Bank community. A secondary contribution of this paper is a unified approach to evaluating core measures, which is applied to assess the current set of official measures used by the BCB.

The remainder of the paper is organized as follows: Section 2 presents the core measures developed by the BCB in chronological order. Section 3 describes some of the key topics addressed in the academic literature on core inflation in Brazil. In Section 4, new

[2] Figure A1 in the Appendix displays quarterly results of Google Trends searches for the topics "Inflation" and "Core inflation" on a global scale. It is evident that, at least in the recent cycle, interest in inflation rises before interest in core inflation. However, the data indicate overall interest in core inflation kept increasing, even after headline inflation (and public interest in it) has reached its peak. In fact, over the last months interest in core inflation has been comparatively greater in historical terms.

findings regarding the assessment of core inflation measures currently in use at the BCB are presented, and Section 5 provides the concluding remarks.

2. Core measures at the BCB

In Brazil, the core inflation measures developed by the BCB for the IPCA[3] have traditionally garnered the highest attention. While market participants may have their preferences for a core measure that better represents trend inflation and/or forecasts inflation, the "official" measures carry more significance as they presumably have a stronger impact on the decision-making process compared to measures not included in the BCB's information set.[4]

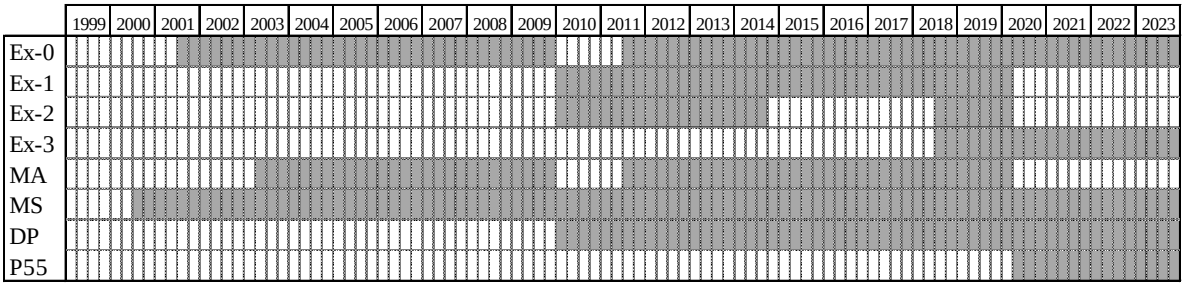
The BCB has consistently adopted a comprehensive approach by examining a set of core inflation measures instead of focusing solely on a single measure. This approach aligns with the literature and general practices of central banks, which recognize no individual measure can fully address the diverse sources of inflation dynamics and their variations over different periods.[5] Throughout the inflation targeting era, the BCB has used a range of measures, which have been communicated through its official documents. These measures encompass various methodologies employed in the related literature. For a chronological view of these measures considered by the BCB, refer to Table 1.

[3] IPCA – Extended National Consumer Price Index; the official CPI used in Brazil in the inflation-targeting framework.

[4] Throughout this text, the term "official" measures will be used to refer to the measures frequently employed by the BCB in its communication.

[5] Indeed, many central banks from emerging and developed countries follow this approach of communicating more than one measure, as Da Silva and Figueiredo (2014a) point out. Concerning the literature, as Rich and Steindel (2007) argue, there is a lack of consensus over the preferred measure of core inflation.

Table 1 - Timeline of core measures at the BCB



Source: BCB

Ex-0: Excludes all items from food-at-home and administered prices

Ex-1: Excludes 10 out of 16 items from food-at-home and all items from administered prices

Ex-2: Excludes 10 out of 16 items from food-at-home and vehicle and domestic fuels from administered prices

MA: "Trimmed mean", where 20% of items with largest and smallest variations are excluded

MS: The same as MA, but some specific remaining items have their variations smoothed

DP: "Double-weighting", where the new weights are a combination of the original ones with each items' volatility

P55: The exact variation of the 55-th percentile of the items distribution

The following subsections offer an overview of these measures in chronological order, as they have been featured in BCB official documents, including Inflation Report boxes and BCB Working Papers. Table 2 presents a compilation of eleven boxes from the Inflation Report that are specifically dedicated to core inflation measures.

Table 2 - List of boxes from the Inflation Report

Issue	Title	Main subject
Jun/2000	Core inflation	Introduction to the topic
Sep/2000	Core inflation	Presentation of the MS core
Sep/2009	Three new measures of core inflation	Presentation of DP, Ex-1 and Ex-2* cores
Sep/2011	New measures of core inflation	Presentation of PVE and RMSE cores
Sep/2016	Services sector inflation	Introduction to the concept of underlying services inflation
Jun/2018	New core inflation measures	Introduction to Ex-2 and Ex-3
Sep/2018	Food inflation pass-through: an international comparison	Impact of food inflation on core inflation
Dec/2018	Informational content of the IPCA cross-sectional	Analysis of inflation percentiles
Dec/2018	Predictive ability and bias of underlying inflation measures	Comparative assessment of existing core measures
Sep/2019	The relation between volatile components and inflation	Exercise relating core and non-core inflation
Jun/2020	Update of the set of core inflation measures commonly considered by the BCB for economic outlook analysis	Presentation of P55 and exclusion of Ex-1, Ex-2 and MA, building the present set of measures.

* The then called Ex-1 was later discontinued and Ex-2 became Ex-1

2.1 “MS” core measure

In the September 2000 Inflation Report this measure was first presented. The MS measure was seemingly the first core measure that the BCB began to monitor and remains

part of the set of official core measures. The name is derived from the Portuguese term "*Médias aparadas com Suavização*", or smoothed trimmed means. It follows the trimmed-mean methodology and consists of a two-step procedure, where the largest and smallest price variations are excluded from the headline index each month, after smoothing the variations of some items.[6]

In essence, the measure trims both tails of the price variation distribution and calculates a weighted average using only the central portion of the distribution. This approach eliminates extreme variations while preserving the center of the distribution, allowing for a better identification of overall price behavior. The smoothing process is necessary to address the issue of some items having infrequent variations, occurring mostly once a year, which could otherwise introduce significant bias into the measure.

An important consideration in this type of measure is the determination of the threshold for tail elimination. The final decision was based on a 20% cut-off for each tail.[7] This threshold was determined to be optimal through a comparison of the 13-month centered moving average with alternative trimmed series, using the root mean square error minimization criterion.

Another core measure known as the "MA" measure, short for "*Médias Aparadas*" or simply trimmed-mean core measure, was introduced as a simplified version of the MS measure, where no items were smoothed. While it was mentioned later as part of the official measures, it was subsequently excluded in 2020 due to its inherent bias problem.

2.2 Exclusion measures

One year later, the BCB introduced the first exclusion measure, later referred to as Ex-0, which involved excluding food-at-home and administered prices. These categories contained items with traditionally more volatile price variations and items subject to specific government-regulated pricing rules, as in the case of administered prices.

[6] For further details on the methodology, see Figueiredo (2001).

[7] More specifically, each month the items are first ranked by their variation. Subsequently, based on the accumulated weights, those falling below the 20th percentile and above the 80th percentile are excluded, and the remaining items are reweighted to form the core measure

Subsequently, in BCB (2009), two additional exclusion-based core measures were introduced, known as Ex-1 and Ex-2[8]. Instead of excluding entire segments of food-at-home and administered prices, these measures focused on excluding only the most volatile items within these categories[9]. For Ex-1, 10 out of 16 food items were excluded, while Ex-2 went further by also excluding domestic fuels and vehicle fuels. The selection process for these exclusions was detailed in Da Silva Filho and Figueiredo (2011).

In BCB (2018a), two new exclusion-based measures, Ex-2 and Ex-3, were introduced with the aim of extracting volatile items by delving deeper into different market price segments, namely food-at-home, services, and industrial goods. Ex-2 excluded administered prices, like Ex-0, but retained the underlying components of these three segments. On the other hand, Ex-3 was more restrictive, excluding food-at-home and combining the underlying components of services and industrial goods (some components of those two groups were excluded, generating core measures for services and industrial goods). As a result of the definition provided in that report, underlying services inflation gained attention from some market participants in their inflation outlook, given its high persistence and cyclical sensitivity, although it is not considered a proper core measure.

Since BCB (2020), the BCB has also begun to follow a widely used measure known as Ex-FE, or Ex-Food and Energy core, although it is not officially included in the core measure set. Despite its unofficial status, Ex-FE is still calculated and updated on the statistics menu of the BCB website. Its broad adoption in many countries makes it particularly useful for international comparisons.[10] Also in BCB (2020), the exclusion measures Ex-1 and Ex-2 were eliminated from the official set, for the sake of parsimony. In the case of Ex-1, it resembled the Ex-FE, with the disadvantage that it did not exclude electricity tariffs, which has turned especially volatile in the recent years. As for Ex-2, it was very similar to Ex-3, but it did not exclude food-at-home completely, therefore it remained quite volatile while still redundant.

[8] These two measures were included in official documents for a certain period, until Ex-2 was renamed as Ex-1 due to its superior performance. See also Section 3.3.
[9] Another rationale for the selection was the high persistence and rigidities often observed in many administered prices. Consequently, completely excluding them could introduce a downward bias in the core measure.
[10] Indeed, such a comparison was conducted with a previous version of this core measure in BCB (2018b).

2.3 “DP” core measure

The "Double Weighting" core measure, known as "*Dupla Ponderação*" in Portuguese (DP), was introduced in BCB (2009). This measure is constructed by adjusting the original expenditure weights of each item based on their relative volatility, which results in the downweighting of more volatile components.

2.4 P55 core measure

The P55, abbreviated for the 55th percentile, is the most recent official core measure, introduced by the BCB in BCB (2020). It is based on the premise that median inflation can serve as a good indicator of underlying inflation. This measure is derived by extracting the variation of the 55th subitem from the weighted distribution of inflation each month. The decision to use the 55th percentile, instead of the median, was made to minimize historical bias. In fact, the cross-sectional price change distribution historically displays right-skewness.

2.5 Other proposed measures

Several alternative measures have been proposed in BCB publications and working papers, mainly as alternatives to the official measures but without being cited in official documents as part of the information set.

Figueiredo (2001) conducted an analysis of alternative specifications for the "MA" measure, exploring two dimensions. The first dimension involved considering trimmed means of 30% in each tail, which performed less effectively than the official 20% trim. The second dimension involved performing the calculations at the subitem level, yielding a similar result to the official calculation at the items level.

In an extension of the work on "MA" and "MS" measures, Da Silva Filho and Figueiredo (2014a) explored different trimming percentiles and asymmetric trimming.

Da Silva Filho and Figueiredo (2014b) proposed a double-weighted measure that combines volatility and persistence weights. This measure preserves the idea that certain volatile items exhibit high persistence, and therefore, one should ideally not disregard them completely in the analysis of underlying inflation.[11]

In a more sophisticated statistical framework, Machado, Nadal, and Kawaoka (2020) introduced the "FC" measure based on a dynamic factor model. The aim of this measure was to capture the time series dimension and the usual cross-section dimension, providing a more comprehensive assessment of underlying inflation.

2.6 Current official set of measures

BCB (2020) marked a recent change in the set of core inflation measures. Prior to this, the BCB had been utilizing seven official measures (Ex-0, Ex-1, Ex-2, Ex-3, MA, MS, and DP). However, in that Inflation Report box, Ex-1, Ex-2, and MA were discontinued, and the P55 measure was introduced, resulting in a more streamlined set of five measures (Ex-0, Ex-3, MS, DP, and P55). An updated assessment of these measures is presented in Section 4.

The decision to redefine the set of measures was based on a trade-off between having too few measures, which might fail to adequately capture underlying inflation, and having too many measures, which could complicate analysis of recent developments and reduce communication transparency.

The reevaluation was motivated by the perception that the number of core measures was excessive, and there was some redundancy among them. Additionally, the P55 core measure had been internally monitored for some time and had demonstrated promising performance, which warranted its inclusion in the revised set.

[11] Several alternatives were also tested, including the combination of persistence and expenditure weights, as well as triple weighted measures that encompass all these factors.

3. Topics on core inflation

This section provides a concise summary of the key findings from the literature, enabling a comprehensive understanding of core inflation-related issues in Brazil. Table A1 in the Appendix presents the surveyed materials, along with their main findings and methodologies. The review comprises a total of 13 papers, 8 theses or dissertations, and 8 BCB working papers. To facilitate presentation, each sub-section contains a selected topic that represents a key aspect of the Brazilian literature.

3.1 Main criteria used for the assessment of core measures

Although no fixed set of criteria exists, much of the literature suggests certain desirable features for core measures. First, I discuss the most typical criteria, followed by additional characteristics frequently encountered in the Brazilian papers. Table A2 provides an overview of the evaluation criteria explored in the surveyed literature.

An essential feature any reliable core inflation measure should possess is unbiasedness relative to the corresponding inflation rate. In other words, a useful core measure should exhibit a similar mean to the main reference CPI variable over time.

A second desirable property concerns the time series' variability. Regardless of the definition of core inflation, it should represent a less noisy measure of inflation, providing a smoother representation of underlying trends.

Furthermore, a robust core measure should have the capacity to track trend inflation effectively. This is often achieved by comparing the resulting measure with a centered moving average representation of CPI inflation.

Another widely discussed property is how well core inflation can attract headline inflation. A direct approach to testing this is by solving the so-called Cogley's equation, as introduced by Cogley (2002):

$$\pi_{t+12} - \pi_t = \alpha + \beta(\pi_t^c - \pi_t) + \varepsilon_{t+12} \quad (1)$$

where π_t is headline inflation and π_t^c is core inflation.

Note the term $(\pi_t^c - \pi_t)$ may represent the transitory component of inflation, or the short-term deviation of inflation from its underlying value. A robust core measure should imply a β close to 1, which means that, if inflation is running below (above) its underlying value, we should expect future inflation to pick up (cool down) in the coming months.[12]

Another set of papers investigate the property that a core measure should act as an attractor of headline inflation by conducting Granger causality tests. Ideally, the core measure should Granger-cause headline inflation, but the converse should not hold true.

Moreover, core inflation is often regarded as a potential key element for inflation forecasting, receiving significant attention from central banks and private agents. Among the various price variables typically considered, core inflation emerges as a natural contender due to its role as a reliable indicator of long-term inflationary pressures in the economy.[13]

Throughout the surveyed papers, these were the main properties. Additionally, two criteria that appeared in a few papers are worth mentioning: First, the relationship between core inflation and some measure of monetary aggregate, such as M2. And second, the sensitivity of core inflation to economic slack, as measured by the output gap, for instance.

3.2 Assessment of the measures developed by the BCB

Numerous articles have undertaken evaluations of the "official" measures provided by the BCB. This inclination often stems from the necessity to compare a novel core measure to an established benchmark.

A more critical tone can be found in papers that focus on the assessment of BCB measures: Da Silva Filho and Figueiredo (2011), Litvac (2013) and Santos and Castelar (2016) argue BCB measures exhibit poor performance in forecasting inflation. Da Silva Filho (2012) takes it a step further, arguing the available measures demonstrate subpar qualitative forecasting.

[12] This idea is valid as long as β is positive. If it is lower than 1, the core measure overestimates the inflation rate. For β higher than 1, the core measure underestimates the inflation rate.

[13] On the other hand, the use of core inflation for inflation forecasting has faced criticism for potentially overlooking significant drivers of inflation. For instance, the omission of volatile yet persistent components like energy prices, especially when they have a substantial weight in the CPI basket, plays against the “official” adoption of a measure such as Ex-Food and Energy for Brazil.

Some papers that present core measures based on alternative methodologies also report superior results in terms of forecast performance compared to BCB measures: Denardin, Kozakevicius and Schmidt (2015), Santos (2017) and Zaniol and Moraes (2020). Moreover, Ferreira, Mattos and Ardeo (2017), Mattos (2018) and Machado, Nadal and Kawaoka (2020) also demonstrate better results than BCB measures in terms of adjustment dynamics and reduced variance.

Braz (2011) and Filomena (2018) present mixed findings, wherein no single measure emerges as dominant across various properties. On a different note, Korek (2016) reports positive outcomes for BCB measures, particularly in their capacity to capture the long-run component of inflation.

3.3 Alternative specifications to the "official measures"

Some early papers go deeper into the specification of the trimmed mean core measure. A key aspect is determining the optimal trimming of symmetric tails. Several studies, such as Picchetti and Toledo (2000), Barros and Schechtman (2001), Bryan and Cecchetti (2001), Figueiredo (2001), Figueiredo and Staub (2002), Braz (2011), and Da Silva Filho and Figueiredo (2014a), have tested alternatives to the "official" 20% trim and have generally found an optimal trim around 20%.

Additionally, certain papers proposed asymmetric trimming, examining the distribution of price changes that exhibit positive skewness. Notably, Picchetti and Toledo (2000), Bryan and Cecchetti (2001), and Figueiredo and Staub (2002) explored this approach.

Regarding exclusion-based methods, BCB (2009) and Da Silva Filho and Figueiredo (2011) presented two alternative exclusion-based methods, initially referred to as Ex-1 and Ex-2. Instead of entirely excluding food and administered prices, as in the seminal Ex-0 measure, these two approaches retained some items from these categories based on their relative volatility. The "former" Ex-2 was subsequently revised in Da Silva Filho and Figueiredo (2014a) and renamed Ex-1, replacing the initial Ex-1. The "official" Ex-2, as mentioned earlier, was later introduced in BCB (2018a) based on an analysis of segments of non-administered prices.

3.4 Alternative methodologies

Within the surveyed literature, several papers explore alternative methodologies to the more traditional core inflation indicators, often involving statistical-based modeling and filtering strategies. For instance, certain studies use wavelet techniques to smooth transitory shocks, as seen in Denardin, Kozakevicius, and Schmidt (2015), Filomena (2018), Zaniol and Moraes (2020), and Silva (2020).

Another strand of research addresses the challenge of disentangling permanent and transitory components using factor models, exemplified by works like Alves (2009) and Machado, Nadal, and Kawaoka (2020).

In other instances, papers employ VAR models with activity variables to capture cyclical movements associated with excess demand pressures, as demonstrated in Picchetti and Kanczuk (2001) and Araujo and Fiorencio (2005).

Some studies combine traditional volatility weighting (as seen in the DP core measure) with persistence-based weights, an approach observed in Braz (2011), Da Silva Filho and Figueiredo (2014b), and Machado and Figueiredo (2017).

Lastly, a filtering combination is employed in Ferreira, Mattos, and Ardeo (2017) and Mattos (2018), where trimmed means are combined with seasonal adjustment and moving averages.

3.5 Combination of core measures

Given the lack of consensus in the literature regarding a preferred measure of core inflation, despite its significance for monetary policy, a natural question arises: Does a combination of core measures yield superior results in terms of conventional criteria? Cogley (2002) proposes aggregating various core measures through a weighted average, capitalizing on the distinct information offered by different methods.

In line with this idea, the BCB has been employing and communicating a straightforward average of five core measures in its primary documents. Section 4 provides a comprehensive evaluation of this average in conjunction with the individual measures.

Figueiredo and Staub (2002) report unsatisfactory outcomes when combining certain early versions of BCB measures. Braz (2011) presents mixed results from several combination strategies. Conversely, Litvac (2013) identifies promising performance through a combination of three measures (MS, DP, and the "former" Ex-2).

4. Assessment of current measures

The BCB currently employs five core measures, as mentioned in Section 2. The evolution of these measures is depicted in Figures 1 and 2. The redefinition of the set of core measures occurred in 2020, using a pre-pandemic information set. Hence, it is valuable to assess how these measures have performed considering the recent economic environment. This section provides an evaluation of the current measures used by the BCB and proposes a unifying approach to facilitate the analysis and comparison of the core inflation measures' main features.

Figure 1 – IPCA and core average

YoY%

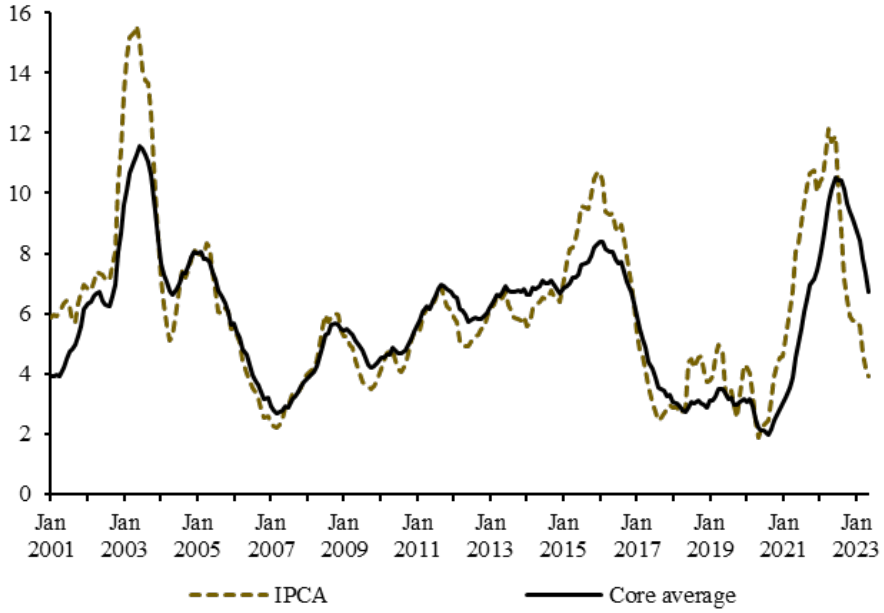
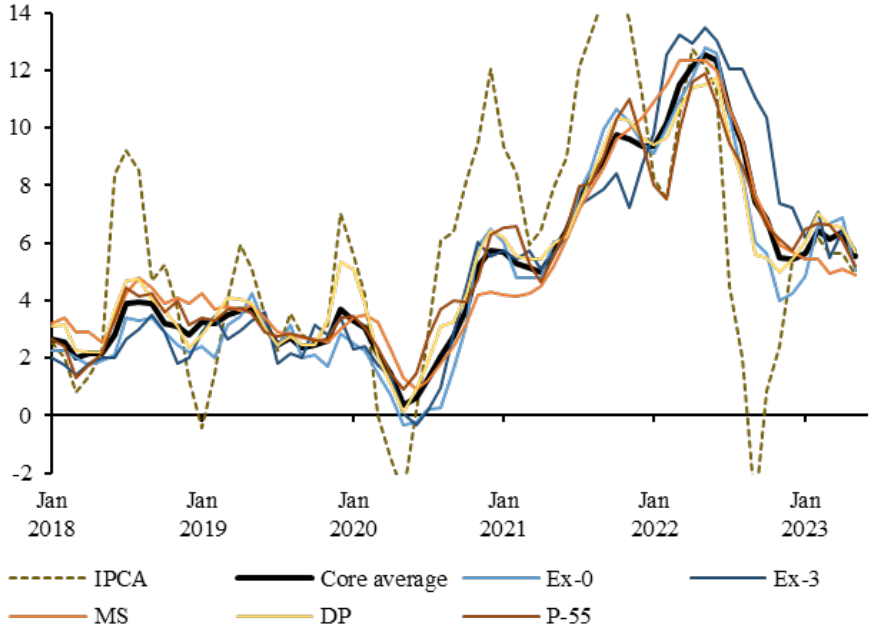


Figure 2 – IPCA, core measures and core average

QoQ% SAAR



SAAR: Seasonally adjusted annual rate

The dataset used in the subsequent analysis spans from January 2004 to May 2023 and comprises the following components:

- Seasonally adjusted annual rates (SAAR) of 3-month-moving averages for headline inflation (IPCA) and the five core measures (Ex-0, Ex-3, DP, MS, and P55), as well as the core average;[14]
- 12-month headline inflation;
- The latest vintage of the "Official" BCB output gap, last estimated in the June 2023 Inflation Report; and
- BCB's Commodities Index (IC-Br) expressed in R$, in quarterly frequency.

As noted earlier, there is no clear consensus in the literature regarding the criteria by which core measures should be evaluated and compared. Here, the set of criteria is the same as we used in BCB (2020). Besides being a comprehensive and yet parsimonious set, it allows for a more precise assessment of the evolution of the performance of core measures.

Table 3 presents descriptive statistics,[15] where the measures are compared based on two criteria. Firstly, the historical average of each measure should ideally be close to the average of headline inflation. Secondly, in terms of volatility, the table displays the standard deviation of the level and first difference of each series. As expected, all measures demonstrate lower variability compared to IPCA.

Table A3 in the Appendix further shows results from t- and Bartlett-tests, concluding, respectively, all core measures have a historical average similar to the IPCA and a lower variability.

[14] The core average is derived as an arithmetic average of the 5 selected measures on a monthly basis. Therefore, in seasonally adjusted terms, it may not precisely match the same average.

[15] In tables 3 to 7, a scale of colors is utilized for the sake of presentation. The red colors represent poorer performance, while the blue colors represent better performance in each criterion. The ranking is carried out independently in each column of the tables. The intensity of the red and blue colors thus determines, within each category, the performance of the core measures. There is no specific criterion for the transition from red to blue.

Table 3 - Descriptive statistics
3-month moving average, SAAR

	Average	Standard deviation	1st diff Standard
IPCA	5.66	3.11	1.51
Ex-0	5.27	2.48	0.83
Ex-3	5.85	2.53	0.69
MS	5.54	2.23	0.48
DP	5.62	2.24	0.68
P-55	5.51	2.10	0.68
Core average	5.56	2.22	0.55

Moving on to the next evaluation criteria, Table 4 presents a summary of the findings related to the core measures' ability to track trend inflation. As a proxy for this trend, two standard windows of headline inflation were considered: the 13-month and 25-month centered moving averages. All measures exhibit lower RMSE than the IPCA itself, which is a desirable characteristic for a core measure.

Table 4 - Ability to track trend inflation
RMSE

	13 months	25 months
IPCA	2.08	2.07
Ex-0	1.75	1.66
Ex-3	1.99	1.76
MS	1.52	1.37
DP	1.40	1.31
P-55	1.37	1.18
Core average	1.46	1.29

The sensitivity of the core measures to economic activity is also tested. From a theoretical standpoint, it is expected that a “cleaner” measure of inflation should be more responsive to economic activity in a Phillips Curve framework. The exercise involves running a Phillips Curve model with quarterly data for the IPCA and competing core measures π_t^c:

$$\pi_t^c = \alpha\pi_{t-1} + \beta\sum_{i=1}^{4} E(\pi_{t+i}) + \gamma\pi_{t-1}^* + \delta\frac{\sum_{j=1}^{2} h_{t-j}}{2} + \varepsilon_t \qquad (2)$$

where π_{t-1} represents the lagged headline IPCA; $E(\pi_{t+i})$ represents IPCA expectations from the Focus Survey; π_{t-1}^* denotes lagged foreign inflation measured by changes in the Commodities Index (IC-Br) expressed in R$; and ε_t is the error term at time *t*. The lagged output gap is denoted by h_{t-j}. The resulting coefficients are presented in Table 5. Some caution is desirable, when interpreting the results.[16]

Table 5 - Sensitivity to economic cycles

	Output gap coefficients	p-value
IPCA	0.06	0.67
Ex-0	0.27	0.00
Ex-3	0.44	0.00
MS	0.12	0.19
DP	0.14	0.06
P-55	0.20	0.03
Core average	0.24	0.00

Regarding forecasting performance, Table 6 displays the outcomes of seven alternative specifications, which are detailed in the Appendix. The numbers indicate the relative performance in terms of RMSE, with the results of IPCA normalized to 1. Table A5 in the Appendix shows Diebold and Mariano (1995) test statistics, comparing the predictive ability of each core measure to that of the IPCA.

[16] First, the magnitude of the coefficients is dependent on the specification of the output gap. Although I opted for the standard BCB methodology, there may be some differences. Second, the Covid-19 period may have altered the relationships more structurally. It is true the results did not differ much from the ones in BCB (2020) with data before the pandemic. However, looking ahead, it is unclear whether they will remain so.

Table 6 - Forecasting performance

	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII
IPCA	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EX-0	0.94	1.09	1.06	1.08	0.99	1.01	1.07
EX-3	0.93	1.11	1.25	1.27	1.02	1.03	1.18
MS	0.94	1.12	1.10	1.11	1.05	1.03	1.02
DP	0.88	1.06	0.99	1.03	1.01	1.03	1.02
P-55	0.82	1.03	0.92	0.99	0.97	0.99	1.01
Core average	0.88	1.07	1.05	1.09	0.99	1.02	1.06

Finally, I provide a classification of core measures based on an important - and often overlooked - feature, concerning how easily they can be communicated to economic agents. In this case, a subjective assessment was conducted, with exclusion-based measures generally considered easier to communicate than statistical-based ones.[17]

4.1. Summary of the results

In order to highlight the relative strengths and weaknesses of each measure, Table 7 provides a classification of the BCB official measures and the core average. Each measure is assigned a grade ranging from 1 to 6 based on its performance in various criteria[18]. The higher the value assigned, the higher the performance. A visual classification is provided in Figure 3.

[17] In this regard, Ex-0 appears simpler than Ex-3, as it involves the complete exclusion of two segments. In the case of statistical-based measures, P55 seems simpler, as it relates to percentiles, while MS and DP entail more complex calculations.

[18] The numbers are presented for qualitative purposes, and the numeric differences are not intended to objectively represent differences in performance.

Table 7 - Summary of overall performance

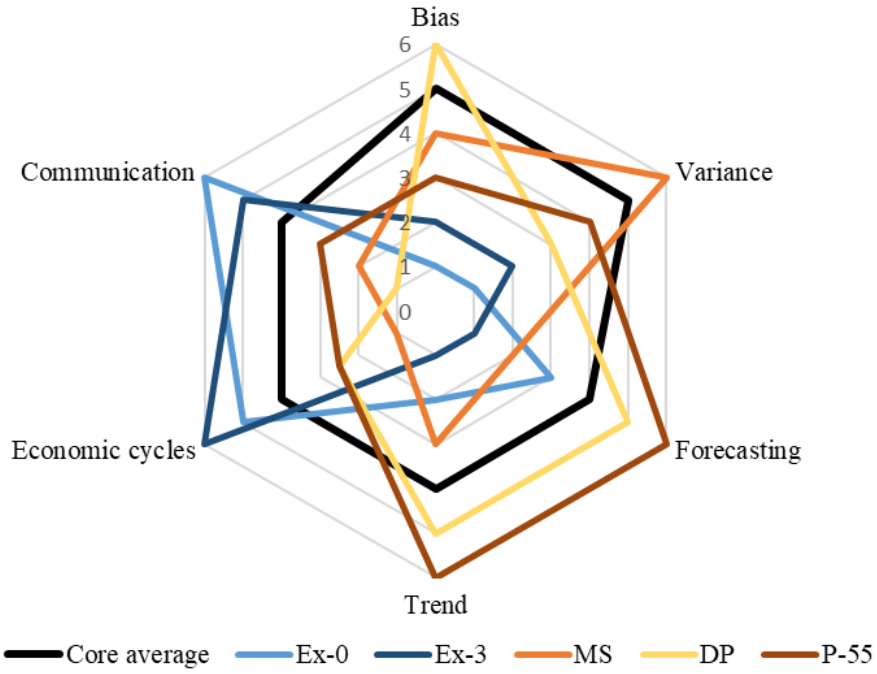
	Bias	Variance	Forecasting	Trend	Economic cycles	Communication	Average of criteria
Ex-0	1	1	3	2	5	6	3.0
Ex-3	2	2	1	1	6	5	2.8
MS	4	6	2	3	1	2	3.0
DP	6	3	5	5	3	1	3.8
P-55	3	4	6	6	3	3	4.1
Core average	5	5	4	4	4	4	4.3

Statistical-based measures demonstrate relatively better performance in terms of lower variability, reduced bias, tracking the inflation trend, and forecasting accuracy[19]. Conversely, exclusion-based measures are more easily understandable and exhibit greater sensitivity to the economic cycle. These findings underscore the complementary nature of the current core measures.

Furthermore, the core average shows an overall good performance. Considering, for the sake of simplicity, that all six criteria should carry equal weight in terms of relevance, the core average attains the highest average score across the criteria (Table 7).

[19] In the case of forecasting ability, a word of caution is needed, since as seen in Table A5, core measures performed poorly when compared to IPCA itself.

Figure 3 - Comparative performance of core measures



Consequently, focusing on the core average, as both the BCB and private agents have done in recent years, appears to be a reasonable strategy. In the same vein, over this period, two core measures stand out with the best average scores: P55 and DP.

When compared to the pre-pandemic results from BCB (2020), several noteworthy findings emerge:

Firstly, the significant spike in inflation, which was not proportionally followed by some of the core measures, caused shifts in their relative performance. Specifically, the MS measure showed increased bias and lower ability to track the inflation trend. On the other hand, the DP measure exhibited an improvement in relative forecasting performance and lower bias. This can be attributed to the fact that the DP measure does not completely filter out large movements in certain prices, particularly when they are substantial and originating from otherwise non-volatile items.

Secondly, recent movements in inflation featured quite unusual behavior in relative prices.[20] As a result, inflation started to peak before core measures (as illustrated in Figure

[20] Until mid-2021, inflation was primarily driven by food prices. Subsequently, from 2022 and partially in 2023, a surge in energy and goods prices, amplified by demand boosts from fiscal expansion, supply chain disruptions,

1). Consequently, the forecasting ability of core measures was relatively weaker when compared to IPCA, and it has worsened when considering the Covid-19 period. It appears this result is further exacerbated by the fact that the evaluation sample is not particularly large, and the "after-pandemic" shock is relatively strong. However, as shown, this subpar forecasting performance aligns with the findings of most papers in the literature.

and the war in Ukraine, was observed. Later, inflation in service prices was fueled by the reopening after the peak of the Covid crisis. This combination led to an uneven distribution of relative prices, amid high levels of inflation.

5. Conclusion

This paper provides the first comprehensive survey of the academic literature on core inflation in Brazil, covering both the official measures and alternatives presented by the academic literature.

The segmentation of the literature into main topics related to core inflation in Brazil makes this survey a valuable resource for academic researchers and the central bank community, especially considering the heightened interest in this subject.

The literature has explored various alternatives to the BCB's official measures, incorporating different specifications and methodologies. However, there is a consensus in the literature that no single preferred measure has been identified. Moreover, the evidence points to the core measures' limited forecasting ability.

A secondary contribution of this paper is the unifying approach used to evaluate core measures. This approach is applied to assess the current set of official measures used by the BCB. The findings reveal: i) the overall strong performance of the average of the five measures; ii) the complementary nature of the measures in various aspects, supporting the adoption of different measures by the BCB; iii) the better relative performance of the P55 and DP measures; and iv) the relatively weaker forecasting performance of core measures compared to the IPCA itself. Although this outcome is in line with results from earlier papers, it contrasts with the findings of BCB (2018c) and BCB (2020), which employed a similar methodology. This suggests the recent specificities of post-pandemic inflation behavior largely influenced the performance decline.

References

Alves, A. (2009). Núcleo da inflação como fator comum do IPCA: Uma abordagem do modelo de fator dinâmico generalizado. *Dissertação de mestrado*, USP/RP.

Araújo, E. & Fiorencio, A (2005). Frequency domain analysis of core inflation measures for Brazil. *Estudos Econômicos*, Vol. 35, No.1, pp 5-36.

Barros, R. & Schechtman, J. (2001). Medidas de núcleo da inflação para a economia brasileira: Utilização das médias aparadas no IPC-DI/FGV. *Proceedings of the 29th Brazilian Economics Meeting, ANPEC* (Brazilian Association of Graduate Programs in Economics).

BCB (2009). Banco Central do Brasil. *September Inflation Report*. Three new measures of core inflation.

BCB (2018a). Banco Central do Brasil. *June Inflation Report*. New core inflation measures.

BCB (2018b). Banco Central do Brasil. *September Inflation Report*. Food inflation pass-through: an international comparison.

BCB (2018c). Banco Central do Brasil. *December Inflation Report*. Predictive ability and bias of underlying inflation measures.

BCB (2020). Banco Central do Brasil. *June Inflation Report*. Update of the set of core inflation measures commonly considered by the BCB for economic outlook analysis.

Braz, A. (2011). Núcleos de Inflação: avaliação das atuais medidas e sugestão de novos indicadores para o Brasil. *Dissertação de mestrado*, FGV/RJ.

Brito, A. (2019). Núcleo da inflação, expectativas e dinâmica inflacionária no Brasil. *Dissertação de mestrado*, UFCE.

Bryan, M. & Cecchetti, S. (2001). A note on the efficient estimation of inflation in Brazil. *Working Papers Series* 11, Central Bank of Brazil.

Cogley, T. (2002). "A simple adaptive measure of core inflation". *Journal of Money, Credit and Banking*, Vol. 34, No. 1, pp. 94-113.

Da Silva Filho, T. & Figueiredo, F. (2011). Has core inflation been doing a good job in Brazil? *Revista Brasileira de Economia*, Vol. 65 No. 2, pp. 207-233.

Da Silva Filho, T. & Figueiredo, F. (2014a). Revisitando as medidas de núcleo de inflação do Banco Central do Brasil. *Working Papers Series* 356, Central Bank of Brazil.

Da Silva Filho, T. & Figueiredo, F. (2014b). A volatility and persistence-based core inflation. *Working Papers Series* 367, Central Bank of Brazil.

Denardin, A., Kozakevicius, A. & Schmidt, A. (2015). Avaliação da medida de núcleo de inflação baseada no método wavelet para o Brasil. *Proceedings of the 43rd Brazilian Economics Meeting, ANPEC* (Brazilian Association of Graduate Programs in Economics).

Diebold, F. & Mariano, S. (1995). Comparing predictive accuracy. *Journal of Business and Economic Statistics*, Vol. 13 No. 3, pp. 253-263.

Ferreira, P., Mattos, D. & Ardeo, V. (2017). Triple-filter core inflation: A measure of the inflation trajectory. *Revista Brasileira de Economia*, Vol. 71, pp. 397-411.

Figueiredo, F. (2001). Evaluating core inflation measures for Brazil. *Working Papers Series* 14, Central Bank of Brazil.

Figueiredo, F. & Staub, R. (2002). Evaluation and combination of core inflation measures for Brazil. *Mimeo*.

Filomena, E. (2018). Wavelets: Uma aplicação à estimação do núcleo de inflação brasileiro. *Dissertação de mestrado*, UFRGS.

Fiorencio, A. & Moreira, A. (2002). O núcleo da inflação como a tendência comum dos preços. *Revista Brasileira de Economia*, Vol. 56, pp.175-198.

Korek, K. (2016). Medidas de núcleo de inflação no Brasil e a tendência de longo prazo nos preços: Uma abordagem sobre decomposição de séries de tempo. *Dissertação de mestrado*, FGV-EESP.

Litvac, B. (2013). Núcleos de inflação no Brasil e poder preditivo da inflação total. *Dissertação de mestrado*, FGV-EESP.

Machado, V. & Figueiredo, F. (2017). Assessing inflation persistence in Brazil using disaggregate data. *Proceedings of the XXXII JAE* – Central Bank of Uruguay.

Machado, V., Nadal, R. & Kawaoka, F. (2020). A data-rich measure of underlying inflation for Brazil. *Working Papers Series* 516, Central Bank of Brazil.

Mattos, D. (2018). Estimação do núcleo da inflação via score driven models. *Dissertação de mestrado*, PUC/RJ.

Picchetti, P. & Kanczuk, F. (2001). An application of Quah and Vaheys SVAR methodology for estimating core inflation in Brazil. *Proceedings of the 29th Brazilian Economics Meeting, ANPEC* (Brazilian Association of Graduate Programs in Economics).

Picchetti, P. & Toledo, C. (2000). How much to trim? A methodology for calculating Core Inflation, with an application for Brazil. *Mimeo*.

Quah, D. & Vahey, S. (1995). Measuring core inflation. *Economic Journal*, Vol. 105, pp. 1130-1144.

Rich, R. & Steindel, C. (2007). A comparison of measures of core inflation. *FRBSF Economic Policy Review*, Vol. 13, No.3, pp. 19-38.

Santos, C. (2012). Núcleo da inflação no Brasil: Uma abordagem empírica no domínio da frequência. *Dissertação de mestrado*, UFCE.

Santos, C.; Castelar, I. (2016). Avaliando as medidas de núcleo da inflação no Brasil. *Economia Aplicada*, Vol. 20, No.1, pp.35-56.

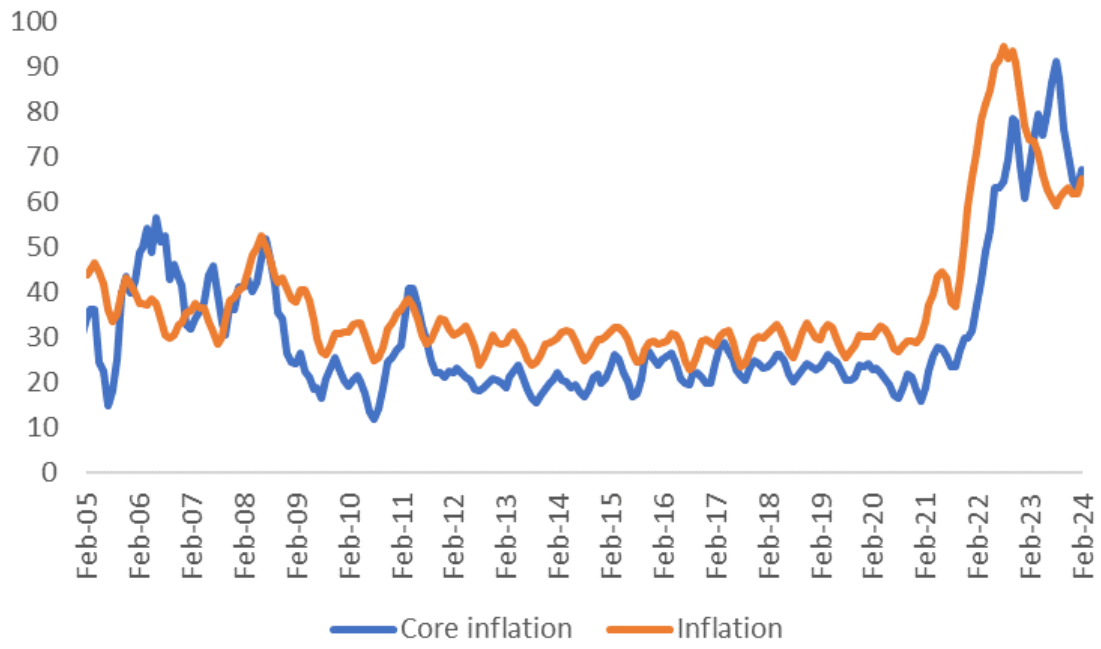
Santos, C. (2017). Ensaios em econometria de series temporais: Núcleo e previsão da inflação no Brasil. *Tese de doutorado*, UFCE.

Silva, C. (2015). Relative price variability in Brazil: an analysis of headline and core inflation rates. *Nova Economia*, Vol. 25, No.1, pp.83-100.

Zaniol, C. & Moraes, J. (2020). Previsão e núcleo de Inflação: uma abordagem baseada em Wavelets e Redes Neurais. *Proceeding Series of the Brazilian Society of Computational and Applied Mathematics*, v. 7, n. 1.

Appendix

Figure A1 - Search results* in Google Trends (3-month moving average)



*The values on the graph represent normalized search volumes, indexed on a scale from 1-100, and then averaged to 3 months. Each monthly point is divided by the highest point, 100. In the case of inflation, it reached 100 in June/2022. Core inflation reached 100 in July/2023. This vintage was extracted on February 19, 2024.

Table 3: Methodologies and main findings

List of papers (in chronological order)	Methodologies and main findings
Picchetti and Toledo (2000)	The paper investigates optimal trimming by using a dynamic factor (DF) technique. It applies the model for the IPC-FIPE and the IPCA. The authors find an optimal combination of 30% for the inferior trim and 40% for the superior trim with respect to the respective calculated DF core.
Barros and Schechtman (2001)	The paper assesses several trimming specifications for the IPC-DI (FGV). The authors find an optimal symmetrical trim of 20%, with an adjustment for items with infrequent variations (similar to the MS core measure).
Picchetti and Kanczuk (2001)	The authors apply Quah and Vahey's (1995) SVAR model to estimate core inflation for Brazil. The model extracts the underlying movement in inflation associated with disturbances representing demand shocks.
Figueiredo and Staub (2002)	The paper focuses on solutions to improve the trimmed mean core measure. These involve, for example, smoothing some items (as in MS), finding optimal trim (20% is found as a good number) and applying Bryan and Cecchetti's (2001) asymmetric trimmed mean method.
Fiorencio and Moreira (2002)	The authors propose a core measure that combines common factor analysis with trimmed mean. They find good results in terms of forecasting, but on the other hand a loss in economic sensitivity.
Araujo and Fiorencio (2005)	The paper compares two versions of core measures: trimmed-mean and an SVAR-based measure. The authors argue that, although trimmed-mean captures well trend inflation, the SVAR-based measure is best prepared to capture cyclical movements associated with excess demand pressures.
Alves (2009)	This dissertation proposes a core measure based on a dynamic factor model. The resulting measure is compared to an exclusion-based core and is shown to have a better long-run relationship with the IPCA.
Da Silva Filho and Figueiredo (2011)	The paper presents 3 new core measures for Brazil (2 exclusion-based measures and DP). The authors argue that, although their behavior is more in accordance to what theory claims, they still lack the ability to forecast inflation, a difficulty that other BCB measures also share.
Braz (2011)	This thesis compares some BCB core measures under several criteria. It also proposes 2 measures, based on persistence and the frequency of price changes. The thesis argues for the importance of understanding each core specificities, instead of using a combination of them.
Litvac (2013)	This thesis compares some BCB core measures (Ex-0, Ex-1, MS, MA and DP) and combinations under several criteria, with an emphasis on forecasting. The author finds poor forecasting performance.
Silva (2015)	The focus is on the relationship between inflation and relative price variability (RPV). The author finds core inflation tends to have a relatively lower relationship with RPV.
Denardin, Kozakevicius and Schmidt (2015)	The paper presents core measures based on several specifications of wavelets. The measures show overall good performance when compared to Ex-1, MS and DP measures.
Santos and Castelar (2016)	This paper compares some BCB core measures (Ex-0, Ex-1, MS and DP) and proposes a statistical core measure based on empirical mode decomposition.
Korek (2016)	This thesis compares some BCB core measures (Ex-1, MS, MA and DP) and proposes a statistical core measure based on unobserved components model. The author finds the measures succeed in capturing the long run component of inflation.
Santos (2017)	This thesis proposes 2 measures based on unobserved components and one based on empirical mode decomposition. The measures show good performance in terms of absence of bias and forecasting, when compared with BCB measures.
Ferreira, Mattos and Ardeo (2017)	This paper presents a new measure of core inflation, which filters inflation in 3 ways: trimmed mean with smoothed items, seasonal adjustment and moving averages. The authors conclude the measure presents good performance in various criteria.
Machado and Figueiredo (2017)	The paper proposes a core measure, based on a triple-weighting scheme. The model takes into account persistence and volatility, besides the expenditure weights of inflation at disaggregate levels.
Mattos (2018)	This thesis discusses two core measures, one based on a triple-filter model and the other based on dynamic conditional score. The author concludes the measure presents good performance in various criteria, when compared with BCB measures.
Filomena (2018)	This thesis presents a measure of core inflation based on wavelets. It is shown this measure performs well compared with BCB measures in several criteria.
Brito (2019)	In a slightly different approach, the author argues core inflation measures can be good proxies for the forward-looking term in a NK Phillips curve. Besides the BCB core measures, the author analyze 2 additional measures, similar to the ones used by Santos (2017).
Zaniol and Moraes (2020)	The paper presents measures of core inflation based on wavelets and uses neural networks for forecasting comparisons. The findings show good forecasting performance when compared with BCB measures.

Table 3: Methodologies and main findings (continued)

List of BCB Working papers	Methodologies and main findings
WP 11 (Bryan and Cecchetti, 2001)	The paper argues assymetrical trimmed-mean reduces the RMSE of inflation as a measure of the inflation trend.
WP 14 (Figueiredo, 2001)	This paper brings first results for Brazil, by comparing the measures "MS", "DP" and weighted median. It also calculates optimal trimming over different time windows.
WP 266 (Da Silva Filho, 2012)	The paper compares core measures in the US, Canada and Brazil, and find they perform badly in forecasting headline inflation, both quantitatively and qualitatively (i.e. directionally).
WP 356 (Da Silva Filho and Figueiredo, 2014a)	It provides a survey of measures used by the BCB up to that point. The paper also tests alternative strategies regarding trimming and the choice of items to be smoothed. A new exclusion-based core is also presented (Ex-2).
WP 367 (Da Silva Filho and Figueiredo, 2014b)	A novel measure is proposed, taking into account both volatility and persistence in the weighting scheme. The measure is relatively succesful compared to other BCB measures in representing the trend, although all of them have poor forecasting performance.
WP 516 (Machado, Nadal and Kawaoka, 2020)	This paper introduces a novel measure for Brazil, using a dynamic factor model. The resulting measure shows good performance in several metrics compared to BCB measures.
WP 528 (Silva, 2020)	The author proposes a core inflation measure using wavelet techniques. The findings point to good performance of both a pure wavelet measure and a hybrid one, when compared to BCB measures.
WP 562 (Caetano, Silva and Moura, 2022)	The paper provides estimates of a trend inflation measure that is argued to be a good complement to traditional core inflation measures at the BCB. The authors follow an unobserved components model.

Table A2 - Evaluation criteria

List of papers (in chronological order)	Variance	Bias	Ability to track trend inflation	Ability to attract inflation	Forecasting performance	Other
Picchetti and Toledo (2000)				$x_{(2)}$		
Barros and Schechtman (2001)			x	x		Correlation with M2, Stationarity
Picchetti and Kanczuk (2001)						
Figueiredo and Staub (2002)	x		x	$x_{(2)}$		Stationarity
Fiorencio and Moreira (2002)				$x_{(1)}$	x	
Araujo and Fiorencio (2005)	x					
Alves (2009)						Cointegration tests
Da Silva Filho and Figueiredo (2011)	x	x	x		x	
Braz (2011)	x	x	x	$x_{(1)}$	x	Correlation with M2
Litvac (2013)	x	x	x		x	
Silva (2015)				$x_{(2)}$		
Denardin, Kozakevicius and Schmidt (2015)		x		x	x	
Santos and Castelar (2016)		x		x	x	
Korek (2016)	x	x				Analysis of the permanent component
Santos (2017)		x		x	x	
Ferreira, Mattos and Ardeo (2017)	x	x	x	x	x	
Machado and Figueiredo (2017)	x	x	x			
Mattos (2018)	x	x			x	
Filomena (2018)	x	x	x		x	
Brito (2019)						Core inflation in a Phillips curve
Zaniol and Moraes (2020)					x	
List of BCB Working papers						
WP 11 (Bryan and Cecchetti, 2001)		x	x			
WP 14 (Figueiredo, 2001)	x		x	$x_{(1)}$		Correlation with M2
WP 266 (Da Silva Filho, 2012)					x	"Qualitative" forecasting
WP 356 (Da Silva Filho and Figueiredo, 2014a)	x	x	x			
WP 367 (Da Silva Filho and Figueiredo, 2014b)	x	x	x		x	
WP 516 (Machado, Nadal and Kawaoka, 2020)	x	x	x	$x_{(1)}$	x	Sensitivity to cycles, communication
WP 528 (Silva, 2020)	x	x	x	$x_{(1)}$	x	
WP 562 (Caetano, Silva and Moura, 2022)					x	

Note: Since the literature varies on the methodology used for the "ability to attract inflation", I used two different subscripts - $x_{(1)}$ denotes the use of Cogley's equation, and $x_{(2)}$ stands for the use of Granger-causality tests. Other methodologies are simply represented by the x.

Table A3 - Descriptive statistics

p-values:

	t-test	Bartlett test
IPCA	-	-
Ex-0	0.13	0.00
Ex-3	0.47	0.00
MS	0.63	0.00
DP	0.86	0.00
P-55	0.55	0.00
Core average	0.68	0.00

Table A4 - Sensitivity to economic cycles

(sample restricted to "non-Covid")

	Output gap coefficients	p-value
IPCA	0.07	0.65
Ex-0	0.35	0.00
Ex-3	0.44	0.00
MS	0.10	0.18
DP	0.16	0.05
P-55	0.16	0.03
Core average	0.24	0.00

Forecasting strategy:

All the models tested use the 3-month moving average, SAAR of the core measures and the IPCA as predictors of the 12-month-ahead IPCA inflation. The specifications are the same we employed in BCB (2020). The estimation sample goes from January 2004 to May 2023. The evaluation sample starts from January 2010. Except from Model I, which follows a direct comparison, in all regression models, the model is continuously estimated after each incremental observation. RMSE results from out-of-sample forecasts are then normalized such that the results for the IPCA are equal to 1.

Model I: Naïve approach, consisting of a direct comparison of 12-month forward IPCA inflation with the core measure (and IPCA itself).

Model II is a simple OLS regression of the core measure (and IPCA) on 12-month forward IPCA inflation, such as:

$$\pi_t^{(12)} = \alpha + \beta\pi_{t-12}^{c} + \varepsilon_{t+h} \quad (3)$$

Model III: Consists of running equation (1), also sometimes called Cogley's equation:

$$\pi_{t+12} - \pi_t = \alpha + \beta(\pi_t^{c} - \pi_t) + \varepsilon_{t+h}$$

Model IV is a more general form of equation (1), allowing a coefficient for $\pi_t^{(12)}$, turning it into:

$$\pi_t^{(12)} = \alpha + \beta\pi_{t-12}^{c} + \gamma\pi_{t-12}^{(12)} + \varepsilon_{t+h} \quad (4)$$

Note that in the special case where $\gamma = 1 - \beta$, equation (4) returns to (1).

Model V is similar to (4), but instead of IPCA, I use the so called x0, which is defined as the complementary of Ex-0, and can be considered a measure of price shock:

$$\pi_t^{(12)} = \alpha + \beta\pi_{t-12}^{c} + \gamma x0_{t-12}^{(12)} + \varepsilon_{t+h} \quad (5)$$

Model VI is similar to (5), but instead of x0, I use the output gap:

$$\pi_t^{(12)} = \alpha + \beta\pi_{t-12}^{c} + \gamma h_{t-12}^{(12)} + \varepsilon_{t+h} \quad (6)$$

Model VII is similar to (6), but adding 12-month IPCA inflation:

$$\pi_t^{(12)} = \alpha + \beta\pi_{t-12}^{c} + \gamma h_{t-12}^{(12)} + \delta\pi_{t-12}^{(12)} + \varepsilon_{t+h} \quad (7)$$

Table A5 - Diebold-Mariano statistics

p-values

	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII
EX-0	0.17	0.98	0.98	0.99	0.35	0.64	1.00
EX-3	0.14	0.99	1.00	1.00	0.63	0.85	1.00
MS	0.18	1.00	0.98	1.00	0.89	0.86	0.63
DP	**0.01***	0.99	0.36	0.84	0.43	0.86	0.64
P-55	**0.00***	0.83	**0.00***	0.34	0.25	0.33	0.42
Core average	**0.02***	0.96	0.95	0.99	0.35	0.64	0.98

Notes: This table presents p-values from Diebold-Mariano tests, where the null hypothesis is that the specific core measure does not predict 12-month-ahead IPCA better than IPCA itself.

* denotes better predictive ability than IPCA at less than 5% level.