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Measuring Core Inflation in India: An Empirical Evaluation of Alternative Methods

Madhu Sehrawat and A K Giri

Department of Economics and Finance, Birla Institute of Technology and Science (BITS), Pilani (Rajasthan), India.
Corresponding author: madhu.sehrawat@gmail.com

ABSTRACT

In view of formulating credible monetary policy to attain the price stability objective, the difficult part for the central banks is to distinguish, within ongoing inflation evolutions, between short term volatility and the underlying pressure of inflation. While it has now become a standard practice for most central banks around the world to monitor core inflation, little progress has so far been made in the Indian context. This paper takes a pioneering look in measuring core inflation in India focusing on the popular exclusion and trimmed mean approaches. The performance criteria adopted in this analysis show that the measure of core inflation developed in the paper has strong money-induced characteristics and therefore, can credibly be used as a short or medium term guide of monetary policy in India. This paper aims to introduce the concept of core inflation and to calculate alternative measures of core inflation for India. We have used two approaches: (1) Exclusion based approach (2) Trimmed mean method, to identify the measures of core inflation. We have obtained five alternative measures of core inflation using exclusion approach these are: WPI excluding food articles, WPI excluding food articles and non food articles, WPI excluding food articles and fuel (minerals oils), WPI excluding fuel (minerals oils) and manufactured products (Beverages, Tobacco and Tobacco Products, Non-Metallic Mineral Products, Basic Metals Alloys and Metals Products), WPI excluding Minerals, Basic Metals Alloys and Metals Products, Minerals Oils, Non-Metallic Mineral Products, Beverages, Tobacco and Tobacco Products., two measures TRIM15_15 and TRIM20_20 using trimmed mean For this we have evaluated these measures of core inflation in India based on new series of WPI (1993-94 =100). These measures were tested for volatility and unbiasedness and co- integration with headline inflation. The co-integration test statistics confirm long run relationship between the core inflation measures and headline inflation. The study found that the exclusion based measures are more appropriate for inflation targeting purposes and the measures based on the trimming may be better for identifying the underlying trends and also in providing a robust forecast of future inflation rates in India.

Keywords: Core inflation Co-Intenation, Casuality, WPL, Inhation, India.
Jel Classification: C43, E31, E52.

Central banks differ in their inflation objectives and conduct of monetary policy. Some of them target inflation mainly and others are charged with some other objectives also e.g. stable exchange rate, ensuring fast economic growth. However, price stability is one of the most important objectives. It means stable and low level of inflation, which is considered to be conducive to economic growth and lies in the comfort zone of the central bank. They confront the problem of identifying the transitory and permanent component of the changes in price level, because monetary policy operates with a lag. Failure in detecting the correct trend of inflation can be extremely costly. If inflation increases due to transitory factors then monetary policy not needed it will reverse itself, otherwise intervention of monetary policy is required to tackle the inflation rate. All sources of inflation cannot be controlled by the monetary authorities; they may generate short run or transitory changes in the inflation rate such as seasonal pattern, broad based resource shocks and exchange rate shocks. This means they need to track the price development and distinguish the inflation trend and noisy shocks. To deal with such situations the concept of core inflation arises, it eliminates the volatile components from the headline inflation and helps in determining the underlying trend in the headline inflation. In this scenario there is need to identify the core measures of core inflation for the decision making purpose of the monetary authorities. Core inflation shows the component of inflation, which is controllable.

Most often, Indian economy experience the supply side shocks and other transitory shocks. Though monetary policy in India is not explicitly defined as inflation targeting policy but it needs to choose a measurement technique to track the price level. Price stability as defined by 'low and stable inflation' being one of the key objectives, the Reserve Bank monitors a range of price indices both at aggregate and disaggregated levels (RBI, 2006). Therefore an attempt has been made in this paper to identify the extent to which transitory factors are related to this WPI inflation.

A representative measure has great significance in the design and conduct of monetary policies. So here comes the importance of the measurement techniques of the inflation. In literature many measurement techniques have been suggested, they differ in the information set which is relevant for the estimation of the underlying trend of the inflation, while each of them have their own advantages and limitations. But an acceptable measurement technique necessarily meets certain criteria of the economic conditions in a particular country. In the present study we compare the measures of core inflation using exclusion and trimmed means in Indian economy and our goal is to use the existing data on prices and extract the persistent trend of the inflation. For this purpose we are using WPI data from January 2000 to July 2010 (with base year 1993-94=100). The rest of the paper is organized as follows: the section II discuses the concept of core inflation and reviews some of the existing approaches to measure core inflation. Section III reviews the literature on core inflation, both in the international and

domestic context. Section IV provides dataset and methodology for computation of measures of core inflation. Section V section evaluates the relative performance of these measures. Section VI provides a summary of findings and the conclusion.

CORE INFLATION: CONCEPTS AND MEASURES

The concept of core inflation has developed in 1970s during the period of high inflation. An early construction, associated with the late Otto Eckstein, was a weighted growth of unit labor and capital costs for the economy as a whole (Eckstein, 1981). Most of the inflation measures can be divided into two parts, one focuses on the core or permanent part which gives the underlying trend of the inflation, second is the non-core part which represents the temporary causes of price movements (Lafleche, 2006).The concept of core inflation refers to the part one and exclude the components of high volatility. Therefore temporary part should be taken out for effective monetary policy decision making because monetary policies are concerned with the underlying trend of the inflation. Thus the core inflation behaves as a proxy measure and a helpful guide for capturing the underlying inflation.

The persistent term has been referred as the core inflation but there is not a unique definition of core inflation in the economic literature. In the economic literature, there are many suggestions are provided regarding the definition of the core inflation. Some of them are as follows: Bryan and Cecchetti (1993) identifies the correlation of core inflation with the growth in money supply, Bryan *et. al.,* (1997) has suggested it as the measure, which has the correlation with the headline inflation, Blinder (1997) has defined it as the durable part of the inflation, Roger (1998) has explained two broad views of core inflation: one, persistent components and two, core inflation as the generalized component of measured inflation, Smith (2004) define core inflation as the best forecaster of inflation.

So for computing core inflation, there have been various methods suggested by researchers to capture underlying or core component of measured inflation. Broadly we can categories them in two approaches. They are "statistical approach" and the "model-based approach." The statistical approach is relatively easy to understand and communicate to the public, because it involves some predefined statistical operation on an aggregate price index. The model based approach involves economic theory within the context of econometric analysis. Here is the brief review of various methods suggested in the literature.

Exclusion based Measures

This methodology involves the exclusion of the commodities which shows high volatility due to temporary causes such as seasonal factors and supply shocks. Selected commodities are excluded from the price index and remaining form

the "core inflation". Generally, exclusions seem to depend on country specific circumstances or are data driven. Exclusion-based core measures have been the preferred choice of policymakers essentially because of their simplicity, easy to compute and less demanding in terms of data requirements. Most of the countries follow this approach but the main criticism is exclusion of fixed set of items may lose some information that could be useful for predicting the trend inflation. Another limitation is that noise is not limited to only some specific commodities, so the exclusion of these won't give the noise free component of inflation.

Measures based on Trimming

These are statistical measures in which the influence of the values located in the tails of the cross-sectional distribution of price changes is reduced. In particular, the trimmed mean excludes the percent changes in price that rank among the smallest or largest (in numerical terms) changes. For a trimmed mean judgment for the selection of commodity avoided but a decision is to be made about the level of trim. Although this method is more justifiable statistically, it still poses the risk of information loss, but to a lesser extent than the exclusion approach because it cuts only the tail of a commodity and avoids the total exclusion of the commodity.

Model based Measures

These measures are based on the economic theory and involves estimates of core inflation that are associated with econometric model. These models are sensitive to the assumptions, therefore much more controversial. However, the methodology is not transparent to the public, because it requires familiarity with econometric techniques. Core inflation figures may also change when econometric models are re-estimated to take account of new time series data. The main advantage of this approach is that it has a clear economic interpretation and gives a direct link between policy and controllable inflation. The restrictions imposed on these models are also uncontroversial and not easy to understand. Model-based core inflation measures could remain problematic to policymakers and the public because the concepts underlying their design can be abstract and their construction can be computationally demanding. So they are not widely used in the estimation of core inflation measures.

Measures based on Smoothing

In the development of core inflation measures, we extract the movement of commodities due to permanent factors and remove the noise. This can be done using Hodrick-Prescott (HP) filter. It is expected to filter out the seasonal, cyclical components from the time series data. The main limitation of this measure is core inflation measures get affected by the new data and it's not suitable for its predictive power.

REVIEW OF LITERATURE

This section provides a brief background for the studies of core inflation measure both in national and international context. The concept of core inflation has been studied extensively with different approaches to calculate its measures, both internationally and domestically. First we look at the international context of core inflation and its measures. Michel F Bryan, S G Ceccehetti (March 1993) used trimmed mean-15 and weighted-median core inflation and also conventional ex-food-energy strategy to develop the core inflation measures for US during the period 1962-1992. The result suggested that median has greatest ability to predict the future trend and high correlation with the previous money and the disproportionate noise comes from the extreme tails so by removing them systematically gives a more persistent component of the inflation. Quah and Vahey (1995) tried to measure the component of inflation that "has no medium- to long-run impact on real output" (Quah and Vahey (1995), p1130). They used model based approach (Vector Auto regression (VAR) system).

Clarke (2001) has evaluated five core measures in the context of New Zealand for the time period from 1967 to 2000, using trimmed mean and exclusion approach. These are the CPI excluding food and energy, the trimmed mean, and the median CPI, the CPI excluding energy, and the CPI excluding the eight most volatile components of the overall index. The results suggested that the trimmed mean and the CPI excluding energy performed well in the prediction of underlying trend of the inflation.

Berkmen (2002) developed three different core inflation measures, namely, trimmed means, price index excluding food and energy prices, and median inflation for Turkey from January 1988 to December 2000. While the comparison between these three measures revealed that the trimmed means provide statistically better estimate in terms of co-integration and sample median provides efficient results.

Marques, Neves and Sarmento (2003) developed three measures for the United States namely, the "excluding food and energy, " the trimmed mean and the weighted median and find that both the trimmed mean and the weighted median are useful indicators of core inflation. Fabio C. Bagliano, Claudio Morana (2003) used the common trend model based (VAR) approach to calculate the CPI core inflation for the US, during the period from 1960– 2000. The conclusion revealed that the measures of core inflation derived from the common trend model provided useful information to track the underlying trend of the inflation. It also suggested that the measures will depend on the specification of the system in terms of variables included, sample period, dynamic specification, and other modeling choices.

Rich and Steindel (2005) made an attempt has made to develop different core measures of consumer price index (CPI) inflation and personal consumption expenditure (PCE) inflation for the United States during the period from 1959-

2004(for PCE) and 1978-2004 (for CPI). These measures are defined as inflation excluding food and energy, inflation excluding energy, and median inflation. The median measure and its exponentially smoothed transformation, performed well in tracking the underlying trend of inflation. Since 1990 or 1995 when the regression models used data starting in 1978, two median measures performed well in predicting future PCE inflation; but the performance status decreases when the estimation period increases. No core measure performed well in case of CPI inflation. The main conclusion is that the criterion defined in the paper doesn't give a clear idea of choosing "best" or "worst" measure of either core PCE or core CPI inflation. Pedersen Michael (2006) has used the trimmed mean and the Edge worth index to construct an alternative measure of core inflation named "Trim of most volatile components (TMVC)". TMVC is based on two existing measures of core inflation: Trimmed mean and the Edge worth index. The data from the euro zone and USA are considered the period from January 1995 to June 2005. In euro zone TMVC performed better but in case of US edge worth based approach performed relatively better than TMVC.

Sadia Tahir (2006) used the disaggregated data of CPI from July 1991 to June 2000, the base of 1990-91 to develop the measures of core inflation in Pakistan. He used exclusion and Limited Influence Method (LIE) for the construction of these measures. Exclusion indicator is based on the exclusion of Food and Energy from the CPI basket and identified two different measures based on LIE method (CPI15 and CPI20). The conclusion suggested that LIE-based measure performed well with those based on methods. Shahiduzzaman Md (2009) has derived measures of core inflation for the Bangladesh for a period of January 2004 to May 2008 using exclusion and trimmed mean approaches over CPI basket. The performance criteria of the measure of core inflation is strong money-induced so that they can be used as a short or medium term guide of monetary policy in Bangladesh. According to the performance criteria, the exclusion based approach can better track the trend inflation and easy to communicate to the people.

In Indian context Samanta (1999) developed four measures of core inflation based on the exclusion method. These measures were identified by excluding different combinations of Primary food articles, Primary non food articles, Food Products under Manufactured Products and commodities with administrative price control. The conclusion suggested that measures by excluding Primary food articles, Primary non food articles, commodities with administrative price control performed well among these four identified measures.

Bicchal, Naresh Kumar Sharma and Bandi Kamaiah (2012) used persistence weighted, variations of 'Neo-Edgeworthian Index', asymmetric trimmed mean, and month by- month exclusion (dynamic trimmed mean) core measures. The study covers the period April 1994–April 2009, with 1993–1994 as the base

year and uses both aggregate WPI and a detailed breakdown of the WPI. In the comparison procedure of these variables, usefulness to the monetary policy has been used as a basic criterion. They find out that that the asymmetric trimmed mean, WPIEX25%, WPIMBM10, double weighted standard deviation based core measures, and median core measure are useful to track and tracking underlying trend inflation. Their study also concluded that trend based HP filter and exponential core measures, in combination with asymmetric trimmed mean and median core measures can be useful to get the overall outlook on dynamics of inflation, which can be helpful for the effective conduct of monetary policy in India. Mohanty, Rath, Ramaiah (Jan. 29 -Feb. 4, 2000) used the method of exclusion and limited influence estimators of trimmed mean along with weighted median to identify the core measures of inflation for the period from April 1983 to March 1999. The monthly estimates of WPI for the 16-year period have been used in this study. The results revealed that 20 per - cent trimmed mean WPI performed well among all the defined indicators.

Durai and Ramachandran (2007) used the multivariate common trend model, exclusion approach and trimmed mean method to identify the measures of core inflation during April 1994 - March 2005. The results suggested that the measures based on exclusion based approach are simple but misleading in nature and among all the identified measures the measures based on trend model performed well and can be used to predict the future inflationary trend. Hence it is observed that model based approach is difficult to communicate with people but the monetary authorities can use these estimates to make internal decisions.

In recent studies, Kar Sujata (2009), adopted statistical and exponential smoothing method to evaluate measures of core inflation and used WPI inflation for the period Feb 1989 – Dec 2005. The study find out that exponential smoothing and weighted percentile performed well to evaluate inflation. Abhiman Das, Joice John and Sanjay Singh (2009) identified 12 different measures of core inflation making use of 8 different methodologies viz. Exclusion basis, Mean-SD, Median, Trimmed Mean, Historical Standard Deviation, Hodrick-Prescott Filter, Wavelet Filter and Structural Vector Auto Regression (SVAR).

Dr. Janak Raj and Misra Sangita (RBI working paper series, 2011), this study has identified six exclusion-based measures of core inflation in India based on new series of WPI (2004-05=100) from April 2005 to July 2011. These are: WPI excluding food; WPI excluding fuel; WPI excluding food and fuel; non-food manufacturing; WPI excluding fuel and basic metals and metal products; and WPI excluding fuel, metal group and nonfood primary articles. These measures have been tested for volatility, unbiasedness and tracking the trend and forecasting of inflation for Indian economy. The study find out that 'Fuel and power' group of WPI was the most volatile subgroup. WPI excluding fuel; non-food manufacturing

inflation; WPI excluding fuel and basic metals and metal products; and WPI excluding fuel, metal and non-food primary articles were the measures, which satisfied the conditions relating to volatility, unbiasedness and tracking the trend, and predictability.

DATA AND METHODOLOGY

We construct measures of core inflation using monthly data for the period from January 2000 to July 2010 (with base year 1993-94=100). The choice of the sample period is done by the availability of consistent time series on price index with the latest base period 1993–1994. For computation of various measures of core inflation, the WPI basket is considered at 81 subgroups under three main categories (1) Primary Articles with weight 22.02525 (2) Fuel, power, light and lubricants with weight 14.2262 (3) Manufactured Products with weight 63.7485. The details of all groups and subgroups with their weights in the WPI basket are given in the appendix. The data on disaggregated price indices are collected from the database on Indian Economy, RBI and various issues of RBI Bulletin. Core constructed and used in the paper are given below. We have used two approaches: (1) Exclusion based approach (2) Trimmed mean method, to identify the measures of core inflation. We have obtained five alternative measures of core inflation using exclusion, three measures using trimmed mean.

EXCLUSION BASED CORE INFLATION MEASURES

Under this approach certain commodities are excluded based on their volatility. The exclusion of these commodities makes the index data noise free. Volatility of various groups/sub groups in WPI was tested using standard deviation that represents the dispersion around the mean and coefficient of variation which represents the relative measure of the dispersion. The final decision on the exclusion of the particular commodity is based on its value of coefficient of variation (CV), because it is considered better than standard deviation when commodities have different measurement units. At the main group level primary articles turned out to be the most volatile group with coefficient of variation (CV) 19.1798, followed by 'fuel power light and lubricants' with coefficient of variation (CV) 18.8505. The 'manufactured products' group was least volatile with coefficient of variation (CV) 14.3106. Within 'primary articles' minerals and non-food articles are highly volatile**.** Within fuel power light and lubricants, mineral oil is the most volatile subgroup followed by coal mining. However being the least volatile group some subgroup shows high volatility, basic metals alloys and metal products exhibited high volatility. It can be seen by the Table 1 below.

Based on the volatility of different groups we have identified five measures of core inflation, all the commodities to be excluded are chosen on the basis of their high value of coefficient of variation. All the measures are having weight age more than 15% in the WPI basket, they are given below in Table 2.

Table 1: Statistics Summary

Commodity Group/Sub-Group	**Coefficient of Variation**
All Commodities	16.1114
I **Primary Article**	19.1798
(A) Food Articles	17.4822
(B) Non-Food Articles	18.9239
(C) Minerals	64.9347
II **Fuel Power Light and Lubricant**	18.8505
(A). Coal Mining	16.7100
(B). Minerals Oils	24.4689
(C). Electricity	11.0559
III **Manufactured Products**	14.3106
(A) Food Products	17.3423
(B) Beverages, Tobacco and Tobacco Products	18.9485
(C) Textiles	8.1822
(D) Wood and Wood Products	13.3356
(E) Paper and Paper Products	7.9840
(F) Leather and Leather Products	8.0071
(G) Rubber and Plastic Products	11.7110
(H) Chemicals and Chemical Products	11.8362
(I) Non-Metallic Mineral Products	19.0775
(J) Basic Metals Alloys and Metals Products	25.8266
(K) Machinery and Machine Tools	13.2594
(L) Transport Equipment and Parts	7.7719

Source: Database on Indian economy, RBI

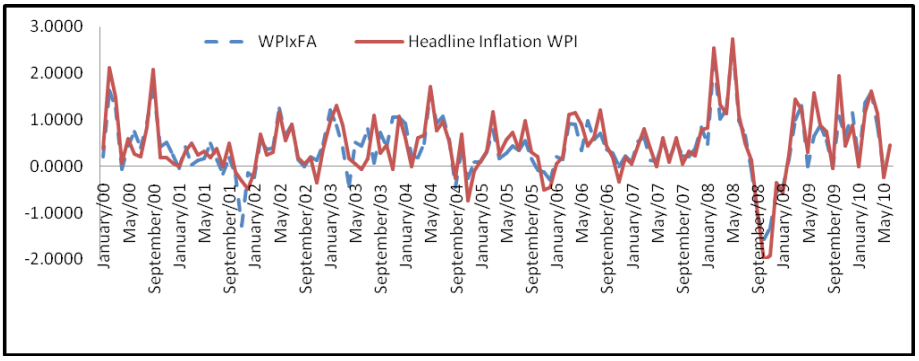
Table 2: Description of the Variable

S. No.	Name	Description	Weight of Excluded Commodities
1	WPIxFA	WPI excluding food articles	15.40
2	WPIxFAnNFA	WPI excluding food articles and non food articles	21.54
3	WPIxFAnFUEL	WPI excluding food articles and mineral oil	22.39
4	WPIxFUELnMAN	WPI excluding fuel (Minerals Oils) and manufactured products (Beverages, Tobacco and Tobacco Products, Non-Metallic Mineral Products, Basic Metals Alloys and Metals Products)	19.19
5	WPIx5	WPI excluding Minerals, Basic Metals Alloys and Metals Products, Minerals Oils, Non-Metallic Mineral Products, Beverages, Tobacco and Tobacco Products)	19.67

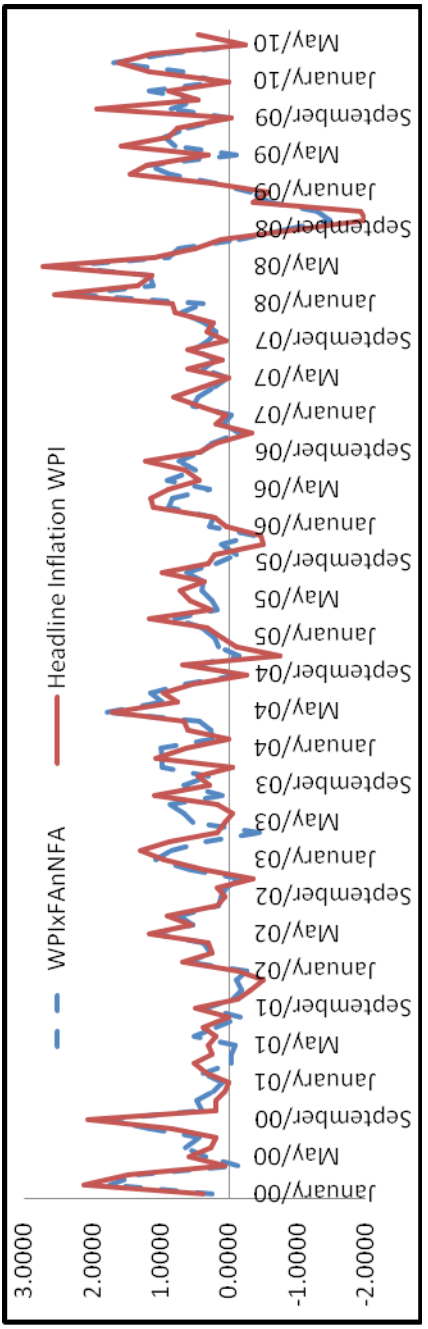
Source: Author's calculation

Inflation Vs Exclusion-based Core Inflation Measures

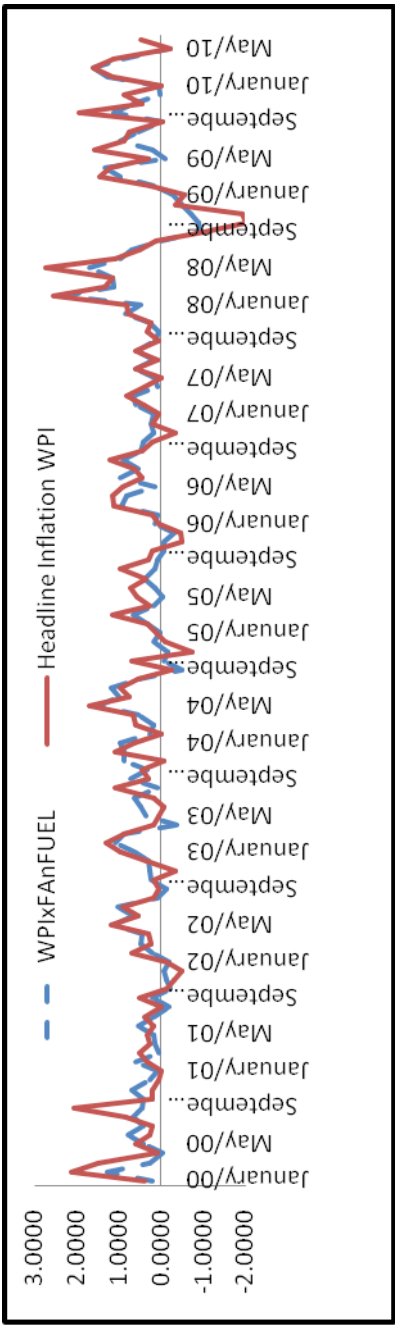
WPI Vs WPIxFA



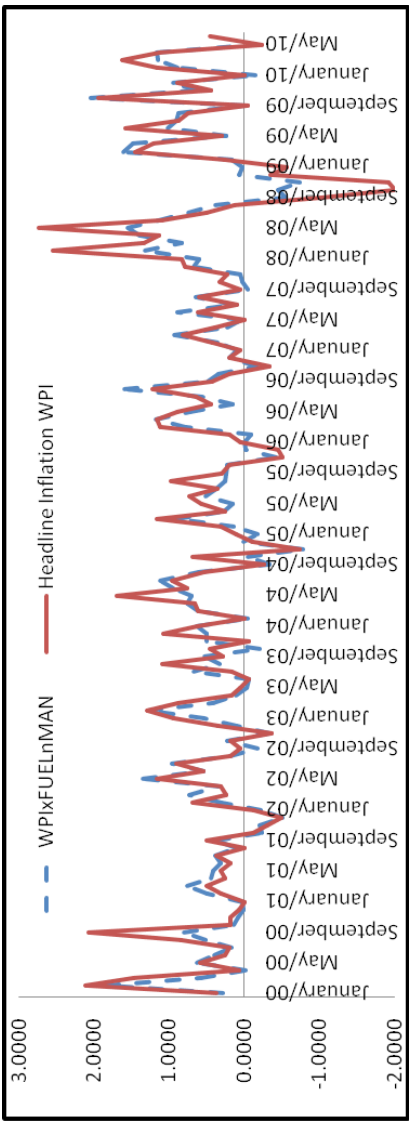
WPI Vs WPIxFAnNFA



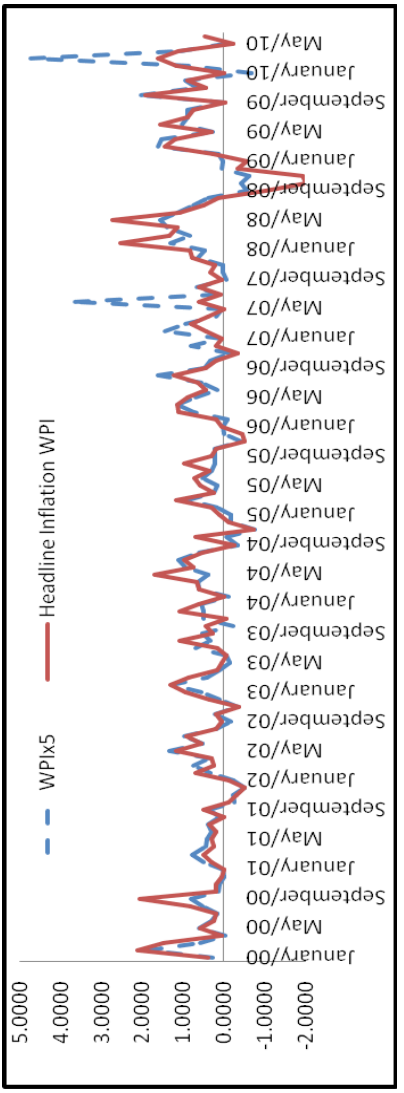
WPI Vs WPIxFAnFUEL



WPI Vs WPIxFUELnMAN



WPI Vs WPIx5



MEASURES BASED ON TRIMMING

The concept of trimmed mean is based on the monthly performance of the price change of different commodities. They behave differently in different months; hence only exclusion based indicators will not give the correct result. In this approach the trimmed mean removes the relatively large price changes in each month from the overall WPI for that month. This approach is proposed by Bryan and Cecchetti (1993) and Bryan *et. al.,* (1997) as a measure of core inflation. The calculation of weighted trimmed involves the following steps:

- Arrange the commodities with respect to their price change in ascending/ descending order for the given time period.
- Compute the cumulative weights such that $Wi = \sum_{j=1}^{i} Wj$
- Decide the set of observation to be averaged for calculation as:

$$I\alpha = \left(\frac{\alpha}{100}\right) < Wi < \left(1 - \frac{\alpha}{100}\right)$$

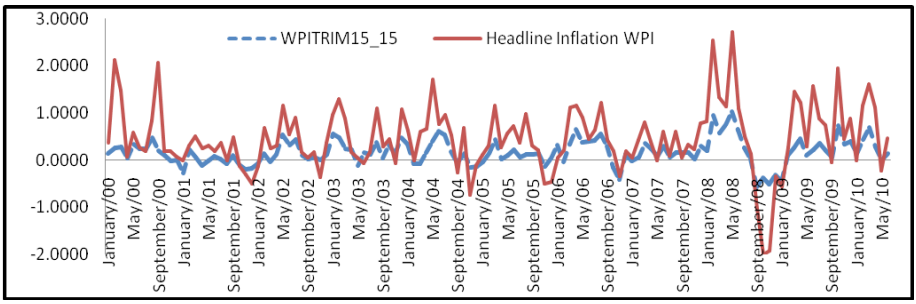
The trimmed mean is calculated as:

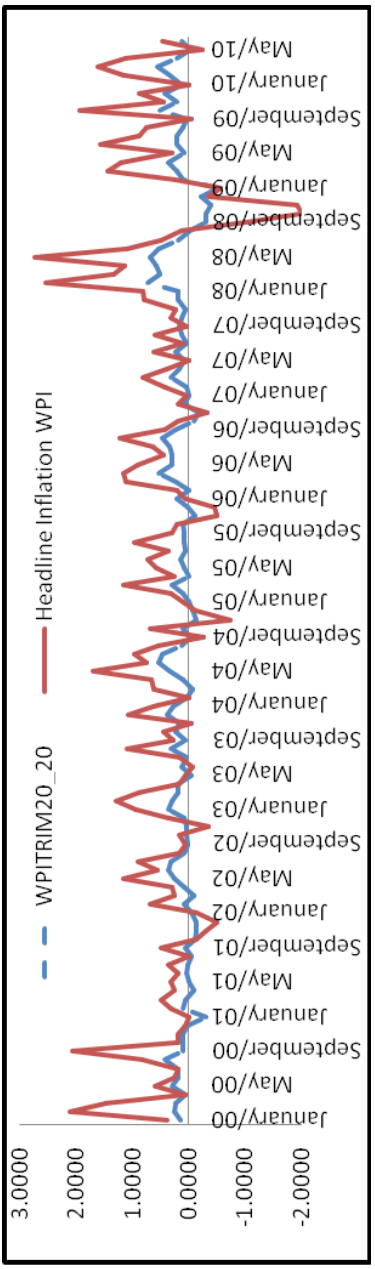
$$\pi\alpha = \frac{1}{1 - 2\left(\frac{\alpha}{100}\right)} \sum_{i \in I\alpha} Wi\pi i$$

Where Π_α is the trimmed WPI computed by ordering the component price change data Π_i and their associated weights w_i and removing the components on each tail of the distribution by α%. We have constructed three measures of core inflation based on the trimmed mean approach with 10, 15 and 20% of extreme price changes.

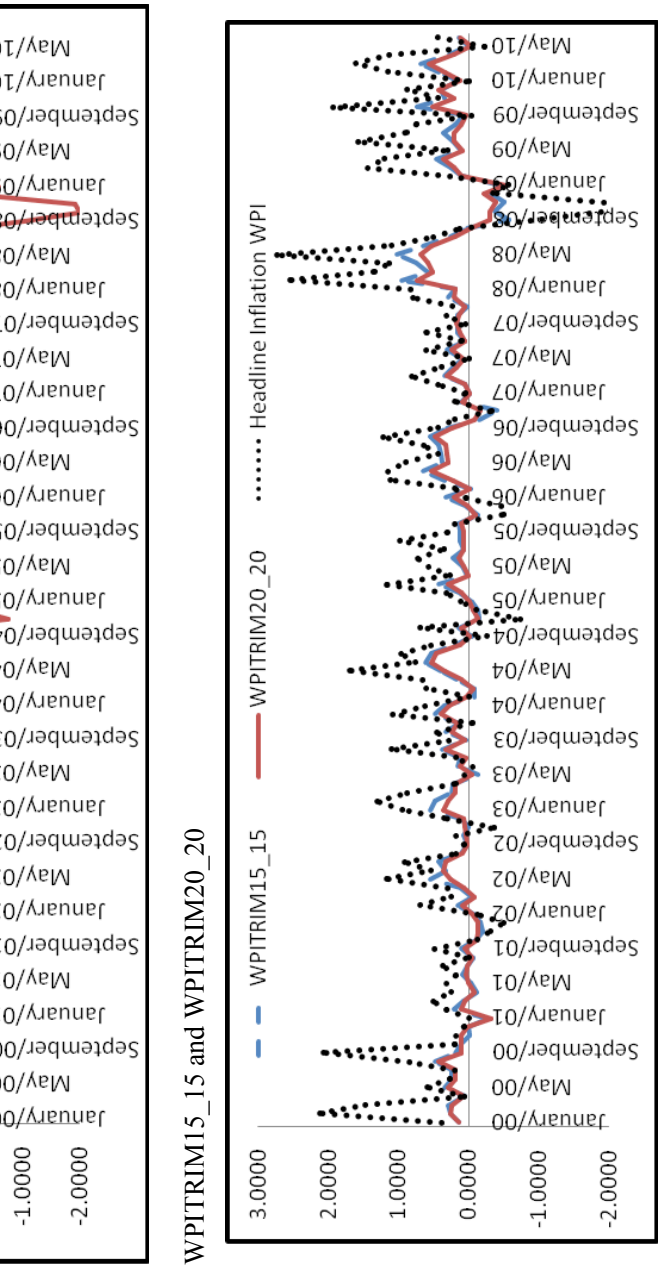
HEADLINE INFLATION VS TRIMMING-BASED CORE INFLATION MEASURES

WPI Vs WPITRIM15_15





WPI Vs WPITRIM20_20



WPI Vs WPITRIM15_15 and WPITRIM20_20

TESTING UNIT ROOT AND CO-INTEGRATION

Before estimating the co-integration models, it is essential to examine the time series properties of the variables in level or in first differences. If the equation is estimated with data that are non-stationary, the application of OLS method would not yield a consistent parameter estimator. That is, the t-statistics of the estimated coefficients are unreliable since the underlying time series would have theoretically infinite variance (Hendry, 1986, Granger, 1986). Moreover, in estimating the co-integration, it is necessary that the variables should be non-stationary. Hence, the following, Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), and KPSS unit root tests are performed to know whether the process governing the concerned variables is stationary or not.

DICKEY-FULLER (DF) AND AUGMENTED DICKEY-FULLER (ADF)

It is necessary to start with a unit root test to check whether a given series say X_t is stationary or not. The Dickey-Fuller and Augmented Dickey-Fuller unit root tests are popular in the literature. The tests require estimation of the following equation.

$$\Delta X_t = \mu + \alpha X_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta X_{t-i} + \varepsilon_t \qquad (4.1)$$

where k is the value which ensure ε_t be a white noise series, Δ is the difference operator, α and γ_i are parameters. The above procedure is known as the ADF test. The DF test follows a special case of ADF test when summation part of the equation (4.1) is zero, that is when $k = 0$. The test statistics of DF and ADF are tested under the null hypothesis of non-stationarity against the alternative of stationarity.

Phillips-Perron

Phillips and Perron (1988) have suggested an alternative unit root test. The advantage of this test is that it is neutral to the selection of lag-length in the ADF equation. Further, the error term over there could be serially correlated and heteroscedastic. This test also tested with the null hypothesis of non-stationarity and alternative of stationarity for which the procedure requires that the test statistics are to be negative and statistically significant in comparison to the tabulated value.

COINTEGRATION

Cointagration theory was developed by Granger and his associates to examine whether long run equilibrium exist between the variables (Granger, 1986, Engle and Granger, 1987).

Consider initially a pair of series X_t and Y_t, each of which is said to be integrated of order one, denoted by $I(1)$ and having no drift or trend in mean. It is generally true that any linear combination of these variables will also be integrated of order one. However, it is possible that there exist a linear combination say Z_t, such that it is $I(0)$ or stationary, it is said that X_t and Y_t are cointegrated.

However, when X_t is the vector of N components time series, each without trend in mean and each $I(d)$, $d > 0$. Then X_t will be said to be cointegrated $CI(d, b)$ if there exist a vector such that $Z_t = \alpha' X_t$ is $I(d-b)$, $b > 0$.

The case considered earlier has $N = 2$ and $d = b = 1$. Moving to a general values for N, d, b, adds a large number of possible interrelationships and models. In particular, α will not be unique, as there will be several equilibrium relationship linking $N > 2$ variables. If there are r vectors α, each of which produces Z's integrated of order less than d, then r is called the "order of integration" and is easily seen that $r < N$-1.

ENGLE GRANGER TWO STEP PROCEDURE

Suppose that by using the unit root tests described above, we have detected that variables are non-stationary at levels or having random walk, but at first differences they are stationary. It is then quite easy to test whether the combinations of the variables are cointegrated. To ascertain this, Engle Granger (1987) propose a two step procedure, where the first step is running the OLS regression of the combination of variables and extracting the residuals from the regression. And the second step is testing or ascertaining the stationarity of these residuals. To test the stationarity of the residuals, the usual unit root tests are followed.

EMPIRICAL EVALUATION OF THE VARIOUS MEASURES OF CORE INFLATION

In the preceding section we have constructed eight measures of core inflation; five exclusion based measure (WPIxFA, WPIxFAnNFA, WPIxFAnFUEL, WPIxFUELnMAN, and WPIx5) and two measures based on trimmed mean approach (WPITRIM15_15 and WPITRIM20_20). In this section we evaluate the relative performance of these measures. The literature has suggested some criteria to evaluate the reliability, how well they are in tracking the underlying inflation and predicting the future inflation trends. In this study we examine the unbiasedness, volatility, and how well core measures are associated with the headline inflation in the long run. Marques *et. al.,* (2000) has suggested three criteria to identify core inflation as an indicator of permanent component of headline inflation: (i) the targeted and core inflation must be co-integrated and the co-integrating parameter must be unity; (ii) core inflation must be an attractor of targeted inflation; and

(iii) targeted inflation must not be an attractor of core inflation. We have considered the following evaluation techniques in this study.

Unbiased and Volatility

The measures of core inflation are expected to remove the noise or temporary fluctuation part from the headline inflation, hence they should be less volatile than the headline inflation (exhibit low CV than the headline). In exclusion based core measures WPIxFAnNFA, WPIxFAnFUEL and WPIxFUELnMAN exhibited lower coefficient of variation than the headline. But in the case of trimmed mean based measure both of them are having higher coefficient of variation.

Summary Statistics of Exclusion based measures Vs Headline Inflation:

Inflation Measures	Mean	Std. Deviation	Coefficient of Variation
Headline Inflation WPI	0.4654	0.7009	13.4173
WPIxFA	0.4616	0.6959	13.4312
WPIxFAnNFA	0.4630	0.6811	13.1052
WPIxFAnFUEL	0.4299	0.6291	13.0371
WPIxFUELnMAN	0.4475	0.6395	12.7311
WPIx5	0.4989	0.8015	14.3118

Summary Statistics of trimmed mean based Vs Headline Inflation:

Inflation Measures	Mean	Std. Deviation	Coefficient of Variation
Headline Inflation WPI	0.4654	0.7009	13.4173
WPITRIM15_15	0.1712	0.2706	14.0808
WPITRIM20_20	0.1362	0.2091	13.6773

Unit Root Evidence

The unit root tests are employed to test the presence of stochastic trend of core inflation measures the total sample data. The variables considered HEAD, TRIM15, TRIM20, EX1, EX2, EX3, EX4 AND EX4. The data are monthly deseasonalised and in logs. For the test of unit root, the present study used Dickey-Fuller (DF), Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results are presented in Table appendix A.2

The table presents the unit root test statistics for all the variables at their first differences. From the results it is found that the DF, ADF, PP, Bayesian test

statistics are statistically significant for almost all the series. Hence, the evidence across the tests indicates that the given macro economic variables are difference stationary (i.e., (I (1))).

COINTEGRATION AND CAUSALITY TESTS

Cointegration tests are employed to check the long run equilibrium relationship among the observed time series variables. The essence of the cointegration analysis is that if the variables are individually integrated of the same order, say I (1), but a linear combination of the variables exists such that it is I(0), then it may be stated that there exists stable long run equilibrium relation among them, though each tends to drift away from the others over time.

The cointegration test (Engle-Granger two step procedure) for the total sample data suggests that each of the core inflation measures (both trimmed and exclusion based measures) has a long run trend relationship with the head line inflation variable for the present sample. The test statistics presented in Appendix A.3 confirm long run relationship between the core inflation measures and headline inflation is not diverging. It is clear from the results that the DF test is able to reject the non-stationarity of residuals of all the core inflation measures at 1% level of significance. However, the ADF test fails to reject non-stationarity of error at 1% level of significance for HEAD with EX3 (WPI excluding food articles and mineral oil) variable.

All the core measures under consideration as the attractors of the headline inflations. Further among these TRIM15, TRIM 20, EX3 and EX4 are strongly exogenous, not getting attracted by the headline inflation. As these measures are exogenous, they are also expected to be useful for forecasting the headline inflation.

CONCLUSION

The headline measure of inflation gets affected by not only the long run inflationary trends, but also by the transient factors, which introduce noise in the time series. In order to separate out the noise from the trend, different measures of core inflation have been proposed in the literature. The construction of core inflation measures depends on the purpose for which the measures to be used. The existing literature on this issue as well as the results of the present study suggest that one measure of core inflation may not satisfy all the requirements of an ideal measure. For the purpose the present study tested for both exclusion based and trimmed based core inflation measures. In exclusion based core measures WPIxFAnNFA, WPIxFAnFuel and WPIxFUELnMan exhibited lower coefficient of variation than the headline. But in the case of trimmed mean based measure both of them are having higher coefficient of variation. The cointegration test statistics confirm

long run relationship between the core inflation measures and headline inflation is not diverging. Further among these TRIM15, TRIM 20, EX3 and EX4 are strongly exogenous, not getting attracted by the headline inflation. As these measures are exogenous, they are also expected to be useful for forecasting the headline inflation. On the whole, while the exclusion based measures are more appropriate for inflation targeting purposes, the measures based on the trimming may be better for identifying the underlying trends and also in providing a robust forecast of future inflation rates in India.

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