CORE INFLATION IN SRI LANKA:

Is It a Useful Guiding Indicator in Conducting Monetary Policy?

by

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ABSTRACT

Measures of core inflation are designed to abstract the underlying trend in inflation from the headline measure of inflation and it is considered as the component of price change related to monetary phenomena. In that regard, core inflation can be considered as an important indicator of the inflation trends, which is useful for the conduct of monetary policy. The Central Bank of Sri Lanka perceives that monitoring and analysing a proper measure of long-term underlying trend inflation in Sri Lanka is imperative to conduct its monetary policy. Therefore, several attempts have been made to compile and analyse representative measures of core inflation. Recognising the need for exploring alternative core inflation measures for Sri Lanka, this paper presents a range of core inflation measures compiled using several methods. At the same time, this focuses investigating the validity of using core inflation to gauge future inflation trends and using it as a major input in the conduct of monetary policy. Different measures produce mixed results in terms of qualifying performance criteria of a representative core inflation measure raising issues on the use of core inflation as a guiding indicator. Although some measures show certain ability to forecast future path of inflation, none of the core measures does an outstanding work in predicting inflation in Sri Lanka. However, this may be attributed to issues with regard to headline inflation series and may not be entirely due to the weaknesses in core inflation measures. Hence, these results do not undermine the usefulness of core inflation for policy formulation and analytical purposes since it serves as an important variable in tracking prevailing underlying inflation and provides an explanation on the dynamics of inflation to guide monetary policy. Core inflation indicators based on alternative methods could provide Sri Lankan monetary policymakers more timely information in addition to the current official measure of core inflation.

JEL Classification: E31, E47, E52, E58

Key Words: Core Inflation, Headline Inflation, Monetary Policy, Predictability

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I. Overview

Monetary policy is a forward-looking strategy, which influences the cost and the availability of money with an aim to contain inflation. Monetary policy is considered as forward-looking as any monetary policy action of monetary authorities impacts inflation in particular, and the economy in general, with a considerable time-lag. Hence, monetary authorities are required to understand the current trends and future path of inflation and also leading indicators of inflation in order to better calibrate policy actions with a forward-looking perspective.

In the conduct of monetary policy, monetary authorities do not merely consider fluctuations in individual prices in the economy, but, focus on the underlying trends in general price levels. The concept of core inflation refers notionally to general or underlying trend in inflation, which is driven by demand pressures of the economy[1].

Core inflation is basically explained in the context of the quantity theory of money where the general trend in inflation corresponds to the inflation that arises as a result of a monetary disturbance (Johnson, 2006)[2]. By this reasoning, inflation is a monetary phenomenon in the long-run, and therefore core inflation should measure the component of price change related to monetary phenomena (Bryan and Cecchetti 1994; Wynne, 1999). Hence, it is believed that monetary policy actions of a monetary authority are closely related to core inflation than headline inflation. Accordingly, as monetary authorities focus on the persistent trends in inflation rather than temporary movements in prices for policy purposes, core inflation may be considered as a measure of inflation, which is the outcome of policy (Johnson, 2006). Defined in this way, core inflation is the measure over which monetary policy has the most influence (Roger, 1997).

A good measure of core inflation is expected to provide as much information on the underlying trend as is possible from each month's consumer price index data (Bryan and Cecchetti, 1994). Moreover, proper core inflation should track the component of overall price change that is expected to persist for several periods and therefore, be useful for near-term and medium-term inflation forecasting (Bryan and Cecchetti 1994; Blinder 1997).

Central Bank of Sri Lanka (CBSL) intends to maintain low and stable inflation[3] conducive for long-term economic growth of the country by conducting its monetary policy although it does not follow an explicit inflation target. In this context, the CBSL perceives that a proper - representative measure of true, long-term inflation trend is a must for the successful conduct of monetary policy. This is particularly so, as headline inflation in Sri Lanka, which is measured using the Colombo Consumer's Price Index (CCPI), is highly vulnerable to supply shocks, owing to its significant weight of food

[1] Supply side shocks too play an important role in determining inflation. Although demand pressures impact on long term trend inflation, supply side impacts inflation by way of generating temporary price variations. As such, some argue that positive demand shocks and negative supply shocks have important and similar effects on inflation, as they pass through the same channel and the monetary policy reaction to these shocks should be identical. Accordingly, there remains an argument that core inflation measure should incorporate the effects on inflation of the demand shock, as well as those of the supply shock. However, this tends to contradict the Quah and Vahey approach of measuring core inflation that excludes the effect of the shock that has permanent output effects (Aucremanne and Wouters, __).

[2] As quoted in Bryan and Pike in 1991, Friedman (1969) noted that there are usually two different explanations of price movements. "*One, common to all disturbances, is that the price movements reflect changes in the quantity of money... The other explanation has been in terms of some special circumstances of the particular occasion: good or bad harvests; disruptions in international trade; and so on in great variety*" (Johnson, 2006).

[3] The core objectives of the CBSL are specified as maintaining economic and price stability and maintaining financial system stability with a view to encouraging and promoting the development of the productive resources of Sri Lanka (Section 5, Monetary Law Act, 2002 amended).

items[4]. At the same time, administered prices, which mainly include energy, do not respond to monetary policy actions and hence, such situation could hinder efforts of gauging dynamics of inflation in the economy. In this context, the CBSL has paid greater attention in tracking underlying trends in inflation in Sri Lanka for its monetary policy purposes. As such, several attempts have been made to compile core inflation measures, particularly based on the widely known exclusion method (CBSL, 1997 and 2006; Jayamaha et al, 2002). At the same time, some individual research activity can also be noted, which are based on alternative methods, in addition to exclusion based methods (Tennekoon, 2008; Gupta and Saxegaard, 2009).

Given the importance of extending research efforts of exploring alternative core inflation measures for Sri Lanka, this paper presents a range of alternative core inflation measures complied using several methods suggested in the literature and also evaluates them based on most important criteria. It is particularly intended to examine the validity of choosing such measures as guiding indicators in gauging underlying trends and the future path of inflation in Sri Lanka. Hence, more importantly, this paper evaluates the validity of tracking core inflation as a guiding indicator of inflation in Sri Lanka and discusses the rationale of using core inflation as a major policy input in conducting monetary policy.

The remainder of this paper is structured in the following manner: Section II provides an introduction to the concept of core inflation mainly focusing the need and the significance and also elaborating international experiences of measuring core inflation. Section III elaborates the need for a core inflation measure for Sri Lanka and reviews the attempts taken thus far in the Sri Lankan context. Section IV presents a range of alternative measures of core inflation for Sri Lanka. Subsequently, it presents an analysis on the most representative measures based on the representativeness and the controllability criteria. Section V provides the main analysis on the validity of using core inflation as a guiding indicator in the conduct of monetary policy. This section includes a review of the relevant empirical literature and several tests including causality, long-run relationships, predictability and correlations of core inflation measures and related observations. Finally, Section VI provides a discussion on policy implications and recommendations.

II. CORE INFLATION: CONCEPT, MEASURES AND PRACTICES

a. Need and the Significance of Measuring Core Inflation

Most of the monetary authorities who target inflation explicitly or implicitly rely on historical and current movements and forecasts of headline inflation and pursue expansionary or contractionary monetary policies depending on the movements of inflation and the behaviour of other leading indictors, particularly money and credit. Hence, the mechanism of monetary policy relies not only on a measure of inflation that captures the general (historical) growth rate of prices but also a measure of

[4] CCPI (1952 = 100) computed by the Department of Census and Statistics (DCS) was used as the official price index for more than five decades in Sri Lanka. However, it suffered from many inherent weaknesses including the outdated base, non representation of the current consumption behaviour of an average household in the reference population and the limited sample of goods and services. Realising these deficiencies, the DCS constructed a Consumer Price Index, ‘the New Colombo Consumers’ Price Index’ (CCPI, 2002 = 100) in November 2007. The most notable feature in the new index was the drastic fall in the share of expenditure on food from 68 per cent to 47 per cent and inclusion of prices of new items. However, still the food component remains high, reflecting the typical patterns of consumer behaviour in a developing country.

inflation that is forecastable. If the forecasts are misguided, the policy framework may tend to increase the volatility of nominal aggregates and probably real aggregates in the short run (Morón and Zegarra, 1999).

The primary purpose of using headline rate is that it represents a more widely accepted and understood measure of inflation. In that context, the use of headline inflation rate is likely to promote accountability, as well as public understanding and acceptance of the monetary policy framework (Cockerell, 1999). However, headline rate of inflation still includes changes in prices, which are unrepresentative of general trend in inflation and correspondingly, tends to be a noisier measure of general price movements.

When temporary, ad hoc or noisy movements tend to shift relative prices, the corresponding price movements will generate transitory fluctuations in price levels, which are generally, reflected in the headline inflation rate. These fluctuations can be divided into two main types: First, there will be fluctuations in prices to which monetary authorities would not react and such volatile prices are likely to be quickly reversed on their own. Second, there will be other short-term fluctuations, which represent price shocks arising from sources beyond the control of the monetary authority[5]. These price changes will not become permanently incorporated into the underlying inflation process unless there is a change in the stance of monetary policy to accommodate any change in inflation and inflation expectations resulted from such shocks. Generally, such temporary nature of price movements is not in the interest to policy makers and hence, for policy purposes, monetary authorities focus on the persistent trends in inflation.

As core inflation attempts to abstract from the noisy price movements, it becomes a significant and important variable in policy purposes as explained in the following paragraphs based on the Cockerell and Johnson's work (Cockerell, 1999; Johnson, 2006).

First, core inflation can be considered as a good indicator of current and future trends in inflation. Naturally, monetary authorities closely monitor all available information on the current state of the economy and the current inflation rate, particularly the more persistent movements in prices. Core measures provide an analysis, which is helpful to monetary authorities to separate the noise and short-run fluctuations in price data from its more persistent trend. At the same time, monetary authorities are much concerned about the future path of inflation as monetary policy affects inflation with long and variable lags. The most useful measures of core inflation will minimise misleading signals about the future trend in inflation.

Second, core inflation is considered as a good measure of inflation for empirical work. Policy makers including central bankers are required to understand the evolving interactions between monetary policy, economic activity, and inflation and further investigations into policy rules. In order to undertake such activity, it is imperative to have accurate measurements of inflation, particularly core inflation measures.

Third, core inflation can be a viable target for monetary policy. As transitory shocks could obscure important relationships between monetary policy and prices, a core inflation measure might better clarify the relationships between policy variables and targets. As explained above, if price fluctuations from non-monetary sources can be excluded, the resulting core inflation could be regarded as a measure of the inflation that is the outcome of policy. In such context, some measures of core inflation could be considered as more controllable by monetary authorities than headline

[5] For examples: changes in supply such as a crop failure, changes in taste or specific events such as changes in indirect taxes. One-time shifts in the level of the real exchange rate due to non-monetary sources could also lead to shifts in relative prices.

inflation rates suggesting that core inflation might be a better target for monetary policy[6]. Even in a framework of targeting headline inflation, core measures remain a useful source of information about the general direction of price inflation (Cockerell, 1999). Also, core inflation can also be a useful tool to assess the effectiveness of policy.

Fourth, core measures assists in improving communication or transparency since it improves public understanding of the notion that policy is linked to the more persistent movements in inflation. The use of a core measure as a target would focus public attention on the persistent trend in inflation, bringing it into line with the focus of the monetary authority and more importantly anchoring the inflation expectations, which are incorporated into decisions and contracts.

b. Theoretical Explanations of Core Inflation

Measures of core inflation are primarily designed to abstract underlying inflation from influences on the aggregate or headline measure of inflation. However, there remains no clear consensus on what core inflation should be measuring and what method to derive core inflation should be using.

One standard definition of core inflation relates to the concept of the implied steady-state rate of inflation, where inflation would be if output was consistent with the natural rate and the economy was free of all supply shocks. Alternative definitions mainly include: the persistence or momentum in inflation, the transitory impact from fluctuations in aggregate demand and/or movements in the real exchange rate (Cockerell, 1999).

As Bryan and Cecchetti argues, although there are several frameworks to discuss core inflation, such frameworks need not be considered as complete theories of inflation as they ignore the policy response to ‘price’ shocks and therefore, are subject to the Lucas critique[7] (Bryan and Cecchetti, 1993).

Cecchetti (1997) decomposes an individual item’s price change (π_{it}) into two braoder components: a price change common to all items (core inflation, ΔP_t) and an idiosyncratic price change (Δpit). Thus, at any given time, some prices are rising significantly relative to core inflation whilst others are falling significantly relative to core inflation.

$$\pi_{it} = \Delta P_t + \Delta pit \qquad (1)$$

[6] As argued by Johnson (2006), since the use of a target implies that the monetary authority will accept responsibility for inflation *ex post*, it makes sense to define the target in terms of the measure of inflation for which it has the most *ex ante* control. This would further establish accountability for policy.

[7] The Lucas critique, named for Robert Lucas′ work on macroeconomic policymaking, says that it is naïve to try to predict the effects of a change in economic policy entirely on the basis of relationships observed in historical data, especially highly aggregated historical data. It suggests that if anyone wants to predict the effect of a policy experiment, he should model the "deep parameters" (relating to preferences, technology and resource constraints) that govern individual behaviour. It is possible to then predict what individuals will do taking into account the change in policy, and then aggregate the individual decisions to calculate the macroeconomic effects of the policy change.

Monetary authorities are interested in responding to price changes common to all goods, ΔP_t, which are not directly observable. Only the overall change in a specific basket of goods and services, π_t (the weighted sum of individual price changes, π_{it}) is observable[8].

Based on this premise, describing core rate of inflation as the persistent or permanent component of inflation, can be stated as the most common approach used in discussing core inflation (Cockerell, 1999). This is explained in equation 2 as:

$$\pi = \pi^p + \pi^t \qquad (2)$$

where, inflation π, is divided in a statistical sense between its trend, π^p, and transitory components, π^t.

Although this statistical explanation seems to be vague in explaining the determinants of inflation (Cockerell, 1999), it provides some useful information on the inflation process. As such, the trend component can be identified as being at least partially determined by the stance of monetary policy and the transitory component may include fluctuations in aggregate demand as well as supply shocks to inflation.

In addition to this general framework, a second approach to discuss core inflation can be elaborated based on the Phillips curve framework.

$$\pi = \pi^e + \alpha(y_t - \bar{y}) + \beta\Delta e_t + \varepsilon^s \qquad (3)$$

According to equation 3, inflation settles down to the level of inflation expectations, π^e, in the steady state when output y is at the natural rate $\bar{y}$, the real exchange rate, e, is stable and the economy is absent of supply shocks, ε^s. In this framework, it is possible to identify core inflation with the steady-state inflation rate, which is given by inflation expectations. Most notably, in terms of this Phillips curve framework, core inflation measure would not only include the steady-state component identified with inflation expectations, but would also incorporate medium-term inflationary pressures from fluctuations in demand and movements in real exchange rate as well as any general persistence in the inflation rate (Cockerell, 1999).

c. Measures of Core Inflation

As explained in the previous section, measures of core inflation are developed to extract from published inflation rates, by decomposing published inflation into its persistent and transitory components. Therefore, core measures are derived by eliminating, to the extent possible, the price shocks that can be identified as being either noise, or as arising from a source, which is exogenous to the process influenced by monetary policy (Johnson, 2006).

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[8] $\pi_t = \sum_t^n (w_{it} * \pi_{it})$, where, n is the number of items in the price basket, w_{it} is the weight of item i in time period, *t* and $\sum_t^n w_{it} = 1$.

Core or underlying inflation is measured in several ways. Until the 1990s, in many countries, core inflation remained synonymous to Consumer Price Index (CPI) inflation excluding food and energy. However, after 1990s, there has been increased motivation for further research on core inflation, particularly with the introduction of inflation targeting as an important monetary policy framework.

There exist two main approaches in measuring core inflation. The first approach estimates an econometric model (mostly Vector Auto Regressions, VARs) and then uses the long-run restrictions implicit in the definition of core inflation in order to identify measures of core inflation. This approach attempts to establish a link between core inflation and its underlying economic determinants, most importantly monetary policy variables and provides a clear rationale why monetary authorities should analyse core inflation. The main problem with this approach is that it is model-specific and the identification of core inflation depends on assumptions used in the model, including price flexibility, formation of inflation expectations, and the nature of price shocks. Also, as estimates of the model change when new data arrive and the sample period is extended, estimates of earlier observations of core inflation would change invariably. At the same time, different specifications of the model could provide different results. Because of this subjectivity and its highly technical nature, econometric approach in measuring core inflation has been rarely applied in practice[9].

The other approach attempts to extract core inflation from existing information on the sub-components of headline inflation and hence, focuses on two main branches, (i) core measures, which use time series properties of the data, and (ii) core measures, which use the cross-sectional distribution of the data.

The first approach attempts to identify transitory components of inflation, i.e. noise reflected through seasonal movements, volatile supply shocks, or one-time relative price shocks. These noises need to be excluded from headline inflation to derive core inflation. However, the identification of such components relies on the judgments based on hindsight, or the practices in other countries.

The second approach also attempts to exclude "noise" from headline inflation. However, instead of defining the more volatile and hence, excludable components, this method observes the cross-sectional distribution of price changes to identify outliers. The two tails of the distribution of price changes are identified as idiosyncratic movements, and excluded from headline inflation to derive core inflation. Au such, this method excludes high variance components of the general price index, but instead of fixing the excluded components as in the previous method, it allows the components to vary from period to period.

Broadly, all the methods of deriving core inflation can be identified in a statistical perspective as they rely on aggregated or disaggregated price data (Álvarez and Matea, 1999). The aggregate approach uses the full sample of aggregate data and statistical techniques to identify directly the core measure itself. This approach focuses exclusively on the information contained in the dynamics of the aggregate index. Empirical research along these lines includes simple averaging or averages over other horizons and seasonal adjustment, as well as more sophisticated filters such as those of Cogley of 1998 and 2002.

Within the disaggregated approach[10], there are two types of inflation measures: i) those that use the distribution of inflation at a point in time (eg: a measure, which eliminates movements in the tails of

[9] If the connection between core and headline inflation in not clear and calculation is complicated, that could impact credibility of such measures undermining the usefulness of core inflation as a policy input for the monetary authorities.
[10] Disaggregated approach includes the various papers on the weighted median and other limited information estimators by Bryan and Pike (1991); Bryan and Cecchetti (1993b, 1996); Bryan, Cecchetti and Wiggins II (1997); Cecchetti (1996); Roger (1995, 1997) and Shiratsuka (1997).

the distribution and the weighted median, and ii) those that use the time series properties of the data (eg: measure based on excluding food, energy and indirect taxes; excluding most volatile components, reweighing components according to their historical variability).

Based on these approaches, several methods, which are used practically in deriving core inflation measures, are highlighted below[11]:

1. **Smoothing**: Measures of core inflation can be derived by smoothing methods, which ranges from simple moving averages to the fitting of trend lines such as the Hodrick-Prescott filter and each of them are highlighted below.

    a. ***Average Headline Inflation***: Annual average (moving average) inflation can be used as a measure of core inflation, as the volatility of the headline index is smoothened-out over the period through averaging (Álvarez and Matea, 1999)[12].

    b. ***Seasonally Adjusted Headline Inflation***: When headline index is adjusted seasonally, the volatility of prices is removed and smoothened-out and hence, that index can be regarded as a measure of underlying/ core inflation. When the seasonal effects are cancelled-out within a year and irregular movements disappear, it is regarded as the trend component[13].

    c. ***Hodrick-Prescott Filtered Headline Inflation*:** The Hodrick-Prescott (HP) filter is a smoothing method that is widely used by macroeconomists to obtain a smooth estimate of the long-term trend component of a series[14]. Accordingly, filtered headline inflation can be defined as a measure of core inflation.

    d. ***Exponentially Smoothed Headline Inflation:*** Colgey (2002) proposed an exponentially smoothened version of an aggregate price index in contrast to the popular methods of compiling core inflation measures. This measure is believed to pick up the movements in the mean of inflation and hence, the component of inflation that is likely to be sustained over time.

2. **Exclusion Based Methods**: The most common approach is the 'exclusion method', which derives core inflation behaviourally by recompiling price indices after removing a fixed number of components from the original index in each period consistently. The items usually excluded are the items with highly volatile and erratic prices, one-off changes and items with administered prices, usually energy and food items or prices of imported components. Hence, exclusion-based measures of core inflation are designed to directly identify and explicitly exclude distortionary

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[11] Relevant mathematical/statistical explanations are given in Annexure I.

[12] For example, Bangladesh Bank monitors the 12-month moving average inflation in order to eliminate the noise components of fluctuations. However, the moving average method is not a well defined measure of core inflation. One of the problems with this method is that the effect of any shock does not average out properly if the distribution of the sector-specific shocks is skewed (Bryan and Cecchetti, 1993 as quoted by Shahiduzzaman 2006).

[13] However, the trend component generally fluctuates considerably less than the seasonally adjusted series (Álvarez and Matea, 1999) and hence, the seasonally adjusted headline cannot be treated as a better measure of core inflation.

[14] This method was first used in a working paper (circulated in the early 1980's and published in 1997) by Hodrick and Prescott to analyze post-war U.S. business cycles. However, although it can be used as a measure of core inflation , which is computable in real time, the "end of sample" problems with this filter documented by Baxter and King (1995) make it particularly unappealing as a basis for core inflation measurement.(Wynne, 1999). Usefulness of seasonal adjustment method and Hodrick- Prescott Filter for estimating core inflation in Indian economy is examined by Samanta and Bhattacharjee. The performance of core inflation measures based on these techniques was compared with a core inflation measure obtained from exclusion. Their analysis showed that though seasonally adjusted inflation is marginally better than headline inflation for the purpose of monetary policy, it merits no gain when compared with the exclusion- based core inflation measure. They also confirmed that core inflation measures based on HP Filter is inferior to headline inflation as well as other core inflation measures (Samanta and Bhattacharjee,___).

changes in components of inflation. Components are excluded if they are deemed to be volatile, seasonal or subject to government policy.

3. **Statistical Approach**: The volatile components are also removed from indices using statistical approaches. These approaches are generally based on the observation that the moments of inflation are non-normal and correlated. This technique is used to filter large and influential price movements and there are different methods of extracting underlying inflation through the statistical approach including limited influence estimators and weighted median approach.

   a. ***Limited Influence Estimators***: 'Trimmed Mean' measures, which remove extreme price deviations from the index (Bryan and Cecchetti, 1994) are the most popular limited influence estimators. This method is also based on the recompilation of the index after removing certain items, but differs from the behavioural approach, as the items so excluded are not consistent over time (for instance, items with highest and/or lowest volatility in each month are excluded). 'Weighted Median', which is the second measure proposed by Bryan and Cecchetti (1994), is also derived using the same approach as trimmed means, but trims all the midpoint of price changes. The trimmed mean and weighted median are both unbiased estimators of the population mean if the population from which the samples are drawn is approximately symmetrically distributed (Cockerell, 1999).

   b. ***Volatility Weights:*** This method allows to reweigh items in the basket using the inverse of standard deviation. Hence, none of the items are excluded, but lower weights are assigned for more volatile items based on the premise that core inflation measure should be able to minimise the volatility.

4. **Econometric Methods:** The econometric/modelling approach involves to define core inflation on theoretical grounds and to use a model to operationalise it. Hence, this approach draws a direct link between policy and core inflation as the inflation which is controllable through policy (Johnson, 2006). The modelling approach has been dominated by the work of Quah and Vahey (1995), which acknowledges the importance of a theoretical definition for core inflation and uses the notion to determine the long-run restrictions in the model[15]. Many other researchers have developed alternative Structural Vector Autoregressions (SVARs) based upon the original Quah and Vahey approach[16] and other models including p-star models[17].

Table 1 summarises the key advantages and disadvantages of each method of measuring core inflation.

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[15] Quah and Vahey (1995) define core inflation to be that component of measured inflation which has no long-run impact on output. The main advantage of this approach is that it has a clear economic interpretation. Economic agents are assumed to incorporate core inflation into their actions, thus core inflation has no long-run impact on output. However, as this approach is based on the estimation of a VAR model, revisions will be made to the entire series of core inflation estimates as new observations become available, which is indeed a shortcoming (Meyler, 1999).

[16] Other researchers who have developed alternative SVARs based upon the original Quah and Vahey approach include, for example: Blix (1995), Bjornland (1997), Claus (1997), Dewachter and Lustig (1997), Fase and Folkertsma (1998) and Gartner and Wehinger (1998).

[17] The long-run equilibrium level of prices in standard p-star models could be interpreted as the price level that corresponds to core inflation, for example: Attah-Mensah (1996), Armour et al. (1996), and Hallman, Porter, and Small (1989).

Table1
Advantages and Limitations of Various Underlying/ Core Inflation Measures

Measure of Underlying/ Core Inflation	Advantages	Limitations
Smoothing	- Provides a clear indication of the trend inflation	- Potential differences in the assessment of outliers and in the estimation of the trend - Depends on the statistical and/or econometric techniques and long time series
Exclusion	- Readily understandable - Easy to compute/replicate - No need to have a long time series	- A prior decision must be made as to articles whose prices should be excluded - Standard deviation being calculated over a specific time period would change with the time period
Statistical Approach	- No need for a prior decision as to articles whose prices should be excluded - Easy to compute/ replicate - No need for a long time series	- Choice of where to trim the tails of the cross-sectional distribution - Computed/implied weights may significant differ from original weights
Model Estimates	- Consistent with a widely accepted economic theory (eg: vertical long run Phillips curve) - Multivariate nature	- An additional hypothesis required to determine its level - Complicate to compute/ replicate - Estimates vary when new observations included

Source: Extracted from Álvarez and Matea (1999) and Modified by the Author

d. International Experiences in Measuring Core Inflation

Measures of core inflation first appeared in the 1970s when policy makers were dissatisfied with the CPIs and concerned about the implications of food and energy price shocks in understanding the general direction of inflation. At the initial stage, Eckstein (1981) constructed a measure, which was the appropriately weighted growth of unit labour and capital costs and was viewed as a proxy for 'the trend rate of increase of the price of aggregate supply'. The basic logic was that if the aggregate price index was to grow at this rate, then the employment of labour and capital would be stabilised. However, the practical use of this core inflation concept was limited as there are difficulties in observing labour and capital costs in a timely fashion. Second, there is no clear conceptual basis to distinguish between the supply and demand factors influencing aggregate prices. As a result, there is no real presumption that policy could stabilise inflation at the currently observed core rate, since future changes in the core rate would not be independent of current policy decisions (Rich and Steindel, 2005).

The more popular core inflation measure as aggregate price growth excluding food and energy appears to have first been analysed by Robert Gordon in 1975. He investigated the relative importance of demand and cost factors of inflation in the United States and his aggregate 'core' price equation was estimated for final sales prices excluding food and energy. Consequently, as in the United States, in many other countries around the world, core inflation became synonymous with a measure of the CPI excluding food and energy prices. In the 1980s, smoothing techniques were adopted as an alternative approach to abstract from temporary influences on inflation. More recently, attention has cantered on the implication of skew and kurtosis in the inflation distribution for understanding the efficiency and robustness of the conventional CPI measure of inflation. Also, model based measures are used in some occasions.

Even in the current context, it not possible to identify single measure of core inflation as authorities rely on a wider range of measures in gauging underlying inflationary pressures in economies. Table 2 provides different approaches of measuring core inflation in different countries and it indicates that the exclusion is the most common approach.

Table 2
Measures of Core Inflation Used in Selected Countries

Country	Measure of Core Measure
Argentina	*A Series of Measures:* Headline CPI excluding highly volatile or with a seasonal pattern items CPI excluding food and energy *IPCP – consumer price index weighted by the persistence (Cutler measure)*
Australia	*A Series of Measures:* CPI less mortgage interest payments, government controlled prices, and energy items Weighted Median Trimmed Mean (30%)
Belgium	*A Series of Measures:* CPI net (main indirect taxes) ULI1 (net of food and energy) ULI2 (net of energy) ULI3 (net of energy, main indirect taxes) CPI less energy, potatoes, and fruit and vegetables
Brazil	*A Series of Measures:* Core IPCA trimmed means non smoothed Core IPCA - excluding administered prices and food at home Core IPCA trimmed means with smoothed Core IPCA trimmed means (exclude cumulative weight is either less than 14.4% or higher than 90.4%)
Canada	*A Series of Measures:* CPI excluding food, energy and first round effects of indirect taxes with a weight of 26.3% CPI excluding 8 most volatile components (16%) and adjusted the remainder for the effects of indirect taxes CPIW (weighted variance) Weighted Median Trimmed Mean (15%)
Chile	CPI excluding 20% with higher (-) variations and 8% with higher (+) variations
Colombia	CPI excluding agricultural food, public services and transport
Denmark	*A Series of Measures:* CPI net (indirect taxes, subsidies) ULI 1 (net of indirect taxes, subsidies, food, energy, rents, public services, effect of imports) ULI2 (net of indirect taxes, subsidies, food, energy, rents, public services)
European Union	*A Series of Measures:* HICP excluding energy and unprocessed food HICP excluding energy Trimmed means
Finland	CPI less housing capital costs, indirect taxes, and government subsidies
France	ULI (CPI net of food, energy, tobacco and taxation effects) Seasonally adjusted inflation indicator excluding public tariffs, volatile prices and impact of fiscal measures
Germany	*A Series of Measures:* Headline inflation HICP excluding energy and unprocessed food Headline inflation CPI excluding energy and unprocessed food CPI weighted mean CPI 5%-trimmed mean CPI volatility adjusted-weights
Greece	ULI (CPI net of food and energy) Case-by-Case (oil, public utilities, regulated prices, indirect taxes, subsidies, etc.)
India	Wholesale Price Index excluding food and fuel items
Indonesia	CPI excluding administered prices and volatile food
Ireland	ULI1 (CPI net of mortgage interest payments) ULI2 (CPI net of MIPs, food and energy)
Israel	CPI less government goods, housing, and fruit and vegetables
Italy	*A Series of Measures:* HICP excluding unprocessed food and energy prices National CPI excluding food, energy and regulated prices.
Japan	CPI excluding Fresh Food
Korea	CPI excluding energy and non-grain agriculture

Contd.

Country	Measure of Core Measure
Malaysia	CPI excluding food and fuel
Mexico	CPI excluding the most volatile items
Netherlands	ULI (exclude vegetables, fruit and energy from CPI) CPI market (public services, natural gas, rents, indirect and consumption-linked taxes)
Norway	CPI excluding electricity prices and indirect taxes
New Zealand	CPI less commodity prices, government controlled prices, and interest and credit charges
Pakistan	CPI excluding food and energy (NFNE)
Peru	CPI excluding 9 volatile items (food, fruits and vegetables, and urban transport, about 21.2%)
Philippines	Excluding selected food and energy items from headline CPI A statistical trend line
Poland	*A Series of Measures:* CPI excluding officially controlled prices CPI excluding prices with highest volatility Trimmed Mean (15%)
Portugal	ULI (CPI net of unprocessed food and energy) 10 percent trimmed mean of the CPI
Russia	CPI excluding volatile and administered items
Singapore	*A Series of Measures:* CPI excluding costs of private road transport and costs of accommodation CPI excluding volatile items (30%) Weighted Median Trimmed Mean (15%) Structural Vector Auto Regression (SVAR) Model Estimates
South Africa	CPI excluding certain food items, cost of mortgage bonds and certain indirect taxes
Spain	*A Series of Measures:* IPSEBENE (exclude energy, unprocessed food) CPI less mortgage interest payments Case-by-Case (indirect taxes, exogenous prices) CPI excluding energy and unprocessed food
Sveriges Riksbank	*A Series of Measures:* UND1 (exclude interest costs for owner-occupied housing, indirect taxes, subsides, depreciation after float from CPI) UND2 (ditto, plus heating oil and propellants)
Sweden	*A Series of Measures:* CPI excluding housing mortgage interest and effects of taxes and subsidies (UND1) UND1 excluding petroleum goods (UND2) UND1 less mainly imported goods (UNDINH)
Thailand	CPI excluding Fresh Food and Energy (23%) Trimmed Mean (10%)
United Kingdom	*A Series of Measures:* Retail Price Index excluding mortgage interest payments (MIPs) Retail Price Index excluding MIPs, food, fuel, light TPI excluding direct taxes THARP (indirect and local taxes) Weighted Median
United States	*A Series of Measures:* CPI excluding food and energy prices PCE excluding food, alcoholic beverages and energy Trimmed mean for the CPI and PCE. (weighted) median for CPI and PCE

Sources: Erichsen and Riet,1995; Bryan and Cecchetti, 1999; Shahiduzzaman, 2006; CBSL, 2007; BIS 2009

III. DEVELOPING MEASURES OF CORE INFLATION FOR SRI LANKA

a. Need for a Core Inflation Measure for Sri Lanka

The prime objective of monetary policy of the CBSL is to maintain price stability, which is conducive for long-term sustainable output growth of the country. As such, the CBSL operates within a monetary targeting[18] framework with a view to attain price stability through influencing money and

[18] Within monetary targeting regime, monetary policy is focused on ensuring an appropriate growth rate of the chosen monetary aggregate and thereby to impact on inflation. Under the monetary targeting framework of the CBSL, price stability objective is to be achieved by influencing changes in the broad money supply, which is linked to reserve money through the money multiplier assuming that demand for money as reflected by the velocity, remains stable (CBSL, 2007).

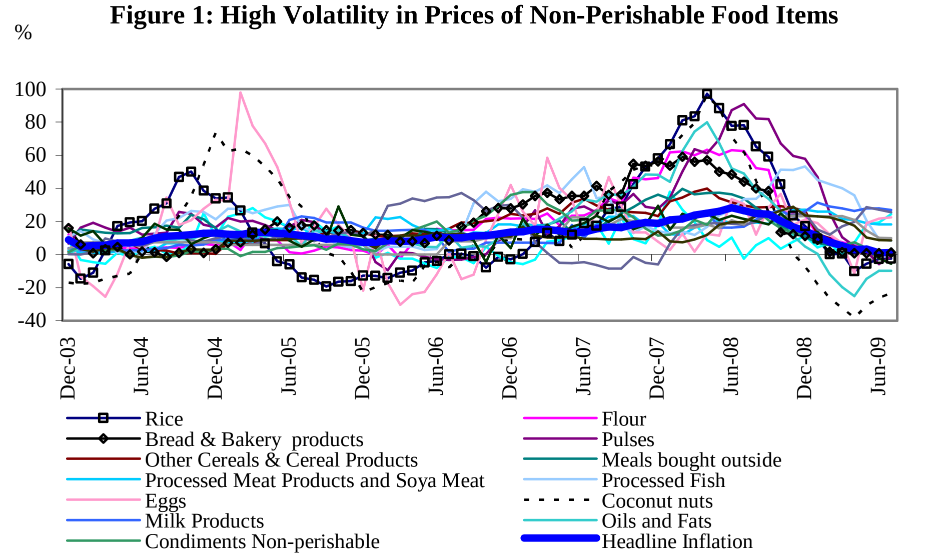
credit aggregates. At the same time, the CBSL perceives that a proper and representative price index, which measures long-term inflation trends in Sri Lanka, is a must for the successful conduct of its monetary policy.

The price stability objective of the CBSL is guided by developments in movements (12-month moving average and year-on-year changes) in the CCPI compiled by the Department of the Census and Statistics (DCS) based on the actual prices of a typical basket of domestic and imported final goods and services. However, depending only on changes in total CCPI as an operational guide for monetary policy could mislead or divert the focus of the policy[19] as some volatile components may impact the CCPI inflation over the short-term.

It is noted that large fluctuations due to good and bad harvests, disruption in external trade, and the impact of external price shocks create transitory noise in the CCPI immediately, and those persist only for a temporary period. For example, due to a sudden flood, vegetable production in a particular year may be affected creating adverse supply shocks. Such supply shocks may tend to increase total CCPI inflation. A similar situation may also arise because of short supply of rice due to poor harvest or rise in the prices of oil in the world market. This is particularly so, as the headline inflation of Sri Lanka, measured using the CCPI, is highly vulnerable to supply shocks due to high weight of food items.

Figure 1 and 2 indicate high volatility of perishable and non-perishable food items included in the CCPI basket.

Figure 1: High Volatility in Prices of Non-Perishable Food Items



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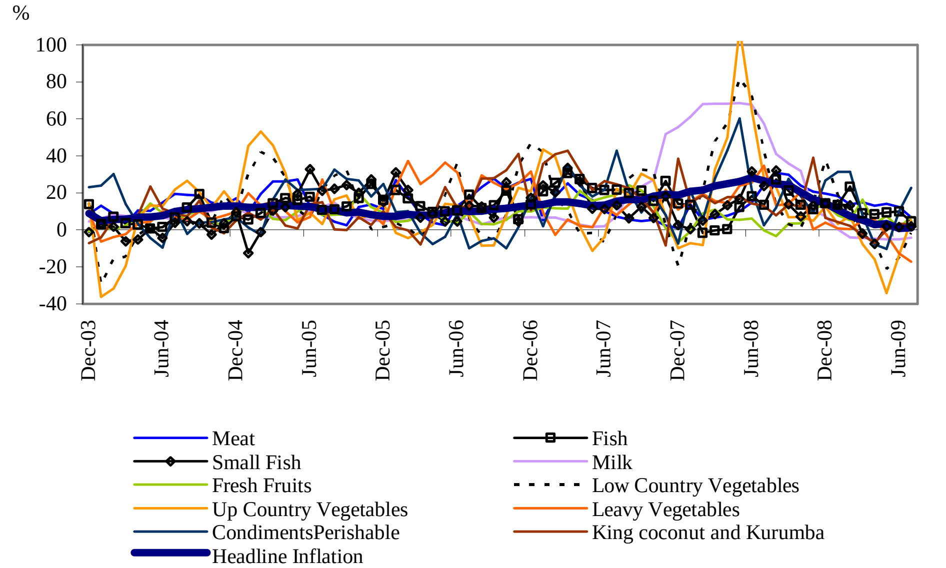
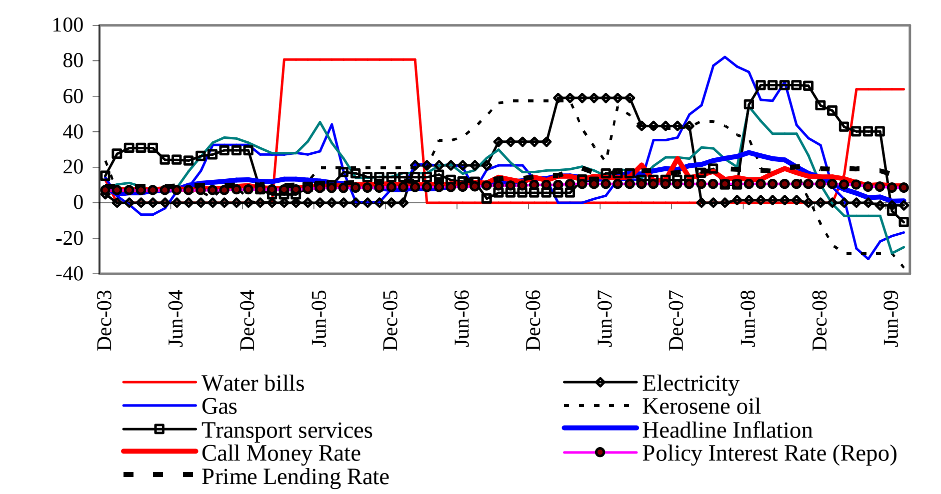
[19] Bryan and Cecchetti (1993) argued that transitory fluctuations in the price level caused by non-monetary events, such as sector specific shocks or measurement errors, should not reflect in the policy decisions of the monetary authority as these price changes do not constitute underlying monetary inflation. Monetary policy decisions need to be credible and so that these are not supposed to be changed because of such short-term fluctuations. Hence, aggregate price inflation loses its credibility to be a suitable measure of the price level as a short or medium-term operational guide in implementing monetary policy actions (Shahiduzzaman, 2006).

Figure 2: High Volatility in Prices of Perishable Food Items



As highlighted in Figure 3, administered prices, which mainly include energy, do not respond to monetary policy actions as any of the administered prices does not depict significant relationship with policy interest rates or market interest rates. Accordingly, such non-responsive nature of prices could hinder the efforts of gauging underlying trend in inflation in Sri Lanka.

Figure 3: Responses of Adminstered Prices to Changes in Interest Rates



When figuring out component volatility of the CCPI, as indicated in Table 3, it can be noted that most of the food items and administered prices show the highest volatility in terms of year-on-year changes in prices[20]. The first 10 most volatile items approximately accounts for 19 per cent of the total index whereas the first 20 most volatile items account about 40 per cent of the total index. The first 20 most volatile items however include prices, which are not highly responsive to supply shocks as well as to policy changes.

[20] This proves the rationale of excluding those (food and energy) categories from headline inflation to derive the core inflation (Tennakoon, 2008).

Table 3
Volatility of Year-on-Year Changes in Prices of Components in the CCPI (2002=100)*

Sample: Dec - 03 to Aug -09

Rank	Component	Standard Deviation	Rank	Component	Standard Deviation
1	Coconut nuts	34.0	29	Other Cereals & Cereal Products	11.2
2	Water bills	33.1	30	Fire wood	11.1
3	Rice	30.3	31	Condiments Non-perishable	11.0
4	Kerosene oil	25.0	32	Small Fish	10.8
5	Gas	24.5	33	Starchy Food	10.2
6	Eggs	24.1	34	Maintenance and repair of personal transport equipment	9.6
7	Pulses	24.0	35	Meals bought outside	9.6
8	Up Country Vegetables	23.0	36	Furniture and furnishings	8.6
9	Low Country Vegetables	21.5	37	Milk Products	8.6
10	Electricity	20.9	38	Purchase of vehicles	8.4
11	Oils and Fats	20.9	39	Meat	7.8
12	Milk	20.6	40	Fish	7.6
13	Flour	19.6	41	Marmite and Vegemite	7.3
14	Medical products, appliances and equipment	18.3	42	Tea & Coffee	7.3
15	Bread & Bakery products	18.2	43	Rent (Actual)	7.0
16	Transport services	18.2	44	Recreation and culture	7.0
17	Maintenance	17.3	45	Postal and Telegraph charges	6.8
18	Outpatient services	15.8	46	Processed Meat Products and Soya Meat	6.8
19	Contribution to trade unions etc.	15.6	47	Mineral Waters, Soft Drinks and Vegetable Juices	6.7
20	Fuels and lubricants for personal transport equipment	14.9	48	Fresh Fruits	6.0
21	Condiments Perishable	14.8	49	Goods and services for routine household maintenance	4.9
22	Processed Fish	14.7	50	Hairdressing salons and personal grooming establishments	4.8
23	Hotel Charges	13.2	51	Other appliances, articles and products for personal care	4.5
24	King coconut and Kurumba	12.8	52	Footwear	4.0
25	Dried Fish	12.1	53	Clothing	3.7
26	Sugar, Jam, Honey, Chocolate and Confectionary	12.0	54	Household Textiles	2.9
27	Leavy Vegetables	11.5	55	Insurance - Health	2.0
28	Telephone and telefax equipment	11.4	56	Education	1.8

* Disaggregated data of CCPI up to 56 categories and ranked highest to lowest in terms of standard deviation

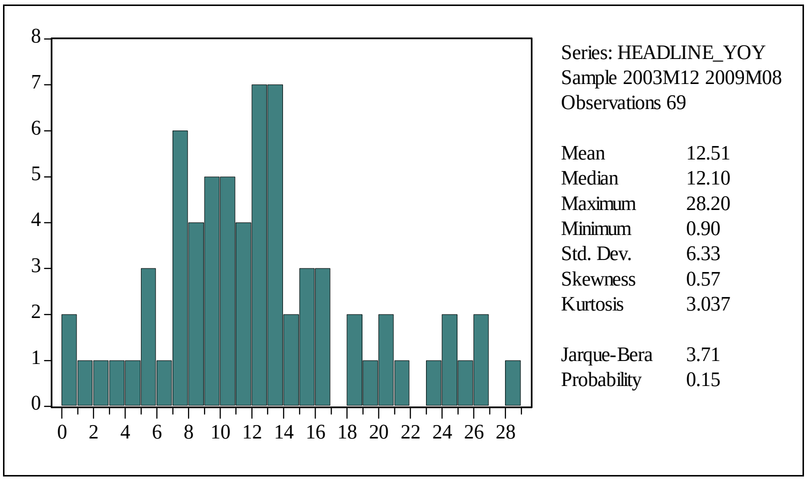
The volatility of prices of components naturally leads to increase the volatility in the overall price index; however, the changes in monetary policy stance will have no significant effect on it. This is indicated clearly through behaviour of year-on-year price changes of the CCPI. Such situation endorses the need for having a core inflation index, which is free from volatility and abnormal price shocks in order to trace the underlying trend inflation in Sri Lanka.

The moments of price changes shown in Figure 4, provide useful summary about the shape of distribution of price changes. The Jarque-Bera test accepts the null hypothesis of normality providing some evidence that the headline series is normally distributed. However, the probability value slightly exceeds the 10 per cent level. This is also confirmed by the kurtosis value. The value of kurtosis is slightly greater than 3, meaning that the series has a slightly heavier tail than the standard normal distribution, which means the series is broadly normally distributed[21]. However, the series has a significant difference between its maximum and minimum values. The standard deviation also indicates high fluctuations. The series is positively skewed meaning that the right tail is extreme and series is non-symmetric[22].

[21] The coefficient of kurtosis indicates the extent to which the distribution is fat tailed (leptokurtosis $K_t > 3$) or thin tailed (Platykurtosis $K_t < 3$) relative to a normal distribution, which has a kurtosis coefficient of 3 (Mesokurtosis $K_t = 3$). A leptokurtic distribution indicates that exceptionally large price changes—positive or negative.

[22] For a symmetric distribution, the coefficient of skewness is zero. A positive coefficient of skewness indicates that the distribution is skewed to the right i.e., exceptional price rises are more common or more extreme than exceptional price declines. Conversely, a negative skewness coefficient indicates that sharp price declines are more common or more extreme than price increases. A skewed distribution (either negative or positive) signifies the predominance of outliers in terms of price changes, thereby giving a distorted impression of the general trend of inflation.

Figure 4
Moments of Year-on-Year Price Changes of the CCPI



As shown in Table 4, descriptive statistics for year-on-year changes of headline inflation also confirms higher variations in prices.

Table 4
Moments of Year-on-Year Price Changes of the CCPI

Sample Moments	2004	2005	2006	2007	2008	2009*
Mean	9.0	11.0	10.0	15.8	22.7	4.1
Median	8.8	11.7	10.0	15.3	24.1	3.1
Maximum	13.0	13.3	13.5	19.3	28.2	10.7
Minimum	4.8	7.4	7.3	13.2	14.4	0.9
Std.Deviation	3.0	2.0	1.9	2.1	4.2	3.6
Skewness	0.0	(0.5)	0.3	0.5	(0.7)	0.8
Kurtosis	1.4	1.9	2.1	2.0	2.5	2.4
Jarque-Bera	1.2	1.1	0.6	1.0	1.1	1.0
Probability	0.5	0.6	0.7	0.6	0.6	0.6
Observations	12	12	12	12	12	8

** Up to August Only*

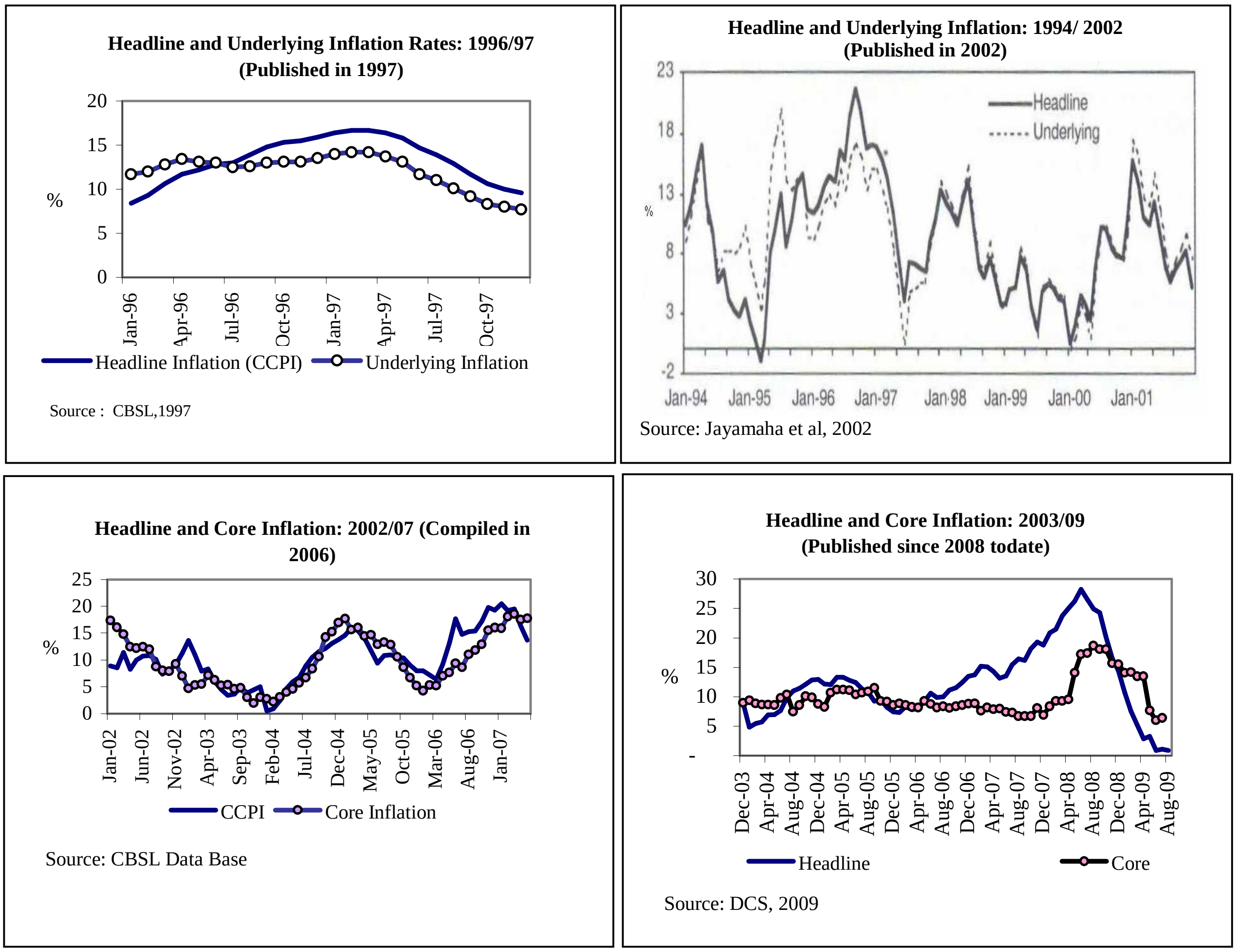
It is proven that headline inflation series in Sri Lanka owes sharp variations and therefore, CCPI would be frequently subject to distortions by such extreme price changes. Hence, in statistical terms, this implies that the CPI mean or 'headline' inflation rate may not be a 'robust' indicator of the general trend of inflation (Tahir, 2003).

b. Attempts to Measure Underlying Inflation in Sri Lanka

In 1997, the CBSL published its first set of core inflation numbers derived by removing items with administered prices (with a total weight of 16 per cent) from the CCPI (1952 =100) and those have been published for 24 months up to December 1997. It was perceived that this measure was not an exact measure of core inflation as it inherited several weaknesses those embedded with CCPI. Hence, it was suggested further refinements to obtain more appropriate indictor of core inflation (CBSL, 1997).

In 2002, Jayamaha and Others examined two measures of core inflation. One measure was compiled by removing components with administered prices, thus isolating only free prices. The other measure was a trimmed mean measure, which removes the most volatile items from the CCPI. However, the computation of the trimmed mean measure was reported as unsuccessful due to some technical problems and hence, a measure of core inflation was obtained by removing administered prices from the CCPI with the coverage of data being extended to 96 months from January 1994 to December 2001. Their study concluded that free prices respond not only to monetary policy measures, but also to administered price changes as any changes made to administered prices had an impact on free prices (Jayamaha et al, 2002).

Figure 5
Different Core Inflation Measures Compiled for Sri Lanka (1997-2008)



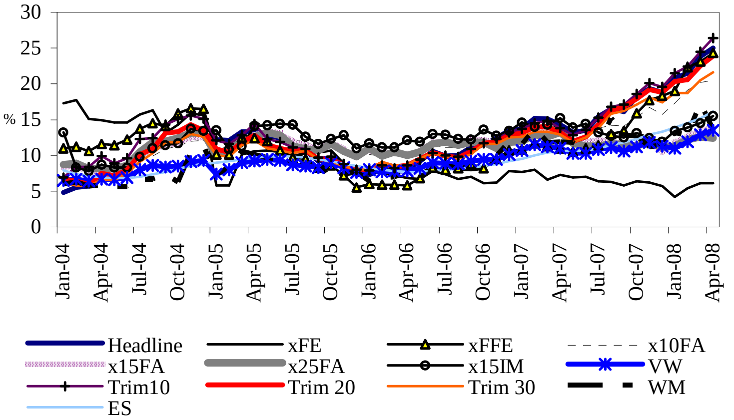
In 2006, the CBSL compiled an index to measure core inflation by excluding vegetables, fruits and fresh fish from the CCPI basket, in addition to the items with administered prices. However, this measure was not communicated explicitly to the general public and used only for internal policy purposes.

After adopting the new CCPI (2002=100), the CBSL commenced to derive a core inflation measure by removing the entire food basket and energy items (CBSL, 2007). This measure[23] has been communicated to the general public through press releases since early 2008 to date by the DCS.

[23] In this paper, the measure derived and published in this manner is referred as the official core inflation measure.

In 2008, Tennekoon presented a range of alternative core inflation measures, derived using the disaggregated components of new CCPI (2002 = 100) to evaluate the compliance of each measure with the desired qualities of a core inflation measure. These results also did not show that any of the measures were examined are superior to all other measures in all disciplines. In the meantime, he noticed that the measure, which excludes 10 most volatile food and administered items (x10FA), 30 per cent symmetric trimmed mean (Trim30), the volatility-based double-weighted measure (VW) and the exponentially smoothened measure (ES) stand relatively ahead other measures with regard to their compliance with desired characteristics of a core inflation measure (Tennekoon, 2008).

Figure 6: Headline and Alternative Core Inflation Measures - 2004/2008 (Compiled in 2008)



Source: Tennakoon,2008

Recently, Gupta and Saxegaard attempted to compare the performance of the official measure of core inflation against alternative measures of core inflation based on the same data set used by Tennekoon despite some differences in disaggregating levels, in order to assess the extent to which inflationary pressures in Sri Lanka remain important. Statistical tests confirmed that the official measure does contain information about the future path of headline information (Gupta and Saxegaard, 2009).

c. Need for Exploring Alternative Measures of Core Inflation for Sri Lanka

The official core inflation measure of the DCS that was commenced to publish since early 2008 is criticised in many dimensions. Tennekoon suggested that core inflation measure published by the DCS is inferior to alternative measures in several respects, and hence recommended moving to a more suitable alternative measure (Tennekoon, 2008). The findings of Gupta and Saxegaard indicated that the official measure of core inflation and the exclusion based measures are leading indicators of headline inflation (but not vice versa) and therefore, provide a useful indication of the future path of headline inflation. They however suggested that using the official measure of core inflation (as it currently stands) may be inadequate as a communication tool because of its apparent biasedness with respect to headline inflation. Hence, they suggested that designing of a more credible measure of core inflation for communication purposes (but not necessarily for the setting of monetary policy) should therefore be high on the policy agenda (Gupta and Saxegaard, 2009).

The current official core index is computed by removing food and energy categories, which accounts for 54.6 per cent of the total index. Removal of substantial percentage from the index may tend to assign unnecessary higher weight to items, which originally have lower weights and that could overestimate the behaviour of the core index. On the other hand, food and energy categories also have a certain component, which could respond to demand pressures in the economy and hence, removing the entire chunk of food and energy would tend to ignore such impacts. At the same time, current measure does not satisfy important statistical criteria. Precisely, as indicated in Table 5, it does not show a lower deviation from headline inflation, a significant positive correlation with money supply and lower forecast error with regard to the predictive power.

Table 5
Statistical Properties of Current Official Core Inflation Measure

Criteria	**Statistical Test/ Statistical Property/ Econometric Model**	**Attribute**	**Outcome**	
			Headline Inflation	**Current Official Core Inflation**
Key Moments of a Distribution	Mean	Central Location	12.19	9.91
	Standard Deviation	Spread/ Volatility	6.52	3.11
	Skewness	Asymmetry	0.50	1.30
	Kurtosis	Whether data are peaked or flat relative to a normal distribution	2.97	4.11
Representativeness	- Mean Absolute Deviation (MAD) - Root Mean Squared Error (RMSE)	Deviation from the reference series, i.e. headline inflation (a lower deviation is expected)	-	MAD = 5.0 RMSE = 6.0
Controllability	Correlation	Correlation with the movements in broad money supply (a high positive correlation is expected)	0.71	0.14
Predictability	Vector Error Correction Model*	Predictive power (a low forecast error is expected)	-	14.7

** Money Demand Model of the Economic Research Department of the CBSL : Based on In-sample Forecasts (Data up to December 2008 and Forecast for August 2009)*

In such context, the current official core inflation index may not be the most representative measure and hence, there exists a great need to explore alternative measures to track the underlying trend inflation in Sri Lanka.

IV. Compilation and Comparison of Alternative Measures of Core Inflation

a. Properties of Price Data

The present CCPI (2002=100) is based on the Household Income and Expenditure Survey (HIES) conducted by the DCS in 2002 and with a total basket value (in year) of Rs. 17,996.38 (CBSL, 2007). Although the index includes 334 different items, the analysis carried out in this paper is based on 211 items as some of the expenditure values are already averaged in the dataset of the DCS. In this study, disaggregated price data of the DCS were regrouped into 56 categories with a view to compile alternative core measures[24].

[24] The disaggregated price data of the DCS (expenditure values) are given in Annexure II and the list of 56 categories used in this study is given in Annexure III.

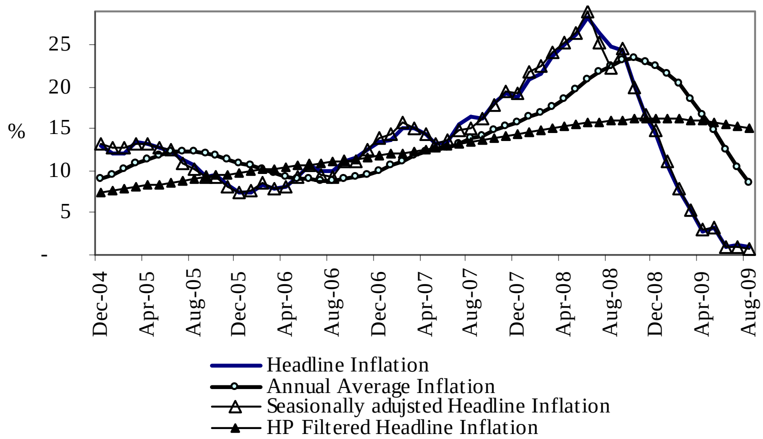
b. Compilation of Alternative Measures of Core Inflation

Based on the regrouped categories of the CCPI, a range of alternative measures of core inflation would be derived in the following sections using widely known methods such as averaging, seasonally adjusting, filtering, excluding, symmetric trimming, volatility weighing, median weighing, and exponentially smoothing[25].

i. Core Inflation Measures based on Smoothing Methods

Year-on-year headline inflation is smoothened using several techniques such as annual averaging, seasonally adjusting and HP filtering and is presented as alternative core inflation measures for Sri Lanka. These methods tend to reduce the noise of the price index and hence, headline CCPI is expected to be much smoother indicating the trend in general price levels. However as evident in Figure 7, although the annual average headline inflation show a smoothened trend over the period, seasonally adjusted headline inflation does not show any significant improvement in terms of volatility compared to the unadjusted (original) series indicating that it may not be a good measure of underlying inflation, which is free from volatility. Conversely, HP filtered headline inflation indicates more smoothened series, which is free from violent price variations (Exponentially smoothened measure is discussed separately).

Figure 7: Headline and Core Inflation (Year-on-Year Change) - Smoothing Method



ii. Core Inflation Measures based on Exclusion Method

Considering characteristics and volatility of items included in the basket, 12 alternative measures were compiled using the exclusion method. Accordingly, selected components such as food, energy, transport were excluded from the headline index and also some of the components were excluded based on the annual or monthly[26] volatility.

[25] Technical details and compilation procedure of each measure are given in the Annexure IV.
[26] Many researchers prefer to exclude items based on annual volatility as monthly percentage changes virtually contain so much noise (see Cecchetti, 1997, p. 154).

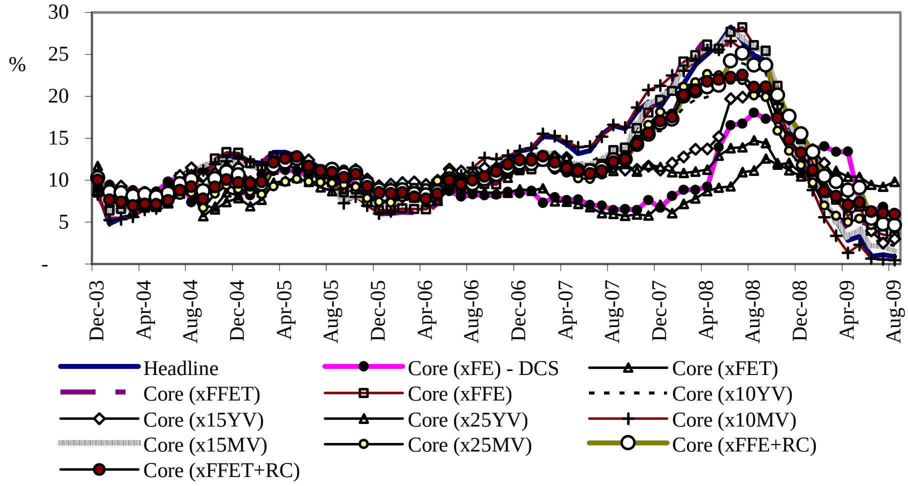
Table 6
Exclusion based Core Inflation Measures

	Measure	Code	Share of Categories Excluded from the Total Index (Total =100)
1	Core (Excluding Food & Energy)[a]	Core (xFE) - DCS	55.9
2	Core (Excluding Fresh Food & Energy) [b]	Core (xFFE)	20.6
3	Core (Excluding Food, Energy & Transport)	Core (xFET)	59.8
4	Core (Excluding Fresh Food, Energy & Transport)	Core (xFFET)	24.0
5	Core (Excluding Fresh Food, Energy, Rice & Coconut[c])	Core (xFFE + RC)	27.7
6	Core (Excluding Fresh Food, Energy, Transport, Rice & Coconut)	Core (xFFET + RC)	31.1
7	Core (Excluding 10 Most YOY[d] Volatile Items)	Core (x10YV)	18.5
8	Core (Excluding 15 Most YOY Volatile Items)	Core (x15YV)	29.3
9	Core (Excluding 25 Most YOY Volatile Items)	Core (x25YV)	45.0
10	Core (Excluding 10 Most Monthly[e] Volatile Items)	Core (x10MV)	10.4
11	Core (Excluding 15 Most Monthly Volatile Items)	Core (x15MV)	20.6
12	Core (Excluding 25 Most Monthly Volatile Items)	Core (x25MV)	39.9

[a] Similar to DCS's core inflation measure. However, DCS measure only excludes 54.6 per cent of the index as it does not consider some energy items included in other categories (eg: fuel and lubricants). However, only a negligible difference is observed and hence, both measures can be treated as identical.
[b] Similar to CBSL's core inflation measure in 2006
[c] Based on high volatility in rice and coconut prices
[d] Year-on-Year Changes
[e] Month-on- Month Changes

The trends in core inflation measures based on exclusion method are shown in Figure 8. It is evident that all the measures broadly follow the trend in headline inflation. It is also evident that reduction in volatility (improvement in smoothness) depends on the extent of exclusion, i.e. higher the exclusion lower the volatility or higher the exclusion higher the smoothness. Accordingly, measures, which exclude larger chunk from the overall index such as Core (xFE) - DCS, Core (xFET), Core (x25YV) and Core (x25MV), indicate lower volatility compared to other alternative measures.

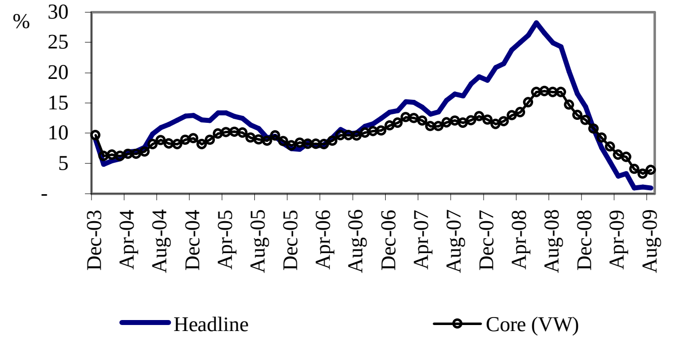
Figure 8: Headline Core Inflation
(Year -on -Year Change) - Exclusion Method



iii. Core Inflation Measures based on Volatility Weighted Method

The volatility weights method does not exclude any of the items from the index. Hence, instead removing, weights of more volatile items are down weighted and assigned to less volatile items, in proportion to the inverse of the standard deviation of year-on-year price changes of each of 56 categories. This approach leads to reduce the high volatility in headline index as shown in Figure 9.

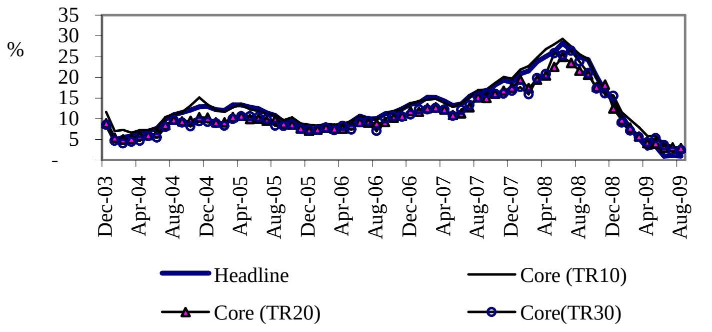
Figure 9: Headline and Core Inflation
(Year - on -Year Change) - Volatility Weighted Method



iv. Core Inflation Measures based on Trimmed Mean Method

This method is based on trimming extreme price changes of the upper and lower ends of the price distribution, i.e. symmetric trimming. Accordingly, 10 per cent, 20 per cent and 30 per cent of the extreme price changes were trimmed[27]. Different sets of categories were excluded each month depending on the volatility in contrast to the exclusion based measures, which remove the same set of categories consistently.

Figure 10: Headline and Core Inflation
(Year - on - Year Change) - Trimmed Mean Method

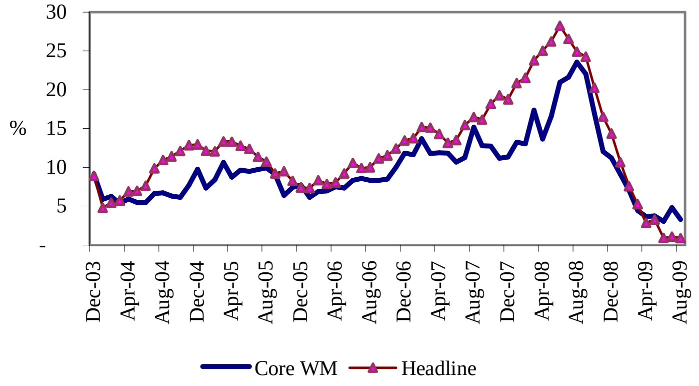


v. Core Inflation Measures based on Weighted Median Method

The weighted median approach, a similar method to trimmed mean, trims all mid points of price changes. Core inflation derived this manner also broadly follows the trend in headline inflation despite some volatility.

[27] However, the selection of upper and lower points of the price data distribution to truncate is a matter of judgment.

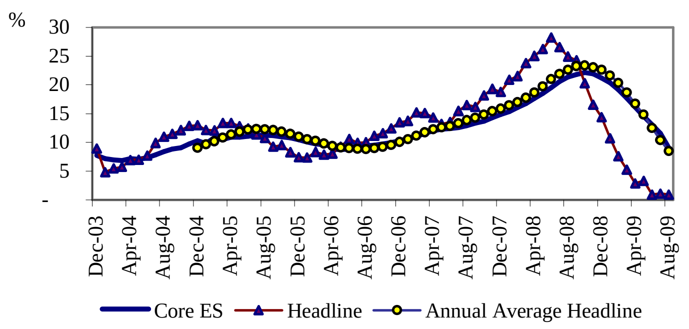
Figure 11: Headline and Core Inflation (Year -on -Year Change) - Weighted Median Method



vi. Core Inflation Measures based on Exponentially Smoothing Method

This method does not use disaggregated price data, but smoothens headline inflation exponentially in order to ascertain its underlying trend. Accordingly, core inflation based on the exponential smoothing method was derived using 60-month lagged values of each data point in headline inflation series. As indicated in Figure 12, this method essentially smoothes high volatility in headline inflation series and the core measure derived using this approach broadly follows the trend in annual average headline inflation.

Figure 12: Headline and Core Inflation (Year -on -Year Change) - Exponentially Smoothing Method



c. Comparison of Alternative Measures of Core Inflation

In order to produce representative core inflation measures for Sri Lanka, this paper presents 21 alternative measures. However, introducing a large number of alternatives could complicate the exercise identifying more appropriate or representative core inflation measures. This is because different core inflation measures provide different results[28], and hence, such differences naturally lead confusions in policy making. However, compilation of large series of indices would help in gauging the overall trend in country's inflation that could broadly capture the economic behaviour. This is particularly so in the Sri Lankan context as all the measures, which are presented in this paper,

[28] In 2004, Heath provided an exhaustive analysis of 102 different measures of core inflation using Australian data, and illustrated how the alternative approaches can provide quite different results (Cockerell, 1999).

indicate a similar trend with headline inflation. Also, trends in alternative core inflation measures do not deviate significantly from its underlying trend despite few exceptions. On the other hand, a series of alternative measures may be useful in policy making as different measures can serve for different policy purposes (Gupta and Saxegaard, 2009).

The visual depiction of movements of alternative core inflation measures is presented in Figure 13 and a summary is given in Table 7[29].

Figure 13: Headline and Alternative Core Inflation Measures (Year-on-Year Changes)

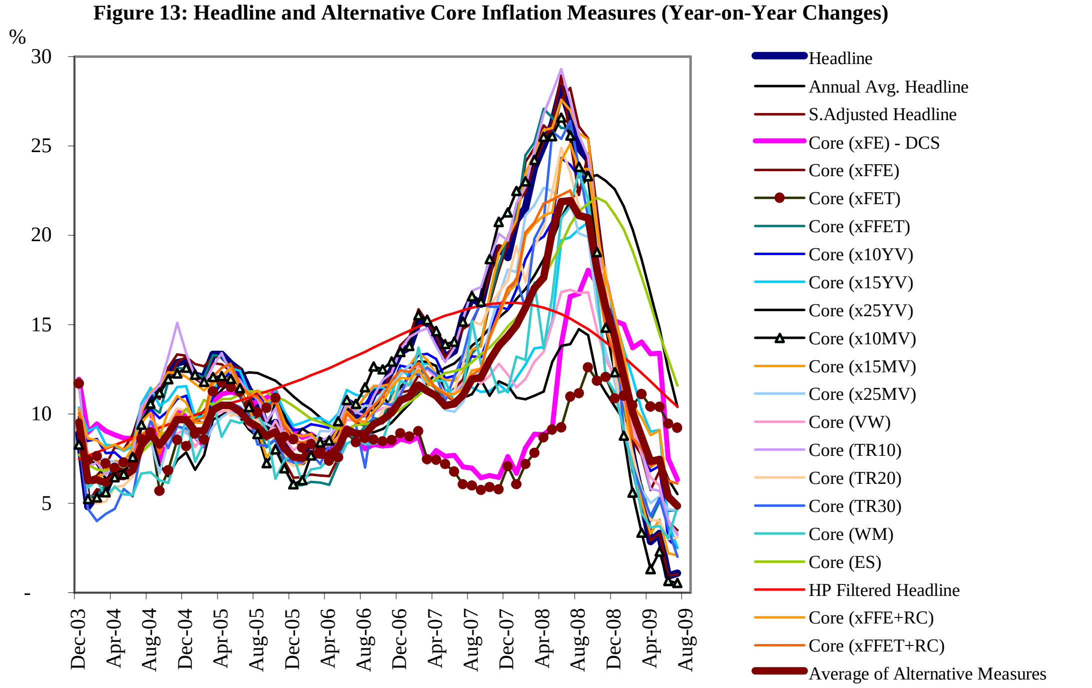


Table 7

Summary of Headline Inflation and Alternative Measures of Core Inflation (Year-on-Year Changes)

Period	Headline	Alternative Measures of Underlying/ Core Inflation: Annual Average Headline	Seasonally Adjusted Headline	HP Filtered Headline	Core (xFE) - DCS	Core (xFFE)	Core (xFET)	Core (xFFET)	Core (xFFE +RC)	Core (xFFET +RC)	Core (x10YV)	Core (x15YV)
Dec-03	8.9		9.0	7.5	12.0	8.5	11.7	8.2	10.3	10.1	10.2	10.4
Dec-04	13.0	9.0	13.2	9.8	9.9	13.3	8.2	12.5	10.6	9.7	11.0	11.6
Dec-05	7.4	11.0	7.5	11.8	9.1	6.4	8.6	6.0	8.8	8.5	9.1	9.3
Dec-06	13.5	10.0	13.8	14.4	8.6	11.2	8.9	11.5	12.0	12.4	12.7	12.5
Dec-07	18.8	15.8	19.3	16.2	7.6	19.6	7.1	19.9	16.8	17.0	15.9	11.2
Dec-08	14.4	22.6	14.8	13.6	15.2	14.9	10.9	12.8	15.5	13.3	14.9	15.4
Aug-09	0.9	8.5	0.8	9.9	6.8	3.3	9.8	4.4	4.6	5.9	2.2	3.0

Period	Headline	Core (x25YV)	Core (x10MV)	Core (x15MV)	Core (x25MV)	Core (VW)	Core (TR10)	Core (TR20)	Core (TR30)	Core (WM)	Core (ES)	Average (21 Measures)
Dec-03	8.9	9.8	8.3	9.3	10.3	9.6	11.7	8.9	8.5	9.2	7.7	**9.1**
Dec-04	13.0	7.9	12.6	12.1	8.9	9.1	13.4	10.2	9.2	9.8	10.3	**10.6**
Dec-05	7.4	8.6	6.1	7.1	7.4	8.0	8.5	7.1	7.3	7.7	10.5	**8.3**
Dec-06	13.5	11.5	13.5	12.2	12.2	11.3	13.6	11.8	11.0	11.9	10.3	**11.8**
Dec-07	18.8	11.6	21.3	19.9	18.1	12.2	19.7	17.5	16.7	11.4	14.9	**15.7**
Dec-08	14.4	10.4	12.4	14.2	11.8	12.2	15.6	12.4	15.5	11.2	21.2	**14.3**
Aug-09	0.9	5.1	0.5	1.5	5.0	3.9	2.6	2.9	2.4	3.3	9.1	**4.5**

[29] The monthly series of core inflation measures for the entire period are given in Annexure V.

Table 8 presents four important central moments of a distribution (i.e., mean, standard deviation, skewness and kurtosis) and provides valuable information to determine the most efficient measure of central tendency with regard to each of the various inflation measures.

Table 8

Moments of Headline and Alternative Core Inflation Measures

	Measure of Inflation	Mean	Median	Maximum	Minimum	Std. Dev.	Variability	Skewness	Kurtosis
1	Headline	12.5	12.1	28.2	0.9	6.3	0.5	0.6	3.0
2	Annual Average Headline	13.9	12.3	23.4	8.8	4.6	0.3	0.8	2.4
3	Seasonally Adjusted Headline	12.5	11.9	28.9	0.8	6.3	0.5	0.6	3.0
4	HP FilteredHeadline	12.5	12.6	16.2	7.5	2.7	0.2	-0.18	1.8
5	Core (xFE) - DCS	9.9	8.8	18.0	6.3	2.9	0.3	1.3	3.8
6	Core (xFFE)	12.3	11.1	28.2	3.3	6.2	0.5	1.2	3.5
7	Core (xFET)	8.8	8.6	12.6	5.7	1.8	0.2	0.2	2.2
8	Core (xFFET)	11.8	11.0	27.1	4.0	6.1	0.5	1.1	3.4
9	Core (xFFE + RC)	12.1	10.9	25.1	4.6	4.7	0.4	1.3	4.0
10	Core (xFFET + RC)	11.6	10.7	22.5	5.9	4.4	0.4	1.2	3.5
11	Core (x10YV)	12.0	11.0	24.3	2.2	4.7	0.4	0.8	3.8
12	Core (x15YV)	11.5	11.3	20.7	2.5	3.3	0.3	0.5	5.2
13	Core (x25YV)	9.8	9.9	14.8	5.1	2.2	0.2	0.08	2.5
14	Core (x10MV)	12.2	11.9	26.6	0.5	6.6	0.5	0.5	2.7
15	Core (x15MV)	12.3	11.6	27.6	1.5	6.3	0.5	0.9	3.4
16	Core (x25MV)	11.1	9.8	22.6	4.6	4.7	0.4	1.1	3.5
17	Core (VW)	10.0	9.6	17.0	3.3	3.0	0.3	0.3	3.2
18	Core (TR10)	13.2	11.9	29.3	2.6	6.1	0.5	0.9	3.3
19	Core (TR20)	11.0	9.7	24.9	2.9	5.2	0.5	0.8	3.1
20	Core (TR30)	10.9	9.4	26.4	2.0	5.6	0.5	1.0	3.6
21	Core (WM)	9.8	9.1	23.5	3.0	4.4	0.5	1.1	4.3
22	Core (ES)	12.4	11.0	22.1	6.8	4.3	0.3	0.9	2.8

The sample mean, which is simply the weighted sum of the individual price changes, indicate that the mean of core inflation measures ranges from 8.8 per cent to 13.9 per cent. The second moment, the variance of the distribution is a measure of the dispersion of the distribution and the standard deviation is the square root of the variance. If core inflation measures properly capture trend inflation, they should be less volatile than headline inflation. It is clearly noted that alternative core measures such as seasonally adjusted headline, xFFE, xFFET, x10MV and TR10 do not reduce volatility as they record more or less the same standard deviation of headline measure. In terms of variability, defined as the standard deviation divided by the mean, core measures such as HP filtered headline, xFET and x25YV show improved variability as they record lower variability and many of other core measures still record relatively higher variability.

It is important to consider whether there is any correlation between different moments. This is of importance especially when considering whether the skewness and kurtosis are independent of the mean of the distribution of price changes.

Table 9

Correlation between Moments of Core Inflation

Moment	Mean	Std. Dev.	Skewness	Kurtosis
Mean	1.00	0.65	0.11	-0.13
Std. Dev.	0.65	1.00	0.52	0.15
Skewness	0.11	0.52	1.00	0.57
Kurtosis	-0.13	0.15	0.57	1.00

Table 9 indicates that there is a correlation of 0.65 between the mean of and the standard deviation[30]. The mean appears to be positively correlated with the skewness of the distribution. The positive correlation between the mean and skewness of the distribution has implications for the construction of a statistical measure of core inflation. At the same time, the kurtosis of the distribution appears to be negatively correlated with the mean. This feature also needs to be considered particularly when constructing a statistically-based measure of core inflation (Meyler, 1999).

d. Selecting Representative Measures of Core Inflation for Sri Lanka

Since core inflation measures are important tools for policy, it would be imperative to assess them based on the suitability for various policy purposes. However, as explained in the previous section, moments of alternative measures of core inflation provide different and mixed results and as a result, the selection process of representative measures becomes more complex. At the same time, as in the case of definition and compilation, evaluation of core measures is complicated by the fact that there are no formal or standard criteria by which the accuracy of a core inflation measure can be assessed. Hence, several criteria are proposed and discussed in literature in order to select a suitable measure of core inflation[31]. The expected characteristics of a representative core inflation measure can be summarised as in Table 10.

Table 10
Key Characteristics of a Representative Core Inflation Measure

Characteristics	Attribute
Timeliness	It should be possible to compute core inflation measure simultaneously with publishing of headline inflation
Acceptability	Published core measures should be acceptable to the general public
Smoothness	Core measures should be free from temporary fluctuations
Representativeness	Core inflation should track the long-term trend of headline inflation
Controllability	Core inflation should be correlated with the movements of money supply
Predictability	Core inflation should be useful in measuring the future movements of headline inflation

Source: Tennakoon, 2008

From the perspective of monetary policy, predictability is the most important criterion as it suggests whether core inflation measure can be used as a guiding indicator in conducting monetary policy. As there is no rationale of investigating predictability of all the measures presented in this paper, it would be imperative to identify the most representative measures. In order to select the most representative measures of core inflation, two main approaches can be used; (i) examining the representativeness or the absence of bias (direction of headline inflation), and (ii) investigating the controllability (link with monetary aggregates).

[30] Correlations between the moments of inflation are examined in many research attempts. For example, the mean of inflation is shown to be positively correlated with both the dispersion and skew in the sample distribution of inflation in Australia and the skew and kurtosis are also shown to be positively correlated. Such observations are not unique to Australia with similar distributional characteristics found in many countries (see Bryan and Cecchetti, 1993; Roger, 1997; Cockerell, 1999; Melyer, 1999).
[31] See Annexure VI for different criteria suggested in literature.

i. Representativeness or the Absence of Bias

A representative core inflation measure that can be used for policy purposes, should track the long-term movements in headline inflation. This indicates that both core and headline inflation must share the same long-term trend. Accordingly, core inflation should be unbiased relative to headline inflation implying that in the long-run, the difference between average of headline and core inflation must be zero. The idea of the absence of bias supports the claim that only short-term shocks are excluded from core inflation measures (Laflèche, and Armour, 2006). Moreover, it is expected that divergence between headline and core inflation is temporary, i.e. headline inflation may deviate from core inflation in the short-run, but converges in the long-run.

Several criteria can be used to trace the direction of headline inflation using a core series (Silver, 2006; Tennekoon, 2008) as given in equations 4 to 6.

- Deviation of the mean (MD) from headline inflation:

$$\text{MD} = \text{Mean}\,(\pi_t) - \text{Mean}\,(\pi_t^c) \qquad (4)$$

- Mean absolute deviation (MAD) from the headline inflation series:

$$\text{MAD} = \left(\frac{1}{n}\right)\sum_{i=1}^{n}\left|\pi_t^c - \pi_t\right| \qquad (5)$$

- Root mean square error (RMSE) from the headline inflation series[32]:

$$\text{RMSE} = \sqrt{\left(\frac{1}{n}\right)\sum_{i=1}^{n}(\pi_t^c - \pi_t)^2} \qquad (6)$$

where,

π_t^c : Core Inflation

π_t : Headline Inflation, and

n : Number of Observations

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[32] Based on Vega and Wynne (2003), Pederson suggests the equation: $RMSE = \sqrt{\sum_{t=1}^{T}(\Pi_t^* - \overline{\Pi}_t)^2 / T}$ where Π_t^* is the core inflation candidate at date t, $\overline{\Pi}$ is the trend inflation, and T is the total number of observations. This method evaluates the performance by the ability to track the underlying trend in the headline inflation defined using the Hodrick-Prescott filter with smoothing parameter λ = 14, 400 as observations are monthly (Pederson, 2006). The same equation was used by Silver (2006). Following Clark (2001), Rich and Stendal computes RMSE of the difference between trend inflation and core inflation using the equation: $RMSE^{CORE} = \sqrt{\sum_{t}^{T}(\pi_t^{TREND} - \pi_t^{CORE}{}_t)^2 / T}, t = 1,...T$ to as a measure of volatility to determine if a core inflation measure provides an accurate read of trend inflation (Rich and Stendal, 2005).

The results of statistical methods such as MD, MAD and RMSE are given in Table 11.

Table 11
Representativeness of Alternative Core Inflation Measures

	Measure	MD	MAD	RMSE	Level of Representativeness
1	Headline Annual Average	(1.32)	4.11	5.38	Low
2	Headline Seasonally Adjusted	(0.00)	0.33	0.52	High
3	HP Filtered Headline	0.00	3.72	4.84	Moderate
4	Core (xFE)	2.63	5.16	6.78	Low
5	Core (xFFE)	0.25	1.42	1.67	High
6	Core (xFET)	3.72	5.56	7.51	Low
7	Core (xFFET)	0.67	1.38	1.69	High
8	Core (xFFE + RC)	0.40	2.10	2.55	High
9	Core (xFFET + RC)	0.87	2.08	2.59	High
10	Core (x10YV)	0.47	1.81	2.21	High
11	Core (x15YV)	1.04	2.96	4.08	Moderate
12	Core (x25YV)	2.75	3.96	5.43	Low
13	Core (x10MV)	0.31	0.83	1.03	High
14	Core (x15MV)	0.26	0.85	1.09	High
15	Core (x25MV)	1.43	2.27	2.76	Moderate
16	Core (VW)	2.51	3.23	4.43	Moderate
17	Core (TR10)	(0.68)	0.84	1.15	High
18	Core (TR20)	1.48	1.80	2.11	High
19	Core (TR30)	1.57	1.87	2.23	High
20	Core (WM)	2.69	3.04	3.88	Moderate
21	Core (ES)	0.12	3.74	4.99	Moderate

It is evident that some of the core measures such as seasonally adjusted headline, xFFE, xFFET, xFFE+RC, xFFET+RC, x10YV, x10MV, x15MV, TR10, TR20 and TR 30 are relatively representative whereas measures such as annual average headline, xFE- DCS, xFET and x25YV appeared to be weak in terms of tracking long-term inflation.

ii. Controllability

Core inflation measures should be controllable through demand management policies, particularly through monetary policies. Accordingly, core inflation measure, which is expected to better represent the demand-driven inflation, has to be closely correlated with the (lagged) movements of monetary aggregates. The controllability of alternative core inflation measures is reflected by correlation coefficients of those measures with lagged changes in money supply[33]. Results of the controllability tests are presented in Table 12.

[33] A measure of core inflation that is designed to capture "monetary" inflation might also be evaluated by the extent to which it is (Granger) caused by some measure of the money stock but does not (Granger) cause money (Bank of International Settlements, Workshop Proceedings, __page 26).

Table 12
Correlation between Lagged Monetary Growth and Inflation

	Measure	Reserve Money		Narrow Money		Broad Money		Controllability
		RM (-18)	RM (-30)	M1 (-18)	M1 (-30)	M2b (-18)	M2b (-30)	
1	Headline Inflation	0.35	0.30	0.08	0.60	0.09	0.71	High
2	Annual Average Headline	0.15	0.23	-0.45	-0.03	0.15	0.62	Moderate
3	Seasonally Adjusted Headline	0.34	0.31	0.07	0.61	0.09	0.71	High
4	HP Filtered Headline	0.55	0.71	0.10	0.80	0.63	0.76	High
5	Core (xFE) - DCS	0.12	-0.05	-0.24	-0.21	-0.02	0.14	Low
6	Core (xFFE)	0.27	0.28	-0.12	0.50	0.00	0.74	High
7	Core (xFET)	0.04	-0.02	-0.17	-0.17	-0.14	-0.05	Low
8	Core (xFFET)	0.27	0.31	-0.09	0.56	-0.01	0.74	High
9	Core (xFFE + RC)	0.38	0.28	-0.09	0.46	0.11	0.69	High
10	Core (xFFET + RC)	0.39	0.33	-0.04	0.57	0.11	0.71	High
11	Core (x10YV)	0.43	0.26	0.06	0.51	0.17	0.66	Moderate
12	Core (x15YV)	0.41	0.17	0.14	0.34	0.18	0.52	Moderate
13	Core (x25YV)	0.60	0.35	0.32	0.56	0.48	0.59	Moderate
14	Core (x10MV)	0.36	0.32	0.11	0.64	0.12	0.72	High
15	Core (x15MV)	0.34	0.27	-0.01	0.56	0.06	0.70	High
16	Core (x25MV)	0.45	0.30	-0.01	0.59	0.17	0.68	Moderate
17	Core (VW)	0.48	0.32	0.19	0.56	0.30	0.67	Moderate
18	Core (TR10)	0.34	0.31	-0.02	0.58	0.10	0.73	High
19	Core (TR20)	0.39	0.33	0.01	0.60	0.16	0.73	High
20	Core (TR30)	0.41	0.35	-0.01	0.59	0.17	0.73	High
21	Core (WM)	0.38	0.30	0.11	0.49	0.19	0.67	Moderate
22	Core (ES)	0.26	0.52	-0.41	0.36	0.28	0.72	High

Note: (-18) indicates 18 Month Lagged Money Growth and (-30) indicates 30 Month Lagged Money Growth. Significant correlation coefficients are highlighted in shaded form.

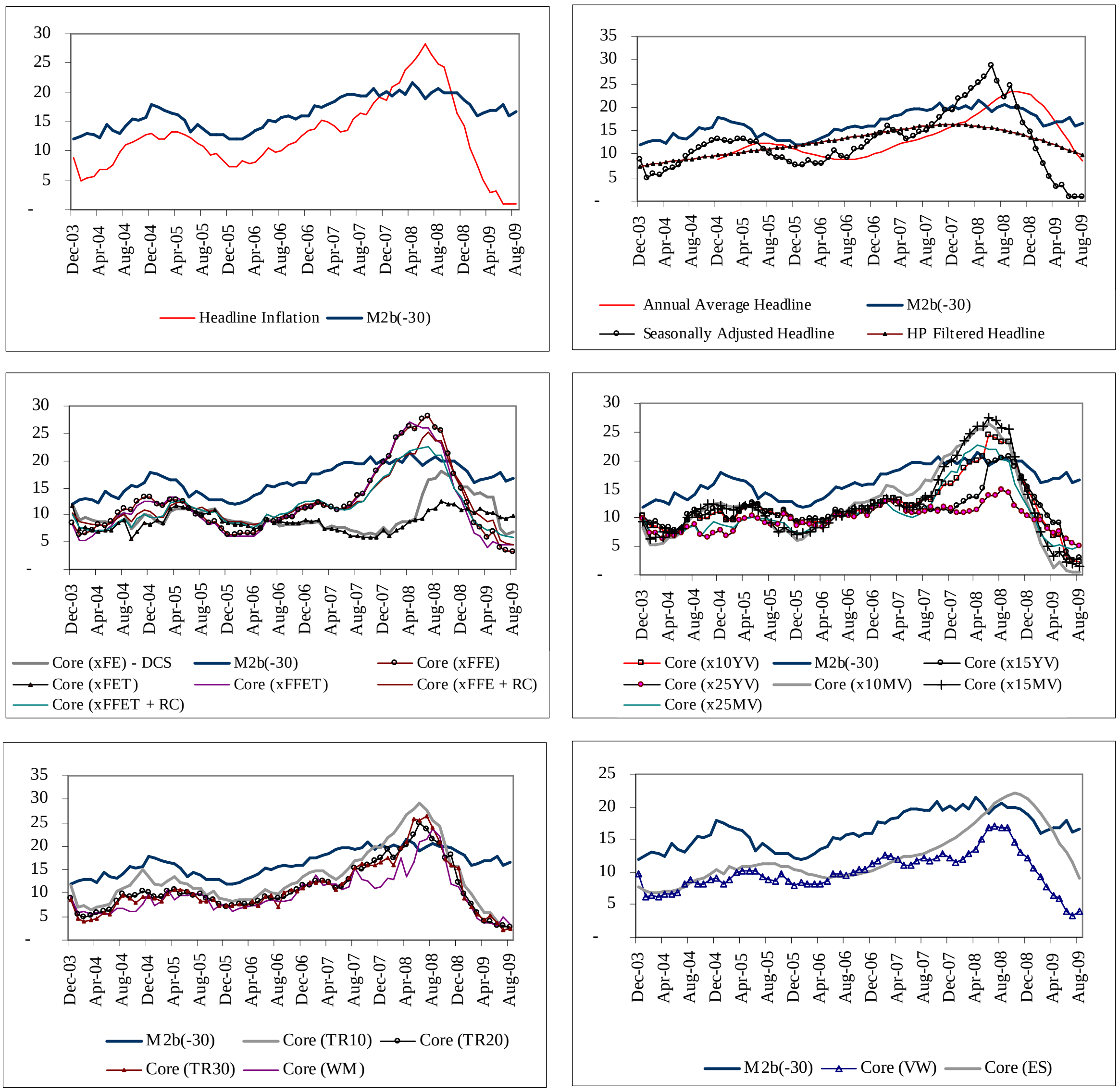
According to Table 12, none of the inflation measures shows significant correlation with reserve money and narrow money. This may be due to the negative growth rates recorded in reserve money and narrow money particularly during the period 2008 - 2009. Correlation coefficient indicates that core measures, which exclude a significant portion from the headline index, i.e. xFE-DCS and xFET show relatively weak correlation with nominal money growth while core inflation measures such as seasonally adjusted and HP filtered headline, some of the exclusion based measures (xFFE, xFFET, xFFE+RC, xFFET+RC, x10MV and x15MV), all the trimmed mean measures and Core (ES) indicate strong correlation with money, particularly broad money as measured by M2b[34].

Graphical illustration presented in Figure 14 also confirms correlation between lagged monetary growth with both headline and core inflation measures.

[34] M2b includes currency, demand deposits and time and savings deposits of Domestic and Offshore Banking Units in Sri Lanka.

Figure 14

Correlation between Lagged Monetary Growth and Inflation*



** Year-on-year percentage changes in broad money supply and price indices*

Table 13 summarises the representativeness and the controllability criteria and provides a better insight in selecting representative core measures, which is useful to carryout the analysis in the next section.

Table 13
Summary of Representativeness and Controllability of Alternative Core Inflation Measures

	Measure	Representativeness	Controllability
1	Headline Inflation	-	High
2	Headline Annual Average	Low	Moderate
3	Headline Seasonally Adjusted	High	High
4	HP Filtered Headline	High	High
5	Core (xFE) - DCS	Low	Low
6	Core (xFFE)	High	High
7	Core (xFET)	Low	Low
8	Core (xFFET)	High	High
9	Core (xFFE + RC)	High	High
10	Core (xFFET + RC)	High	High
11	Core (x10YV)	High	Moderate
12	Core (x15YV)	Moderate	Moderate
13	Core (x25YV)	Low	Moderate
14	Core (x10MV)	High	High
15	Core (x15MV)	High	High
16	Core (x25MV)	Moderate	Moderate
17	Core (VW)	High	Moderate
18	Core (TR10)	High	High
19	Core (TR20)	High	High
20	Core (TR30)	Moderate	High
21	Core (WM)	Moderate	Moderate
22	Core (ES)	Moderate	High

As highlighted in Table 13, about 13 measures can be identified as most representative in terms of tracking trend inflation and correlating with money supply. In the next section, the validity of using core inflation to gauge underlying trend inflation in Sri Lanka, based on selected representative measures, would be examined.

However, all representative measures were not considered for predictability tests. At the same time, some of the moderate or low representative measures were also considered. For example, although seasonally adjusted headline and, Core (TR10) measures are highly representative according to criteria discussed here, those measures were not considered for further analysis as the movements of those measures are broadly similar to the headline index. It is evident that seasonal adjustment does not improve the variability of headline index and also, 10 per cent trimming does not show significant impact on headline index. The same can be observed with regard to Core (x10MV). At the same time, although the official core measure (xFE-DCS) is a relatively poor measure in terms of representativeness and controllability, it is included in the predictability analysis. Accordingly, only the following measures will be used for predictability tests.

- HP Filtered Headline
- Core (xFFE)
- Core (xFFET)
- Core (xFFE +RC)
- Core (xFFET +RC)
- Core (x10YV)
- Core (x15MV)
- Core (TR20)
- Core (TR30)
- Core (VW)
- Core (ES)
- Core (xFE) - DCS

V. EVALUATING THE VALIDITY OF USING CORE INFLATION AS A GUIDING INDICATOR IN CONDUCTING MONETARY POLICY

a. Review of the Previous Research

The importance of core inflation as a major policy input or precisely as a leading indicator in the conduct of monetary policy has been widely reviewed in literature. Amongst the key aspects, the ability of the different core measures to indicate the future path of headline inflation, i.e. predictability, is considered as the most important characteristic with regard to policy significance[35].

This simply means that a good measure of core inflation should be expected to serve as a good predictor of future trends in inflation.

In Bryan and Cecchetti's work on core inflation, the primary motivation was to find a measure that is highly correlated with monetary growth. They investigated the ability of money growth to forecast each of the alternative inflation measures using simple regressions. As such, they looked at the ability of the monetary base, narrow money and broad money to forecast the average level of inflation for a period of one to five years. It was found that the past year's money growth is most highly correlated with the changes in core inflation (computed as weighted median and 15 per cent trimmed mean). Thereafter, they conducted a series of Granger style tests to establish where changes in money growth actually forecast changes in inflation based on the ability of past inflation to forecast. In forecasting, Bryan and Cecchetti proceeded with two related directions. First, univariate forecasts, which showed that core inflation does a slightly better job than inflation in either the All Items CPI or the CPI excluding food and energy, were produced. They noticed two important facts, which confirmed the general impression about the difficulty of forecasting inflation and appropriateness of core measures in providing best forecasts at long horizons. Second, they observed a marginal forecasting power of core inflation when it is added to a multivariate equation including money, output and interest rates and that also essentially produced the same result (Bryan and Cecchetti, 1993).

Although the predictive ability can be examined and verified in different ways, the common approach is based on the premise that if current overall inflation differs from the underlying trend rate, overall inflation should move towards trend. As such, with core inflation corresponding to the underlying inflation trend, when current overall inflation is below core, overall inflation should rise (Clark, 2001). Thus, the predictive content in alternative measures of core inflation can be gauged by estimating regressions for the future changes in overall inflation and comparing the gap between core and overall inflation. Based on this principle, Clark quantified the ability of core inflation to predict future overall inflation by using monthly data to estimate the following regression:

$$(\pi_{t+h} - \pi_t) = a + \beta(\pi_t^{Core} - \pi_t) + \varepsilon_t \qquad (7)$$

where, π denotes overall CPI inflation and π^{Core} refers to one of the indicators of core inflation, both measured on a year-over-year basis. The parameter h takes the values of 12 and 24 (months). Accordingly, the current gap between core and overall inflation predicts how much overall inflation will change over the next one or two years. At the same time, there exists a possibility of adding

[35] However, this criterion is not entirely independent from the ability to track trend inflation. This is because tracking long-term inflation itself indicates the forecasting power of core inflation. To the extent that core measures reflect persistent sources of inflationary pressure, it can be considered as an attractor for future inflation. Thus a measure that tracks headline inflation would help to forecast future inflation (Vega and Wynne, 2001).

many other variables useful for forecasting inflation. Clark's estimates of regression indicated that core measures with the most predictive content for future overall inflation are the trimmed mean (with and without adjustment), median CPI, and CPI excluding energy. Although all core measures were considered to have significant predictive power for overall inflation one year ahead, the regression R^2s were highest only for these three indicators. The results for two-year-ahead inflation prediction had also followed the same basic pattern (Clark 2001).

The same principle was investigated by Laflèche and Armour (2006) and mentioned that forecasting power or the predictive ability of core inflation measure is fundamentally driven by the convergence property. Generally, it is expected that divergences between headline and core inflation to be temporary. The following equations can be estimated as a common way to test the hypothesis that divergences between headline and core inflation are only temporary:

$$(\pi_{t+h} - \pi_t) = \alpha + \beta(\pi_t^{Core} - \pi_t) + u_t \qquad (8)$$

$$(\pi_{t+h}^{Core} - \pi_t^{Core}) = a + B(\pi_t - \pi_t^{Core}) + v_t \qquad (9)$$

where $(\pi_{t+h} - \pi_t)$ is the change in headline inflation, $(\pi_{t+h}^{Core} - \pi_t^{Core})$ is the change in core inflation, u_t and v_t are random error terms, and h is the time horizon.

The basic premise behind these equations is that if core inflation is above headline inflation, total CPI must have been hit by a specific shock, which will generally be reversed. Total CPI inflation should therefore be expected to increase in the future ($\beta > 0$), but core inflation should be unaffected ($B =$ 0). If the restriction $\alpha = 0$ and $\beta = 1$ holds, equation (8) collapses to: $\pi_{t+h} = \pi_t^{Core} + u_t$. In that case, core inflation is an unbiased predictor of total inflation.

Based on this principle, Laflèche and Armour proved that it is not possible to reject the joint hypothesis (with 95 per cent confidence) for any of the core measures considered; nor is it possible to reject the hypothesis that , suggesting that all the core measures are unbiased predictors of headline inflation. This also means that deviations between core and headline inflation are not persistent and that headline inflation moves towards core rather than vice versa. Hence, it was confirmed that core inflation measures are better than headline inflation itself in forecasting future headline inflation. In summary, these results confirmed that all the measures of core inflation are unbiased predictors of headline inflation and contain more information about the future trend of inflation than headline inflation itself.

Many researchers have confirmed that even though the compilation is relatively complicate and affected by data issues, statistical measures of core inflation produce better results. In examining the case of Australia, based on Roger (1997), Cockerell (1999) found some support to the Granger-causality tests suggesting that statistical measures have superior properties in forecasting. It was also noticed that they lend some support to the notion that the Phillips curve is the best specified in terms of core rather than headline inflation.

Examining the Peruvian case, Morón and Zegarra (1999) confirmed that in all cases the latent - Quah inflation is far more predictable than any other inflation measure as results of those were robust changing the long-term forecast horizon from 24 to 12 months. They claimed that their result was robust to different choices of long-term forecast comparison, lag selection rules, and to the correction of small sample bias. As such, they argued that core inflation measured by the Quah and Vahey (1995) procedure is always more predictable than the Peruvian Central Bank's choice, i.e. adjusted mean core inflation. However, they admitted that this measure is the most difficult to understand for the public although it was qualified as the most adequate measure of core inflation to predict. As such, they suggested that the Peruvian Central Bank should keep using the CPI inflation to announce inflation targets but should use the Quah-style inflation as the guide for monetary policy.

In order to evaluate the ability of the different measures to forecast future inflation, Vega and Wynne (2001) examined how well they detected changes in the headline inflation rate for 18 months in the future. More precisely, they investigated the average annual CPI inflation rate over the consequent 18 months. The choice of this horizon was motivated by conventional understanding about the lags in the monetary policy transmission process. They examined the root mean square forecast error (RMSFE) as a function of trim for the trimmed mean measures along with the RMSFEs for excluding energy and seasonal food measure. Accordingly, they evaluated the forecasting performance of the different measures in terms of their average deviation from inflation over the next 18 months. At the most disaggregated four-digit level, the trimmed mean outperformed the traditional excluding energy and seasonal food measure, which trims up to about 25 per cent. At the three-digit aggregation level, the disaggregated data suggested that the trim measure outperforms the traditional measure for most values of the trim. They noticed that a measure, which does well track a trend defined as a 36-month centred moving average of headline inflation probably also does reasonably well forecasting headline inflation 18 months ahead (Vega and Wynne, 2001).

Berkmen (2002) observed the predictability aspect in terms of informational context. As such, he stated that long-term trend in core inflation should be in line with the trend in headline inflation; otherwise, some information can be lost. Hence, it should have some predictive power of the future headline inflation and hence, there should be a close relationship between the measured inflation and core inflation measure. Besides, core inflation measure should Granger cause headline inflation. In order to test whether these conditions are satisfied or not, Engle-Granger two-step cointegration procedure was employed based on Freeman (1998). In this respect, it was shown that trimmed mean estimators of inflation move in line with headline inflation in the long-run. He found a cointegration relation between trimmed mean estimators and headline inflation rates, indicating a close long-run relationship. However, bivariate Granger causality indicated a weak potential for long-term inflation forecasting.

Griffiths and Poshyananda tested the predictive ability for core measure excluding raw food and energy in Thailand by running regressions. To evaluate how well each core measure predicts the future inflation trend, they compared current core inflation with inflation 6, 12 and 18 months ahead and found that core measure excluding raw food and energy performs well as it is the only core measure with RMSE and MAD statistics consistently lower than the corresponding values for headline inflation. They also highlighted the issue related to the predictive power of core measures as some prices in the CPI basket tend to lead other prices. This suggests that a larger proportion of lead items in the inflation measure will tend to improve its predictive power. Hence, they did not exclude lead items in constructing core inflation. In this exercise, they used Granger causality tests to determine whether or not a subcomponent of the CPI is likely to contain some leading information. They concluded that monthly changes are likely to Granger cause the monthly changes of the remaining CPI basket. Causality test results suggested that raw food is likely to contain leading information, so the exclusion of raw food from core measure (whether or not energy is also excluded) is likely to result in some loss of timely price signals (Griffiths and Poshyananda, __).

Durai and Ramachandran investigated cointegrations of core and headline inflation for India. Results indicated that core measures derived using trimmed mean, weighted median and common trends methods are cointegrated with headline inflation and exclusion and another weighted median based measure are not cointegrated with headline inflation. Estimating an error correction model, they also found that core measure derived using common trends approach is a powerful predictor of headline inflation. Hence, they concluded that the model based core inflation emerges as a distinct measure since it possesses all the desirable properties: unbiased to headline inflation, less volatility, relatively high correlation with growth of nominal money, cointegrated with headline inflation, and powerful attractor of headline inflation (Durai and Ramachandran, __).

In order to verify the accuracy and veracity of predictive power of core inflation, many researchers have focused on various aspects of forecasting including, in-sample and out-of-sample forecasts, aggregate and components forecasts, etc.

Smith (2004) checked the robustness of in-sample results, which are derived by performing out-of-sample forecasts. The out-of-sample forecasts supported the conclusion that using a measure that exploits time series information can provide better forecasts than using cross-section information alone. However, he also concluded that focusing on persistence does not seem to be the best way to exploit time-series information.

Rich and Steindel (2005) evaluated a range of candidate core inflation measures. They noticed that exponentially smoothened transformation displayed good explanatory power for within sample exercises for subsequent movements in overall inflation two or three years ahead. However, such results weaken when they examined out-of sample forecasting and the structural stability of the models. At the same time, they found that median measures do a better job in forecasting inflation out-of-sample. However, they concluded that none of core measure does an outstanding work in forecasting CPI inflation. Also, they noticed that the somewhat erratic out-of-sample results were accompanied by evidence of some structural instability in the forecasting equations. Hence, as an overall conclusion, their criteria did not allow them to identify a clear “best” or “worst” measure of core inflation. Hence, they were of the view that no strong evidence to suggest that a selected core measure will be able to retain its relative usefulness as a tool for to forecast inflation for any given period, even when supplemented by measures of slack in the economy. They suggested that while the addition of macroeconomic variables could improve the predictability of aggregate inflation, their contribution can vary considerably across core measures.

Demers and De Champlain (2005) compared models of core inflation for Canada by direct modeling the aggregate measure and by indirect modeling the sub-aggregates from two levels of disaggregating. They emphasised the usefulness of using monthly and quarterly disaggregate models of inflation to forecast core inflation for Canada. By testing these various approaches, they concluded that forecasting accuracy can be improved by using disaggregated models of monthly core inflation, most notably for short-horizon forecasts. At the disaggregated level, Phillips curve types of models appeared to contain valuable information about future inflation, as theory predicts, and also empirically observed by Hubrich in 2005. They were also of the view that the gains from using monthly disaggregate data to forecast the quarterly rate of core inflation are quite moderate and statistically insignificant according to tests for equality of forecast accuracy, although the RMSFEs can be reduced by nearly 10 per cent.

In order to assess whether core measure have any indicator properties for the future trend in inflation, Johnson (2006) reviewed simple correlations between each core measure and the CPI excluding indirect taxes (CPIxT) at various future intervals: 6, 12, 18 and 24 months. Correlations between core measures and the CPIxT rather than the CPI itself were reported in order to abstract from the large indirect tax shocks in data. The importance of indirect tax shocks was evident when comparing the CPI and the CPIxT at all samples. At 6 months ahead, correlation between the CPI and the CPIxT is only 0.65 despite a 6 month overlap in data. The high correlations suggested that core measures do contain information about future movements in inflation. It was also found that core measures perform even better if the sample is limited to periods of low and stable inflation.

Several research can be observed, which attempted to identify underlying inflation trends in Sri Lanka by compiling and analysing several core inflation measures. Only a few has focused to investigate the predictive ability of core inflation measures (Tennekoon, 2008; Gupta and Saxegaard, 2009).

Tennekoon (2008) evaluated the controllability of alternative measures using correlation with lagged changes in money supply and with true demand-driven inflation proxied by the average of correlation coefficients between other core inflation measures. The average of correlation coefficients between each measure with other measures, and correlation with the 18-month and 24-month lagged values of growth in M2b indicated controllability of core inflation measures. The predictability was tested by comparing the 6 -month ahead, 12-month ahead and 18-month ahead forecasts of inflation, projected using each of the core inflation measures, with the realised inflation. Accordingly, he constructed Auto Regressive Moving Average (ARMA) models using data until October 2006, and then these models were used to forecast headline inflation in 6 months (up to April 2007), 12 months (up to October 2007) and 18 months (up to April 2008). Such forecasts were compared with the realised headline inflation numbers in order to derive the forecast error. Based on forecast results of alternative core measures, Tennekoon concluded that the accuracy of core measures based on excluding fresh food and energy and volatility weighted was high as they indicated high predictive power. More importantly, he confirmed that the published official measure, which excludes the entire food and energy category, is inferior as the forecast error was higher and hence, weak in predictive power.

Based on Marques et al. (2004) Tests[36], Gupta and Saxegaard tested the appropriateness of core measures for Sri Lanka. At the first stage, they tested whether or not $u_t = \pi_t - \pi_t^*$ a stationary process, where π_t is the year-on-year rate of change of the headline CPI and π_t^* is the year-on-year change in the different core indices. Stationary property was tested using both Augmented Dickey Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. At the second stage, they tested whether $u_t = \pi_t - \pi_t^*$ has mean of zero by testing the significance of the constant term using a simple t-test.

Consequently, they tested condition (ii)[37] by estimating the following error-correction model for π_t :

[36] Marques et al. (2000) argued that an appropriate measure of core inflation should possess the characteristic that headline inflation converges to core inflation in the long - run but not vice versa. For a measure of core inflation to satisfy this criteria it must be the case that headline and core inflation are cointegrated with unit coefficient [condition (i)]. In other words, the difference between headline and core inflation, $u_t = \pi_t - \pi_t^*$ should be stationary with a mean of zero. If u_t were not stationary, headline and core inflation would tend to diverge in the long-run. If mean of u_t were not zero, core inflation would not be capturing the persistent component of headline inflation and would be biased. For a measure of core inflation to satisfy the criteria set out by Marques et al. (2004) it must also be true that core inflation is an attractor of headline inflation [condition (ii)], and conversely that headline inflation is not an attractor for core inflation [condition (iii)]. Condition (ii) simply indicates that core inflation possesses some information about future headline inflation and should not be interpreted as a test of the ability of core inflation to forecast future inflation. Condition (iii) requires that an error correction representation does not exist for core inflation. In other words, headline inflation should not be an attractor for core inflation (Gupta and Saxegaard, 2009).

[37] If condition (i) holds then there exists an error correction representation for headline and/or core inflation [From Granger's representation theorem (Engle and Granger, 1987). Condition (ii) requires that such a representation exist for headline inflation and implies that if headline inflation is above core inflation, then it can be expected that headline inflation will sooner or later start to decrease and will converge to core inflation. In other words, condition (ii) requires that core inflation Granger causes headline inflation through the error-correction term and thus is a leading indicator for headline inflation.

$$\Delta\pi_t = \sum_{j=1}^{m}\alpha_j \Delta\pi_{t-j} + \sum_{j=1}^{n}\beta_j \Delta\pi^*_{t-j} - \gamma(\pi_{t-1} - \pi^*_{t-1}) + \varepsilon_t \qquad (10)$$

and testing whether the null hypothesis of $\gamma = 0$ is rejected.

The two tests (ADF and KPSS) strongly suggested that official core measure, the Trimmed Mean 15L5R measure, the Trimmed Mean 20L5R measure, and the Trimmed Mean 25L5R measure are not cointegrated with headline inflation and thus are unlikely to converge to the same trend as headline inflation in the long - run. Conversely, tests strongly suggested that the Trimmed Mean 25L10R measure is cointegrated with headline inflation. Through the results from a simple t-test for whether the constant term in the ADF and the KPSS regressions are significantly different from zero, they concluded that only two measures of core inflation (Trimmed Mean 15L5R and the Exclusion 3) can be considered as unbiased estimators of core inflation. It was concluded that Trimmed Mean 25L10R measure, and both exclusion based measures core inflation are attractors of headline inflation and thus satisfy condition (ii). Further tests suggested that official measure of core inflation and the Exclusion 3 measure are leading indicators of headline inflation, but not vice versa. In other words, results indicate that these measures provide a useful guide for the future path of headline inflation (Gupta and Saxegaard, 2009).

b. Empirical Results of Predictive Ability

The emphasis of this study is to produce core inflation measures, which represent the trend of underlying inflation useful for setting the monetary policy. Hence, the desired criteria for assessing such measure of inflation therefore, do not simply include minimisation of its variance or deviations over time. Accordingly, econometric tests need be applied to investigate how closely the different measures accord with economic intuition of core inflation. In order to identify whether core inflation measures can be treated as guiding indicators for the conduct of monetary policy, several econometric tests were conducted. These tests include:

i. Causality
ii. Long-run Relationships
iii. Predictability
iv. Correlation[38].

The empirical results and analysis for each test is presented in the following sections.

i. Causality

In order to test causality between headline and selected core inflation measures, Granger causality tests were performed. The Granger causality test for headline inflation (π) and core inflation (π^{CORE}) involves estimating the following pairs of regression:

[38] Theoretical explanations are given in Annexure VII.

$$\pi_t = \sum_{i=1}^{n} \alpha_i \pi^{CORE}{}_{t-i} + \sum_{j=1}^{n} \beta_j \pi_{t-j} + u_{1t} \quad (11)$$

$$\pi^{CORE}{}_t = \sum_{i=1}^{n} \lambda_i \pi^{CORE}{}_{t-i} + \sum_{j=1}^{n} \delta_j \pi_{t-j} + u_{2t} \quad (12)$$

The results of Granger causality tests are presented in Table 14.

Table 14
Pairwise Granger Causality Tests

Sample: 2003M12 2009M08

	Null Hypothesis:	F-Statistic	Probability
1	HP Filtered Headline does not Granger Cause Headline	6.30	**0.00**
2	Core (xFFE) does not Granger Cause Headline	1.96	0.15
3	Core (xFFET) does not Granger Cause Headline	3.51	**0.04**
4	Core (xFFE + RC) does not Granger Cause Headline	4.76	**0.01**
5	Core (xFFET + RC) does not Granger Cause Headline	4.29	**0.04**
6	Core (x10YV) does not Granger Cause Headline	6.41	**0.00**
7	Core (x15MV) does not Granger Cause Headline	3.20	**0.05**
8	Core (TR20) does not Granger Cause Headline	0.89	0.41
9	Core (TR30) does not Granger Cause Headline	1.96	0.15
10	Core (VW) does not Granger Cause Headline	4.68	**0.01**
11	Core (ES) does not Granger Cause Headline	7.72	**0.00**
12	Core (xFE) - DCS does not Granger Cause Headline	27.11	**0.00**

Bold Values: Significant at 5% Level

The results presented in Table 14 show that statistical measures, particularly trimmed measures do not contain leading information about future inflation. However, conversely exclusion, volatility weighted and smoothing based measures do contain some leading information as they Granger-causes headline inflation.

ii. Long-run Relationships

The long-run relationships between headline and core inflation measures can be observed using cointegration tests[39]. Accordingly, in order to investigate long- run relationships between headline and core measure for Sri Lanka, cointegration tests were carried out using Johansen's (1991) Maximum Likelihood approach.

As the first step to perform cointegration tests, unit root tests were performed in order to investigate the stationary properties of each series. Results of ADF and Phillips-Perron (PP) tests, which used to find unit roots of each series, are presented in Table 15.

[39] Freeman (1998) explained that there must be cointegration between core and headline inflation and Ribba (2002) argued that any measure of core inflation should satisfy two conditions: (i) core and headline inflation are cointegrated with a cointegrating vector (1, -1); and (ii) there exists an error correction representation.

Table 15
Stationarity Properties of Headline and Core Inflation

	Inflation Measure	ADF		PP Statistic	
		t- Statistic	Probability	t- Statistic	Probability
1	Headline	-1.311	0.174	-0.934	0.309
2	HP Filtered Headline	-3.282	0.020	0.122	0.718
3	Core (xFFE)	-1.094	0.246	-0.885	0.329
4	Core (xFFET)	-1.133	0.232	-0.917	0.316
5	Core (xFFE + RC)	-1.924	0.320	-1.464	0.546
6	Core (xFFET + RC)	-2.416	0.141	-1.582	0.486
7	Core (x10YV)	-1.024	0.272	-0.879	0.332
8	Core (x15MV)	-1.168	0.220	-0.969	0.294
9	Core (TR20)	-0.798	0.367	-0.887	0.328
10	Core (TR30)	-0.763	0.382	-0.911	0.318
11	Core (VW)	-0.449	0.517	-0.859	0.340
12	Core (ES)	-2.129	0.033	-0.400	0.536
13	Core (xFE) - DCS	-0.694	0.413	-0.733	0.396

Results of ADF and PP tests indicate that headline and estimated alternative core inflation measures contain unit roots, i.e. series are non-stationary indicating that cointegration tests can be performed. Table 16 presents results of cointegration tests between headline and core inflation measures.

Table 16
Cointegration between Headline and Core Inflation

	Variables	Hypothesis	Eigenvalue	λ Trace		λ Max	
				Statistic	Critical Value	Statistic	Critical Value
1	HP Filtered Headline, Headline	r = 0	0.78	108.34*	15.49	99.35*	14.26
		r ≤ 1	0.13	9.00	3.84	9.00	3.84
2	Core (xFFE), Headline	r = 0	0.12	12.76	15.49	8.60	14.26
		r ≤ 1	0.06	4.16	3.84	4.16	3.84
3	Core (xFFET), Headline	r = 0	0.12	10.11	15.49	8.66	14.26
		r ≤ 1	0.02	1.45	3.84	1.45	3.84
4	Core (xFFE + RC), Headline	r = 0	0.20	24.68*	15.49	14.77*	14.26
		r ≤ 1	0.14	9.91	3.84	9.91	3.84
5	Core (xFFET + RC), Headline	r = 0	0.13	14.79	15.49	9.09	14.26
		r ≤ 1	0.08	5.71	3.84	5.71	3.84
6	Core (x10YV), Headline	r = 0	0.22	23.76*	15.49	15.99*	14.26
		r ≤ 1	0.11	7.78	3.84	7.78	3.84
7	Core (x15MV), Headline	r = 0	0.14	15.72*	15.49	9.89	14.26
		r ≤ 1	0.08	5.83	3.84	5.83	3.84
8	Core (TR20), Headline	r = 0	0.10	11.42	15.49	6.84	14.26
		r ≤ 1	0.07	4.59	3.84	4.59	3.84
9	Core (TR30), Headline	r = 0	0.16	15.46	15.49	11.13	14.26
		r ≤ 1	0.06	4.33	3.84	4.33	3.84
10	Core (VW), Headline	r = 0	0.12	12.29	15.49	8.73	14.26
		r ≤ 1	0.05	3.56	3.84	3.56	3.84
11	Core (ES), Headline	r = 0	0.31	31.57*	15.49	24.39*	14.26
		r ≤ 1	0.10	7.17	3.84	7.17	3.84
12	Core (xFE) - DCS, Headline	r = 0	0.38	46.05*	15.49	31.76*	14.26
		r ≤ 1	0.19	14.29	3.84	14.29	3.84

** Indicates significance level at 5%*

The λ_{TRACE} and λ_{MAX} statistics in Table 16 show that core measures such as HP filtered headline, xFFE+RC, x10YV, x15MV, ES and xFE – DCS are cointegrated with headline inflation indicating that headline inflation does not show any permanent or significant divergence from those core measures. This concludes that exclusion based methods contain some predictive power although many of them are criticised at different dimensions[40].

iii. Predictability

Econometric modeling approach is an important way to identify whether core inflation may be used to summarise information about the predictable component of inflation and therefore, provides an important input for producing forecasts of aggregate inflation. Accordingly, to test the predictive ability of each series of core inflation, two major types of econometric models were used:

a. Auto Regressive Moving Average (ARMA) Models
b. Vector Error Correction (VEC) Models

a. Auto Regressive Moving Average (ARMA) Models

To test the predictive ability of core inflation, Tennekoon (2008) used the ARMA approach of forecasting, which basically assumes that inflation is driven by underlying inflationary inertia, an assumption likely to be corrected for period ahead up to 24 months. Accordingly, ARMA models were derived using alternative series of core inflation and those models were used to predict 6-month, 12-month and 18-month ahead forecasts of headline inflation. The specification used in this exercise is given in equation 13:

$$Headline = \beta_1 * Core_{t-6} + \beta_2 * Core_{t-12} + \beta_3 * Core_{t-18} + e_t \quad (13)$$

Based on equation 13, various ARMA models were constructed[41] and those models were used to forecast headline inflation in 6 months (August 2008), 12 months (February 2009) and 18 months (August 2009) and compared with the actual headline inflation rates. The results are presented in Table 17 with forecast errors.

Table 17
Forecast of Headline Inflation and Forecast Error

		Forecast of Headline Inflation			Forecast Error		
	Inflation Measures	**6 - month ahead**	**12 - month ahead**	**18 - month ahead**	**6 - month ahead**	**12 - month ahead**	**18 - month ahead**
1	Headline Inflation - Actual	24.9	7.6	0.9			
2	HP Filtered Headline	19.0	-11.8	15.0	5.9	19.4	14.1
3	Core (xFFE)	27.9	16.2	10.5	3.0	8.6	9.6
4	Core (xFFET)	29.3	19.9	14.6	4.4	12.3	13.7
5	Core (xFFE + RC)	24.8	14.1	7.1	0.1	6.5	6.2
6	Core (xFFET + RC)	26.6	19.9	12.1	1.7	12.3	11.2
7	Core (x10YV)	14.3	12.9	17.5	10.6	5.3	16.6
8	Core (x15MV)	27.7	17.0	11.4	2.8	9.4	10.5
9	Core (TR20)	17.5	17.6	20.8	7.4	10.0	19.9
10	Core (TR20)	15.0	16.8	20.6	9.9	9.2	19.7
11	Core (VW)	17.3	21.3	17.5	7.6	13.7	16.6
12	Core (ES)	15.1	7.9	11.1	9.8	0.3	10.2
13	Core (xFE) - DCS	15.2	7.9	6.8	9.7	0.4	5.9

[40] In the Indian case, Joshi and Rajpathak (2004) found that several exclusion based methods of core inflation cointegrated with headline inflation, but none of them performed well in predicting headline inflation (Durai and Ramachandran, __)
[41] ARMA models used to forecast future headline inflation is given in Annexure VIII.

In all horizons, exclusion based core inflation appeared to be better measures in forecasting as they record lower forecast errors compared to other measures. Measures based on smoothing also show some performance, however, trimmed based measure does not indicate any significance in terms of predictability. In all horizons, current official core inflation records relatively lower forecast errors indicting that it contains some useful information about future path of headline inflation.

b. Vector Error Correction (VEC) Models

VEC models, expressed on the demand for money equation[42] were also used to investigate predictability of core inflation measures. Accordingly, the model was constructed using for variables, i.e. inflation rate (headline or core), seasonally adjusted Industrial Production Index, IPI[43] (proxy for real output), seasonally adjusted Broad Money (M2)[44], and Average Weighted Call Money Rate (AWCMR). The general specification can be expressed as follows[45]:

$$Inflation_t = Inflation_t + IPI_t + M2_t + AWCMR_t \qquad (14)$$

As the first step of constructing the VECM, cointegration test was performed to identify long-term relationship amongst variables in the model (headline inflation, IPI, M2 and AWCMR). Accordingly, Johanson cointegration test points to a cointegration (long-term relationship) between variables as are more than one relationship[46].

If there remains more than one cointegrated relationships among variables, estimating a VECM is considered as the more appropriate method to proceed. Thus, several VECM models were estimated using data of monthly frequency, for the period December 2003 to August 2009 for each inflation measure and subsequently inflation forecasts were derived for the period up to December 2011 at three steps including in-sample forecasts. At the same time, the same models were re-estimated imposing restrictions. Two restrictions were imposed in doing so, that is, interest rate was equated to zero in the cointegration equation, as it is unlikely to be cointegrated with the other variables in the long-run. However, it was noticed that there is no significant deviation between estimates even with restrictions, and hence, forecasts only without restrictions were considered in the comparison[47].

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42 Demand for money (real money balances) could be expressed as a function of the nominal interest rate and aggregate real income (output) and demand for money function is expressed by the following equation:

$$M / P = f(i, Y)$$

where, M: money, P: price level, *i*: nominal interest rate and Y: real income.

This relationship could be estimated using the method of Ordinary Least Squares (OLS). For this purpose, the above expression could be modelled (in logarithms).

$$m = c_1 + c_2 p + c_3 i + c_4 y + e$$

(Simple letters refer to the logarithms of the respective variables). The parameters c_3 and c_4 give elasticity of money demand to interest rates and income (Wimalasuriya, 2008).

43 Private Sector Monthly Industrial Production Index compiled and published by the CBSL on monthly basis.

44 Even though M2b indicates a strong correlation between inflation measures, M2 (which includes currency, demand deposits and times and savings deposits of Domestic Banking Units) found to be the most significant monetary aggregate in modelling inflation in Sri Lanka (Weerasinghe et al, 2005).

45 This model is found to be useful for forecasting inflation in Sri Lanka (Wimalasuriya, 2008).

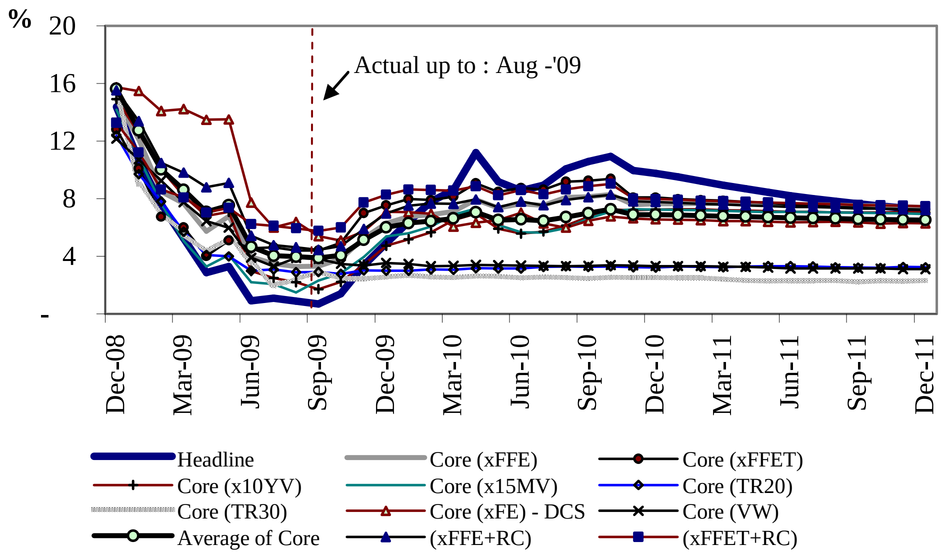
46 Results of the cointegration test are reported in Annexure IX. Similar results were observed with regard to alternative core inflation measures; however those are not reported in order to preserve space.

47 Eviews test results were not reported to preserve space; however relevant equations are given in Annexure X.

- **Forecast: up to December 2011 based on data up to August 2009 (Out-of -Sample Forecasts)**

Figure 15 presents forecast headline and alternative core inflation for the period of August 2009 to December 2011 based on the VECM model.

Figure 15: Inflation Forecast: 2009-2011 (Without Restrictions)



In 2 years ahead, most of inflation forecasts move in similar directions except Core (ES) and HP filtered measures as they produce some arbitrary results[48]. Generally, a convergence between headline and core inflation is expected in the long-run. According to Figure 15, the trend is captured at the longer end providing some evidence for convergence with headline inflation. The official core inflation measure remains closer to forecast headline inflation confirming that some amount of information about headline inflation is included in the official core measure.

Table 18 further confirms that there is evidence about the convergence of headline and core inflation measures as significant deviations are not observed between forecasts of headline and average of representative core measures.

Table 18

Difference of Forecast Inflation (Year-on-Year)

Period	Headline Inflation	Average of Core Inflation	Difference
Dec-09	4.9	6.0	-1.1
Dec-10	9.8	6.9	2.9
Dec-11	7.2	6.5	0.7

However, this cannot be considered as the optimal situation as there is no way to affirm the validity of future path of inflation series. In this context, some in-sample forecasts were also estimated in order to examine the robustness of the forecasts.

48 Although Core (ES) and HP filtered headline measures were identified as more representative measures, forecast of Core (ES) remains at unacceptable levels ranging from -87.4 to +6.3 per cent and forecast of HP filtered headline remains in a range of -17.7 to +8.8 per cent. Hence, Core (ES) and HP filtered headline were removed in this section for the ease of comparison.

- **Forecast up to August 2009 based on data up to December 2008 (In-sample Forecasts)**

Figure 16 presents headline and core inflation forecasts up to August 2009 based on data for the period December 2003 to December 2008. However, it is evident that there is no clear relationship between headline and core inflation forecasts.

Figure 16: Inflation Forecast: 2009-2011 (Without Restrictions)

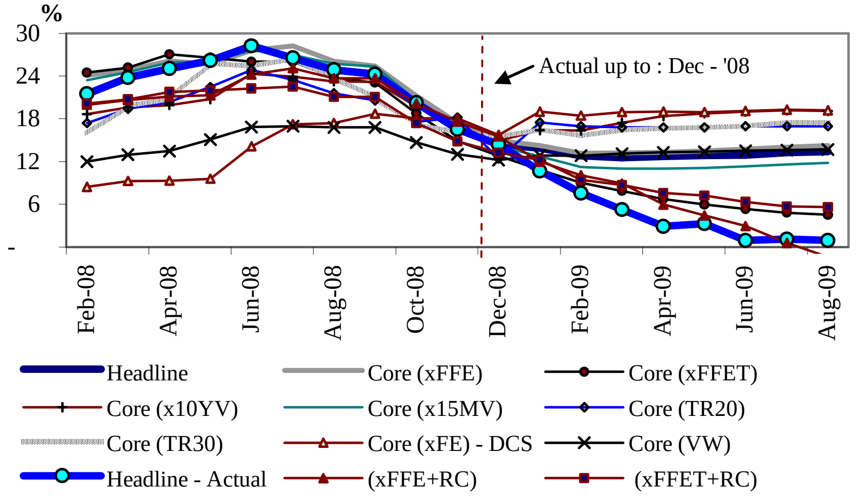


Table 19 provides a summary of forecasts of headline and core inflation measures for the period of 2007 to 2009 and also deviations of such measures with the actual headline inflation. It confirms that forecast errors are significantly high in all the forecast horizons highlighting the weakness of selected core inflation measures in predicting the future path of headline inflation.

Table 19

Forecasts of Headline and Core Inflation and Deviations with Actual

	Measure	Actual by Aug-09	Forecasts up to Aug-09	Deviation with Aug-09
1	Headline - Actual	**0.9**		
2	Headline - Forecast		13.4	12.5
3	Core (xFFE)		4.5	3.6
4	Core (xFFET)		19.1	18.2
5	Core (xFFE + RC)		-1.4	-2.3
6	Core (xFFET + RC)		5.6	4.7
7	Core (x10YV)		11.8	10.9
8	Core (x15MV)		17.0	16.1
9	Core (TR20)		17.4	16.5
10	Core (TR30)		13.7	12.8
11	Core (VW)		23.2	22.3
12	Core (xFE) - DCS		19.2	18.3

iv. Correlation

In order to assess whether core inflation measures contain any indicator properties about the future trend in inflation, simple correlations between each core measure and headline were examined. The correlation matrix is reported in Table 20.

Table 20

Correlation of Core Inflation with Headline Inflation

	Measure	T*	T+28**
1	HP Filtered Headline	0.69	0.42
2	Core (xFFE)	0.97	0.96
3	Core (xFFET)	0.97	0.96
4	Core (xFFE + RC)	0.94	0.93
5	Core (xFFET + RC)	0.96	0.95
6	Core (x10YV)	0.97	0.94
7	Core (x15MV)	0.99	0.97
8	Core (TR20)	0.98	0.92
9	Core (TR30)	0.97	0.91
10	Core (VW)	0.94	0.81
11	Core (ES)	0.61	0.32
12	Core (xFE) - DCS	0.29	0.42

** Aug. '09: Correlation with Actual Inflation*
*** Dec. '11:Correlation with Forecast Inflation*

Table 20 contains correlations co-efficients over two periods: December 2003 to August 2009 (T) and December 2003 to December 2011(T+28). Some correlation coefficients are high suggesting that core measures except HP filtered headline, Core (ES) and the official measure, contain some information about future movements in inflation. Correlations are high, may be simply because all of these measures moves in the same direction of headline inflation. The lower correlations of HP filtered headline and Core (ES) with headline inflation are obvious due to the highly smoothened trend than headline inflation. At the same time, lower correlation of the official measure with the headline inflation indicates that it does not broadly follow the trend of headline inflation although it does contain some information as explained in the previous sections. Table 21 provides a summary of the overall performance of predictability criteria.

Table 21

Overall Performance of Predictability Criteria

	Inflation Measure	Causality* (with Headline)	Co-integration** (with Headline)	Predictability*** Forecast Error (with Headline)	Correlation with Headline
1	HP Filtered Headline	Yes	Yes	Very High	Low
2	Core (xFFE)	No	No	Low	High
3	Core (xFFET)	Yes	No	High	High
4	Core (xFFE+RC)	Yes	Yes	Low	High
5	Core (xFFET+RC)	Yes	No	Low	High
6	Core (x10YV)	Yes	Yes	Moderate	High
7	Core (x15MV)	Yes	Yes	High	High
8	Core (TR20)	No	No	High	High
9	Core (TR30)	No	No	Moderate	High
10	Core (VW)	Yes	No	High	High
11	Core (ES)	Yes	Yes	Very High	Low
12	Core - DCS	Yes	Yes	High	Low

** 10 per cent level*
*** 5 per cent level*

**** Forecasts derived using Money Demand Model of the ERD.*
Error is based on In-sample Forecasts (Data up to December 2008 and Forecast for October 2009)

Table 22 provides a summary of results of tests for leading indicator property of core inflation measures.

Table 22
Summary of Tests for Leading Indicator Property of Core Inflation

Test	Key Findings
Causality	- Statistical measures do not contain leading information about core inflation - Exclusion, volatility weighted and smoothing based measures do contain some leading information
Long-run Relationships	- Only HP filtered headline, Core: xFFE+RC, x10YV, x15MV, ES and xFE – DCS are cointegrated with headline inflation indicating that there is no significant divergence
Predictability	- ARMA Model: Exclusion and smoothing based core inflation are better measures in forecasting, Trimmed based measure does not indicate significance in terms of predictability, Official core inflation contains some useful information about future path of headline inflation - VECM Model: Mixed evidence about the convergence property of headline and core inflation
Correlation	- Core measures except HP filtered, Core (ES) and the official measure, contain some information about future movements in inflation

Accordingly, mixed results are observed with regard to the predictive power of core inflation measures for Sri Lanka.

VI. SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

The concept of underlying or core inflation has become central to monetary policy conduct of central banks around the globe. This is because total consumer price index or headline inflation naturally includes short-term price changes that cannot appropriately explain by monetary phenomena or demand pressures in an economy. Hence, the use of headline inflation alone could mislead monetary policy decisions and as a result, create adverse macroeconomic repercussions. A representative measure of core inflation would be a better guide for current and future policy than headline inflation rates and also, represents inflation that is most controllable. In that regard, an appropriate measure of core inflation is of prime importance as a guiding indicator for monetary policy.

Several methods in measuring core inflation are observed in literature. A commonly used method requires taking subjective decision to exclude particular prices from the aggregate price index. Other approaches use statistical or economic modelling to derive core inflation measures.

So far, the CBSL has taken several initiatives to identify underlying price pressures in the Sri Lankan economy by compiling, monitoring and analysing various core inflation measures. Currently, the DCS compiles a measure of core inflation by removing the entire food and energy categories from the total basket, and publishes along with headline inflation numbers each month. However, although this measure is monitored and analysed for policy purposes, it is subject to many criticisms due to removal of a large chunk from the total index. Hence, there exists a vital need to explore alternative methods of compiling core inflation measures and mainly, the CBSL is entrusted with the responsibility. Hence, there remains an urgent need to introduce a well-thought out methodology to construct a measure of core inflation that can be used as an operational guide to policy formulation. However, in the Sri Lankan context, the computation process of core inflation should consider several issues such as the weight of food items to total index, effect of external shocks on domestic prices and influence of the expenditure patterns on the CCPI.

A range of alternative core inflation measures were compiled for Sri Lanka based on smoothing, exclusion and statistical methods. Those measures were evaluated in order to identify more representative measures with a view to examine whether they can be considered as guiding indicators of future inflation path and hence, to be used in the conduct of monetary policy in Sri Lanka. Hence, selected measures of core inflation were empirically evaluated through investigating how well they qualify certain desirable properties of core inflation. Accordingly, less variability, close association with policy variables, cointegration with headline inflation and predictability of core measures were considered as empirical criteria for judging core measures for their usefulness.

Core inflation measures estimated using different methods produce mixed results in terms of qualifying performance criteria raising issues on the use of core inflation as a guiding indicator for monetary policy conduct. For example, measures based on smoothing show a lower variability, higher controllability and representativeness, but weak in prediction. Although the exclusion and limited influential based methods do not qualify consistently all the criteria, those measure produce some acceptable results in terms of predictability. As such, although the current official core inflation is highly criticised at many dimensions, forecasts based on official core measure indicate that it contains some amount of information about the future path of inflation. However, it should be noted that official measure does not qualify basic evaluation criteria and hence, only the predictive ability may not be useful for policy purposes.

Although a measure of core inflation derived from a common trends model was not considered in this study and it may consistently pass all the empirical tests, there would be difficulties for authorities in using such model based core measures as a part of communication strategy. This is because it is often argued that estimation of common trends model with new observations tends to change the entire series of core inflation. In that context, alternative measures based on smoothing, exclusion and trimming can be considered as more appropriate methods for Sri Lanka. The focus on different methods would be imperative as there remain weaknesses including the inherited noise, particularly within the exclusion based method.

Core inflation measures are considered as better, plausible, forward-looking and leading indictors for monetary policy. However, such principle is not strongly confirmed in the Sri Lankan context. Although some measures show some ability to forecast future path of inflation, none of the core measures does an outstanding work in forecasting inflation. The reason why these measures do not predict the future inflation may not entirely due to their weaknesses or problems in methods used in this study. Conversely, that may be due several reasons. First, the time series used in this study is not long-enough to capture long-term relationships. If the models were re-estimated using a long series of data, results can be different. Second, for the period 2003-2006, the CCPI index has been retrospectively calculated substituting for past values and that also can have an impact on the results. Third, this period includes a substantial supply shock in 2008, and a subsequent fall in 2009. When the series is not long enough, this could reduce the predictive power.

Hence, these results do not undermine the usefulness of core inflation in setting monetary policy in Sri Lanka as core inflation serves as an important variable to track prevailing underlying inflation. Core inflation provides information about the dynamics of inflation and varied information to guide monetary policy. In that regard, core inflation indicators based on alternative methods could provide Sri Lankan monetary policymakers more timely information to guide the policy. At the same time, focusing on the following areas would be imperative in the Sri Lankan context.

- **Focusing on a Range of Measures in Policy Analysis**

Currently, the DCS publishes single measure of core inflation based on the exclusion method, which is recognised as the official measure of core inflation. At the same time, an array of alternative measures are monitored and analysed internally by the CBSL on experimental basis for policy purposes. Since each alternative series differ in the quality and nature of the insight and has relative advantages and the costs, and none of the measures precisely serve for specific policy purpose, there remains a valid reason to monitor a range of core measures of inflation. It is reasonable to conclude that all the core measures contain some amount of information about the underlying trend in inflation and they are particularly useful in identifying the source and the nature of persistent and temporary shocks that affect inflation.

Accordingly, various measures of underlying inflation would do well at different dimensions since each measure of core provides some particular insight into how inflation is evolving. Therefore, rather than selecting one measure[49] as the best to track the trend in inflation, it might be more useful to have a range of measures of underlying inflation. The varied information in each of them can be consolidated to generate a more accurate depiction of the dynamics in inflation[50].

- **Developing a General Equilibrium Model**

Core inflation is considered as the true monetary measure of inflation, but it is difficult to identify theoretical principle for a monetary measure of core inflation. Many of the measures of core inflation that have been constructed are based on the published cost of living index as the basis for measurement. This makes evaluation difficult as the cost of living index only provides a coherent framework for the evaluation of measures of headline inflation such as the CPI. In that context, construction and evaluation of representative core inflation measures based on cost of living indices would be a matter of concern. Thus, in practical terms, it is imperative to construct a core inflation measure to better track the trend inflation rate in real time by developing a full general equilibrium model of the economy. Such model would serve to formulate other macro policies as well.

- **Using Average Inflation Forecasts in Policy Formulation**

It is proven that core inflation measures remain a useful analytical device for summarising information about the persistent component of the inflation rate, and for isolating temporary factors that are less relevant for monetary policy. However, the distinction between underlying and headline CPI inflation does not have a direct operational significance for monetary policy although it could provide some inputs in policy analysis. This is because, over time, core and headline measures of prices can be expected to increase at similar rates. As such, distinction between headline and core inflation for monetary policy could be less relevant. Hence, it would be ideal specifying and using inflation forecasts based on the average of the headline inflation and formulate policies[51]. The main

[49] The CBSL intends to introduce a new core measure in 2010, which is derived excluding categories such as 'fresh food, energy, transport, rice and coconut' (i.e. Core xFFET+RC discussed in this paper) along with the revision to the CCPI basket based on the recent Household Income - Expenditure Survey in 2006/07 (CBSL, 2010).

[50] This is the approach currently in place at the Bank of Canada and Reserve Bank of Australia. For example, at the Bank of Canada, the measure of MEANTSD specifically identifies the subcomponents which have extreme fluctuations and others that exclude or down weight traditionally variable elements - CPIxFET, CPIX and CPIW - assist in identifying the source of the shock if there are differences in inflation as indicated by the different core measures. On the other hand, although the Reserve Bank of Australia retains CPIX as its official measure of core inflation, it monitors the other measures closely. The Bank also reports an alternative measure (CPIW) in the Monetary Policy Report.

[51] The fact that the inflation target in Australia is expressed as a medium-term average means that the distinction between underlying and CPI inflation does not have a direct operational significance for monetary policy (Cockerell, 1999).

advantage of expressing the policy target in terms of the headline rate is that this is likely to be better understood and accepted by the public and average headline inflation would be useful as it does not contain high volatility.

- **Targeting Headline Inflation in an Inflation Targeting Regime**

CBSL has expressed its intention to move towards an Inflation Targeting (IT) regime in the medium-term (CBSL, 2007). However, there remains a debate on which inflation measure should be targeted. Although many IT countries target headline inflation, there exists a possibility of targeting core inflation as well. However, depending on the practical success, it would be ideal in targeting headline inflation as it is the widely accepted and understood measure by the general public. However, since there are practical difficulties in adopting full-fledged IT explicitly in a country with a relatively high inflation, Sri Lanka would need to adopt Inflation Targeting Lite or Implicit Inflation Targeting. Within such framework, Sri Lanka may focus on targeting core inflation initially without publishing and thereafter gradually shift targeting headline inflation. On the other hand, once the CBSL decided to use an IT framework, it could decide on the appropriate measures to announce and monetary policy design.

- **Improving Awareness on Core Inflation Measures**

Many central banks highlight core inflation in the course of policy formulation and communication. Although core measures are widely discussed amongst policy makers, general public is not fully aware about core inflation measures. Such situation may lead to higher inflation expectations as general public is normally driven by the changes in the overall CPI. Hence, improved awareness of the general public about core inflation would be very useful in setting and conducting monetary policy successfully.

- **Conducting Further Research Activity**

It may be interesting to pursue alternative avenues of research in the future. As for directions for future research, relatively short time series of the CCPI is a major constraint on the ability of researchers to make strong recommendations about the best measure of core inflation for Sri Lanka. Hence, it might be useful to explore methods to extend the CCPI time series. At the same time, the evidence on the usefulness of various core measures described in this paper would be strengthened by comparison with the different alternative measures that are produced by the model-based approach. In this context, using a multivariate perspective, a permanent inflation measure, which shows the explanatory power of shocks having a long-run effect on inflation, and a core inflation measure, which is determined by the effect on inflation of shocks would be useful in analysing underlying inflation in Sri Lanka. Besides providing underlying inflation measures, the examination of these multivariate approaches would permit identifying the economic determinants of inflation. Also, there exists a need to improve the available methods of compiling core inflation measures as still there remains variability in many of the alternative measures. Particularly, this suggests considering additional noise-reduction techniques, including longer-run averages of the price data and other statistical signal-extraction techniques to provide policymakers with sufficient information to accurately gauge inflationary pressures.

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Annexure I: Mathematical/ Statistical Analysis of Methods of Deriving Core Inflation

- ***Exponentially Smoothing***

The exponentially smoothed (ES) measure of core inflation can be expressed as:

$$\mu_t = \varphi\Sigma(1-\varphi)^j \pi_{t-j} \qquad \text{(A1)}$$

where μ_t is the ES measure at time t, 0≤φ≤1, is an adaptive expectations adjustment parameter, which reflects the backward learning process, and π_{t-j} is the measured headline inflation at time t-j. The range of the parameter φ (0≤φ≤1) ensures that it is a weighted mean of the lagged values of headline inflation, with the highest weight for the most recent observation. The original paper by Colgey (2002), as well as Rich and Staindel (2005), has used φ=0.125.

- ***Exclusion***

If there are N items in the CPI basket of which base prices are $P_{0,1}$, $P_{0,2}$, $P_{0,2}$,….. $P_{0,N}$, weights in the index are W_1, W_2…. W_N and prices at time t are $P_{t,1}$, $P_{t,2}$, $P_{t,2}$,….. $P_{t,N}$, then, CPI at time t can be represented as:

$$\text{CPI}_t = \sum_{i=1}^{N} \frac{P_{t,i} * W_i}{P_{0,i}} \qquad \text{where,} \sum_{i=1}^{N} W_i = 100 \qquad \text{(A2)}$$

Headline inflation at time t, measured by percentage increase in CPI during the preceding 12-months, can be represented as,

$$\Delta\text{CPI}_t = \left[\frac{\sum_{i=1}^{N} \frac{P_{t,i} * W_i}{P_{0,i}}}{\sum_{i=1}^{N} \frac{P_{t-12,i} * W_i}{P_{0,i}}} - 1 \right] * 100 \qquad \text{(A3)}$$

If the number of items excluded in the computation of core inflation is n, core inflation at time t can be defined as,

$$\Delta\text{CPI}_{t,\text{core}} = \left[\frac{\sum_{i=1}^{N-n} \frac{P_{t,i} * W_i}{P_{0,i}}}{\sum_{i=1}^{N-n} \frac{P_{t-12,i} * W_i}{P_{0,i}}} - 1 \right] * 100 \qquad \text{(A4)}$$

The exclusion of selected components of CPI effectively redistributes the weight of the excluded category among the remaining groups on pro-rata basis.

- ***Limited Influence Estimators (Trimmed Mean and Weighted Median)***

Prior to compilation of a limited influence estimator, the appropriate level of desegregation has to be decided. Thereafter, disaggregated items are sorted, ranking them in ascending order by the percentage change of price of each disaggregated component, such that,

$$\left(\frac{P_{i,t}}{P_{i,t-12}}\right) \geq \left(\frac{P_{i-1,t}}{P_{i-1,t-12}}\right) \qquad \text{for all } i = 1,2\ldots\ldots\ldots N \qquad \text{(A5)}$$

where N is the number of disaggregated components, $P_{i,t}$ is the price of component i at time t, and $P_{i,t-12}$ is the price of component i before 12 months.

The cumulative weight, $w^c_{i,t}$ of each component, ranked as above, is derived as,

$$w^c_{i,t} = \sum_{n=1}^{i} w_{n,0} \qquad \text{(A6)}$$

where $w_{n,o}$ is the original weight of component n at the base period.

Then, the components with extreme price changes needs to be down weighted or zero weighted. For that the new weight of each component, $w^T_{i,t}$, is assigned as follows.

$$\mathrm{w}^{\mathrm{T}}_{\mathrm{i,t}} = \begin{cases} \max\left[0, \mathrm{w}^{\mathrm{c}}_{\mathrm{i,t}} - \max(w_{LB}, \mathrm{w}^{\mathrm{c}}_{\mathrm{i\text{-}1,t}})\right] \; for \; \mathrm{w}^{\mathrm{c}}_{\mathrm{i,t}} < 0.5 \\ \max\left[\min(w_{UB}, \mathrm{w}^{\mathrm{c}}_{\mathrm{i+1,t}}) - \mathrm{w}^{\mathrm{c}}_{\mathrm{i,t}}, 0\right] \; for \; \mathrm{w}^{\mathrm{c}}_{\mathrm{i,t}} > 0.5 \end{cases} \qquad \text{(A7)}$$

w_{LB} and w_{UB} are the lower and upper cut-off points, respectively. After reassigning the new weights, the trimmed mean can be computed using equation (1). However, the sum of the weights will not add up to 100 now, and it would be equal to,

$$\sum_{i=1}^{N} W_i = 100\,(w_{UB} - w_{LB}) \qquad \text{(A8)}$$

The weighted median is also is derived using the same approach as trimmed means, but trims all but the midpoint of price changes. The derivation of weighted median also involves the initial steps of deriving a trimmed mean. After ranking the components in ascending order based on the price change of each component, the cumulative weights are derived using equation (A5).

Now the component at the centre of the distribution, i, is selected such that,

$$w^c_{i,t} \geq 0.5 \geq w^c_{i-1,t} \qquad \text{(A9)}$$

Weighted median, Π_{WM}, is calculated using linear interpolation as a weighted average of price changes of $item_i$ and $item_{i-1}$.

$$\Pi_{WM} = \left(\frac{P_{i,t}}{P_{i,t-12}}\right) * \frac{\left(0.5 - w^c_{i-1,t}\right)}{\left(w^c_{i,t} - w^c_{i-1,t}\right)} + \left(\frac{P_{i-1,t}}{P_{i-1,t-12}}\right) * \frac{\left(w^c_{i,t} - 0.5\right)}{\left(w^c_{i,t} - w^c_{i-1,t}\right)} \qquad \text{(A10)}$$

- ***Volatility Weights***

Volatility weights include all components, but assign lower weights to more volatile items. The method uses a double weight structure, one weight to represent the consumption share, and another weight to represent the volatility. The weights of each disaggregated component is reassigned such that,

$$W_j^{NEW} = \frac{W_j^0}{\sigma_j} \qquad \text{(A11)}$$

σ_j is the standard deviation of $item_j$ during a reference period. The reassigned weights may be normalised if required. The computation after reassigning the weights is the same as explained by equation (A1).

Annexure II: Disaggregated Price Data of the CCPI

Colombo Consumers' Price Index - Expenditure Values

Base Year : 2002

Item	Unit	Base.2002	Aug-09
1.1 Food			
1.1.1.Bread and Cerials			
1.1.1.1.Rice		867.28	1624.16
1.1.1.1.1. Rice - Samba	kg.	504.15	951.40
1.1.1.1.2. Rice - Kekulu (Red)	kg.	160.80	281.98
1.1.1.1.3. Rice - Kekulu (White)	kg.	107.20	222.37
1.1.1.1.4. Rice - Nadu	kg.	95.13	168.41
1.1.1.2.Flour		72.32	197.35
1.1.1.2.1.Wheat Flour	kg.	41.60	129.69
1.1.1.2.2.Rice Flour	kg.	30.72	67.66
1.1.1.3.Bread & Bakery products		602.02	1850.25
1.1.1.3.1.Bread (Normal)	450 g	453.21	1500.75
1.1.1.3.2.Biscuits	100g.	82.91	188.30
1.1.1.3.3.Buns	each	65.90	161.21
1.1.1.4.Starchy Food		135.19	242.17
1.1.1.4.1.Yams - Potatoes	kg.	103.93	174.46
1.1.1.4.2.Other Starchy Foods - Jak and Jak Seeds		17.16	34.54
1.1.1.4.3. - Sweet Potatoes	kg.	6.07	15.29
1.1.1.4.4. - Bread Fruit		8.03	17.87
1.1.1.5.Pulses		196.29	635.95
1.1.1.5.1.Dhal	kg.	143.73	541.08
1.1.1.5.2.Gram	kg.	29.10	50.82
1.1.1.5.3.Green Gram	kg.	23.46	44.06
1.1.1.5.4.Soya Meat	kg.	19.10	31.83
1.1.1.6.Other Cereals & Cereal Products		74.81	168.69
1.1.1.6.1.Noodles	kg.	42.05	102.60
1.1.1.6.2.Papadam	kg.	17.44	35.57
1.1.1.6.3.Black Gram - Flour	200g.	11.73	22.87
1.1.1.6.4.Infants Cereal Foods	kg.	3.59	7.65
1.1.1.7.Meals bought outside		1119.55	2715.19
1.1.1.7.1.Rice with Fish & Vegetables	each	277.64	602.83
1.1.1.7.2.Rice with Meat & Vegetables	each	206.97	479.54
1.1.1.7.3.Rice with only Vegetables	each	53.34	103.40
1.1.1.7.4.String Hoppers	each	215.59	484.51
1.1.1.7.5.Pittu	each	53.57	207.07
1.1.1.7.6.Hoppers	each	61.76	187.50
1.1.1.7.7.Rotti	each	39.59	81.88
1.1.1.7.8.Thosai / Italy	each	53.10	133.46
1.1.1.7.10.Milk Tea	each	111.25	323.99
1.1.1.7.11.Plain Tea	each	46.74	111.02
1.1.2.Meat and Meat products			
1.1.2.1.Meat		505.22	1147.04
1.1.2.1.1.Chicken	kg.	372.56	824.23
1.1.2.1.2.Beef	kg.	117.23	285.49
1.1.2.1.3.Mutton	kg.	15.43	37.32
1.1.2.2.Processed Meat Products		48.63	112.20
1.1.2.2.1.Sausages		23.68	67.20
1.1.2.2.2.Meat balls		5.85	13.18
1.1.3.Fish and Sea Food			
1.1.3.1.Fish		634.61	1437.56
1.1.3.1.1.Kelavalla	kg.	192.92	443.93
1.1.3.1.2.Thalapath	kg.	132.03	289.64
1.1.3.1.3.Balaya	kg.	63.84	160.81
1.1.3.1.4.Mullet	kg.	78.21	171.60
1.1.3.1.5.Paraw	kg.	92.35	206.99
1.1.3.1.6.Seer	kg.	75.26	164.59
1.1.3.2.Small Fish		135.23	284.34
1.1.3.2.1.Salaya and Sudaya	kg.	44.02	85.00
1.1.3.2.2.Hurulla	kg.	31.97	59.86
1.1.3.2.3.Small Mullet & Parati	kg.	27.26	60.56
1.1.3.2.4.Kumbalawa and Angila	kg.	20.49	48.14
1.1.3.2.5.Sprats	kg.	11.49	30.77
1.1.3.3.Dried Fish		150.69	386.60
1.1.3.3.1.Sprats (dried)	kg.	57.51	136.77
1.1.3.3.2.Katta (dried)	kg.	56.04	140.02
1.1.3.3.3.Balaya (dried)	kg.	13.36	43.17
1.1.3.3.4.Keeramin/ Salaya (dried)	kg.	13.20	42.90
1.1.3.3.5.Seer (dried)	kg.	10.58	23.73

Contd.

Item	Unit	Base.2002	Aug-09
1.1.3.4.Processed Fish		90.54	291.73
1.1.3.4.1.Maldives fish	kg.	61.39	188.61
1.1.3.4.2.Canned fish (Salmon)	425g.	29.15	103.12
1.1.4.Milk, Cheese and Eggs			
1.1.4.1.Eggs			
1.1.4.1.1.Hen	each	68.04	143.43
1.1.4.2.Milk		751.12	1553.69
1.1.4.2.1.Milk powder	400g.	687.54	1411.06
1.1.4.2.2.Infant milk powder	400g.	63.58	142.64
1.1.4.3.Coconut Products			
1.1.4.3.1.Coconut nuts	each	418.83	629.77
1.1.4.4.Milk Products		121.96	286.38
1.1.4.4.1.Ice-cream	lt	58.84	124.05
1.1.4.4.2.Yogurt	Cup	31.92	55.85
1.1.4.4.3.Cheese	250g./Pkt.	31.20	106.48
1.1.5.Oils and Fats			
1.1.5.1.Cooking Oil & Fat		273.27	585.33
1.1.5.1.2.Coconut oil	750ml.	123.67	232.55
1.1.5.1.3.Margarine	250g.	48.15	101.98
1.1.5.1.4.Butter	227g.	57.98	151.05
1.1.5.1.5.Vegetable oil	1lt.	36.84	87.50
1.1.5.2.Oil Seed / Nuts			
1.1.5.2.1.Groundnuts	kg.	6.63	12.25
1.1.6.Fruit			
1.1.6.1.Fresh Fruits		392.99	753.70
1.1.6.1.1.Plantains	each.	171.19	292.39
1.1.6.2.Fresh Fruits			
1.1.6.2.1.Papaw	Number	95.53	209.07
1.1.6.2.2.Apple	Number	47.94	71.77
1.1.6.2.3.Mangoes	Number	31.14	89.60
1.1.6.2.4.Grapes	grams	16.44	35.48
1.1.6.2.5.Oranges	Number	19.22	33.32
1.1.6.2.6.Pineapple	Number	11.53	22.06
1.1.7.Vegetables			
1.1.7.1.Low Country Vegetables		194.50	354.71
1.1.7.1.1.Brinjal	kg.	40.56	66.36
1.1.7.1.2.Sweet pumpkin	kg.	27.51	53.90
1.1.7.1.3.Tomatoes	kg.	23.39	38.87
1.1.7.1.4.Bandakka	kg.	19.23	36.99
1.1.7.1.5.Long beans	kg.	16.58	33.28
1.1.7.1.6.Ash plantain	kg.	17.82	29.68
1.1.7.1.7.Bitter gourd	kg.	17.13	36.80
1.1.7.1.8.Snake gourd	kg.	11.88	23.97
1.1.7.1.9.Ridge gourd	kg.	10.46	17.40
1.1.7.1.10.Cucumber	kg.	9.94	17.48
1.1.7.2.Up Country Vegetables		237.85	433.15
1.1.7.2.1.Beans	kg.	93.58	172.35
1.1.7.2.2.Carrot	kg.	52.77	98.09
1.1.7.2.3.Cabbage	kg.	32.38	65.41
1.1.7.2.4.Beet-root	kg.	34.44	60.11
1.1.7.2.5.Leeks	kg.	24.68	37.20
1.1.7.3.Leavy Vegetables		146.98	245.56
1.1.7.3.1.Mukunuwenna	Bundles	62.86	112.32
1.1.7.3.2.Gotukola	Bundles	31.35	48.80
1.1.7.3.3.Kankun	Bundles	24.81	42.49
1.1.7.3.4.Katurumurunga	Bundles	13.98	20.44
1.1.7.3.5.Sarana		13.98	21.51
1.1.8.Sugar, Jam, Honey, Chocolate and Confectionary		302.57	690.44
1.1.8.1.Sugar			
1.1.8.1.1.Sugar	kg.	205.81	500.98
1.1.8.2.Jaggery & Treacle			
1.1.8.2.1.Jaggery	kg.	9.49	17.55
1.1.8.3.Confectionery			
1.1.8.3.1.Jam	425g	56.87	118.64
1.1.8.3.2.Chocolates	kg.	24.01	38.94
1.1.8.3.3.Toffees	each.	6.39	14.33
1.1.9.Food Products n.e.c.			
1.1.9.1.Preserved Food Items			
1.1.9.1.1.Marmite and Vegemite		15.30	29.19

Contd.

Item	Unit	Base.2002	Aug-09
1.1.9.2.Condiments			
Perishable		295.87	517.52
Non-perishable		337.00	665.49
1.1.9.2.1.Bombay onions	kg.	138.41	280.95
1.1.9.2.2.Chilly powder	100g.	93.26	148.75
1.1.9.2.3.Curry powder (Sarakku)	100g.	57.47	118.82
1.1.9.2.4.Red onions	kg.	62.32	79.11
1.1.9.2.5.Pepper	kg.	46.34	94.70
1.1.9.2.6.Green chilies	kg.	39.83	83.15
1.1.9.2.7.Limes	kg.	36.55	53.56
1.1.9.2.8.Salt	kg.	28.86	83.64
1.1.9.2.9.Dried chilies	kg.	34.77	56.73
1.1.9.2.11.Garlic	kg.	30.26	58.82
1.1.9.2.12.Turmeric and Turmeric powder	kg.	19.20	55.43
1.1.9.2.13.Curry leaves	kg.	18.76	20.76
1.1.9.2.14.Tamarind	kg.	13.07	23.14
1.1.9.2.15.Cinnamon	kg.	13.77	25.46
1.2.Non - Alcoholic Beverages			
1.2.1.Coffee, Tea and Cocoa			
1.2.1.1.Tea & Coffee		135.81	281.48
1.2.1.1.1.Tea dust and leaves	kg.	119.02	229.20
1.2.1.1.2.Coffee powder and seeds	kg.	16.79	52.29
1.2.2.Mineral Waters, Soft drinks, Fruit and Vegetable juices			
1.2.2.1.Mineral Waters, Soft Drinks and Vegetable Juices		65.06	121.27
1.2.2.1.1.Soft drinks	No.	30.73	55.61
1.2.2.1.2.Fruit drinks and cordial	No.	34.33	65.66
1.2.2.1.3.King coconut and Kurumba	No.	16.10	33.06
Group III - Clothing and Footwear			
3.1.Clothing		469.49	808.60
3.1.1.Clothing materials			
3.1.1.1.Textiles purchased by meter for garments			
3.1.1.1.1.Materials for clothing	Meter	26.24	37.14
3.1.1.1.2.Materials for school uniforms	Meter	5.88	8.33
3.1.2.Garments			
3.1.2.1.Mens & Boys (>13 Years) Wear			
3.1.2.1.1.Shirts	each	84.69	204.87
3.1.2.1.2.Trousers	each	84.68	137.18
3.1.2.1.3.T-shirts	each	33.80	59.38
3.1.2.1.4.Sarongs/ Vetties	each	19.48	37.52
3.1.2.2.Girls & Women (>13 Years Wear)			
3.1.2.2.1.Frocks	each	51.66	68.04
3.1.2.2.2.Skirts/ Blouses	each	53.19	87.86
3.1.2.2.3.Sarees	each	51.19	75.47
3.1.2.2.4.Women's under wears	each	10.03	9.91
3.1.2.3.Infants(<Yrs), Childrens'(3-13) Wear & School wear			
3.1.2.3.1.Children's dresses	each	35.84	60.91
3.1.4.Cleaning, repair and hire of clothing			
3.1.4.1.Tailoring Charges			
3.1.4.1.1.Tailoring charges for clothing		12.81	21.99
3.2.Footwear		85.37	122.03
3.2.1.Shoes and other Footwear			
3.2.1.1.Shoes and Sandles			
3.2.1.1.1.Shoes	each	53.82	85.31
3.2.1.1.2.Sandals/ Slippers	each	31.55	36.73
Group IV - Housing, Water, Electricity, Gas and other Fuels			
4.1.Actual rentals for housing			
4.1.1.Actuals rentals paid by tenants			
4.1.1.1.Rent			
4.1.1.1.1.Rent (Actual)		1537.24	3070.91
4.3.Maintenance and repair of the dwelling			
4.3.1.Materials for the maintenance and repair of the dwellings			
4.3.1.1.Materials and Maintenance	No.		
4.3.1.1.1.Maintenance		375.55	1133.39
4.4.Water supply and miscellaneous services relating to the dwellings			
4.4.1.Water supply			
4.4.1.1.Water bills		186.16	623.75
4.5.Electricity, Gas and other fuels			
4.5.1.Electricity			
4.5.1.1.Electricity		735.51	1483.48
4.5.2.Gas			
4.5.2.1.Gas	12.5kg.	287.28	791.39
4.5.3.Liquid Fuels			
4.5.3.1.Kerosene oil	lt.	134.18	334.95
4.5.4.Solid Fuels			
4.5.4.1.Fire wood	kg.	35.38	93.35

Contd.

Item	Unit	Base.2002	Aug-09
Group V - Furnishing, household equipment and routine household maintenance	No.		
5.1.Furniture and furnishings, carpets and other floor coverings	No.		
5.1.1.Furniture and furnishings		156.78	256.70
5.1.1.1.Almyrahs	each	49.53	65.22
5.1.1.2.Chairs	each	49.56	81.93
5.1.1.3.Mattress	each	31.77	67.74
5.1.1.4.Beds	each	25.92	41.81
5.2.Household Textiles		189.63	342.61
5.2.0.Household Textiles			
5.2.0.1.Mosquito nets		3.98	7.50
5.2.0.2.Materials for curtains/ furnishing		6.13	9.39
5.2.0.3.Bed sheets		5.91	8.82
5.3.Household appliances	No.		
5.3.1.Major household appliances, whether electric or not	Bundle		
5.3.1.1.Refrigerators		41.00	92.39
5.3.1.2.Cookers (Kerosene/ Gas/ Electric)		9.70	15.13
5.3.1.3.Washing machines		20.36	33.44
5.4.Glassware, tableware and household utensils			
5.4.0.Glassware, tableware and household utensils			
5.4.0.1.Plastic ware	each	35.01	50.51
5.4.0.2.Aluminum ware	each	21.06	32.12
5.4.0.3.Glass ware	each	25.96	49.48
5.5.Tools and equipment for house and garden			
5.5.2.Small tools and miscellaneous accessories			
5.5.2.1.Electrical bulbs		11.95	26.70
5.5.2.2.Dry cell batteries		8.57	17.13
5.6.Goods and services for routine household maintenance		233.74	386.18
5.6.1.Non - durable household goods			
5.6.1.1.Washing soap	each	85.35	153.84
5.6.1.2.Washing powder	each	64.63	92.92
5.6.1.3.Mosquito coils	each	39.94	46.25
5.6.1.5.Candles	each	15.67	44.14
5.6.1.6.Matches	each	7.75	12.49
5.6.1.7.Detergents/ disinfectants	each	11.75	19.09
5.6.2.Domestic services and household services			
5.6.2.1.Laundry charges		8.65	17.45
Group VI - Health			
6.1.Medical products, appliances and equipment		250.48	445.22
6.1.1.Pharmaceutical products			
6.1.1.1.Purchase of medical. & pharmaceuticals		210.93	394.88
6.1.3.Therapeutic appliances & Equipment			
6.1.3.1.Corrective eyeglasses		39.55	50.34
6.2.Outpatient services		501.54	1080.01
6.2.1.Medical services			
6.2.1.1.Fees to private medical practice including medicine	Metre	251.79	475.59
6.2.1.2.Consultation fees to specialists		40.84	142.93
6.2.1.3.Payments to private hospital etc.		120.19	263.75
6.2.3.Paramedical services			
6.2.3.1.Payments to medical lab test analysis.		50.75	121.80
6.2.3.2.Other health expenses		37.97	75.93
Group VII - Transport			
7.1.Purchase of vehicles			
7.1.2.Motor cycles		266.52	440.27
7.1.2.1.Motor cycles/ Scooters		178.55	250.16
7.2.Operation of personal transport equipment			
7.2.1.Spare parts and accessories for personal transport equipment			
7.2.1.1.Tyres/ tubs and spare parts		87.97	190.11
7.2.2.Fuels and lubricants for personal transport equipment		466.44	1216.90
7.2.2.1.Petrol and other fuels		450.74	1172.77
7.2.2.2.Lubricating/ gear and brake oil		15.70	44.13
7.2.3.Maintenance and repair of personal transport equipment		367.94	634.38
7.2.3.1.Repair charges or spare parts and accessories		61.73	196.90
7.2.3.2.Cost of servicing of vehicles		145.15	210.08
7.2.4.Other services in respect of personal transport equipment			
7.2.4.1.License and Insurance fees		161.06	227.40
7.3.Transport services		602.93	1816.83
7.3.1.Passenger transport by railway			
7.3.1.1.Train/ Bus (other than schooling)		299.84	981.84
7.3.2.Passenger transport by road			
7.3.2.1.Taxi and three wheelers		130.83	430.80
7.3.6.Other purchased transport services			
7.3.6.1.Transport charges for schooling		172.26	404.19

Contd.

Item	Unit	Base.2002	Aug-09
Group VIII - Communication			
8.1.Postal services			
8.1.0.Postal services			
8.1.0.1.Postal and Telegraph charges		32.74	43.64
8.2.Telephone and telefax equipment		763.32	829.50
8.2.0.Telephone and telefax equipment			
8.2.0.1..Telephones (Mobile Phone)		60.14	19.58
8.3.Telephone and telefax services			
8.3.0.Telephone and telefax services			
8.3.0.1.Telephone charges		703.18	809.92
Group IX - Recreation and culture		254.02	349.10
9.1.Audio - Visual, photographic and information processing unit			
9.1.1.Equipment for the reception, recording and reproduction of sound and pictures			
9.1.1.1.Television and Video decks		56.28	72.84
9.1.3. Information processing equipment			
9.1.3.1. Personal Computer		29.16	25.32
9.1.5.Repair of audio - visual, photographic and information processing equipment			
9.1.5.1.Maintenance of radio receivers TVs		7.61	7.73
9.3.Other recreational items and equipment, gardens and pets			
9.3.1.Games, toys and hobbies			
9.3.1.1.Toys		16.51	27.00
9.4.Recreational and cultural services			
9.4.1.Recreational and sporting services			
9.4.1.1.Sports		14.98	24.25
9.4.2.Cultural services			
9.4.2.1.Cinamas/ Drama/ Video films		15.16	29.37
9.4.3.Games of chance			
9.4.3.1.Lotteries/ Betting's		35.19	70.38
9.5.Newspapers, books and stationary			
9.5.2.Newspapers and periodicals			
9.5.2.1.Books/ News papers/ Magazines		79.13	92.21
9.6.Package holidays			
9.6.0.Package holidays			
9.6.0.1.Hotel Charges		139.19	298.26
Group X - Education		1041.68	1621.41
10.2.Secondary education			
10.2.0.Secondary education			
10.2.0.1.Tuition fees		384.42	752.61
10.2.0.2.Exercise books and stationeries		97.99	141.48
10.2.0.3.School facility fees (Government)		53.83	53.83
10.2.0.4.School fees (Private)		276.11	289.22
10.3.Post secondary non tertiary education			
10.3.0.Post secondary non tertiary education			
10.3.0.1.Higher Education (Charted)		131.71	193.69
10.5.Education not definable by level			
10.5.0.Education not definable by level			
10.5.0.1.Vocational training (Computer Diploma Course)		97.62	190.59
Group XII - Miscellaneous goods and services			
12.1.Personal care	Per Mile		
12.1.1.Hairdressing salons and personal grooming establishments	Per Sect.	82.98	142.44
12.1.1.1.Hair dressing and shaving charges		74.43	130.04
12.1.1.2.Beauticare/ Cookery and Dress making		8.55	12.39
12.1.3.Other appliances, articles and products for personal care		291.67	523.40
12.1.3.1.Toilet soap		84.79	170.37
12.1.3.2.Tooth paste		40.27	66.18
12.1.3.3.Shaving goods		32.20	41.92
12.1.3.4.Perfumes		33.56	48.75
12.1.3.4.Powder		14.40	20.38
12.1.3.5.Face cream & Lotions		22.92	36.69
12.1.3.6.Tooth brushes		12.81	17.97
12.3.Personal effects n.e.c			
12.3.1.Jewellery, Clocks and watches			
12.3.1.1.Jewelleries		37.38	98.69
12.3.1.2.Clocks/ watches		1.90	1.90
12.3.2.Other personal effects			
12.3.2.1.Hand bags/ Traveling bags		8.10	14.91
12.3.2.2.Umbrellas		3.34	5.65
12.5.Insurance			
12.5.3.Insurance connected with health			
12.5.3.1.Insurance - Health		82.71	96.50
12.6.Financial services			
12.6.2.Other financial services n.e.c.			
12.6.2.1.Contribution to trade unions etc.		20.31	50.77

Note: Components selected and regrouped for this analysis are given in shaded form.

Annexure III: Regrouped Categories of the CCPI for Compilation of Core Inflation Measures

Serial No.	Regrouped Category	Weight
1	Rice	4.8
2	Flour	0.4
3	Bread & Bakery products	3.3
4	Starchy Food	0.8
5	Pulses	1.1
6	Other Cereals & Cereal Products	0.4
7	Meals bought outside	6.2
8	Meat	2.8
9	Processed Meat Products and Soya Meat	0.3
10	Fish	3.5
11	Small Fish	0.8
12	Dried Fish	0.8
13	Processed Fish	0.5
14	Eggs	0.4
15	Milk	4.2
16	Coconut nuts	2.3
17	Milk Products	0.7
18	Oils and Fats	1.5
19	Fresh Fruits	2.2
20	Low Country Vegetables	1.1
21	Up Country Vegetables	1.3
22	Leavy Vegetables	0.8
23	Sugar, Jam, Honey, Chocolate and Confectionary	1.7
24	Marmite and Vegemite	0.1
25	Condiments Perishable	1.6
26	Condiments Non-perishable	1.9
27	Tea & Coffee	0.8
28	Mineral Waters, Soft Drinks and Vegetable Juices	0.4
29	King coconut and Kurumba	0.1
30	Clothing	2.6
31	Footwear	0.5
32	Rent (Actual)	8.5
33	Maintenance	2.1
34	Water bills	1.0
35	Electricity	4.1
36	Gas	1.6
37	Kerosene oil	0.7
38	Fire wood	0.2
39	Furniture and furnishings	0.9
40	Household Textiles	1.1
41	Goods and services for routine household maintenance	1.3
42	Medical products, appliances and equipment	1.4
43	Outpatient services	2.8
44	Purchase of vehicles	1.5
45	Fuels and lubricants for personal transport equipment	2.6
46	Maintenance and repair of personal transport equipment	2.0
47	Transport services	3.4
48	Postal and Telegraph charges	0.2
49	Telephone and telefax equipment	4.2
50	Recreation and culture	1.4
51	Hotel Charges	0.8
52	Education	5.8
53	Hairdressing salons and personal grooming establishments	0.5
54	Other appliances, articles and products for personal care	1.6
55	Insurance - Health	0.5
56	Contribution to trade unions etc.	0.1
	TOTAL WEIGHT	**100.0**

Annexure IV: Compilation Procedures of Core Inflation Measures

- ***Annual Average Headline Inflation***

Annual average (moving average) change of the CCPI index calculated as: [(average of the preceding 12-months of the index of the current year/ average of the preceding 12-months of the index of the previous year) – 1].

- ***Seasonal Adjusted Headline Inflation***

Headline series was seasonally adjusted using the Census X11- Multiplicative Method, available with Eviews Econometric Software (Version 5).

- ***HP Filtered Headline Inflation***

Headline series was smoothened using the Hodrick-Prescott Filter (Lambda = 14,400), available with Eviews Econometric Software (Version 5).

- ***Exponentially Smoothened Headline Inflation***

Each month's exponentially smoothed inflation rate is calculated using the following steps:

- Calculating year-on-year changes of the CCPI index
- Adjusting the period starting from current month to 60 - months backwards
- Adjusting (1-ahlpha)^^{period} for 60 - months
- Adjusting year-on-year headline inflation: starting from previous (t-j) month to 60 months backwards
- Calculating alpha)^^{period} multiplied by year-on-year headline inflation and summing-up the series
- Specifying the total sum multiplied by alpha (0.125) as the inflation rate

- ***Exclusion Method based Core Inflation***

The following table provides details of exclusions.

Measure	**Code**	**Categories Excluded**	**Share of Categories Excluded (Total =100)**
Core (Excluding Food & Energy)	**Core (xFE) - DCS**	Entire food and non-alcoholic beverages group, as well as selected energy items, including kerosene oil, gas, electricity, fire wood and fuels and lubricants for personal transport equipment	**55.9**
Core (Excluding Fresh Food & Energy)	**Core (xFFE)**	Selected fresh food items - fresh fish (small and large), vegetables (up country, low country and leafy), fruits, vegetable juices (king coconut and Kurumba) and perishable condiments including lime, onions, green chilies and curry leaves, together with the 6 energy categories excluded in xFE	**20.6**
Core (Excluding Food, Energy & Transport)	**Core (xFET)**	Entire food and non-alcoholic beverages group, energy items and transport services	**59.8**
Core (Excluding Fresh Food, Energy & Transport)	**Core (xFFET)**	Selected fresh food items, energy (as in the Core FFE) and transport services	**24.0**
Core (Excluding	**Core**	Items included in Core (xFFE) plus Rice and	**27.7**

Fresh Food, Energy, Rice and Coconut)	**(xFFE+RC)**	Coconut	
Core (Excluding Fresh Food, Energy, Transport, Rice & Coconut)	**Core (xFFET+RC)**	Items included in Core (xFFET) plus Rice and Coconut	**31.1**
Core (Excluding 10 Most YOY Volatile Items)	**Core (x10YV)**	Most Volatile 10 Items based on the year-on-year changes (Rice, Pulses, Eggs, Coconut Nuts, Low Country Vegetables, Up Country Vegetables, Water Bills, Electricity, Gas, Kerosene Oil	**18.5**
Core (Excluding 15 Most YOY Volatile Items)	**Core (x15YV)**	Most Volatile 15 Items based on the year-on-year changes (items included in Corex10YV and Flour, Bread & Bakery Products, Milk, Oil and Fats and Medical products, appliances and equipment)	**29.3**
Core (Excluding 25 Most YOY Volatile Items)	**Core (x25YV)**	Most Volatile 25 Items based on the year-on-year changes (items included in Corex15YV and Dried Fish, Processed Fish, Sugar, Jam, Honey, Chocolate and Confectionary, King coconut and Kurumba, Condiments Perishable, Maintenance, Outpatient Services, Fuels and lubricants for personal transport equipment, transport services and Contribution to trade unions)	**45.0**
Core (Excluding 10 Most Monthly Volatile Items)	**Core (x10MV)**	Most Volatile 10 Items based on the monthly changes (Starchy Food, Small Fish, Eggs, Low Country Vegetables, Up Country Vegetables, King coconut and Kurumba, Water bills, Condiments Perishable, Transport Services)	**10.4**
Core (Excluding 15 Most Monthly Volatile Items)	**Core (x15MV)**	Most Volatile 15 Items based on the monthly changes (items included in Corex10MV and Coconut nuts, Fresh Fruit, Leavy Vegetables, Electricity and Kerosene Oil)	**20.6**
Core (Excluding 25 Most Monthly Volatile Items)	**Core (x25MV)**	Most Volatile 25 Items based on the monthly changes (items included in Corex15MV and Rice, Pulses, Meat, Fish, Dried Fish, Processed Fish, Tea and Coffee, Gas, Fuels and lubricants for personal transport equipment and Hotel Charges)	**39.9**

After excluding, inflation was measured by percentage increase in remaining index during the preceding 12-months.

- ***Trimmed Mean based Core Inflation***

Each month's trimmed mean inflation rate is calculated using the following steps.

- Computing year-on-year per cent change in each component
- Sorting the percentage changes in price from (numerically) smallest to largest, and sorting the relative importance weights for each component along with the price changes
- Forming the cumulative sum of the sorted relative importance weights for each ordered price change
- Excluding those percentage changes in price for which the cumulative weight is either less than 5 per cent, 10 per cent and 15 per cent, respectively, (smallest per cent changes) and greater than 95 per cent, 90 per cent and 85 per cent, respectively, (largest per cent changes), i.e. trimming 10 per cent, 20 per cent or 30 per cent from two ends.
- Computing the trimmed mean inflation rate as where the summations start with the first (ordered) price change to be included and end with the last (ordered) price change to be included, and the first term effectively renormalizes the weights of the included components to sum to 1.

- ***Weighted Median based Core Inflation***

Each month's weighted median CPI rate is calculated by first following steps 1-3 above and then simply setting the median rate equal to the first per cent change in price with a cumulative weight greater than or equal to 50 per cent. Monthly inflation rates for this core measure are computed as a weighted sum of the price changes in the included components. The weights equal relative importance normalised to sum to 1.

- ***Volatility Weighted Method based Core Inflation***

New weights are assigned to each component based on standard deviation during the reference period. Original and new weights are given in the following table.

Weights of Regrouped Components/Items

Component/Item	Original Weight	New Weight
Rice	4.8	1.2
Flour	0.4	0.2
Bread & Bakery products	3.3	1.4
Starchy Food	0.8	0.6
Pulses	1.1	0.4
Meals bought outside	6.2	5.2
Meat	2.8	2.8
Fish	3.5	3.6
Small Fish	0.8	0.5
Dried Fish	0.8	0.5
Processed Fish	0.5	0.3
Eggs	0.4	0.1
Milk	4.2	1.6
Coconut nuts	2.3	0.5
Oils and Fats	1.5	0.6
Fresh Fruits	2.2	2.8
Low Country Vegetables	1.1	0.4
Up Country Vegetables	1.3	0.5
Leavy Vegetables	0.8	0.6
CondimentsPerishable	1.6	0.9
CondimentsNon-perishable	1.9	1.3
Clothing	2.6	5.5
Footwear	0.5	0.9
Rent (Actual)	8.5	9.5
Maintenance	2.1	1.0
Water bills	1.0	0.3
Electricity	4.1	1.5
Gas	1.6	0.5
Kerosene oil	0.7	0.3
Fire wood	0.2	0.1
Furniture and furnishings	0.9	0.8
Household Textiles	1.1	2.9
Goods and services for routine household maintenance	1.3	2.1
Medical products, appliances and equipment	1.4	0.6
Outpatient services	2.8	1.4
Fuels and lubricants for personal transport equipment	2.6	1.7
Transport services	3.4	1.5
Telephone and telefax equipment	4.2	2.9
Recreation and culture	1.4	1.7
Hotel Charges	0.8	0.6
Other appliances, articles and products for personal care	1.6	2.8
Insurance - Health	0.5	1.7

After reassigning the weights, inflation was measured by percentage increase in CCPI during the preceding 12-months.

Annexure V: Headline and Alternative Measures of Core Inflation (Year-on-Year Changes)

Period	Headline	Alternative Measures of Underlying/ Core Inflation											
		Annual Average Headline	Seasonally Adjusted Headline	HP Filtered Headline	Core (Excluding Food & Energy) Core (xFE) - DCS	Core (Excluding Fresh Food & Energy) Core (xFFE)	Core (Excluding Food, Energy & Transport) Core (xFET)	Core (Excluding Fresh Food, Energy & Transport) Core (xFFET)	Core (Excluding Fresh Food, Energy, Rice & Coconut) Core (xFFE + RC)	Core (Excluding Fresh Food, Energy, Transport, Rice & Coconut) Core (xFFET + RC)	Core (Excluding 10 Most YOY Volatile Items) Core (x10YV)	Core (Excluding 15 Most YOY Volatile Items) Core (x15YV)	Core (Excluding 25 Most YOY Volatile Items) Core (x25YV)
Dec-03	8.9			7.5	11.9	8.5	11.7	8.2	10.3	10.1	10.2	10.4	9.8
Jan-04	4.8		4.9	7.7	9.0	6.4	7.4	5.4	8.6	7.7	8.5	9.0	7.4
Feb-04	5.5		5.4	7.9	9.4	6.5	7.6	5.4	8.5	7.4	8.6	9.3	7.2
Mar-04	5.7		5.7	8.1	8.9	7.1	7.2	6.1	8.1	7.0	7.8	8.3	6.4
Apr-04	6.9		6.9	8.3	8.7	8.1	7.0	7.1	8.3	7.2	7.9	8.2	6.8
May-04	7.0		7.0	8.5	8.7	8.0	7.3	7.2	8.0	7.1	7.4	7.9	6.8
Jun-04	7.7		7.6	8.7	8.6	8.8	7.2	8.1	8.4	7.6	7.7	8.2	7.4
Jul-04	9.9		9.8	8.8	9.8	10.4	8.6	9.7	9.6	8.8	9.6	10.6	8.4
Aug-04	10.9		10.9	9.0	10.4	11.2	9.0	10.4	10.1	9.2	10.3	11.5	8.9
Sep-04	11.4		11.4	9.2	7.5	10.8	5.7	10.1	8.7	7.8	9.8	10.5	7.2
Oct-04	12.1		12.1	9.4	8.6	12.6	6.8	11.8	10.2	9.2	10.2	10.8	6.5
Nov-04	12.9		12.9	9.6	10.1	13.3	8.5	12.6	11.0	10.1	10.9	11.5	7.4
Dec-04	13.0	9.0	13.0	9.8	9.9	13.3	8.2	12.5	10.6	9.7	11.0	11.6	7.9
Jan-05	12.2	9.6	12.4	9.9	8.8	12.0	8.9	12.3	9.5	9.6	9.6	9.8	6.9
Feb-05	12.1	10.2	12.1	10.1	8.3	11.6	8.6	12.0	9.5	9.8	9.5	9.9	7.7
Mar-05	13.3	10.8	13.3	10.3	10.7	12.8	11.3	13.3	11.7	12.1	11.0	11.3	9.7
Apr-05	13.3	11.3	13.3	10.4	11.2	12.8	11.8	13.2	12.1	12.6	11.7	12.1	9.9
May-05	12.8	11.8	12.9	10.6	11.2	12.4	11.5	12.6	12.6	12.8	12.4	12.6	10.3
Jun-05	12.4	12.2	12.3	10.8	11.1	11.1	11.2	11.2	11.5	11.7	12.2	12.4	9.8
Jul-05	11.3	12.3	11.2	10.9	10.4	10.0	10.5	10.0	11.0	11.1	11.2	11.2	9.1
Aug-05	10.7	12.3	10.6	11.1	10.7	9.7	10.1	9.3	11.3	10.9	11.2	10.8	8.7
Sep-05	9.2	12.1	9.2	11.3	10.9	8.6	10.3	8.1	10.7	10.3	10.3	10.3	8.9
Oct-05	9.5	11.9	9.4	11.4	11.5	8.9	10.9	8.6	10.9	10.7	11.0	11.3	10.7
Nov-05	8.2	11.5	8.2	11.6	9.3	7.4	8.7	7.0	9.5	9.2	9.9	10.1	9.9
Dec-05	7.4	11.0	7.4	11.8	9.2	6.4	8.6	6.0	8.8	8.5	9.1	9.3	8.6
Jan-06	7.3	10.6	7.7	12.0	8.6	6.5	8.1	6.0	8.7	8.4	9.2	9.5	9.2
Feb-06	8.3	10.3	8.5	12.2	8.9	6.6	8.3	6.2	8.9	8.5	9.4	9.7	8.8
Mar-06	7.9	9.8	7.8	12.4	8.6	6.6	7.9	6.2	8.4	8.0	9.3	9.8	8.6
Apr-06	8.1	9.4	8.1	12.6	8.3	6.5	7.4	6.0	8.2	7.8	9.2	9.5	8.4
May-06	9.2	9.1	9.4	12.8	8.2	7.5	7.6	7.2	8.6	8.4	9.6	10.0	9.1
Jun-06	10.6	9.0	10.5	13.0	9.3	9.1	8.9	8.9	10.1	10.0	10.9	11.3	10.3
Jul-06	9.9	8.9	9.8	13.2	8.8	8.8	8.4	8.6	9.6	9.5	10.6	11.1	10.4
Aug-06	10.0	8.8	9.9	13.5	8.2	8.9	8.7	9.3	9.6	10.0	10.5	11.0	10.3
Sep-06	11.1	9.0	11.1	13.7	8.4	9.5	8.6	9.8	10.2	10.4	11.2	11.5	10.2
Oct-06	11.5	9.2	11.5	14.0	8.1	9.5	8.5	9.7	10.7	11.0	11.6	11.5	11.0
Nov-06	12.4	9.5	12.5	14.2	8.4	10.8	8.5	11.1	11.5	11.9	11.5	11.1	10.3
Dec-06	13.5	10.0	13.6	14.4	8.6	11.2	8.9	11.5	12.0	12.4	12.7	12.5	11.5
Jan-07	13.7	10.6	14.0	14.7	8.8	11.3	8.7	11.6	12.0	12.4	12.6	12.1	12.1
Feb-07	15.2	11.1	15.2	14.9	8.9	12.2	9.0	12.5	12.5	12.9	13.3	12.8	12.9
Mar-07	15.1	11.7	15.0	15.1	7.6	11.8	7.5	12.1	11.7	12.1	13.4	12.8	12.9
Apr-07	14.3	12.3	14.3	15.3	8.2	11.4	7.4	11.3	11.5	11.4	13.1	12.7	12.7
May-07	13.2	12.6	13.1	15.5	7.9	11.0	7.2	11.0	11.2	11.1	12.0	11.3	11.1
Jun-07	13.5	12.8	13.3	15.7	8.0	11.4	6.8	11.1	11.1	10.8	12.1	11.3	10.8
Jul-07	15.4	13.3	15.1	15.8	7.4	11.9	6.1	11.7	11.4	11.1	12.9	11.7	10.9
Aug-07	16.5	13.8	16.5	15.9	7.3	13.6	6.0	13.4	12.4	12.2	13.2	11.5	11.1
Sep-07	16.1	14.2	16.2	16.1	6.7	13.9	5.8	14.0	12.5	12.5	13.2	11.2	11.9
Oct-07	18.2	14.8	18.2	16.1	6.7	16.2	5.9	16.4	14.2	14.3	14.5	11.3	11.0
Nov-07	19.3	15.4	19.4	16.2	6.7	18.0	5.8	18.3	15.5	15.6	16.0	11.7	11.8
Dec-07	18.8	15.8	18.9	16.2	8.1	19.6	7.1	19.9	16.8	17.0	15.9	11.2	11.6
Jan-08	20.8	16.4	21.1	16.2	6.9	20.6	6.1	21.1	17.3	17.5	17.0	12.0	10.9
Feb-08	21.5	17.0	21.6	16.2	8.4	24.1	7.2	24.5	20.0	20.2	18.7	12.8	10.8
Mar-08	23.8	17.7	23.7	16.1	9.3	24.9	7.8	25.2	20.6	20.7	19.6	13.7	11.0
Apr-08	25.0	18.7	25.1	15.9	9.3	26.2	8.7	27.1	21.1	21.8	19.9	13.7	11.3
May-08	26.2	19.7	26.2	15.8	9.6	25.7	9.1	26.6	21.3	22.0	20.8	15.2	12.9
Jun-08	28.2	21.0	28.1	15.6	14.1	27.7	9.2	26.0	24.2	22.2	24.3	19.7	13.8
Jul-08	26.6	21.9	26.4	15.3	17.2	28.2	11.0	26.0	25.1	22.5	23.9	19.9	13.9
Aug-08	24.9	22.6	24.9	15.1	17.4	26.1	11.2	23.8	23.7	21.1	23.3	20.3	14.8
Sep-08	24.3	23.2	24.3	14.7	18.7	25.4	12.6	23.1	23.7	21.1	23.2	20.7	14.4
Oct-08	20.3	23.4	20.2	14.4	18.1	21.2	11.9	18.7	20.1	17.4	19.7	18.8	12.0
Nov-08	16.5	23.0	16.6	14.0	18.1	17.4	12.1	14.9	17.6	14.8	16.9	17.3	11.2
Dec-08	14.4	22.6	14.4	13.6	15.7	14.9	10.9	12.8	15.5	13.3	14.9	15.4	10.4
Jan-09	10.7	21.6	10.8	13.2	15.5	12.1	11.0	10.1	13.4	11.2	12.5	13.6	9.7
Feb-09	7.6	20.3	7.6	12.7	14.1	8.5	10.5	6.8	10.5	8.7	10.0	12.0	9.6
Mar-09	5.3	18.7	5.2	12.3	14.2	7.7	11.1	6.0	9.8	8.1	8.2	10.2	8.1
Apr-09	2.9	16.7	2.9	11.8	13.5	5.8	10.4	4.0	8.8	7.0	6.8	9.0	7.4
May-09	3.3	14.8	3.4	11.4	13.5	6.8	10.4	5.1	9.1	7.4	7.1	9.1	7.6
Jun-09	0.9	12.5	0.9	10.9	7.7	3.9	9.4	4.6	5.4	6.3	3.0	4.0	6.3
Jul-09	1.1	10.4	1.1	10.4	6.0	3.5	9.2	4.6	4.8	6.1	2.5	2.5	5.5
Aug-09	0.9	8.4	0.8	9.9	6.4	3.3	9.8	4.4	4.6	5.9	2.2	3.0	5.1

Contd.

Period	Headline	Alternative Measures of Underlying/ Core Inflation								
		Core (Excluding 10 Most Monthly Volatile Items) Core (x10MV)	Core (Excluding 15 Most Monthly Volatile Items) Core (x15MV)	Core (Excluding 25 Most Monthly Volatile Items) Core (x25MV)	Core (Volatility Weighted) Core (VW)	Core (Trim Mean 10) Core (TR10)	Core (Trim Mean 20) Core (TR20)	Core (Trim Mean 30) Core (TR30)	Core (Weighted Median) Core (WM)	Core (Exponentially Smoothing) Core (ES)
Dec-03	8.9	8.3	9.3	10.3	9.6	11.7	8.9	8.5	9.2	7.7
Jan-04	4.8	5.2	6.4	7.7	6.2	7.0	5.4	4.7	5.9	7.2
Feb-04	5.5	5.3	6.5	7.5	6.4	7.3	5	4.0	6.3	6.9
Mar-04	5.7	5.6	6.7	7.5	6.2	6.6	5.1	4.4	5.4	6.8
Apr-04	6.9	6.5	7.4	7.3	6.6	7.2	5.9	4.7	5.9	7.2
May-04	7.0	6.6	7.3	7.1	6.6	7.3	6	5.8	5.5	7.0
Jun-04	7.7	7.6	8.1	7.4	6.9	7.7	6.5	5.4	5.5	7.3
Jul-04	9.9	9.4	10.1	8.2	8.2	10.4	8.4	8.0	6.7	7.8
Aug-04	10.9	10.6	11.2	8.5	8.8	11.1	9.7	9.6	6.7	8.4
Sep-04	11.4	11.2	11.6	6.7	8.2	11.6	9.3	9.0	6.3	8.8
Oct-04	12.1	11.9	12.3	8.4	8.2	13.2	9.5	8.1	6.2	9.1
Nov-04	12.9	12.3	12.3	9.4	8.9	15.1	10.3	9.3	7.7	9.7
Dec-04	13.0	12.6	12.1	8.9	9.1	13.4	10.2	9.2	9.8	10.3
Jan-05	12.2	12.2	11.7	8.7	8.2	12.1	9.1	8.9	7.3	9.8
Feb-05	12.1	11.8	11.3	8.3	8.9	11.7	9.1	8.3	8.4	10.8
Mar-05	13.3	12.1	11.8	9.3	9.9	12.7	10.4	9.9	10.6	10.5
Apr-05	13.3	12.1	12.1	9.8	10.1	13.4	10.7	10.6	8.7	10.9
May-05	12.8	12.0	11.9	10.2	10.2	12.3	9.9	10.6	9.7	10.9
Jun-05	12.4	11.4	11.4	9.8	10.1	11.9	10	10.4	9.5	11.1
Jul-05	11.3	10.4	10.3	9.7	9.3	11.1	9.5	9.9	9.7	11.3
Aug-05	10.7	8.9	9.2	9.6	8.9	10.9	9.7	8.3	9.9	11.3
Sep-05	9.2	7.2	7.6	9.4	8.7	9.6	8.8	8.2	9.1	11.2
Oct-05	9.5	8.0	8.2	9.2	9.6	10.3	8.6	8.6	6.4	11.0
Nov-05	8.2	7.0	7.5	7.8	8.7	8.8	7.7	7.5	7.4	10.8
Dec-05	7.4	6.1	7.1	7.4	8.0	8.5	7.1	7.3	7.7	10.5
Jan-06	7.3	6.3	7.2	7.3	8.4	8.3	7.4	7.3	6.1	10.1
Feb-06	8.3	7.7	7.6	8.0	8.2	8.7	7.8	7.8	6.9	9.7
Mar-06	7.9	8.4	8.4	9.1	8.2	8.5	7.6	7.2	7.0	9.6
Apr-06	8.1	8.5	8.3	9.0	8.2	8.7	7.6	8.3	7.5	9.3
May-06	9.2	9.6	9.2	9.9	8.7	9.4	8.4	7.4	7.3	9.2
Jun-06	10.6	10.8	10.5	11.1	9.7	10.6	9.2	9.1	8.4	9.2
Jul-06	9.9	10.6	10.2	10.0	9.6	10.1	9	9.4	8.6	9.4
Aug-06	10.0	11.5	11.0	10.5	9.6	9.9	8.8	7.0	8.3	9.4
Sep-06	11.1	12.7	11.6	10.4	10.0	11.0	9.2	10.1	8.3	9.5
Oct-06	11.5	12.5	11.6	11.3	10.3	11.9	10.2	10.6	8.5	9.7
Nov-06	12.4	12.9	11.7	11.6	10.5	12.3	10.7	10.5	10.0	9.9
Dec-06	13.5	13.5	12.2	12.2	11.3	13.6	11.8	11.0	11.9	10.3
Jan-07	13.7	13.8	12.7	12.8	11.7	14.3	11.7	12.3	11.6	10.7
Feb-07	15.2	15.5	13.4	12.6	12.7	14.6	12.5	12.2	13.7	11.0
Mar-07	15.1	15.3	13.0	11.2	12.5	14.8	12.7	12.6	11.8	11.6
Apr-07	14.3	14.6	12.2	10.9	12.1	13.8	12.2	12.2	11.9	12.0
May-07	13.2	13.9	11.9	10.2	11.1	12.9	10.9	10.7	11.8	12.3
Jun-07	13.5	14.1	11.9	10.1	11.1	13.7	11.3	12.1	10.7	12.4
Jul-07	15.4	15.2	12.4	10.7	11.7	15.3	12.8	13.3	11.3	12.5
Aug-07	16.5	16.6	13.6	11.8	12.1	16.9	15.2	15.2	15.2	12.9
Sep-07	16.1	16.3	13.8	12.4	11.7	17.1	15	16.2	12.8	13.4
Oct-07	18.2	18.7	16.7	14.8	12.1	18.6	16	16.0	12.7	13.7
Nov-07	19.3	20.8	19.0	16.6	12.8	20.1	16.8	16.0	11.2	14.3
Dec-07	18.8	21.3	19.9	18.1	12.2	19.7	17.5	16.7	11.4	14.9
Jan-08	20.8	22.5	20.8	17.9	11.5	21.8	19.4	17.6	13.2	15.4
Feb-08	21.5	23.0	23.4	21.1	12.0	22.7	17.4	15.9	13.0	16.1
Mar-08	23.8	24.2	24.6	21.7	12.9	24.8	19.4	19.8	17.4	16.7
Apr-08	25.0	25.5	25.9	22.6	13.5	26.8	20.4	20.8	13.7	17.6
May-08	26.2	25.6	26.0	22.5	15.1	28.0	22.5	25.8	16.6	18.6
Jun-08	28.2	26.6	27.6	21.9	16.8	29.3	24.9	25.4	21.0	19.5
Jul-08	26.6	25.6	27.0	21.9	17.0	27.5	23.5	26.4	21.6	20.6
Aug-08	24.9	23.8	25.7	20.1	16.8	25.6	21.6	23.8	23.5	21.3
Sep-08	24.3	23.3	25.4	19.9	16.8	24.4	20.6	21.0	22.0	21.8
Oct-08	20.3	19.1	20.5	15.9	14.7	20.1	17.6	17.2	16.9	22.1
Nov-08	16.5	14.8	16.6	13.5	13.0	15.8	18.2	16.1	12.1	21.9
Dec-08	14.4	12.4	14.2	11.8	12.2	15.6	12.4	15.5	11.2	21.2
Jan-09	10.7	8.8	10.9	9.7	10.7	11.6	9.7	9.0	9.1	20.3
Feb-09	7.6	5.6	7.7	7.0	9.2	9.8	7.8	7.1	7.1	19.1
Mar-09	5.3	3.4	5.1	5.8	7.8	7.9	5.7	5.6	4.5	17.7
Apr-09	2.9	1.3	3.3	5.0	6.4	5.8	4.1	4.3	3.7	16.1
May-09	3.3	2.3	4.1	5.4	6.0	5.7	4.0	5.3	3.7	14.5
Jun-09	0.9	0.7	2.2	4.7	3.9	4.1	3.0	3.6	3.0	13.1
Jul-09	1.1	0.5	2.1	4.6	3.3	3.2	3.1	2.0	4.8	11.6
Aug-09	0.9	0.5	1.5	5.0	3.9	2.6	2.9	2.4	3.3	9.1

Annexure VI: Different Criteria Suggested in Literature to Evaluate Core Inflation Measures

Research	Suggested Characteristics
Roger (1998)	Timeliness Credible (verifiable by the agents independent of the central bank) Easily understood by the public Not significantly biased with respect to the targeted measure
Wynne (1999)	Computable in real time Forward looking Robust and unbiased Have a track record of some sort Have some theoretical basis, ideally in monetary theory Be familiar and understandable to the public Not be subject to revisions
Hogan, Johnson and Lafleche (2001)	A good indicator of current and future trends in inflation A viable target of monetary policy
Clark (2001)	Tracking trend inflation Similarity of means Predicting future inflation Complexity (public transparency)
Mankikar and Paisley (2002)	Targeted inflation and core inflation should be co-integrated with a unit co-efficient Core inflation should be an attracter of targeted inflation Targeted inflation should not be an attracter of core inflation
Rich and Steindel (2005)	Transparency of construction Similarity of means Tracking trend inflation Forecasting ability
Giannone and Matheson (2006)	Predicting trend inflation
Silver (2006)	Credibility and general considerations Judging on the basis of control Judging on the basis of deviation from a reference series Justifying the exclusion of product groups on the basis of volatility Judging on the basis of predictive ability Judging on the basis of tests (Unbiasedness, Granger-causality, co-integration based tests) Judging on the basis of money supply
Horden (2006)	Simplicity Picking up persistent changes in inflation Leading or being coincident with measured inflation (i.e., not lagging measured inflation) Unbiased indication of measured inflation Smoothness (having a low variance) Low prediction error for measured inflation

Source: Tennakoon, 2008

Annexure VII: Theoretical Explanations for Predictability Tests

1. Granger Causality

Granger causality is used to determine whether one time series is useful in forecasting another.

A time series *X* is said to Granger-cause *Y* if it can be shown, usually through a series of F-tests on lagged values of *X* (and with lagged values of *Y* also known), that those *X* values provide statistically significant information about future values of *Y*.

The Granger causality between two variables such as X and Y are said to be:

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \qquad \text{(A12)}$$

$$X_t = \sum_{i=1}^{n} \lambda_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + u_{2t} \qquad \text{(A13)}$$

where u_{1t} and u_{2t} are serially uncorrelated random disturbances with zero mean. If X Granger causes Y;

$\mathrm{H}_0 : \alpha_1 = \alpha_2 = \alpha_3 = \ldots \alpha_m = 0$ is rejected against the alternative, $\mathrm{H}_1 : \text{not } \mathrm{H}_0$

Similarly if Y Granger causes X;

$\mathrm{H}_0^* : \delta_1 = \delta_2 = \delta_3 = \ldots \delta_m = 0$ is rejected against the alternative, $\mathrm{H}_1^* : \text{not } \mathrm{H}_0$

If better predictors of a given series Y can be obtained by adding lagged values of Y current and lagged values of another variable X, then X is said to Granger cause Y.

The test works by first doing a regression of ΔY on lagged values of ΔY. Once the appropriate lag interval for Y is proved significant (t-stat or p-value), subsequent regressions for lagged levels of ΔX are performed and added to the regression provided that they 1) are significant in and of themselves and 2) add explanatory power to the model. This can be repeated for multiple ΔX's (with each ΔX being tested independently of other ΔX's, but in conjunction with the proven lag level of ΔY). More than 1 lag level of a variable can be included in the final regression model, provided it is statistically significant and provides explanatory power.

2. Cointegration

Cointegration analysis examines whether there exist any cointegrating relationship between variables using VAR in Johansen's Maximum Likelihood (Johansen's ML) approach (Johenson, 1988; Johenson and Juselius 1990). Accordingly the VAR of order k for Y is represented in error correction form as follows:

$$\Delta Y_t = \sum_{i=1}^{k} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-k} + \varepsilon_t \qquad \text{(A14)}$$

Where: Γi = (Π1 + ……+ Πi – I)

Π = (Π1 + ……+ Πk - I)

The rank (r) of the long-run matrix (Π), determines the number of cointegrating vectors in the system, where, r takes any value between 0 and the number of countries in the group (n). The tests used to obtain r are, the

Trace (λ-Trace) and the Maximum eigenvalue test (λ-Max) tests. λ-Trace tests whether the smallest n-r estimated eigenvalues are significantly different from zero, while λ-Max test whether the estimated (r+1)th largest eigenvalue is significantly different from zero.

Maximum eigenvalue statistic for H0: rank ≤ r, Vs. H1: rank = r+1 is given by:

$$\lambda_{Max}(r, r+1) = -T \ln(1-\lambda_{r+1}) \qquad (A15)$$

Trace statistic for H0: rank ≤ r, Vs. H1: rank ≥ r+1 is given by:

$$\lambda_{Trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i) \qquad (A16)$$

If the rank of the matrix Π is greater than zero and less than the number of endogenous variables, n, then equation (A14) becomes a vector error correction model (VECM) and, the matrix Π describes the adjustment speed for each variable after a deviation from the long-run relationship. This implies that the elements in Π weight the error correction term in each row of the VECM and that the matrix Π contains the coefficients of the cointegration relation.

3. *Autoregressive Moving Average Model (ARMA)*

ARMA methodology is usually used to estimate time series data. Given a time series of data X_t, the ARMA model is a tool for understanding and predicting future values in a series. The model consists of two parts, an autoregressive (AR) part and a moving average (MA) part. The model is usually then referred to as the ARMA (*p*,*q*) model where *p* is the order of the autoregressive part and *q* is the order of the moving average part.

The notation AR (*p*) refers to the autoregressive model of order *p*. The AR (*p*) model is written as:

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-i} + \varepsilon_t \qquad (A17)$$

where, $\varphi_1, \ldots. \varphi_p$ are the parameters of the model, *c* is a constant and is ε_t white noise. An autoregressive model is essentially an all-pole infinite impulse response filter. Some constraints are necessary on the values of the parameters of this model in order that the model remains stationary.

The notation MA (*q*) refers to the moving average model of order *q*:

$$X_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \qquad (A18)$$

Where, $\theta_1, \ldots, \theta_q$ are the parameters of the model, μ is the expectation of X_t (often assumed to equal 0), and the ε_t, ε_{t-i} are again, white noise error terms. The moving average model is essentially a finite impulse response filter with some additional interpretation placed on it.

The notation ARMA (*p*, *q*) refers to the model with *p* autoregressive terms and *q* moving average terms. This model contains the AR (*p*) and MA (*q*) models,

$$X_t = c + \varepsilon_t + \sum_{i=1}^{p} \varphi_i X_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \qquad (A19)$$

4. Vector Error Correction Model (VECM)

A VECM is a restricted VAR that has cointegration restrictions built into the specification. So that it is designed for use with non-stationary series that are known to be cointegrated. The VEC specification restricts the long – run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short run dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series if partial short run dynamics. The cointegration term is known as the error correction term since the deviation from long run equilibrium is corrected gradually through a series of partial short run adjustments.

For example, when considering a two variable system with one cointegrating equation and no lagged difference terms, the cointegrating equation can be written as:

$$Y_{2,t} = \beta y_{i,t} \qquad \text{(A20)}$$

and the VEC is,

$$\Delta Y_{1,t} = \gamma_1 (Y_{2,t-1} - \beta y_{1,t-1}) + e_{1,t} \qquad \text{(A21)}$$

$$\Delta Y_{2,t} = \gamma_2 (Y_{2,t-1} - \beta y_{1,t-1}) + e_{2,t} \qquad \text{(A22)}$$

In this model, the only right-hand side variables are the error correction term. In the long-run equilibrium, this term is zero. However, if Y_1 deviated from the long-run equilibrium last period, the error correction term is non zero and each variable adjusts to partially restore the equilibrium relations. The coefficients γ_1 and γ_2 measure the speed of adjustment.

5. Correlation

Correlation (often measured as a correlation coefficient, **ρ**) indicates the strength and direction of a linear relationship between two random variables. A number of different coefficients are used for different situations. The best known is the Pearson product-moment correlation coefficient, which is obtained by dividing the covariance of the two variables by the product of their standard deviations.

The correlation coefficient $\rho_{X,Y}$ between two random variables *X* and *Y* with expected values μ_X and μ_Y and standard deviations σ_X and σ_Y is defined as:

$$\rho x, y = \frac{\text{cov}(X, Y)}{\sigma x \sigma y} = \frac{E((X - \mu x)(Y - \mu y))}{\sigma x \sigma y} \qquad \text{(A23)}$$

where *E* is the expected value operator and 'cov' means covariance.

The correlation is defined only if both of the standard deviations are finite and both of them are nonzero. The correlation is 1 in the case of an increasing linear relationship, −1 for a decreasing linear relationship, and some value in between in all other cases, indicating the degree of linear dependence between the variables. The closer the coefficient is to either −1 or 1, the stronger the correlation between the variables.

Annexure VIII – ARMA Models used to forecast Headline Inflation

HEADLINE = -6.078609*HPF (-6) + 23.44471*HPF (-12) -17.24332*HPF (-18)

HEADLINE = 1.356898*xFFE (-6) -1.808931* xFFE (-12) + 1.618723* xFFE (-18)

HEADLINE = 1.353755*xFFET (-6) -1.530444* xFFET (-12) + 1.325522* xFFET (-18)

HEADLINE = 1.234537*xFFE+RC (-6) -2.185643* xFFE+RC (-12) + 2.197244* xFFE+RC (-18)

HEADLINE = 1.374532*xFFET+RC (-6) -1.804675* xFFET+RC (-12) + 1.632322* xFFET+RC (-18)

HEADLINE = 0.213810*x10YV (-6) -0.077557* x10YV (-12) + 0.851740* x10YV (-18)

HEADLINE = 1.270540*x15MV (-6) -1.669292* x15MV (-12) + 1.538198* x15MV (-18)

HEADLINE = 1.527572*TR20 (-6) -1.776098* TR20 (-12) + 1.432990* TR20 (-18)

HEADLINE = 1.095362*TR30 (-6) -1.128191* TR30 (-12) + 1.204477* TR30 (-18)

HEADLINE = 0.902402*VW (-6) -1.324037* VW (-12) + 1.778532* VW (-18)

HEADLINE = 1.637757*ES (-6) -3.976386* ES (-12) + 3.636399* ES (-18)

HEADLINE = -0.262139*xFE DCS (-6) -0.913479* xFE DCS (-12) + 2.701894* xFE DCS (-18)

Annexure IX: Results of Cointegration Test

Date: 09/25/09 Time: 09:20
Sample (adjusted): 2004M03 2009M08
Included observations: 66 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: HEADLINE INDPSA M2SA AWCMR
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.605896	127.2327	63.87610	0.0000
At most 1 *	0.472178	65.77746	42.91525	0.0001
At most 2	0.262587	23.60370	25.87211	0.0933
At most 3	0.051644	3.499658	12.51798	0.8126

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.605896	61.45526	32.11832	0.0000
At most 1 *	0.472178	42.17376	25.82321	0.0002
At most 2 *	0.262587	20.10404	19.38704	0.0393
At most 3	0.051644	3.499658	12.51798	0.8126

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

HEADLINE	INDPSA	M2SA	AWCMR	@TREND(02M02)
0.001852	-0.783262	-7.80E-06	0.331187	0.578654
0.142011	-0.290417	1.63E-05	-0.034714	-0.010702
0.249798	0.041101	4.95E-07	-0.542849	0.019377
-0.012441	-0.012821	9.38E-07	0.431193	-0.022482

Unrestricted Adjustment Coefficients (alpha):

D(HEADLINE)	-0.069925	0.197838	-0.506505	0.010026
D(INDPSA)	2.272929	0.490834	-0.092104	-0.311568
D(M2SA)	50038.46	-83033.31	-20550.84	8288.735
D(AWCMR)	-0.277985	-0.550635	0.207145	-0.347737

1 Cointegrating Equation(s): Log likelihood -1244.433

Normalized cointegrating coefficients (standard error in parentheses)

HEADLINE	INDPSA	M2SA	AWCMR	@TREND(02M02)
1.000000	-422.8976	-0.004210	178.8139	312.4258
	(48.5125)	(0.00095)	(41.1392)	(33.7080)

Adjustment coefficients (standard error in parentheses)

D(HEADLINE)	-0.000130
	(0.00026)
D(INDPSA)	0.004210
	(0.00060)
D(M2SA)	92.67785
	(34.2670)
D(AWCMR)	-0.000515
	(0.00044)

2 Cointegrating Equation(s): Log likelihood -1223.347

Normalized cointegrating coefficients (standard error in parentheses)

HEADLINE	INDPSA	M2SA	AWCMR	@TREND(02M0

				2)
1.000000	0.000000	0.000136	-1.114537	-1.593881
		(1.7E-05)	(0.57188)	(0.22735)
0.000000	1.000000	1.03E-05	-0.425466	-0.742543
		(2.2E-06)	(0.07612)	(0.03026)

Adjustment coefficients (standard error in parentheses)

D(HEADLINE)	0.027966	-0.002686
	(0.01922)	(0.11307)
D(INDPSA)	0.073914	-1.922846
	(0.04468)	(0.26279)
D(M2SA)	-11698.98	-15078.95
	(2102.64)	(12367.5)
D(AWCMR)	-0.078711	0.377649
	(0.03229)	(0.18991)

3 Cointegrating Equation(s): Log likelihood -1213.295

Normalized cointegrating coefficients (standard error in parentheses)

HEADLINE	INDPSA	M2SA	AWCMR	@TREND(02M02)
1.000000	0.000000	0.000000	-2.105286	0.203627
			(0.48902)	(0.08616)
0.000000	1.000000	0.000000	-0.500528	-0.606358
			(0.08303)	(0.01463)
0.000000	0.000000	1.000000	7304.825	-13253.09
			(5537.96)	(975.752)

Adjustment coefficients (standard error in parentheses)

D(HEADLINE)	-0.098558	-0.023504	3.51E-06
	(0.03368)	(0.09803)	(2.1E-06)
D(INDPSA)	0.050906	-1.926631	-9.78E-06
	(0.09032)	(0.26290)	(5.7E-06)
D(M2SA)	-16832.54	-15923.61	-1.751856
	(4180.34)	(12167.6)	(0.26266)
D(AWCMR)	-0.026967	0.386163	-6.69E-06
	(0.06484)	(0.18872)	(4.1E-06)

Annexure X: VECM Models Used to Forecast Headline and Core Inflation

Forecast: up to December 2011 based on data up to August 2009 (Out-of-sample Forecast)*

HEADLINE	=	226.0214	-	2.2950INDPSA	+	0.0001M2SA	+	0.0575AWCMR
				(-6.86)		(7.93)		(0.08)
HPF	=	43.0304	-	0.4106INDPSA	+	0.0000M2SA	-	0.1598AWCMR
				(-8.70)		(-5.53)		(-1.71)
xFFE	=	534.4779	-	5.4364INDPSA	+	0.0002M2SA	+	3.2277AWCMR
				(-7.94)		(8.56)		(1.38)
xFFET	=	461.3700	-	4.7154INDPSA	+	0.0002M2SA	+	2.4642AWCMR
				(-7.07)		(7.76)		(1.87)
xFFE+RC	=	319.9076	-	34.238INDPSA	+	0.0002M2SA	+	3.0577AWCMR
				(-7.94)		(7.56)		(1.33)
xFFET+RC	=	790.3342	-	8.3438INDPSA	+	0.0004M2SA	+	0.2729AWCMR
				(-7.32)		(6.576)		(1.23)
x10YV	=	154.3906	-	1.5962INDPSA	+	0.0000M2SA	-	0.0393AWCMR
				(-8.54)		(9.73)		(-1.10)
x15MV	=	590.2732	-	5.9711INDPSA	+	0.0002M2SA	+	2.8663AWCMR
				(-7.26)		(7.89)		(1.75)
TR20	=	120.7644	-	1.2313INDPSA	+	0.0000M2SA	-	0.5305AWCMR
				(-7.25)		(8.70)		(-1.59)
TR30	=	136.8048	-	1.3660INDPSA	+	0.0000M2SA	-	0.3626AWCMR
				(-7.68)		(8.56)		(-1.05)
VW	=	57.8825	-	0.6223INDPSA	+	0.0000M2SA	-	0.3789AWCMR
				(-7.17)		(8.44)		(-2.14)
ES	=	97.2694	-	1.0101INDPSA	+	0.0000M2SA	+	0.0745AWCMR
				(-7.28)		(6.75)		(0.20)
xFE-DCS	=	178.9379	-	1.9242INDPSA	+	0.0001M2SA	+	0.8071AWCMR
				(-9.10)		(9.88)		(1.89)

Note: t-statistics are given in parentheses
**In sample models were not recorded to preserve space*