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MEASURING CORE INFLATION

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Abstract

The Bank of Jamaica has as its mandate the object of achieving and maintaining price stability. Developing a core measure of inflation is one of the preliminary stages in the design and implementation of a price stability program. This, as the use of an inflation target measured by changes in the CPI has been found to be inappropriate by various practitioners. The concept of core inflation may be defined as the long term persistent component of price change that is usually associated with changes in the money supply. It is that part of inflation which is of consequence to policy makers, since it is supposed to capture the inflationary impact of policy bereft of other short term one-off changes in price. This concept is more pertinent for monetary policy as it involves abstracting the underlying inflation process from the different sources of □noise□ that may affect the CPI, based on its many biases and how its treatment of shocks. Consequently, it is this measure that monetary policy should target and not the headline rate of inflation.

In an attempt to develop a core measure for Jamaica, several series were derived based on exemption clauses, smoothing and limited influence estimators. The series were then evaluated based on their relationships with monetary aggregates and their forecasting ability. Among the series considered, the trimmed mean was found to be the best core inflation measure. This, as it had the highest coefficient of determination in relation to monetary aggregates and the lowest root mean square error in forecasting the CPI. Further, the monetary aggregate which was found to be most appropriate for monetary targeting was the monetary base.

1.0 Introduction

Inflation is commonly defined as a sustained rise in the general price level. This may be as a consequence of several factors, which are ultimately captured by changes in the cost (on the supply side) or by demand side influences. Inflation has various costs and implications for an economy. Because of the possible effects of inflation on an economy, it is imperative that its definition and measurement are relevant to a country□s macroeconomic orientation.

Different countries have adopted various techniques of measuring inflation, the most common being the change in the Retail or Consumer Price Index (CPI). The CPI is defined as the weighted average of prices in a basket of goods purchased by a typical family. In order to make comparison over time, the index is based at a representative period (base year). The base year for the Jamaican CPI is currently 1988. The CPI yields timely information on price movements since it is available monthly and with a short time lag. The percentage change in this index is used as a measure of inflation commonly referred to as the □headline□ rate.

The CPI has been widely criticised as being an inappropriate measure by various economists such as Skinner and Robinson (1989) and Evans (1989). Much of the criticisms are due to various types of measurement biases. These biases are caused by the fixed composition of the CPI basket, the exclusion of new goods from the current basket, the changing quality of goods and shifts in market share between retail outlets with differing pricing strategies. Further, while inflation is generally associated with a sustained increase in the general price level, the CPI is designed to assess the cost of particular goods and services. Thus, there is a conceptual disjuncture between this measure and

inflation. Increasing debate as to the CPI□s usefulness as a measure has helped to unearth new methods of measuring inflation.

Recently there has been heightened interest by monetary authorities whose objective is price stability, as to the nature of the inflationary process and how best it can be measured. Attempts have been made to develop an alternative measure to capture more precisely what is deemed to be the □core□ or □underlying□ inflation. Core inflation normally entails some long term persistent component of price changes that is usually associated with changes in the money supply. Quah and Vahey (1989) defined core inflation as that component of measured inflation that has no medium to long run impact on real output.

Developing a core measure of inflation is one of the preliminary stages in the design and implementation of a price stabilisation program, the primary focus of the Central Bank at this time. The concern with price stabilisation makes the matter of core inflation an important one to the Bank, particularly its movement relative to the headline CPI rate and changes in monetary aggregates. This is so because from a policy point of view, core or underlying tendencies of inflation is affected directly by policy variables such as changes in the money supply.

The core or underlying inflation has been estimated in various ways in different countries. In the U.K., core inflation is calculated from the Retail Price Index excluding mortgage interest payment. The Bank of Canada views core inflation as the changes in the CPI excluding food, energy and the effect of indirect taxes. Estimation of core inflation is also done by time series modification of the CPI. The two most popular methods used are

moving average and Kalman filter. This paper will examine ways of measuring core inflation with a subsequent attempt at developing a core inflation series for Jamaica.

The paper continues by examining the Consumer Price Index and related issues such as definition, measurement and criticisms about its use as an appropriate measure of inflation. Theoretical issues on the topic of core inflation are discussed followed by a review of the various methodologies being employed in the emerging literature to date. The final section focuses on the development of an appropriate definition to employ for a core series in Jamaica. The series are then evaluated based on their empirical results with monetary aggregates and their forecasting ability.

2.0 Measuring Inflation

Given the objective of price stability, the ability to monitor and effect accurate policy changes, a measure of the general price movements within an economy becomes necessary. However, an inflationary situation is far easier to recognise than to define or measure. Unlike most other economic concepts, such as money or output, there is no unique way to measure price inflation. Rather, there are many different aggregate price measures, any of which could be used to measure the change in price over time. These include GDP deflators, Producers Price Index and Retail or Consumer Price Index. GDP deflators are derived by dividing the expenditure measure of nominal GDP by real GDP. Unlike a price index with fixed weights, it is an implicit deflator with moving weights. The Producer Price Index is a weighted index that measures the changes in the price offered to producers for their products. The most popular measure is the CPI (or RPI) which is

used extensively across the world.

2.1 CPI and Inflation

The changes in the CPI is an indicator of changes in the price level of consumer goods and services, yielding monthly information on retail price movements. It is one of the most important variable in the decision making process of the government, households and the private sector. Inflation measurement in Jamaica is done by The Statistical Institute of Jamaica (STATIN) using the CPI. This index is constructed monthly and is the official measure of inflation used by policy makers. The CPI is measured by sampling the current prices of a fixed basket of items and constructing an index relative to a base year prices with fixed weights. The formula used for such measure is the Laspeyres Weighted

$$INDEX = \frac{\sum_{i=1}^{m} (P_{mi} / P_{oi}) * W_i}{\sum_{i=1}^{m} W_i}$$

Formula. The formula is expressed as:

where - P_{ni} is current price of item I,

-P_{oi} is the base price of item I,

-W_i is the weight of item I

-and m the number of items in the basket.

The use of the CPI as a measure of inflation is extensive and apart from the tediousness of data collection the use of computers has made its development quite

simple. However, the CPI has its problems which create a bias in terms of its ability to measure inflation. The fact that the basket remains constant means that the index does not reflect changes in consumers□ tastes or preferences or changes in the standard of living due to changes in income levels over time. Further, changes in the CPI does not reflect the true changes in the economy□s relative prices, as given the static nature of the basket, it excludes the effects of purchases of new products.

Other factors which affect this measure are shifts in income distribution, changes in the age structure of the population, the sample size and areas covered and the frequency of arrival of new goods and the decline of □old□ goods compared to the frequency of update of the basket. Increasing technological changes render many goods and services obsolete over very short periods of time. Therefore, the frequency of update may have to be improved if the CPI estimates are to maintain relevance. The outlets selected for surveying prices may introduce bias due to availability of goods and the concentration of low/middle income families in an area. Further there are quality and substitution biases which affect the CPI, since spending patterns over time may be oriented towards higher quality and relatively cheaper items that are not in the CPI.

With the recent introduction of a more laissez faire economy it is easy to understand how these problems may influence the calculated inflation rate. In this new economic environment there is the increased possibility of new goods appearing and □old□ goods being removed from the market. Also, there is an increased number of brand names available as a result of a more open economy. The pricing strategy of firms will have to change in response to increased competition in the respective markets and could also

result in the shift of business from a CPI dependent outlet to another. Decrease in business activity for a CPI dependent outlet may distort the CPI as price increases may be used to regain income loss.

It is important to emphasize that the CPI refers to a specific income group within the economy and thus captures the spending patterns of this group. The CPI therefore does not measure inflation in the broadest sense. Its measure unfortunately, depends on what it is being used for, that is, measure changes in consumer cost of living in order to judge whether wages and benefits are keeping pace with price changes and to monitor inflationary pressures. These problems lead to a conceptual question raised by Quah and Vahey as to whether it gives a notion of inflation or whether it is a measure of the cost of living.

2.2 Seasonality in CPI

The notion of seasonality in consumer prices and how it is treated should be of importance to the people who measure and use the CPI estimate. Recent studies by economists such as Bryan and Cecchetti have found increasing evidence of seasonal shocks in consumer prices. It is noteworthy that no such analysis is done by STATIN to examine the effects of seasonality on the CPI. The existence of idiosyncratic seasonal shocks increases the likelihood of allowing noise in the CPI at a seasonal frequency. However, while seasonality may be easy to understand in theory, it is extremely difficult to actually remove it from most economic series. Therefore when making policy decisions, central bankers should avoid responding to seasonal fluctuation in price data.

Figure 1 (appendix) shows a plot of changes in the CPI and the seasonally adjusted series. The seasonally adjusted series closely maps the original series. Closer examination however, shows that about December the two series diverge which indicate seasonal influences around that time. December was found to have the highest seasonal factor. This may be due to the increased demand for goods and services around this time of the year.

Arising from the problems noted above, researchers have been studying alternative ways and methods of calculating inflation[1]. Some of these alternative methods are offshoots of the CPI while others are conceptually different in nature.

3.0 Core inflation

Although there is no universal definition of core in the literature, it does involve some notion of a long term persistence in price changes. *The concept of core inflation may be defined as the long term persistent component of price change that is usually associated with changes in the money supply. It is that part of inflation which is of consequence to policy makers since it is supposed to capture the inflationary impact of policy bereft of other short term one-off changes in price. Consequently, it is this measure that monetary policy should target and not the headline rate of inflation.* Recently, researchers have sought to develop a measure of core that isolates the short term transitory movements in prices and

[1] For example Beaton and Fisher (1996), Bryan and Pike (1991), Bryan and Cecchetti (1994) among others.

other things that may hide the true underlying process.

Distinguishing between core inflation and relative price movements is very important for the conduct of monetary policy. The CPI is constructed as a weighted mean of all consumer prices and as such does not discriminate between relative price changes and core inflation. Indeed the CPI may rise when the price of just one commodity increases. Without a clear distinction between the two, policy makers may inadvertently react to relative price changes and thereby complicate the economy□s adjustment to a new set of prices.

To accurately gauge the economy□s current inflationary momentum, we must somehow disentangle relative price □noise□ from the inflation signal. This has led to the alternative calculation where some items in the CPI index are excluded due to the reasons given above. The sections below describe some of the approaches that have been used to develop a core inflation series.

3.1 Filtering Methods

In measuring core inflation one approach is to transform the CPI data so as to minimise the error between □true□ inflation and measured inflation that result from any biases associated with the CPI. This approach is known as the smoothing or filtering method and is generally done in one of two ways. The first involves calculating a moving average of the one-month percentage change in the CPI and then seasonally adjusting the resulting series. A clear advantage of using this method is the ease with which it is calculated given that it uses the CPI which is readily available. However, one of the

problems with this method is that there is no clear rationale as to why the resulting series can be considered as a measure for core inflation. Another problem is to decide on the time dimension for the moving average. One does not know whether to use a three, six or nine months moving average.

The second approach, the most familiar of which is the Kalman filter, involves hypothesising a functional form for the underlying process and then estimating it from a chosen measure of inflation. Like the previous method, this method suffers from lack of information about time dimension which cannot be helped by economic rationale. Consequently, one has to make a judgement as to whether or not the underlying process takes on an autoregressive (AR) or an autoregressive integrated moving average (ARIMA) process and the necessary lag lengths.

There has been a host of filtering or smoothing techniques which, in the main, are similar to the two described above. These techniques are very simple and easy to use and make use of the readily available CPI measure. However these techniques suffer from a lack of concrete theoretic base and rely on questionable assumptions. One such assumption is that time series are of a random walk nature, a condition that may not necessarily hold.

3.2 VAR Estimation

Vector autoregressions have also been used to derive a measure of core inflation. Quah and Vahey (1995) developed this technique based on an explicit long run economic hypothesis. This was based on their definition of core which they defined to be that component of measured inflation that has no (medium to) long run impact on real output.

This notion of inflation is consistent with the vertical long run Philip□s curve interpretation of the comovement in inflation and output. That is, inflation is associated with no change in real output. Quah and Vahey argued that the CPI is conceptually mismatched with the core and the difference between the two is more than just a measurement error.

Further, Quah and Vahey contended that there are two types of exogenous shocks that are classified by their effect on measured inflation. The first shock has no impact on real output in the medium to long run. The second has unrestricted effects on measured inflation and real output. These shocks are uncorrelated with each other. Core inflation by definition is associated with the first type of shock. While core inflation is identified as being output neutral in the medium to long run, it may have effects at shorter horizons. Quah and Vahey estimated a VAR system in the growth of real industrial output and the one month change in the RPI which includes constant, trend, 12 lags and seasonal dummies. Using impulse response analysis they found the economy□s adjustment to core inflation to be swift with little real effects. This led them to conclude that inflationary disturbances are quickly adjusted to by the real economy but are persistent influences on the measured rate.

Quah and Vahey (1995) represents a different methodological approach to studying core inflation. However, the identification procedure used restricted core inflation shocks to the long run horizon while impact at short run horizon was unspecified. Also the concept of only two disturbances means that one disturbance accounts for, or envelopes all other disturbances that is possible to the inflation process. This seems impractical as the nature of the disturbances to the inflation process may be unknown. However, this has shown

new insight into the inflationary process and represents a new area for additional research.

3.3 Limited Information Estimates

Limited information estimates seek to factor out short term transitory movements or shocks to the measured CPI or RPI. Short term transitory movements may lead to erroneous interpretation of the underlying movement in prices and hence the need for their exclusion.

Bryan and Cecchetti (1994) have argued that there are basically two types of price setters whose behavioural patterns are distinct and would therefore influence prices differently. The first type of price setters, the realisation based price setters, have flexible price structures with low adjustment costs and quick response to changes in the economic conditions. The other group, the expectation based price setters, are faced with high adjustment cost and generally respond more slowly to economic change. Because of the high adjustment cost, price changes normally correct for past level of inflation and future expectations.

The realisation based price setters Bryan and Cecchetti argued, introduce short term transitory movements or □noise□ in price. Because these price setters can change their prices quickly and often, such firms have little reason to care about long run trends in inflation or money growth. By comparison the expectation based price setters have a substantially smoother price path, since mistakes are costly and are not quickly corrected. This group have the necessary information to estimate the core or underlying inflation. Bryan and Cecchetti assumed that if measured inflation □m□ is equated to core inflation

□c□ and firms were faced with an unanticipated shock, then for equilibrium to exist, firms should adjust prices by the size of the shock. However, because of the menu cost involved in price adjustment, only firms with □large□ shocks □ε□ (affected greatly by the shock) would change their prices.

Since the shock would have different effects on firms then a distribution of firms□ ε may be produced. If we make ε^L and ε^U the lower and upper threshold respectively then $\varepsilon^L > \varepsilon > \varepsilon^U$ defines the range of ε over which firms would change prices in response to a shock ε (see **Figure 1A**). Firms that chose not to change prices (that is firms within $\varepsilon^L < \varepsilon < \varepsilon^U$) in response to the shock would change price by m. Measured inflation would then equate to core. In the event that the resultant price changes are distributed normally, then a true representation of inflation can be calculated. However, if the distribution of ε is skewed then the core would either be overstated or understated since the modal price change will move towards m∀ε (**Figure 1B**). To obtain a measure of inflation that is isolated from this transitory shock, one could exclude the prices of firms that experience the shock, that is, those that can change prices by m∀ε. Estimating core will then involve

Figure 1A

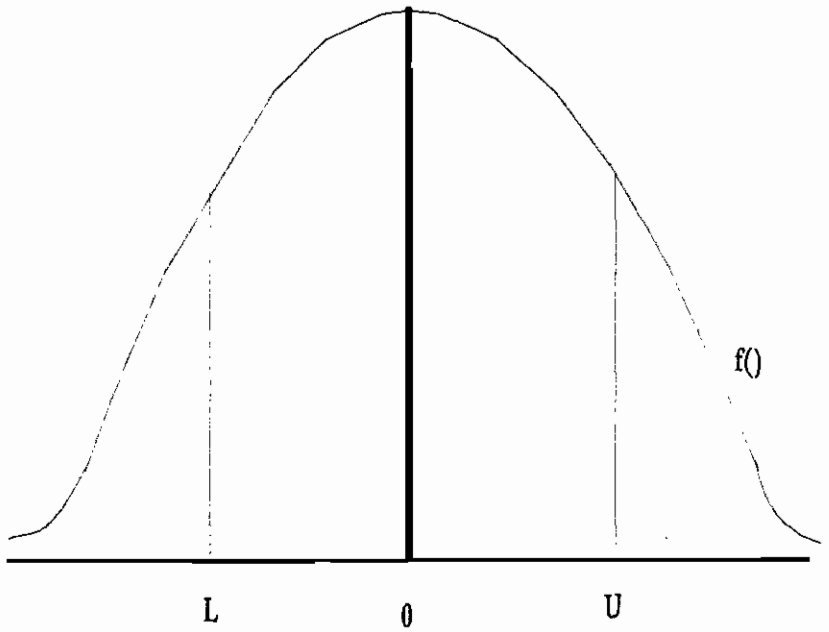
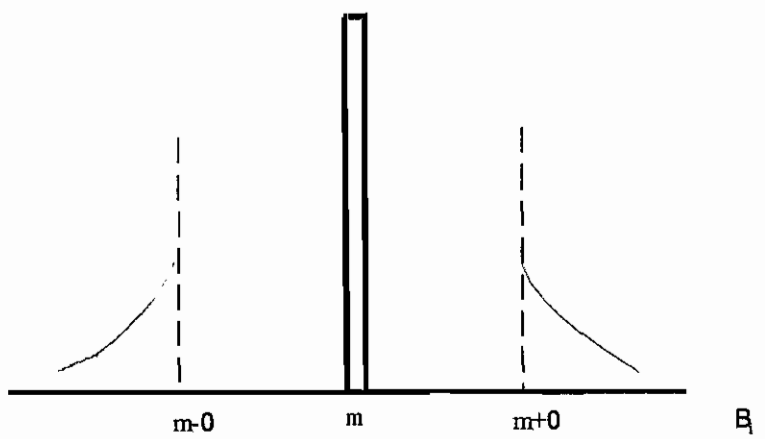


Figure 1B



identifying m relative to m+ε. To do this Bryan and Cecchetti suggested averaging over the central portion of the distribution. A disproportionate share of the noise in the price

data comes from the extreme tails of the distribution of price changes, and so systematically eliminating the tails of the distribution should give us a more robust measure of the persistent component of inflation. This technique limits the influence of outliers (price changes in the tails of the distribution) and therefore the resultant price changes used to calculate core inflation will be closer to a normal distribution. This presents a better estimate of underlying inflation than the CPI, as abnormal shocks which would affect the results have been taken out.

The approach described above is based on the concept of limited influence or limited information estimators - the most common of which are weighted median and trimmed mean. The weighted median is derived by taking the median price changes and calculating an average using adjusted weights based on the relative weights of the categories remaining. The median also has the intuitively appealing property of lying closer to the majority of price changes than does any alternative measure. The trimmed mean is an average calculated within a specified range over the central portion of weighted price changes and which therefore ignores the influences of extreme data points. Different percentiles of the trimmed mean and alternate ways of combining the weighted median have been employed by other researchers.

The computation of a limited influence estimator from the cross sectional distribution of price changes each period has a number of potential advantages over standard methods. In particular, measures such as the median are robust in the presence of many types of noise. For example to the extent that some price change observations contain a combination of sampling measurement errors and actual price mistakes, both of which are

likely to be short lived, this noise creates misleading movements in the aggregate index only when it is far from the central tendency of the distribution. Estimating a trimmed mean or a median will minimise the importance of this effect and result in a more robust measure of inflation. Other advantages of using limited influence estimators are that it uses readily available CPI data and that limits are consistently set. This makes the calculations very objective in approach. For example a twenty percent limited influence estimator will always exclude the highest and the lowest 20 percent of the data no matter what is happening to prices in that month.

A drawback of the limited influence estimators method however is the fact that the choice of the cut off point in a trimmed mean is often arbitrary. One way of mitigating this is to develop different series with different percentage cut off and to analyse their performance over time.

3.4 Exemption Clauses or Zero Weighting

The method of exemption clause involves abstracting from the measure of CPI, effects which are deemed to be momentary. The use of exemption clause also known as zero-weighting is done by assigning a zero weight to a particular item that is to be isolated from the index. This method also makes use of the CPI and boast simplicity in its calculation and applicational ease. As stated earlier, most definitions of core inflation involve some long term persistent trend in prices. This means that one may want to isolate not only the short term transitory movement in prices, but any other aspect of measured inflation that may create □noise□, thus concealing the underlying processes. This includes

influences which although affecting the price level permanently, are expected to have only an initial and final effect on the inflation rate.

Using an exemption clause allows for the removal of highly volatile seasonal price changes and therefore reduces the probability of policy having a perverse response to inflation. Exemption clauses are the most widely used method of estimating core inflation. Various countries that use exemption clauses have found it necessary to exclude a range of items from the RPI. The table below gives examples of selected countries and the items or categories that have been isolated in the measurement of core inflation.

COUNTRIES	EXEMPTION CLAUSES
Australia (1993)	CPI excluding mortgage interest payment, government controlled prices

	and energy prices
Canada (Feb. 1991)	CPI excluding food and energy prices and first-round effects of indirect taxes
Finland (Feb. 1993)	CPI excluding government subsidies, indirect taxes, housing prices and mortgage interest payments
Spain (Jan. 1995)	CPI excluding first-round effects of indirect tax and mortgage interest payments
U. K. (Oct. 1992)	RPI excluding mortgage interest payments, the RPIX
New Zealand (Mar. 1990)	CPI excluding commodity prices, government controlled prices, interest and credit

The most common measure in this group is the RPI excluding food and energy, two most volatile components in the index. Clearly, the objective of this modified index is to clarify the inflation signal in the price data. A rationale for using this measure is the seasonal nature of food prices, which may be a result of climatic differences throughout the year. To a lesser extent the same is true for energy. The Jamaican CPI has a weighting of over 55% for food and therefore the exclusion of this item from the index may lead to a misrepresentation of inflation and would overstate considerably the effects of other components of the index.

Several countries exempt mortgage interest payment from the measure of core inflation. The rationale for doing so is to prevent measures aimed at lowering inflation to be obscured through the mortgage component of the index which may very well affect inflation on the upside. Increasing interest rate as a policy tool to control inflation could push up mortgages and resultantly increase inflation.

Indirect taxes tend to have a short run one-off effect on prices, consequently they are not seen as contributing to the long term trend in inflation. Therefore, it may be useful to exclude them from any measure of inflation. However this may be somewhat atheoretical as no behavioural assumption can be made . For example, if taxes should rise and retailers do not respond but instead leave price unchanged, then the CPI excluding indirect taxes would understate the inflation rate. A drawback of this method is that because of difficulties in apportioning taxes accrued to the months in which they were generated, approximations and assumptions must be made to determine taxes that were generated for each month□s activities.

Exemption clauses have been used extensively and provide further information about what supply shock should be eliminated. However, the exclusion of cross sectional data may be a misrepresentation of the inflationary process. All goods and services reflect relative price changes to some degree and it is impossible to know how persistent these changes will be. Therefore, it is not possible to clearly identify which price changes are creating □noise□ in the inflationary process. This introduces subjectivity into the inflation monitoring process.

4.0 Defining Core in Jamaica

The Jamaican CPI given its drawbacks could best be described as an indicator of how a society□s standard of living changes. The index is constructed based on a typical consumer□s expenditure. It also gives an indication of how the consumer□s ability to purchase the same set of commodity changes over time. The core or underlying inflation being posited here, is therefore of greater interest to policy makers. In fine tuning policy, core inflation could be seen as part of a feedback process used to measure the effects of monetary policy in an economy. That is, core inflation is being defined as that component of inflation that is brought about by changes in monetary policy. To measure this, one would attempt to establish different measures of inflation and test their relationship with monetary aggregates.

In an attempt to measure core inflation, several series were developed based on the methods of exemption clauses, smoothing and limited influence estimators described earlier. Monthly data were used over the period 1988:1 to 1997:2. The analysis was done over the entire period and the subperiod 1991:10 to 1997:2. The second sample period was used to account for the impact of liberalisation which accelerated over that time. The series developed were the CPI excluding Fuel sub-category, CPI excluding Food & Drink sub-category, CPI excluding Food & Drink and Fuel sub-categories, the weighted median, trimmed mean and the CPI moving average seasonally adjusted series.[2] **Table 1a** reports the summary statistics for the CPI and the core measures over the period 1988:1 to

[2] For the explicit definition as to how these rates were calculated see Appendix

1991:10. With the exception of CPI excluding fuel and food and the CPI excluding food, the standard deviations of the core measures are lower than that of the CPI. The limited influence estimators had the smallest standard deviation of all the core measures. The range which is another measure of variation, showed the CPI as having the □widest□ variability. **Table 1b** reports over the period after liberalisation and indicate that both the range and the standard deviation figures have been lower than over the entire period.

This result showing the core measures having a smaller variance than the CPI is expected since the core measures are supposed to be bereft of price shocks which would affect their variance positively. The absence of extreme price shocks also ensure that core measures would be closer to normality than the CPI. With the exception of CPI excluding Food & Drink and Fuel and CPI excluding Food & Drink sub-category, the other measures of core showed a price distribution which is more normal than the CPI.

Figures 2a, b and **c** graph the core measures along with the CPI for comparison. The price movements of the core measures as shown by the graph were less erratic and showed lower peaks than the CPI. Most noteworthy are the trimmed mean, CPI moving average and the median. This demonstrates that inflation as measured by the CPI may include transitory shocks to relative prices that need to be abstracted from, in order to derive a proper measure of underlying inflation. The median and the trimmed mean remained below the CPI for almost the entire series.

To determine that these core measures are better estimates of money-induced inflation we ascribe to a process of evaluation through a series of tests. First, Granger causality tests were done to establish direction and strength of relationship between

money aggregates and the inflation measures. Then the relationship of the core measures with the monetary aggregates are studied. The monetary aggregates used were the monetary base, M1, M2 and M3 denominated in Jamaican dollars. Further, the ability of the measures to forecast CPI inflation over different horizons under the assumption that since supply disturbances affect measured CPI in the short run, current core should provide some information about future aggregate price increases.

Granger Causality tests were conducted to establish whether changes in money growth actually forecast changes in core inflation measures. In the Granger framework the presence of causation between current value of two variables after account has been taken of the effects of past values of the independent variable, implies that there is a significant contemporaneous relation. The existence of causation between the past values of money and current inflation while accounting for past inflation effect indicate that Granger causality exists running from money to inflation. The converse also holds that the existence of correlation between the past values of inflation and current monetary aggregates while accounting for past monetary effect, indicate that Granger causality exists running from inflation to money. Testing for Granger causality was done by estimating the following equation and testing the joint significance of the coefficients on

$$Y_t = a + \sum_{i=1}^{m} b_i Y_{t-1} + \sum_{i=1}^{m} c_i X_{t-1} + \mu_t$$

the X's in the regression:

where X and Y can be either a monetary aggregate or an inflation measure depending on

the direction of causation being tested.

Table 2 (Appendix) gives the probability values for Granger F - test between monetary aggregates and the inflation measures. Based on a 5% level of significance, the results indicate that causality runs from base money to the weighted median rate. However, the level of causality going from the other monetary aggregates to median rate appears to be weak. The causation is stronger for the post 1991 period than over the entire period. This suggest that the transmission system of money to inflation may be less clouded since liberalisation. There is also the presence of reverse causation which goes from the CPI moving average to base money and this may be evidence of monetary accommodation in inflationary times.

We go further and test directly the correlation of the core measures with money growth using a simple regression model outlined by Bryan and Cecchetti. The model estimated various measures of core regressed on lags of different monetary aggregates. The monetary aggregates used were monetary base, M1 M2 and M3 and the model

$$\frac{1}{K}\sum_{j=1}^{K} R_{i,t+j} = \alpha + \sum_{i=0}^{n} \beta_i \left(lnM_t - lnM_{t-i} \right) + T + \varepsilon_t$$

estimated was :

where M represents the different monetary aggregates and R represents the different measures of core. This model looks at the ability of the monetary series to forecast inflation over different time horizons of 1-month, 3-month, 6-month and 12-month. A time trend was included in the model.

The result of significance from this estimation is the R^2, which as a measure of fit, indicates the extent to which money growth would explain the changes in price level. The higher the R^2, the larger the extent to which money growth explains inflation and hence the stronger the relationship between the variables.

The models were run and the R^2's are reported in **Table 3a** and **3b**. The trimmed mean was found to be the most appropriate core inflation series, with the monetary base emerging as the monetary series that is most correlated with this measure. Examining **Table 3a** and **3b**, it is clear that base money and the trim mean did not emerge winner over their respective competitors on all occasions. Therefore an evaluation was done using a point system. A point was given for the highest R^2, two points for second highest and so on. The evaluation was done in two ways. Firstly, the monetary aggregates were ranked in order of R^2 for a given inflation measure. This was done for all the core measures and the scores were totalled. Secondly the inflation measures were ranked in order of R^2 for a given monetary aggregate. This was done for all the monetary aggregates and the scores were totalled. The inflation rate or monetary series with the lowest points was the most desirable rate or money series. Using this evaluation technique the trimmed mean and the monetary base emerged winners in their respective categories over both sample periods.

Past base money growth was most highly correlated with changes in the trimmed mean followed by the CPI minus food measure. It is significant to note that all the measures of core performed better than the CPI in terms of having better correlation with the monetary aggregates. Testing the causation of the trimmed mean with the monetary

base showed that the R^2's were higher for the period 1991 to 1997 than over the entire period, reinforcing the notion that the transmission mechanism may have improved with liberalisation.

Next, an attempt was made to test the ability of the different core measures to forecast actual or headline inflation over different horizons. The purpose of this was to determine the level of informativeness of the measure of core in forecasting inflation over different time horizons. To ascertain which of the core series performs best we used the

$$\pi_t^K = \alpha + \beta R_t^{12} + \varepsilon_t$$

root mean square error as an indicator. The simple model below was estimated.

Where π^K_t is inflation over K months at time t and R_t^{12} is the 12-month moving average measure of core at time t. **Table 4** presents the results of forecasting over the period 1988:1 to 1997:2. The results show that over the one-month and three-month period, the trimmed mean had the smallest root mean square error of all the measures. The root mean square error increased as the forecasting period lengthens. This suggest that over longer periods, policy shifts or non-monetary factors may distort the forecasting process.

5.0 Conclusion

The inflationary process in any economy is difficult to understand and define. However the ability to accurately define a relevant measure of this phenomenon is of paramount importance to any central bank. The traditional measure of changes in the CPI was found to be an inappropriate measure to be used as a target by the Central Bank.

This was based on the fact that conceptually the CPI may not be ideal given the biases inherent in its calculations.

To address this problem, a number of central banks have sought to develop a core or underlying inflation measure. This concept is more pertinent for monetary policy as it involves abstracting the underlying inflation process from the different sources of □noise□ that may affect the CPI, based on its many biases and how it treats shocks. The paper attempted several measures of core and the trimmed mean was surveyed as the superior measure. This as it had the best correlation with monetary aggregates and the lowest root mean square error in forecasting the CPI. Further, the monetary aggregate which was found to be most appropriate for monetary targeting was the monetary base.

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APPENDICES

APPENDIX

[1] DEFINITION OF VARIABLES USED

CPI - Headline Inflation Rate

CPIFF - CPI ex Food & Drink and Fuel and Other Household Supplies category

FUEL - CPI ex Fuel and Other Household Supplies category

FOOD - CPI ex Food & Drink category

TRIM - Trimmed Mean

MEDX - Weighted Median

[2] DERIVATION OF CORE MEASURES

CPIFF uses exemption clause method. Calculated by making inflation in the food and drink and the fuel and other household supples category zero.

FUEL uses exemption clause method. Calculated by making inflation in the fuel and other household supples category zero.

FOOD uses exemption clause method. Calculated by making inflation in the food and drink category zero.

TRIM uses limited influence estimators method. Calculated by ranking the weighted inflation in ascending order and discard the four extreme points (two highest and lowest weighted inflation) that is forcing them to zero. If two elements have the same weighted price change, the one with the highest weight is eliminated.

CPIMA uses smoothing or filtering method. Computed by calculating a centered twelve month moving average incorporating the most recent inflation out turn and then seasonally adjusting the series.

MEDX uses limited influence estimator method. Computed by a weighted average of the middle six price change of the possible 20 in the CPI basket. The weights used was recalculated based on relative weights in basket of the six categories.

[3] DECISION CRITERIA

Examining Table 2a and 2b, it is clear that base money and the trim mean did not emerge winner on all occasion over their respective competitors. Therefore an evaluation was done using a point system. A point was given for the highest R^2, two points for second highest and so on. The inflation rate or monetary series with the lowest points was the most desirable rate or money series. Using this evaluation

technique the trimmed mean and the monetary base emerged winners in their respective categories over both sample periods.

Table 1a: Comparison of the CPI and the Various Measures of Core
Period: 1988:1 to 1997:2

	CPI	CPIFF	CPIMA	FOOD	FUEL	MEDX	TRIM
Mean	2.150	2.064	2.165	2.079	2.174	1.420	1.417
Median	1.400	1.536	1.813	1.466	1.451	1.040	1.010
Maximum	10.20	10.33	6.28	9.89	9.46	6.46	5.88
Minimum	-0.30	-0.06	0.57	0.03	-0.05	-0.71	0.02
Std. Dev.	1.94	1.95	1.36	1.95	1.92	1.21	1.20
Skewness	1.80	1.89	1.42	1.81	1.75	1.57	1.61
Kurtosis	6.63	6.90	4.39	6.28	6.30	5.83	5.69
Range	10.50	10.39	5.71	9.86	9.52	7.17	5.86
Obs.	110	110	110	110	110	110	110

Table 1b: Comparison of the CPI and the Various Measures of Core

Period: 1991:10 to 1997:2

	CPI	CPIFF	CPIMA	FOOD	FUEL	MEDX	TRIM
Mean	2.291	2.364	2.280	2.330	2.330	1.620	1.580
Median	1.600	1.767	1.990	1.820	1.660	1.250	1.200
Maximum	8.80	10.32	6.28	9.89	9.17	6.46	5.88
Minimum	0.40	0.24	0.68	0.26	0.38	0.16	0.30
Std. Dev.	1.94	2.03	1.33	2.02	1.95	1.29	1.23
Skewness	1.69	2.06	1.57	1.94	1.79	1.63	1.59
Kurtosis	5.54	7.52	5.00	6.73	6.00	5.59	5.45
Range	8.40	10.08	5.60	9.63	8.79	6.30	5.58
Obs.	65	65	65	65	65	65	65

Table 2a
Tests of Granger-Style Forecasting Ability: Money and Inflation
(Sample: 1988:1 to 1997:2)

Inflation	BM		M1		M2		M3	
	M to π	π to M	M to π	π to M	M to π	π to M	M to π	π to M
CPI	0.510	0.713	0.614	0.371	0.330	0.588	0.852	0.430
FOOD	0.738	0.068	0.394	0.407	0.267	0.613	0.456	0.163
FUEL	0.303	0.782	0.811	0.340	0.352	0.534	0.778	0.217
MED	0.051	0.194	0.652	0.151	0.124	0.175	0.434	0.026
TRIM	0.365	0.695	0.789	0.418	0.624	0.302	0.882	0.066
CPIFF	0.596	0.147	0.330	0.248	0.189	0.618	0.223	0.164
CPIMA	0.856	0.009	0.364	.008	0.349	0.005	0.753	0.129

Values are p-values for Granger F-tests

Table 2b

Tests of Granger-Style Forecasting Ability: Money and Inflation
(Sample: 1991:10 to 1997:2)

Inflation	BM		M1		M2		M3	
	M to π	π to M	M to π	π to M	M to π	π to M	M to π	π to M
CPI	0.100	0.380	0.284	0.522	0.572	0.460	0.181	0.210
FOOD	0.350	0.222	0.234	0.500	0.352	0.443	0.710	0.133
FUEL	0.083	0.256	0.261	0.488	0.456	0.366	0.542	0.205
MED	0.047	0.488	0.759	0.196	0.172	0.258	0.492	0.035
TRIM	0.100	0.836	0.838	0.309	0.805	0.263	0.396	0.122
CPIFF	0.364	0.223	0.290	0.336	0.352	0.309	0.678	0.233
CPIMA	0.315	0.013	0.080	0.042	0.161	0.011	0.829	0.340

Values are p-values for Granger F-tests

Table 3a
Forecasting Inflation with Money Growth
PERIOD: 1988:1 TO 1997:2

Horizon	CPI	FOOD	FUEL	MED	TRIM	CPIFF	CPIMA
M = MB							
1-mth	**0.158**	**0.170**	**0.172**	**0.210**	**0.197**	**0.277**	**0.118**
3-mths	**0.115**	**0.168**	**0.121**	**0.188**	**0.199**	**0.148**	**0.363**
6-mths	**0.351**	**0.339**	**0.336**	**0.376**	**0.494**	**0.274**	**0.131**
12-mths	**0.529**	**0.531**	**0.526**	**0.505**	**0.636**	**0.454**	**0.516**
M = M1							
1-mth	**0.141**	**0.166**	**0.152**	**0.173**	**0.175**	**0.224**	**0.145**
3-mths	**0.086**	**0.133**	**0.090**	**0.117**	**0.186**	**0.117**	**0.397**
6-mths	**0.324**	**0.330**	**0.324**	**0.366**	**0.468**	**0.270**	**0.079**

Horizon	CPI	FOOD	FUEL	MED	TRIM	CPIFF	CPIMA
12-mths	**0.542**	**0.530**	**0.522**	**0.511**	**0.638**	**0.444**	**0.531**
M = M2							
1-mth	**0.154**	**0.176**	**0.236**	**0.184**	**0.182**	**0.232**	**0.156**
3-mths	**0.090**	**0.130**	**0.092**	**0.130**	**0.190**	**0.113**	**0.407**
6-mths	**0.319**	**0.330**	**0.325**	**0.364**	**0.469**	**0.268**	**0.109**
12-mths	**0.549**	**0.536**	**0.530**	**0.510**	**0.636**	**0.450**	**0.540**
M = M3							
1-mth	**0.143**	**0.180**	**0.144**	**0.196**	**0.163**	**0.201**	**0.117**
3-mths	**0.090**	**0.122**	**0.087**	**0.117**	**0.189**	**0.093**	**0.369**
6-mths	**0.337**	**0.332**	**0.332**	**0.414**	**0.489**	**0.263**	**0.061**
12-mths	**0.514**	**0.531**	**0.515**	**0.509**	**0.625**	**0.449**	**0.505**

Table 3b
Forecasting Inflation with Money Growth
PERIOD:1991:10 TO 1997:2

Horizon	CPI	FOOD	FUEL	MED	TRIM	CPIFF	CPIMA
M = MB							
1-mth	**0.240**	**0.333**	**0.290**	**0.294**	**0.306**	**0.303**	**0.195**
3-mths	**0.197**	**0.354**	**0.196**	**0.213**	**0.209**	**0.150**	**0.494**
6-mths	**0.462**	**0.400**	**0.516**	**0.421**	**0.564**	**0.303**	**0.144**
12-mths	**0.643**	**0.558**	**0.640**	**0.554**	**0.688**	**0.492**	**0.619**
M = M1							
1-mth	**0.173**	**0.334**	**0.232**	**0.244**	**0.208**	**0.302**	**0.188**
3-mths	**0.094**	**0.303**	**0.112**	**0.196**	**0.147**	**0.169**	**0.506**

Horizon	CPI	FOOD	FUEL	MED	TRIM	CPIFF	CPIMA
6-mths	**0.422**	**0.389**	**0.468**	**0.383**	**0.519**	**0.304**	**0.089**
12-mths	**0.652**	**0.558**	**0.631**	**0.559**	**0.687**	**0.492**	**0.631**
M = M2							
1-mth	**0.192**	**0.341**	**0.251**	**0.271**	**0.218**	**0.307**	**0.215**
3-mths	**0.131**	**0.301**	**0.152**	**0.203**	**0.171**	**0.171**	**0.520**
6-mths	**0.416**	**0.391**	**0.471**	**0.395**	**0.526**	**0.297**	**0.162**
12-mths	**0.644**	**0.561**	**0.633**	**0.564**	**0.679**	**0.496**	**0.637**
M = M3							
1-mth	**0.193**	**0.298**	**0.213**	**0.314**	**0.226**	**0.280**	**0.159**
3-mths	**0.096**	**0.268**	**0.081**	**0.140**	**0.144**	**0.073**	**0.468**
6-mths	**0.478**	**0.402**	**0.502**	**0.518**	**0.571**	**0.299**	**0.559**
12-mths	**0.620**	**0.556**	**0.629**	**0.565**	**0.676**	**0.485**	**0.612**

Table 4
Comparison of Forecast of CPI Inflation over Different Horizons
Forecating Period: 1988:1 to 1997:2

CANDIDATE INDEX	**ROOT MEAN SQUARE ERROR** Horizons			
	1-mth	3-mths	6-mths	12-mths
Forecasting Period: 1988:1 to 1997:02				
CPI	2.010	2.029	2.061	2.182
CPIMA	2.122	2.095	1.914	2.154
CPIFF	2.050	2.072	2.039	2.156
FOOD	2.002	2.073	2.050	2.148
FUEL	1.988	2.022	2.050	2.191

MEDX	1.925	2.009	2.018	2.146
TRIM	1.894	1.936	2.048	2.177

Figure 1
Consumer Price Index compared with the Seasonally Adjusted Series

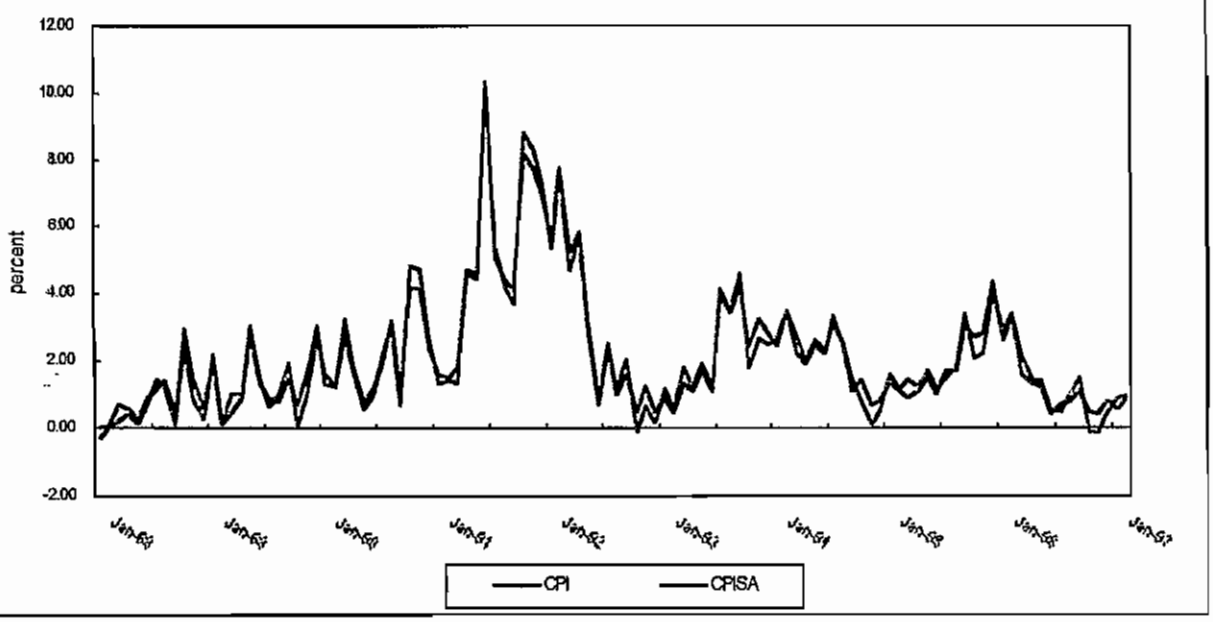


Fig 2a

CPI compared with CPIFF and CPIMA

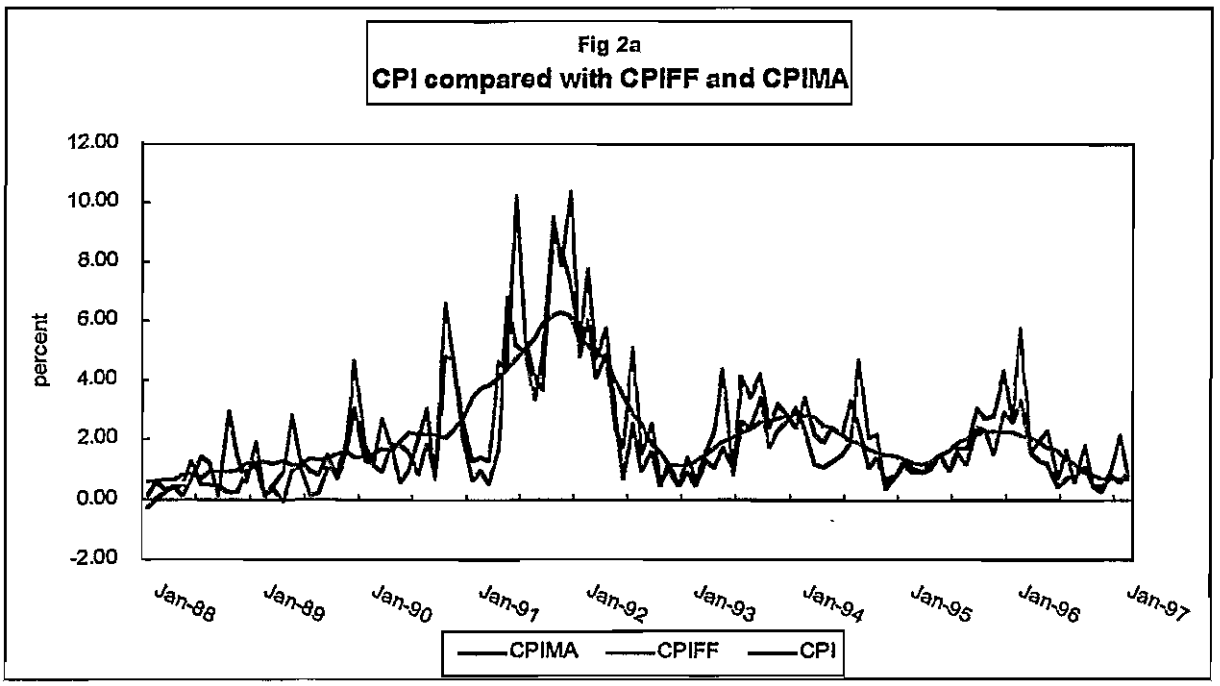
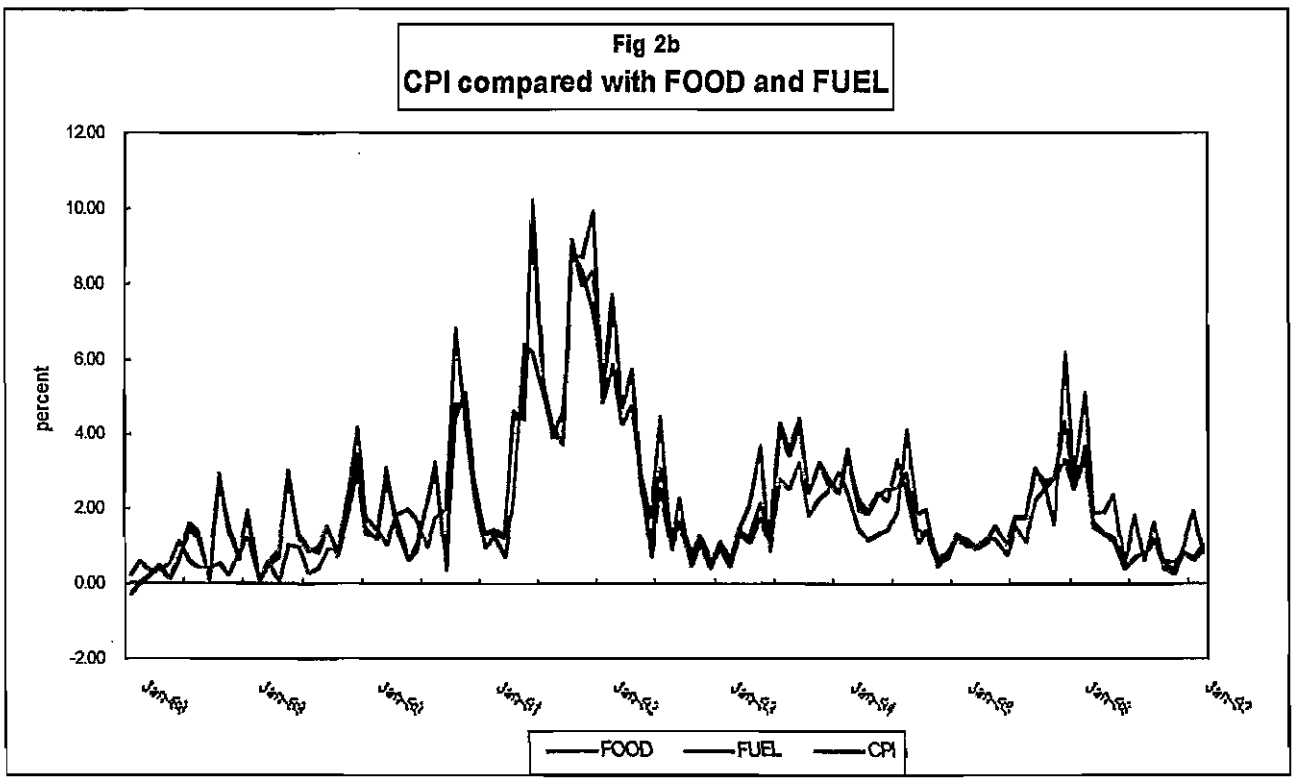


Fig 2b

CPI compared with FOOD and FUEL



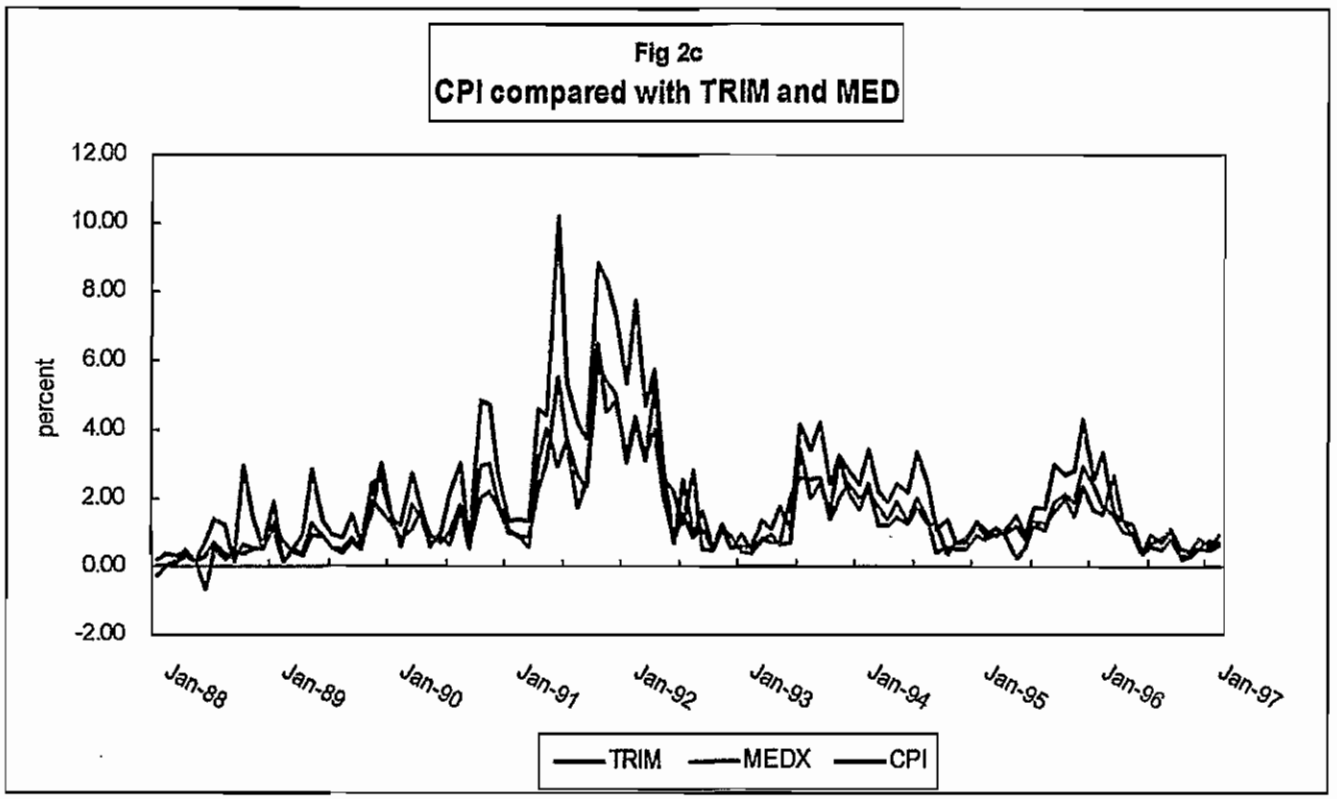


Fig 2c
CPI compared with TRIM and MED
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
percent
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
TRIM
MEDX
CPI