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DOES FOOD PRICES EXHIBIT LONG MEMORY IN MALAYSIA? AN EMPIRICAL EVIDENCE USING NON-PARAMETRIC TEST

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Abstract

In many countries food prices are excluded from core measures of inflation. This is due to the assumption that food prices are transitory. Exclusion of food prices may lead to information loss, leading to higher inflation expectations and a downward bias in forecasting future inflation. Correct identification of the memory in the food price series is vital for the correct model specification and is important for policy makers. This study aims to examine whether food price inflation in Malaysia is transitory or permanent by estimating the memory properties of food price inflation series using non-parametric tests. The study covers the period from 2000M1 to 2016M7. Research findings show that food price inflation is not transitory but has a long memory series. Food price inflation in Malaysia co-moves with long memory series of global food prices. The empirical results of this study have momentous implications towards food policy, trade policy and monetary policy makers. These findings suggest that neglecting food prices may lead to a biased measure of long run inflation.

Keywords: long memory, food price inflation, non-parametric test

1. Introduction

In today's globalized world, food price dynamics have a visible influence on the world's economic and political stableness as well as on the wellbeing of every single country. High and increasing food prices pose a significant policy challenge to macroeconomic stability in developing countries where the food expenditure share in household expenditure is relatively high (Mishra & Roy, 2012). Extreme volatility and increasing trend of food prices has energized the necessity of perceiving the behavior and the characteristics of food prices. According to Deaton (1999), a better understanding of commodity prices is necessary to construct good policy. The rising food prices during last two decades have driven general inflation higher worldwide. How should monetary policy makers react? Does the monetary policy makers dares in dealing with higher inflation arising from increases in food prices. Food prices might respond to shocks faster than the prices of non-food items.

Malaysia has undergone its structural transformation from a commodity-based economy to an industrial-based economy. This transformation has seen Malaysia to be increasingly reliant on food imports for its consumption and finally became a net food importer country. Being heavily dependent on food imports, Malaysia is arguably more exposed to oil and global food crises. Food expenditure accounts around 30.3 percent of total household expenditure in Malaysia in 2015 (Department of Statistics Malaysia, 2015). The contribution of food and non-alcoholic beverages to general inflation was 41.7 percent in Malaysia. This means that the rising food prices will affect households at bottom 40 per cent household income group (B40) more than those at the upper income levels.

Figure 1 exhibits the behavior of domestic food price index (DFPI), domestic consumer price index (CPI), global food price index (GFPI) and global oil price index (GOPI). DFPI, CPI, GFPI and GOPI increased 88 percent, 73 percent, 84 percent and 76 percent respectively during the study period. The common features of these price series are; (i) average price has been increasing, (ii) each price series are highly volatile, and (iii) all these price series are moving in tandem with each other in an increasing trend.

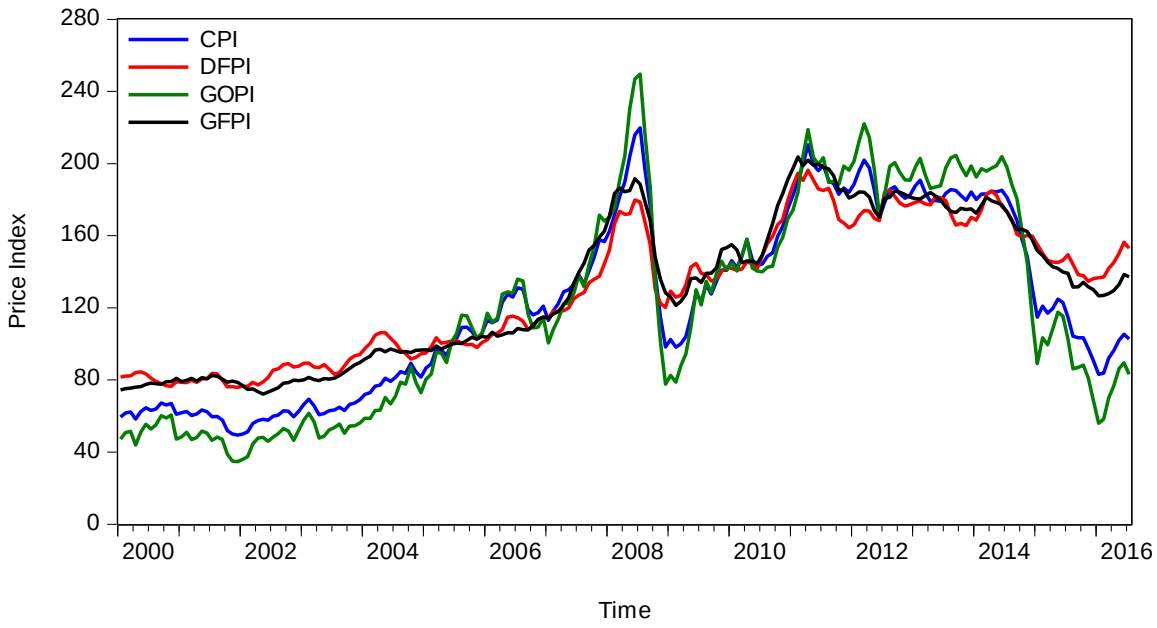


Figure 1: Domestic and World Food Price Behaviour, 2000M1-2016M7

The central issue of the study is whether food price shocks are transitory or permanent (long memory) in Malaysia. Long memory (LM), is a phenomenon that may arise in the analysis of time series and it relates to the rate of decay of statistical dependence of two points with an increasing time interval. A phenomenon is usually considered to have LM if the dependence decays more slowly than an exponential decay. In general, a nonstationary series often have LM but it cannot be denied that series using advanced econometric techniques revealed that stationary process that does not have explosive behavior may also have long memory.

The long memory investigation will help to identify that how long the effects of food price shock last. The shock is said to be transitory if the effect of the shock dies out over time and if the effect of a shock does not die out over time, the shock is said to be permanent. Persistent food price shocks are much more likely to feed into inflationary expectations, (Walsh, 2011). Thus, the memory characteristics of food price series are necessary to be investigated.

The objective of this study is to examine long memory property of the food price inflation in Malaysia. The structure of the paper is as follows. Section 2 briefly reviews the literature. Section 3 describes data and methodology of the study. The penultimate section discusses the empirical results obtained and the final section concludes, and gives some policy recommendations from the results obtained.

2. Literature Review

Long memory in inflation rates is the topic that has been widely examined in the empirical literature. Several studies such as Klein (1976), Ball and Cecchetti (1990), Barsky (1987) have examined the characteristics of aggregate inflation for developed countries namely Brazil, Canada, France, Germany, Israel, Italy, Japan, United kingdom (UK) and United States (U.S). They found empirical evidence of a shock has a permanent impact on inflation. The fractional integration or I(d) models have been used extensively in the case of developed countries. For instance, Backus and Zin (1993) found a fractional degree of integration in the U.S monthly data regarding inflation persistence. Hassler (1993) and Delgado and Robinson (1994) found strong evidence of long memory or I(d) behavior in the Swiss and Spanish inflation rates respectively. De Boef and Granato (1997) reviewed that some data are long memory processes but do not have unit roots, especially in the range $0<d<1$. Even though it does not contain a unit root, it does have long memory, whereby shocks to the series persist for at least 12 months. Hassler and Wolters (1995) have examined inflation rates of five developed countries for the period of 1969 to 1992 and found that inflation series are having long memory. They found that the order of integration of the series are significantly different from 1or 0. Hassler (1993), Baillie, Bollerslev and Mikkelsen (1996) studied monthly post-World War II CPI inflation in ten countries and found evidence of long memory with mean-reverting demeanor in all the countries excluding Japan. In particularly the same evidence was found by Hassler and Wolters (1995) and Baum, Barkoulas and Caglayan, (1999). Bos, Franses and Ooms, (1999) examined inflation in the G7 countries, found that the evidence of long memory.

In another area of agricultural commodity price, a number of studies have examined the long memory hypothesis using data from agricultural commodity prices. Kohzadi and Boyd (1995), Barkoulas, Labys and Onochie (1997), Jin and Frechette (2004), Kovacs, Huszsvai and Balogh (2014) are few examples of them. Stigler and Prakash (2011) have examined time series properties of commodity prices using 24 commodities for developed countries. There is a lack of evidence of I(d) behaviour for food inflation rates for developing countries (Kallon, 1994; Moriyama & Naseer, 2009). Studies such as Gilbert (2010), Cooke (2009), Leoning, Durevall and Birru (2009), Walsh (2011), Sumlinski, Al-Eyd, Amaglobeli and Shukurov (2012) focused food price dynamics in African countries. Rangasamy (2009) found that food inflation is highly persistent in South Africa.

Most of the previous studies focused on the impacts of food price increases or determinants of food price. There are scarce studies on memory of food price dynamics with the exception of a study by Sivarajasingham and Shri-Dewi Applanaidu, (2015) which examined the LM of food price inflation in Sri Lanka. However, with an extensive review we realized that there are no studies investigating the memory properties of food price series in Malaysia. Therefore, this study attempts to fill this gap by examining the series of food price inflation in Malaysia whether transitory or permanent. The fractional integration parameter for food price dynamics also has been estimated in this study. A comprehensive understanding of time series and statistical properties of food prices in Malaysia might provide useful implications for effective food and monetary, agricultural and trade policies. Therefore, this study would contribute significantly to the existing knowledge.

3. Methods

3.1 Data and Variable

Data used in this study are monthly data spanning from 2000M1 to 2016M7. The starting time period, 2000 was selected as food prices started to move upward exponentially in Malaysia. Variables used in the study include; Consumer Price Index for all items (CPI_t), Consumer Price Index for Food and non-alcoholic beverages, ($CFPI_{,t}$),Consumer Price Index for non-food items ($CNPI_t$) and Global Food Price Index ($GFPI_t$). GFPI has been included in this study as it moves closely with CFPI and CPI. Data for CPI was collected from International Monetary Fund (IMF) website while data for CFPI and GFPI are from FAOSTAT website. All the series are transformed into natural logarithm. Inflation is defined as log difference series. The Hodrick-Prescott (HP) filter is used in this study to separate the trend component and cycle component of a series.

3.2 Analytical Methods

This study uses Exploratory Data Analysis (EDA) and non-parametric test method. First, the visual analysis using graphs were employed to discover long memory in food prices. The other method is the inferential method to detect the long memory. In this study we used nonparametric inferential methods which consist of two measures that capture the long memory of food price inflation, namely, unit root tests and the rescaled range (*R/S)* statistic.

3.2.1 Exploratory Data Analysis

First, the EDA provides clues and evidence for hidden feature of a distribution. This technique can discover the underlying structure of dynamic behaviour of the food price series. Smoothing scatterplots, confidence ellipse, Locally Weighted Scatter-plot Smoother (LOESS) regression curve line graphs, autocorrelation function and correlograms are used in this study. One can examine the dynamics of a variable via the autocorrelation function in the time domain. The autocorrelation function is defined as $ACF(\tau) = \gamma(\tau) = corr(y_t, y_{t-\tau})$. Autocorrelation can be detected by using time series plot, lagged scatter plot and autocorrelation function. Strong positive autocorrelation indicates long memory. The ACF is a preliminary diagnostic tool to detect long memory of a process. Box, Jenkins and Reinsel (2008) defined short memory (SM) process as those whose ACF decay exponentially fast and LM process as ACF decay at the hyperbolic rate. By visually inspecting these graphs, one can identify whether the series has a long memory or not.

3.2.2 Inferential Tests

i. Unit Root Test

To investigate the issue of unit roots in empirical food price behaviour in Malaysia, the Phillips and Perron (PP) test is implemented on all food and nonfood price series. The PP tests are used to test the null

hypothesis of the series are non-stationary (I(1), against the alternative hypothesis that they are stationary I(0). A stationary process will not drift too far away from its mean value because of the finite variance. By contrast, a non-stationary time series, I(1), will have time varying mean or variance or both. They only identify the series are I(0) or I(1). So we use other recent developed technique to estimate long memory parameter.

ii. The Rescaled Range Statistic (Hurst Exponent)

Among various methods that measure long memory, the "rescaled range" is the most extensively used. Mandelbrot (1975) has suggested the *R/S* statistic which was developed by Hurst (1951). The "range over standard deviation statistic" or (*R/S*) to detect long range dependence of a series has the form

$$(R/S)_n = \frac{1}{s_n}\left[Max\sum_{j=1}^{k}(x_j - \bar{x}_n) - Min\sum_{j=1}^{k}(x_j - \bar{x}_n) \right] \qquad (1)$$

Where $1 \le k \le n$

R(n) is the range of the first n values, and *S(n*) is their standard deviation. The *R/S* statistic is the range of partial sums of deviations of a time series from its mean, rescaled by its standard deviation. The Hurst exponent, *H*, is defined in terms of the asymptotic behaviour of the rescaled range as a function of the time span of a time series as follows:

$$E\left[R(n)/S(n)\right] = Cn^H \quad \text{as } n \to \infty \qquad (2)$$

where R(n), S(n) are defined as in equation 1. *E(.)* is the expected value, *n* is the time span of the observation (number of data points in a time series) and C is a constant. The Hurst exponent (*H*) is estimated by fitting the power law to the data. The rate of decay is estimated by the *R/S* method (Beran, 1994). The *H* is the index of dependence that lies between 0 and 1. A value of *H*=0.5 can indicate a completely uncorrelated series (independent process). If 0.5<H<1, the series possess long range dependence if $0.0 < H < 0.5$, then the series is called ant-persistent. This behavior is sometimes called mean or trend reversions.

4. Empirical Results

4.1 EDA results

First, the basic features of price series are examined by visual inspection. It indicates that the series includes non-periodical cycles and non-stationary. The average food price change during the latter part of the sample period (since 2007) is higher than that of the non-food price changes. Average food inflation exceeds the average headline inflation in recent periods (Figure 3). Variability of food inflation series varies over time. There is a positive significant correlation, *r*=0.568 (0.00), between movements in head line and food inflation.

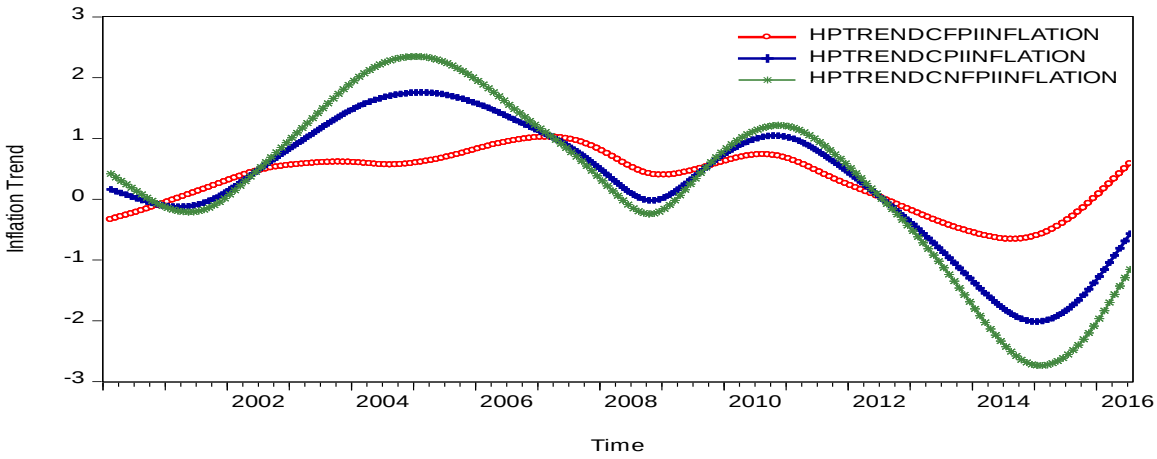
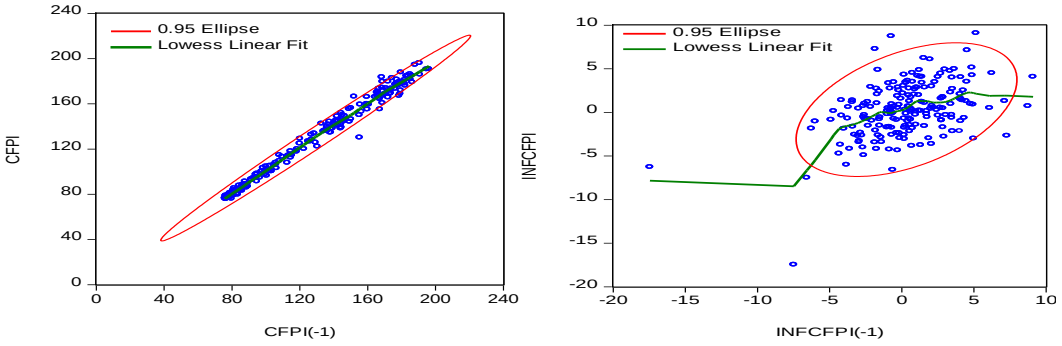


Figure 3 Long Term Trend of Inflation of CFPI, CPI and CNFPI, 2000M1-2016M7

The simplest graphical summary of autocorrelation in a time series is given by the lagged scatterplot with confidence ellipse and LOESS regression curve. Figure 4(a) exhibits scatter plots of CFPI of month *t* against $CFPI_{t-1}$ and 4(b) scatter plots of food inflation (INFCFPI) of month t against food inflation of month *t-1* ($INFCFPI_{t-1}$). The scatter plots (a) and (b) in Figure 4 are densed around the centre line. This indicates that the value at time t depends on the value at *t-1*. These scatter plot with confidence ellipse shows the dependence nature of the food price inflation dynamics. All scatter plots show these variables are highly positively auto-correlated. Hence, food price inflation is highly persistent in Malaysia.



(a) (b)

(note: Food inflation is calculated from log food price index. INFCFPI(-1) refers food price inflation with lag one.)

Figure 4 Autocorrelation Nature of CFPI, CFPI inflation in Malaysia, 2000M1-2016M7

While, the autocorrelation function (ACF) can be used as a preliminary diagnostic tool of long memory. ACF represents the degree of persistence over respective lags of a variable. A slow decay of the ACF is an indicator of long memory. In Figure 5, ACF for CFPI, CPI and GFPI decay slowly to zero at a polynomial rate as the lag increases. Results indicate that CFPI series has a very long memory with lagged coefficients that are clearly statistically significant. The impact of a shock ε_t on CFPI does not diminish over time. Therefore, the shocks on food price are persistent. Further, ACF results of CPI and

GFPI also indicate that each series has a long memory and is largely persistent with lagged coefficients that are clearly statistically significant.

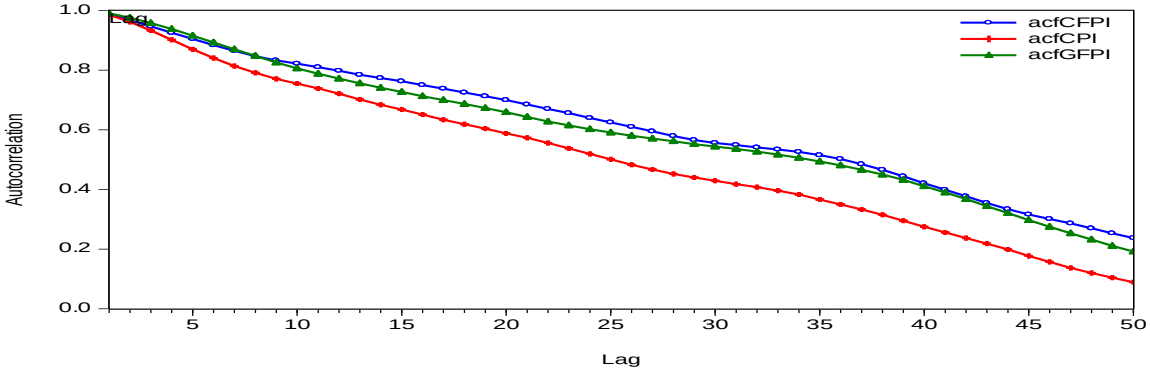


Figure 5: Correlogram for the Food Price Series, Malaysia, 2000M1-2016M7

While for the autocorrelation function for food price inflation series, sample autocorrelations of inflation series are generally very small and statistically insignificant at a 5 percent level. Figure 6 presents the autocorrelation function of food price inflation series. The ACF of food price inflation for CFPI, CPI and GFPI series exhibit sluggish decline and large oscillations. This shows that ACF of food price inflation decay very slowly that implies food price inflation possesses long memory. The *p* value for (Ljung-Box test statistic) the joint significance of the correlation coefficients, indicates that they are significantly different from zero even for large lags. This implies the autocorrelation exist for longer time. The past shocks continue to play a significant role in determining the future food price path. Therefore, the shocks on food price are persistent. The ACF has been used in literature by various authors, for example, Baillie (1996) for wheat price index, Granger and Ding (1996) for the stock price to identify long memory of those series.

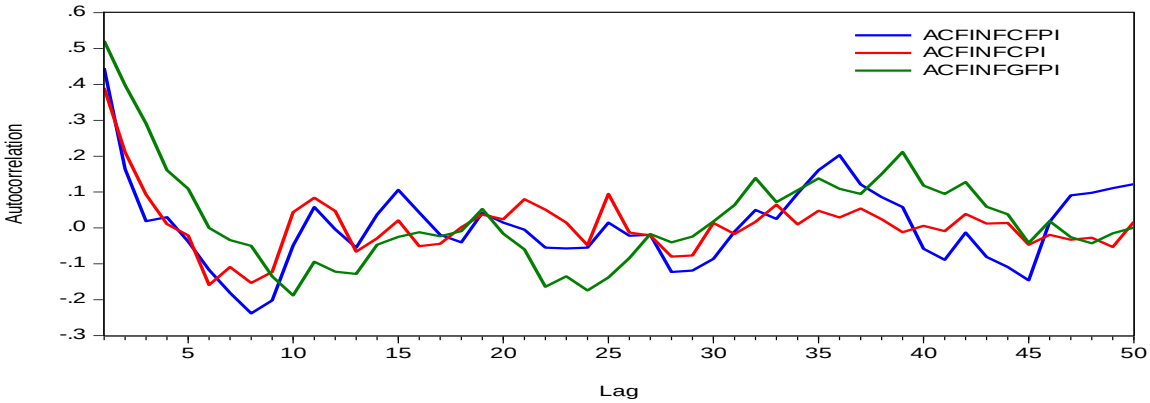


Figure 6: Correlogram for Food Price Inflation Malaysia

4.2 Unit root test Results

i. *Unit Root Tests of Variables*

The results of standard unit root tests PP reported in Table 1 show that the food price series are non-stationary and food inflation series is stationary. According to these tests, all series are nonstationary at their level. The results show that the null hypothesis of a unit root tests (PP tests) for each variable is not rejected as the test statistics values are not greater than the critical values at 5 percent level. The *p*–value for the corresponding test statistic for each case is greater than 0.05. These results suggest that variables

are not stationary series. On the other hand, the results from first difference indicate that all test statistics are statistically significant as the corresponding *p*-values for each test statistic is less than 0.05. Therefore, all the series in the study are I(1). All these tests only count the integer order of integration of the series. I(1) or I(0). It has not identified the fractional integration.

Table 1 *Unit Root Test Statistics for Variables-Malaysia*

Variables	**Level Intercept only Test Statistics**	**First Difference Intercept only Test Statistics**	**Order of Integration**
	PP	**PP**	
LCFPI	-1.384	-8.659	I(1)
	(0.586)	(0.000)	
LCNFPI	-1.684	-9.781	I(1)
	(0.437)	(0.000)	
LCPI	-1.650	-9.198	I(1)
	(0.455)	(0.000)	
LGFPI	-1.576	-8.099	I(1)
	(0.493)	(0.000)	

Note: -at 5% significance level, all variables stationary at first difference.
-unit root test regression model is selected with intercept only
-probability values are in parenthesis , *(p*)
-5 % critical values are in square brackets [cv]

*4.3 The Rescaled Range Statistic (R/S) Plot and Hurst Estimator (***H***)*

The results of the rescaled range analysis (Table3) show that all *H* estimates are greater than 0.5. It implies that all inflation series are persistent.

Table 2 Hurst Estimates of Inflation Series -Malaysia

Price Series	***H***
CPI food inflation	0.567 *
	(0.019)
CPI headline inflation	0.666*
	(0.015)
Global food inflation	0.739*
	(0.056)
Non-food inflation	0.642*
	(0.016)

Note :* indicates highly significant at 5 %, Standard error are in parenthesis
$0.5 < H < 1$:Persistence, $0 < H < 0.5$:Anti-persistent, $H = 0.5$:Random walk,

For food inflation, the values of *H* statistic in Table 2 ($0.5 < H < 1$) provide strong evidence for long memory in all inflation series. The estimated Hurst exponent (*R/S*) *H* estimate for CFPI inflation seems to be within the range of $0.5 < \hat{H} < 1$. The results show that the *H* coefficient of CFPI inflation is significantly different from 0.5. Hence, food price inflation is a long memory process. Peters (1994) and Van Quang (2005) have also used *R/S* regression analysis to show the long memory in their analysis

5. Conclusions and Policy Recommendations

In this study, we used EDA and a nonparametric test to investigate long memory of food price series. All these tests show that food price series have long memory and they are fractionally integrated. Results imply strong evidence of long memory in food inflation in Malaysia. Policy makers may include food prices in the computation of any measure long run inflation where this inclusion could provide a clear picture of underlying inflation trends. The empirical results of this study have important policy implications for food, trade and monetary policy makers. Results suggest that neglecting food prices may render the inflation a biased measure of long run inflation and the appropriate policy may focus is on headline inflation.

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