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AN ANALYSIS OF MAJOR DETERMINANTS OF FOOD INFLATION IN INDIA

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ABSTRACT

The study has exclusively analyzed the major determinants of food inflation in India by using the monthly data from January 2006 to December 2013. Using Johansen's cointegration technique, it was shown that in long run, all major determinants of food inflation such as money supply, interest rate, exchange rate, crude oil and rainfall except world food prices affect food inflation significantly. The Error Correction Model was also used to comprehend the short run behavior of food inflation and its determinants. The error correction term turned out to be significant statistically which further confirmed the long run causality as well as the speed of convergence towards long run equilibrium. In short-run, only world food and crude oil prices affect the food inflation.

Keywords: Cointegration, food inflation, inflationary pressure
JEL Classification: E31, E37, E52

INTRODUCTION

Last decade witnessed a rapid and substantial rise in the prices of food and energy which posed a complex challenges for the policy makers at world level in general and in South Asia in particular, where the food inflation crossed the headline inflation for the past few years (Mitchell, 2008, Abdullah and Kalim, 2012 and Shrestha and Chaudhary, 2012). The persistently high food inflation in India over the past few years has also become a major concern for the policy makers as they seem unable to control price rise of food articles. The inflationary pressure has mainly come from the rise in the prices of fruits and vegetables and protein based products such as milk, eggs, meat, fish, etc. The available literature suggests that there are no perpetual drivers of food inflation. It has been rather noticed that the drivers have been changing over time, the influence of one declines and some new source of price pressure emerges (Subbarao, 2011). The classical economists led by Irving Fisher explained that prices always change in proportion to change in the quantity of money. Since then, many economists have applied this hypothesis to agricultural prices and confirmed that monetary variables have real impact on the agricultural prices (Schuh 1974, Frankel, 1986, Saghaian *et. al.*, 2002a and 2002b, Siddique and Hye, 2010a and 2010b, Khundrakpam and Das, 2011 and Akinbobola, 2012). In addition, some recently emerged studies in Indian context revealed that food inflation is a very intricate phenomenon which

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is caused by several factors as for example Sthanumoorthy (2008) analyzed that food products (manufactured) were the leading factors responsible for soaring food prices due to the high import of edible oil during 2006-07. Similarly, Chand (2010) attributed the rise of food inflation to drought, resulting in slow growth of production of food items and higher cost of the production. While Kumar *et al.* (2010) argued that soaring food inflation in India is caused by various structural and contingent factors such as declining per capita food availability, rising gap between per capita income, the resultant rise in demand for food products, etc. However, the present inflationary boom in food items occurred due to the shift in demand from low value commodity to vitamin-based products. Furthermore, various studies also suggest that long run food inflation is caused by increase in income of the people and shift of demand from low priced agricultural commodities to high priced dietary agricultural commodities (Nair and Eapen, 2012, Bandara, 2013 and Gulati and Saini, 2013). In addition, Mohanty (2014) claimed that food inflation is a supply side phenomenon and has occurred because the prices of various inputs have gone up due to increase in cost of fuel and fertilizers caused by high international oil prices combined with exchange rate depreciation. Another determinant of food inflation in India is the rise in international food prices which have been transmitted in varying degrees from international to local markets (Rajmal and Misra, 2009).

In a developing country like India, food price inflation is least tolerated as an average household spend about 60 percent of expenditure on food (NSSO, 2001) and around 68 percent of poor lived on less than US$ 2 per day during 2010 (World Bank, 2014). These poor households cannot easily hedge much against inflation especially in food items. Thus, food price increase results in malnutrition and therefore, productivity losses (Alderman, 2005). Hence, to determine the factors behind persistent food inflation is of great interest to the policy makers. Moreover, little empirical research has been done in India to study both demand and supply side factors influencing food inflation together. It is in this context that an attempt has been made to study the major determinants of food inflation in India by using the monthly data from January 2006 to December 2013 and employing Johansen's cointegration approach. The study is organized into four sections. Following this introductory part, second section outlines the sources of data and methodology used in the study. The results and discussion part presented in the section three describes the major determinants of food inflation. Finally, section four concludes the study with major policy suggestions.

METHODOLOGY

Model Specification

The specification of the model is assumed with the help of domestic as well as cross-countries evidences on food inflation which incorporate both demand and supply side factors. The major variables influencing the food inflation are specified as follows:

FI = f(CO, WFP, RF, MS, CR, NEER)

Where,

FI = Food price index
CO = Oil price index
WFP = World food price index
RF = Rainfall
MS = Broad money (M_3)
CR = Interest rate on the short term loan
NEER = Nominal effective exchange rate

The monthly data of the variables were studied for the period of 2006 to 2013. The data regarding food price index and oil price index were collected from Office of Economic Advisor, Ministry of Commerce and Industry, Government of India. The world food price index data is culled from official website of FAO. While monthly rainfall data (millimeter) were compiled from Indian Meteorological Department. The data on broad money (`billion), interest rate and exchange rate is

culled from Handbook of Statistics on the Indian Economy published by Reserve Bank of India. The analytical approaches used in the analysis are described as under:

Unit Root Test

An implicit assumption of the Johansen's cointegration is that the variables must be integrated on the same order. In this study, Augmented Dickey Fuller test proposed by Dickey and Fuller (1979 and 1981) was applied to check the order of integration by using following model.

$$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \sum_{j=1}^{q} \beta_j \Delta Y_{t-j} + \varepsilon_t ...(i)$$

Where,

$\Delta Y_t = Y_t - Y_{t-1}$

β_0 is the constant or drift

t is the time or trend variable

ε_t is the white error term

Where ε_t is a pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, etc. The number of lagged difference terms to be included is often determined empirically, the idea being to include the enough lag terms so that the error term was serially uncorrelated to obtain an unbiased estimate of δ, the coefficient of lagged Y_{t-1}.

Johansen Cointegration Test

Variables are said to be cointegrated if they move together in the long-run. In this study, Johansen cointegration method proposed by Johansen and Jesulis (1988 and 1990) was applied in order to comprehend the long run relationship among the concerned variables. The Trace Test and Maximum Eigen Value Test were also applied for indicating the number of cointegrating vectors. The Equation (ii) represents the Vector Error Correction Model derived from the general Vector Autoregressive Model (VAR).

$$\Delta Y_t = \mu + \Pi_{t-p} Y_{t-p} + \sum_{i=1}^{m-1} \Gamma_i \Delta Y_{t-i} + \beta \mu_t + \varepsilon_t ...(ii)$$

Where Y_t is a p-dimensional process, while Π and the $\Gamma_{i`s}$ are $p \times p$ parameter matrices. μ_t contains deterministic terms such as a constant, a linear trend and seasonal dummies and β contains the parameters associated with μ_t, while ε_t is a p-dimensional vector of white noise components. The coefficients matrices Π_{t-p} describes the long run dynamics of the vector Y_{t-p}. Coefficient matrix Γ_i which captures the short run impact is described as under in the form of Error correction model.

Error Correction Model (ECM)

Error correction is also applied to determine short relationships among the concerned variables. The following ECM representation is specified for this study

$$\Delta \log FP_t = \alpha + \lambda ECT_{t-1} + \sum_{i=0}^{n-1} \beta_{1,i} \Delta \log CO_{t-i} + \sum_{i=0}^{n-1} \beta_{2,i} \Delta \log MS_{t-i} + \sum_{i=0}^{n-1} \beta_{3,i} \Delta \log NEER_{t-i} + \sum_{i=0}^{n-1} \beta_{4,i} \Delta \log CR_{t-i} + \sum_{i=0}^{n-1} \beta_{5,i} \Delta \log WFP_{t-i} + \sum_{i=0}^{n-1} \beta_{6,i} \Delta \log RF_{t-1} + \varepsilon_t ...(iii)$$

Where,

$$ECT_{t-i} = FP_{t-1} - \beta_1 CO - \beta_2 MS - \beta_3 NEER - \beta_4 CR - \beta_5 WFP - \beta_6 RF$$

Where, α is the constant representing a linear trend, Δ denotes the first difference, ε_t is random error and ECT_{t-i} is the error correction term which is derived from the long run cointegrating equation. The significance of the ECT_{t-1} term coefficient (λ), confirms that there exists short run relationship among the variables. The value of coefficient (λ) explains the speed of adjustment towards the long run equilibrium.

RESULTS AND DISCUSSION

The data presented in Table 1 exhibit the descriptive statistics of the variables considered as the majors determinants of food inflation in India. The descriptive statistics of data measured by the coefficient of variation show that among all the variables, variation was highest in rainfall followed by call rate, crude oil index and money supply. Interestingly, fluctuation in domestic food price was much more than that of world food index.

Table 1: Descriptive statistics of raw data (n=96)

Variables	Mean	SD	CV	Maximum	Minimum
Food index	165.24	42.16	25.51	258.30	105.01
Crude Oil Index	212.35	83.60	39.37	385.40	101.90
Call Rate (%)	3.28	2.04	62.19	7.10	0.01
Money Supply (`billion)	55306	19662	35.55	93590	25228
Exchange rate	90.68	9.85	10.86	106.29	67.42
World food index	186.54	35.17	18.85	240.21	122.09
Rainfall (mm)	97.48	101.98	104.62	375.23	1.70

SD: Standard deviation and CV: Coefficient of variation

The rainfall has highest fluctuation due to its seasonal nature. Thus, baring the exchange rate and world food index, all other variables has highest variability.

Augmented Dicky Fuller (ADF) Test

The ADF test results reported in the Table 2 show that all the variables at their respective levels are non-stationary at 5 per cent level of significance. The number of augmenting lags (p's) are determined by using Schwartz Bayesian information criterion. From the results, all the null hypotheses were accepted (unit root) for all variables as the absolute values of the test statistics were less than their respective critical values and reject the alternative hypotheses at level. While at first difference, all the null hypotheses were rejected as the absolute values of all the test statistics were greater than their critical values at 5 per cent level of significance. Thus, all the alternative hypotheses (there is no unit root) were accepted which means that all variables are integrated at first difference.

Johansen Cointegration Tests

The cointegration test was sensitive to the lag length criteria. One lag length was used as suggested by various lags length criteria such as Akaike, Schwarz and Hannan-Quinn information criteria. The Johansen method suggests two tests, trace test and maximum Eigen value test to determine the number of cointegrating vectors. Both the tests indicate one cointegrating equation at 5 percent significance level as first null hypothesis, r=0 is rejected and alternative hypothesis, r 81 was accepted since absolute value of trace and maximum eigen value test is more than their critical values. All other null hypotheses are accepted at 5 per cent level of significance as absolute values of trace and maximum eigen value tests are less than the critical values (Table 3).

Table 2: Augmented Dickey-Fuller (ADF) Test results at level and first difference

Variables	t-statistics	CV (5%)	p-value	Remarks
At Level				
Food Index	-1.24	-3.46	0.89	NS
Crude Oil Index	-2.64	-3.46	0.26	NS
Call Rate	-1.82	-1.94	0.06	NS
Money Supply	-0.85	-3.46	0.95	NS
Exchange Rate	0.52	-2.89	0.98	NS
World Food index	-1.21	-3.43	0.90	NS
Rainfall	-1.58	-1.94	0.06	NS
After 1st Difference				
W Food Index	-8.11	-3.46	0.00	S
WCrude Oil Index	-9.54	-3.46	0.00	S
WCall Rate	-13.32	-1.94	0.00	S
WMoney Supply	-9.80	-3.46	0.00	S
WExchange Rate	-8.04	-2.89	0.00	S
WWorld Food index	-4.87	-3.46	0.00	S
WRainfall	-6.14	-1.94	0.00	S

NS: Non-stationary
S: Stationary

Table 3: Johansen Cointegration Test results- Trace Test and Maximum Eigen value test

Cointegrating equations		Statistics	C.V. (5%)	p-value
H_0	H_1			
Trace test				
r = 0*	r 8 1	140.11	125.62	0.00
r 71	r 8 2	85.86	95.75	0.20
r 72	r 8 3	55.19	69.82	0.41
r 7 3	r 8 4	29.93	47.86	0.72
r 74	r 8 5	16.01	29.80	0.71
r 7 5	r 8 6	6.71	15.49	0.61
r 7 6	r = 7	0.22	3.84	0.64
Maximum Eigen value test				
r = 0*	r 8 1	54.25	46.23	0.01
r 7 1	r 8 2	30.67	40.08	0.38
r 7 2	r 8 3	25.26	33.88	0.37
r 7 3	r 8 4	13.92	27.58	0.83
r 7 4	r 8 5	9.30	21.13	0.81
r 7 5	r 8 6	6.50	14.26	0.55
r 7 6	r = 7	0.22	3.84	0.64

** Indicate the rejection of H_0 at 5 per cent level of significance*

Long-run Model Estimates

The results of the long run model were presented in the Table 4. The long run relationship is impact of exchange rate, world food prices, money supply, interest rate, crude oil and rainfall on food prices. The sign of the coefficients in the long run model are as per *a priori* expectation and significant at 5 percent level of significance. The long-run model shows that exchange rate, oil prices, money supply and rainfall were positively related to food prices, while world food prices, rainfall and interest rate are negatively related to food prices. The coefficient of oil prices was positively related which shows that oil prices have real impact on food inflation. The coefficient of oil prices indicates that in the long run one percent increase in oil prices lead to 25 percent increase in food prices.

Table 4: Long-run relationship of variables with food inflation

Variables	Coefficients	t-Statistic	P-value
Food Index	1		
Crude Oil Index	-0.26**	-3.01	0.003
Money Supply	-0.72**	-1.92	0.005
Call Rate	0.06**	-6.75	0.00
Exchange Rate	-0.53**	-1.92	0.005
World Food	0.34NS	2.74	0.06
Rainfall	0.07**	-7.56	0.00
Constant	5.11		

***** Significant statistically***
NS: Non-significant

The study also support that the monetary instruments have real impact on the food prices. The long run model explains that one per cent decrease in call rate leads to six percent increase in food prices. Similarly, one percent increase in money supply leads to 72 percent increase in food prices. The coefficient of exchange rate was also positively related and explains that in the long run, one percent depreciation in exchange rate leads to 51 percent increase in food inflation.

The coefficient of world food prices was negatively related with food inflation and was non-significant statistically, which means that in the long run, world food prices have no impact on the domestic food prices. The international food prices tend to get transmitted from the international market to the domestic market via open trade. When food prices rise in the international market, the countries that were net exporter of food items benefit from improved terms of trade. On the other hand, the countries that are net importer of food items, however, face the challenges of meeting consumption demand. Rainfall is negatively related with food inflation, which ensures that decrease in the amount of rainfall increase the prices of food and agricultural products. The coefficient of the rainfall in the long run model equation explains that one percent decrease in the amount of rainfall lead to seven percent increase in price of food articles in the long run in India. The overall long run equation demonstrates that except the world food prices, all the variables have real impact on the food prices.

Error Correction Model (ECM) Estimates

The results of the error correction model are reported in Table 5. The error correction term of short run model was also statistically significant with a negative sign. It is another proof that long run relationship exists among the variables used in the study. The negative value of coefficient of ECT_{t-1} (-0.17) indicates very high speed of convergence towards long run equilibrium. The estimated value of ECT_{t-1}

Table 5: Error correction model estimates (short run causality)

Variable	Coefficient	t-statistic	p-value
C	0.01**	3.31	0.0014
D(CO)	0.02**	0.02	0.0075
D(M3)	-0.15NS	-0.84	0.4036
D(LCR)	0.00NS	0.22	0.8232
D(TNEER)	-0.15NS	-1.51	0.1355
D(WFPI)	0.04NS	0. 06	0.0070
D(RF)	0.00NS	0.30	0.7671
ECTt-1	-0.18**	-3.53	0.11
R^2	0.1756	D-W Test value	1.6775
F-statistcs	2.6482	Prob (F-statistcs)	0.0157

***** significant s of the coefficient at 5 percent critical level***
NS: Non-significant

indicates the speed of adjustment to long-run equilibrium in response to disequilibrium, which was due to short-run shocks of the previous period. Since we have monthly data, it takes almost 17 months to restore complete equilibrium. Empirical results of the study reveal that crude oil and world food prices have positive relation with food price inflation and both were statistically significant in the short run.

In the short run, with increase in demand for food (cereals) at international level, the international prices also increase which adversely affect the prices of domestic food prices. While in the long run the coefficient of world food prices is not statistically significant due to its volatility nature. the money supply, interest rate and exchange rate have no impact in the short run, while in the long run these were major driving force to food inflation. The results are in conformity with an earlier study of the RBI in the case of three variables namely interest rate, exchange rate, and money supply. The study shows that all the three variable caused the food prices in the long run but in the short run, the food inflation is free from monetary phenomenon (Khundrakpam and Das, 2011). Rainfall is also positively related with food prices in the short run but is not significant.

CONCLUSIONS AND POLICY SUGGESTIONS

The rising food inflation is global phenomena. It acts as a strong hidden tax for the poor masses. The above analysis shows that food inflation as a major structural and policy issue. Based on result, the study concluded that food inflation in India is a very complex phenomenon that is caused by various factors such as demand and supply as well cost push factors. The relative change in agricultural prices determines the income of the farmers, their investment decisions and the productivity in this sector. Thus, understanding the factors that influence food and agricultural prices is fundamental for the design of policies aimed that the sustainable growth in this sector and the rest of the economy. The study suggests the following few recommendations based on the empirical results.

1. Over the past few years, demand for protein based fruit and vegetables have increased manifolds, resulting in sharp increase in their prices. Several studies in Indian context (Suryanarayana and Gopal, 2011 and Fatehpuria, 2013) have shown that about 30 per cent of the fruits and vegetables go waste as post harvest losses due to their highly perishable nature. Therefore, the government should invest in post harvest cold chain facilities and develop cold storages and improve the infrastructure of agricultural markets so that losses be avoided which will ultimately help to reduce the prices. Further, creation of artificial leakages due to speculative hoarding by the middlemen needs to be checked. Agricultural production can be boosted by investing in R&D for better quality seeds.
2. Indian agriculture is heavily dependent upon the monsoon, as coefficient of the rainfall is also significant in this study, and explains that rainfall has long run real impact upon the food inflation. To reduce the dependency on monsoon, particularly in rain fed areas, the study suggests that investments should be made for rainwater harvesting. The rainwater harvesting generally involves creation of structures such as check-dams, ponds and percolation tanks at a planned set of places along the ûow path. The use of micro-irrigation methods such as drip irrigation and sprinkler irrigation need to be further promoted in water deficient areas.
3. In order to reduce the dependency on import of oil, government should encourage the use of bio-fuels. Although increasing demand of biofuel will increase the prices of food items but comparatively lesser than the crude oil.
4. Monetary policy has a limited role,

although the money supply is a chief determinant of food inflation. Rising food prices pose a serious challenge to monetary policy. On the one hand, tightening monetary policy would be ineffective in the face of an exogenous shock. On the other hand, loosening monetary policy, driven by the need to manage capital inflows and real exchange rate appreciation, would exacerbate the situation. The government should focus towards the trade policy by easing import restrictions on food items, but if global prices remain high and volatile, well designed policy interventions to protect the poor would still be needed.

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