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Rising Food Prices and India's Monetary Policy

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Abstract

It is increasingly being discussed whether the Reserve Bank of India should react to rising food prices, generally considered to be due to supply shocks, when overall inflation seems to be under control. This paper first provides evidence, based on the OPEC 1973 price hike, against the supply shock view, and then points to the low trend growth in agriculture as the main factor keeping India's food inflation high. It then presents a simple model of a two person (rich and poor), two commodity (food and non food) economy with rising food and falling nonfood prices. Simulation results show that GDP can go up while aggregate utility goes down. Simultaneously the GDP deflator (considered to be the general price level) falls relative to the consumer price index, a weighted average of the price index for the poor and rich. Accordingly it argues for a population weighted Consumer Price Index to be constructed and its inflation rate made the primary target of monetary policy, eschewing other inflation measures.

Keywords: Inflation measures, supply shock, monetary policy.

1   Introduction

The Indian economy has grown rather rapidly in the last several years, well above prior estimates of sustainable GDP growth, hugely defying expectations. In the five years ending March 2010, real GDP growth averaged 8.5%. More crucially the economy weathered the crisis due to the collapse in the US economy after the Lehman Brothers meltdown. Even during the worst period in early 2009, GDP growth in January-March 2009 was 5.8%. After the initial pessimism about the impact of US collapse on our economy has been overcome, projections for growth are now generally rosy, with 8-9% quite normal.

However simultaneously food price inflation and general consumer price inflation too have been high. While the GDP deflator (that many consider to be the broadest and most relevant measure) has shown moderate inflation in the five years, food prices and CPI inflation has been rising sharply. A correct diagnosis of the factors underlying this inflation is needed to assess whether prevailing policy responses to rising food prices have been adequate, and to formulate ongoing suitable responses. Insofar as the inflation is due to supply shocks, as seems to be the general consensus among policy makers, then it should be ignored. On the other hand if it is due to demand overheating, then monetary policy should tighten severely. However, if the food price situation corresponds to neither demand overheating nor supply shock but to a different set of circumstances, then appropriate policies for these circumstances options need to be explored. In short, a careful assessment of the situation is first needed.

The paper is organized as follows. Section 2 cites senior officials to document that the predominant view among Indian policy makers has been that India's inflation is driven by supply shocks, within which recently food prices have played a major role. Section 3 conceptually examines the widely used term supply shock, with reference to Indian data. Section 4 provides clear evidence, and cites academic literature showing that the 1973 OPEC fourfold price hike, widely believed to be a huge global supply shock, can be traced to demand overheating in the late 1960s. Based on the 1970s experience, Section 5 critically evaluates the concept of core inflation, on which current RBI policy is based.

Against this analytical backdrop, Section 6 then characterizes the broad patterns in relevant data about food inflation, output and the macro economy in India, distinguishing between a food *supply limitation* and a food supply shock. Section 7 evaluates the relevance of different inflation measures in India and recommends an aggressive tightening of monetary policy now. Section 8 first presents a simple model of a two person (rich and poor), two commodity (food & non food) economy and simulates the impact of *rising food & falling non food prices*. The CPI inflation rate in the model turns out to be *systematically higher* than a GDP based measure of inflation. The model goes on to assess the welfare consequences of rising food prices when the aggregate price level is on target, and shows that aggregate *utility can decline* when GDP goes up. It goes on to recommend that a population weighted CPI be devised for India and made the focus of policy. Section 9 concludes.

2 The Approach to Inflation of Current Policy Makers

Policy makers have been making various statements about inflation over the years. While some of these would reflect their genuine opinions about the economic situation, often the statements made to the press are meant to promote confidence in the economy, and may not reflect their underlying perceptions. However, with regard to the RBI, the annual reports and their published speeches provide an official statement of their view of the situation and associated policy recommendations. This section cites and evaluates statements, mainly by the RBI since 2009, some of which – though not all – attribute primacy to food prices in determining overall inflation.

To begin with, the latest Annual Report of 2009-2010 stated,
> "the identification of the source of inflation is important for the conduct of monetary policy … When the inflationary pressure is dominated by adverse supply shocks, monetary policy could be less effective in containing price pressures" (Reserve Bank of India "Annual Report 2009-2010", pg. 33, italics added.)

In a recent speech, Deputy Governor Shyamala Gopinath stressed food prices as the main factor,
> "Given the dominance of food price inflation in shaping the overall course of the inflation path, the policy challenge though is to address the supply constraints" (Gopinath 2010, pg. 21)

Analytically, the RBI looks at inflation by breaking it down into its *core* and *non-core* components– the former corresponding to underlying inflation based on demand pressures, while the latter reflects

random movements in food and oil prices arising from supply side shocks. [1] The aggregate number, what is called headline inflation, is the sum of the two. The general view, as expressed in the latest Annual Report, is that supply shocks are the *drivers* of headline inflation, and the response of economic agents to higher prices from supply shocks leads to subsequent impact that feeds into *core* inflation.

The Annual Report goes on to present statistical evidence to back this approach. The relevant passage is cited at length below since it will be evaluated in Section 5.

> "In India, the dominance of supply shocks in affecting the underlying inflation trend is borne out by the Granger causality tests. The test results suggest the presence of unidirectional causality with food and fuel inflation, reflecting the supply shocks, Granger causing the changes in core inflation. The "non-oil non-food component" is used as a measure of core inflation for this test. Although the results are significant only at 10 per cent level, the results indicate supply shocks contributing to possible second round effects … The second round reflects the risks to overall inflation from shifts in relative prices that originate through supply shocks … The variance decomposition analysis based on a structural VAR framework sheds light on the impact of supply shocks on India's headline inflation. About one-third of the variation in the headline inflation over the horizon of two years seems to have been explained by the supply shocks (food and oil). It is also to be noted that the impact of oil shocks has a relatively greater impact (about 20 per cent) on variation in headline as compared to food shocks (about 14 percent). The empirical results also indicate that about 54 percent of the variation in headline inflation is caused by the residual shocks to the headline inflation itself, which is suggestive of the role of inflation persistence and inflation expectations in explaining the inflation process." (RBI "Annual Report 2009-10", pg. 34)

For a much earlier period, a research study conducted under the auspices of the Reserve Bank (Balakrishnan, 1991) concluded that inflation in India was driven mainly by supply shocks. The Finance Ministry's latest Economic Survey takes the same view "Since December 2009, there have been signs of these high food prices, … getting transmitted to other nonfood items" (Government of India, 'Economic Survey 2009-2010', pg. 3) It can be easily concluded that the view in policy circles is that inflation in India is driven by supply shocks.

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[1] "In a long term framework, the inflation rate can be hypothesized to evolve around a trend. The *underlying* trend can be considered as the core which is largely influenced by *demand* conditions" (p. 1983, Mohanty, 2010b).

3 Some Neglected but Crucial Analytics of Supply Shocks

The concepts of supply shocks and core inflation are widely used at present in macroeconomic policy all over the world, not just by the RBI as cited above. These concepts originated in USA in the mid 1970s. A careful examination of the origins and validity of these concepts is required to assess whether they should be given prominence in Indian policy, as is currently being done, and as documented above.

A supply shock can be said to occur when a *reduction* in supply, typically due to bad weather for food, or due to other disruptions, pushes up the price of that commodity, and thereby the price level and also the inflation rate for that period.[2] However, as the supply shock gets reversed in the next period, the price level and the inflation rate should *revert* to their previous (or trend) levels. From a monetarist perspective, inflation is a *sustained,* continuous rise in prices. Hence a *one time* jump (or fall) in the price level and should not be considered an inflation (or deflation), which requires prices to rise (or fall) for more than one period.

Further, a supply shock may not cause inflation *even* for one period, an important conceptual point, explained below. It is not even necessary that a onetime jump in the price of a (large) commodity will lead to a corresponding jump in the aggregate price level. This is because, from a monetarist perspective, there is a nominal GNP constraint that the monetary authorities can and should impose.[3] If *more* income is spent on a commodity whose price has risen and for which demand is inelastic, such as food or oil, then *less* income is left to spend on other commodities, which will tend to reduce their prices. Only if these other prices are sticky, will the supply shock raise the price level, with output contracting simultaneously, based on the nominal GNP constraint.[4]

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[2] For the supply shock to have a significant impact, the commodity in question must comprise a big share of the consumer's budget and the price index e.g. oil or foodgrains. With many agricultural commodities (more than 55 are listed in the WPI at the most disaggregated level) minor positive and negative supply shocks will always be occurring in any given year, but they should *cancel out* or have a negligible macroeconomic impact.

[3] A monetarist perspective as defined here is not necessarily based on stable money demand or a Quantity Theoretic approach.

[4] For an original and powerful exposition of these simple arguments and related ones, see Milton Friedman's (1966) debate with Robert Solow on wage-price guideposts, which includes his famous, oft cited statement, "Inflation is anywhere and everywhere a monetary phenomenon." In that debate he also introduced, in his rejoinder to Solow, the natural rate of unemployment concept. Friedman also cites at length an *illuminating* example from the microeconomics textbook of Alchian and Allen. They describe how an increase in consumer demand for beef (a demand shock), embedded in an inventory supply chain of production, that ends up raising the retail price, appears to all but one participants in the chain as

However, as an empirical matter, the stickiness of prices varies with the monetary policy regime. If the central bank is committed to overall price stability, then prices or contracts may be negotiated or renegotiated, taking into account the central bank's stance and influence upon aggregate demand. Thus, following a supply shock prices in the rest of the economy might fall such that the overall price level is unchanged, even over a period as short as say one year. In short from this perspective, inflation that prevails for more than one period (typically a year) is demand induced, calling for monetary tightening. In a growth context the demand constraint is not the level of nominal GDP but its growth rate, which anchors the overall inflation rate, with the price level rising around the trend inflation rate.[5]

A clear instance of a large supply shock in India occurred in late 1998 when onion production fell sharply and food prices rose. As a result, CPI inflation, heavily weighted by food prices, rose sharply but then fell to zero, while CPI inflation for the food subgroup food turned negative (see Table 1 below).

Table 1: The Onion Crisis and the Base Effect

Month	November 1997	November 1998	November 1999
CPI	366	438	438
CPI Inflation	5.8%	19.7%	Zero
CPI Food	387	485	462
CPI Food Inflation	2.1%	25.3%	- 4.7%

A supply shock generally implies a corresponding 'base effect' in inflation data. The base effect refers to the negative correlation in measured inflation over the relevant horizon. When the price level jumps there is a corresponding jump in the inflation rate that reverses itself in the next period. The base effect is present whenever there are *price* shocks, some of which may be due to supply shocks, but can occur for other reasons also. India's Wholesale Price Index (WPI) also shows a big base effect: the monthly

occurring solely due to a rise in costs i.e. supply induced. Some of this debate, with relevant citations, is summarized in Chapter 6 of Moorthy (2006).

[5] If money demand (or velocity of money) is stable, then money growth targeting amounts to nominal GNP targeting. Due to instability in money demand, direct nominal GNP targeting to replace money growth targeting began to be considered in monetary policy discussions (for instance see Hilton and Moorthy, 1990). Subsequently, Frankel and Chinn (1994) showed that to maximize social welfare in the presence of supply shocks, a nominal GNP rule beats a money growth and an exchange rate rule.

and weekly inflation highs (measured year over year) tend to be the lows for the next year and vice versa (Moorthy, 2008a).

4 The Widely Misunderstood OPEC Saga

The term supply shock came into use following OPEC's decision in October 1973 to raise the price of crude oil from about $3.00 to $11.80 a barrel, as the Yom Kippur Arab Israel war broke out that month. Both CPI inflation and unemployment rose sharply in 1974, in USA and other countries. This phenomenon of *rising inflation and unemployment* came to be called *stagflation* and was very widely attributed to OPEC's actions.[6] Examining the validity of this view is critical to assess whether recent food price rises in India are due to supply shocks.

However, there is compelling evidence to indicate that the OPEC hikes were not a supply shock, but resulted from a shift up in the short run Phillips curve in the U.S. economy starting in the late 1960s. This was in accordance with the Expectations Augmented Phillips Curve (*henceforth called EAPC)* approach and prediction of Friedman (1968) and Phelps (1968). In this model, as inflation expectations rise in response to actual inflation, the negatively sloped short run Phillips curve will shift up. As this happens, both inflation and unemployment will rise i.e. the phenomenon of stagflation *will be observed*.

As can be seen in Table 2, between 1967 and 1970, CPI inflation in the U.S. rose from 3.0% to 5.6% while unemployment also rose from 3.8% to 4.9%. These movements corresponded to the shifting Phillips curve stage of the EAPC.[7] Basically with unemployment below 4% during 1966-1969, the U.S. economy was below the natural rate.[8] So actual inflation rose, and that filtered into expected

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[6] Two noted economists Bruno and Sachs (1985) wrote a book titled "The Economics of Worldwide Stagflation" (1985) modeling a downward shift in the production function due to a decline in the major input (oil) complementary to capital and labour, leading to rising inflation and falling output. All major macroeconomics textbooks (e.g Dornbusch and Fischer, Mankiw, various editions) explain this stagflation as being OPEC induced.

[7] Any standard textbook outlines this process graphically or algebraically. The term expectations augmented Phillips curve (EAPC) that we repeatedly use represents not just one curve, but a whole process and a model expounded by Friedman and Phelps. It combines the negatively sloped *short run* original Phillips curve, the *shifting* short run Phillips curve as inflation expectations rise, and the *long run vertical* Phillips curve, when the economy is at the natural rate of unemployment and actual inflation equals expected inflation. Using the term Phillips curve loosely, without specifying which part of the above process is being described, is misleading and avoidable.

[8] With the prime-age male (25-34 years) unemployment rate very much lower at 2% the U.S. labour market in 1969 was far tighter than the 'plain vanilla' overall unemployment rate of under 4% indicated.

inflation, as gauged by the Michigan survey of households. Expected inflation rose from 3.8% to 4.9% between 1967 and 1970 (see Table 2). This small rise in both inflation and unemployment during 1967-1970, a *clear-cut mini stagflation* well before OPEC's price hike, went largely unnoticed.[9]

Table 2: Demand overheating precedes the OPEC price hike

Year	Crude Oil price $/barrel	CPI Inflation	Core CPI Inflation	Unemp Rate	Expected Inflation (Mich. Survey)
1967	2.2	3.0	3.8	3.8	3.8
1968	2.2	4.7	5.1	3.6	4.6
1969	2.2	6.2	6.2	2.5	4.5
1970	2.2	5.6	6.6	4.9	4.9

Source: Economic Report of the President etc. Average annual values for most variables. Core CPI excludes food and energy prices.

A wide array of solid evidence *from the 1970s* has been convincingly marshalled by Barsky & Kilian (2001, 2004) to argue along the above lines, against the OPEC induced view of stagflation. For reasons of brevity, we cannot go into the 1970s evidence, which involves the complications due to *wage price controls* in 1971 and 1972, the collapse of the Bretton Woods fixed exchange rate regime, the policy decisions of the Federal Reserve before October 1973, the impact of U.S. dollar invoicing on commodity price movements etc. Trehan (1986) was perhaps the first to provide evidence against the OPEC stagflation view, based on causality tests between oil prices and the U.S. dollar.[10]

5 The Core Lesson from the Aftermath of OPEC

For India, and many other economies, the OPEC price hike was *certainly an exogenous supply shock*, emanating from the demand overheating in America. When a country faces a supply shock, this often triggers what are known as *cascading* or second round effects as the rise in input costs filters through

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[9]It might be thought that the data for 1970 could be an outlier. However, it should be pointed out that average values of *annual* data, (a low frequency measure) are not prone to random fluctuations, certainly for unemployment. Regressions with quarterly data from the early 1950s indicate the (negatively sloped) short run Phillips curve to be unstable and shifting up by 1970.

[10] This alternative EAPC explanation of stagflation is based on my class notes for well over a decade, now Chapter 6 of Moorthy (2006), and summarized in Moorthy (2008b). Barsky and Kilian (2001) labeled their approach as a Monetary Explanation of the Great Stagflation. By contrast, Moorthy relies only on the EAPC approach to the Great Stagflation, ignoring money growth data.

the economy, with larger subsequent impact. However, as discussed in Section III, whether cascading occurs largely depends upon the stance of monetary policy. In the USA the oil price shock was largely accommodated, while in West Germany the 'monetarist' Bundesbank moved to offset the shock, reinforced by a rising deutschmark.[11] The Table below lists inflation rates for relevant years. Inflation in USA in 1974 rose even higher than in 1973, the year of the price hike.

Table 3: Inflation Rates after the OPEC Price Hike

Year	USA	Germany	India
1972	3.4	6.4	7.7
1973	**8.8**	**7.8**	**23.8**
1974	**12.2**	**5.7**	**25.4**
1975	7.0	5.4	-6.1

However, as can be seen, this cascading did *not* occur in W. Germany with 1974 inflation (5.7%) lower than 1973 inflation (7.8%). Thus, the lack of cascading in Germany, highly dependent on imported oil, validates the 'monetarist' view outlined earlier that the inflationary impact of a supply shock depends upon the response of monetary policy to the shock, and expectations about the monetary regime.

India's monetary tightening in response to the supply shock was reasonably strong, but in relation to the huge jump in inflation, it can be described as one of moderate accommodation.[12] Thus like the USA, India's inflation in 1974, the year after the shock, was higher than in 1973. The subsequent drop in inflation in 1975 was more due to the base effect kicking in, than to the impact of monetary stringency.

One lasting consequence of the OPEC episode was the widespread acceptance of the concept of core inflation. It is generally believed to have been introduced by then Federal Reserve Chairman Arthur

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[11] This statement is a matter of judgment since the stance of monetary policy in response to a shock cannot be mechanically assessed by the magnitude of the interest rate hike in that country. It needs to be assessed in relation to inflation and other data for that country. A 100 basis point hike in rates is large when inflation has risen by 50 basis points, but small when inflation has risen by 200 basis points. Besides there are changes in other policy measures that may affect the stance of monetary policy much more, such as reserve requirements for India.

[12] Deepak Mohanty (2010) provides a chronology of monetary measures (Bank Rate, CRR, SLR, interest rates on food credit, export credit etc) in response to episodes of double digit inflation from April 1950 to March 2010.

Burns to explain and justify to the U.S. Congress that high inflation was due to special factors (food and energy prices). Ironically, in 1974, when the headline CPI rose from 8.7 to 12.3%, and OPEC was blamed as the villain of the piece, core inflation rose even more from 4.7% to 11.1%! This suggested underlying inflation pressure based on the EAPC. [13]

The core inflation concept is now widely entrenched and used in policy by the Federal Reserve and many central banks the world over. Core inflation prominently figures in the RBI's policy framework, as discussed in Section 2. The one notable exception was the Bundesbank which looked at headline inflation, measured year over year, irrespective of its source.[14]

However, the usefulness of the core inflation concept can be questioned. While supply shocks affect headline inflation, they get reversed soon as documented in Section 3 for India in 1998. Inflation that persists *beyond one year* is most likely due to demand overheating, as in 1974.[15] Indeed, from the consumer's viewpoint, leaving aside the volatility of food and energy prices at high frequencies, much of what is called *core* inflation can be termed *trivial* inflation. By contrast, non core inflation, pertaining to the more *basic needs* of food and fuel, can be characterized as *crucial* inflation (our terms!)

To his credit, former RBI Governor Y.V. Reddy expressed some skepticism about core inflation:
> "Recent experience with regard to impact of increases in oil prices, and more recently elevated food prices shows that ignoring the structural or permanent elements of what is treated as shocks may slow down appropriate monetary policy response especially if the focus is on "core inflation." (Reddy 2007, pg. 1617)

For India, the data weakly reveal statistical causality (at the 10% level) from non core to core inflation over 1994 to 2010 (section 3). However, the estimated coefficients indicating cascading, reflect India's relatively lax monetary regime in the past. They are hardly a guide to policy. The current presumption

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[13] Also noteworthy is that even before the OPEC price shock, between 1967 and 1970, core inflation rose by roughly as much as headline inflation, from 3.8% to 6.8% (see Table 2).

[14] The European Central Bank has been following in the footsteps of the Bundesbank, but with the problems of the whole Eurozone to deal with after the Greek crisis, may not be able to continue with its focus on headline inflation.

[15] In his critique of Fed Chairman Arthur Burns OPEC based explanation of stagflation, Milton Friedman (1975) instead attributed high inflation instead to the EAPC.

underlying the thinking of RBI, and others, at present that inflation starts with supply shocks and then feeds into core inflation is quite dubious.

To summarize, the lesson from the aftermath of the OPEC price hike is that the tendency for supply shocks to feed into inflation expectations and thus overall inflation is not a general phenomenon. It has been manifest in Indian data because of monetary accommodation. RBI officials have been expressing their concerns about controlling these feedbacks or cascading effects. However, if the RBI clearly targeted a low rate of headline inflation (measured at a low frequency) and pursued it, then it would not have to worry about the risks of supply shocks feeding into general inflation.

6   The Great Supply Limitation

The OPEC episode provides a critical backdrop to assess whether food price increases in India are due to supply shocks or due to demand overheating. Tables 4, and 5 present a wide range of summary background data pertaining to agriculture and the Indian economy over the last decade.

Over the last three years, starting from 2007-2008, inflation for food grains has risen *every year* (Table 5A), while foodgrains output has *risen* for two out of these three years (Table 5B).[16] Overall if there are significant movements in food production and food prices in *opposite* directions, allowing for intra year lags, then we can say that food prices are largely driven by supply shocks. This does not seem to be the case for the last three years. For the decade, the simple scatter plots of food prices inflation against change in agricultural production for four major commodities for this decade *do not show* a significant negative correlation (Appendix A)

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[16] For the biggest food item, foodgrains, WPI inflation is 5.6%, 8.0% and 14.7% while output growth is 6.2%, 1.6% and -7.4% respectively over these three years (Table 5 A).

Table 4: Inflation in Food Components of Wholesale Prices

Year	Primary Food Articles	Cereals & Pulses	Other Food Articles	Manu. Food Products	Manu. Non-Food Products	WPI	World Food Price Index
Weights	15.4	5.0	10.4	11.5	52.2		
Level (99-00)	165.5	176.4	160.2	151.3	134.1	145.3	89.2
2000-01	3.0	-1.5	5.4	-3.7	5.0	7.2	1.2
2001-02	3.3	-0.8	5.3	-0.2	2.3	3.6	1.8
2002-03	1.8	1.1	2.1	5.2	2.1	3.4	0.2
2003-04	1.3	1.1	1.3	9.0	4.9	5.5	10.3
2004-05	2.6	0.7	3.6	4.9	6.6	6.5	10.8
2005-06	4.8	5.4	4.6	1.1	3.5	4.4	3.1
2006-07	7.7	10.2	6.6	3.2	4.7	5.4	8.2
2007-08	5.6	4.6	6.1	4.2	5.1	4.6	36.9
2008-09	8.0	8.6	7.7	10.0	7.7	8.4	1.9
2009-10	14.7	15.6	14.3	16.7	0.1	3.8	-9.4
Level (09-10)	275.1	270.6	277.3	244.3	201.9	242.9	158.6

Commodity	Weights	Number of articles
I. PRIMARY ARTICLES	22.03	98
of which A) Food articles	15.40	54
of which a) Food Grains (Cereals + Pulses)	5.01	
of which i) Cereals	4.41	
ii) Pulses	0.60	
b) Vegetables and Fruits	2.92	
c) Milk	4.30	
d) Eggs, Meat and Fish	2.21	
e) Condiments and Spices	0.66	
f) Other food articles	0.24	
B) Non-food articles	6.14	25
C) Minerals	0.48	19
II. FUEL POWER LIGHT & LUBRICANTS	14.23	19
III. MANUFACTURED PRODUCTS	63.75	318
of which A) Food Products	11.54	41
Others	52.21	277

Table 5A: Growth Rates for major Comodities in Indian Agriculture

Year	Cereals	Pulses	Food Grains	Oil Seeds	Sugarcane
Level [1](1999-00)	196.4	13.4	209.8	20.7	299.3
2000-01	-5.4	-17.4	-6.2	-11.0	-1.1
2001-02	7.4	20.8	8.1	12.0	0.4
2002-03	-18.0	-16.8	-17.9	-28.2	-3.3
2003-04	21.2	34.0	22.0	69.7	-18.6
2004-05	-6.6	-11.9	-7.0	-3.3	1.4
2005-06	5.4	2.0	5.2	14.9	18.6
2006-07	4.0	6.0	4.2	-13.2	26.4
2007-08	6.4	3.9	6.2	22.5	-2.1
2008-09	1.8	-1.3	1.6	-6.9	-18.1
2009-10	-7.4	0.1	-6.9	-10.1	-2.6
Level (09-10)	203.6	14.6	218.2	24.9	277.8
CAGR 1990s	2.1	0.9	2.0	2.7	2.8
CAGR 2000s	1.4	2.0	1.4	4.4	0.5

(CAGR: denotes compound annual growth rate)

Table 5B: Inflation and Growth in the Macroeconomy

Year	WPI	CPI	Nominal GDP	Real GDP	GDP Deflator	Real GDP Agriculture	Real GDP Non-Agri.	PFCE Deflator
Level (1999-00)	145.3	91.5	1786525	1786525	100	409660	1151885	
2000-01	7.2	3.7	7.7	4.4	3.3	-0.6	6.1	
2001-02	3.6	4.3	8.4	5.8	3.0	6.5	6.1	
2002-03	3.4	4.1	7.7	3.8	3.8	-8.1	7.3	
2003-04	5.5	3.7	12.2	8.5	3.4	10.8	8.1	
2004-05	6.5	4.0	14.3	7.5	5.5	0.1	9.0	
2005-06	4.4	4.2	13.9	9.5	4.2	5.6	10.8	3.2
2006-07	5.4	6.8	15.1	9.7	4.9	3.8	11.2	6.0
2007-08	4.6	6.4	14.4	9.0	4.9	5.0	10.5	3.6
2008-09	8.4	9.0	12.7	6.7	7.0	1.1	8.3	7.0
2009-10	3.8	12.5	10.0	7.4		0.2	9.0	6.4
Level (09-10)	242.9	161.3	5856569	3586489	148	547980	2991119	
Average 2000-05	5.2	4.0	10.1	6.0	3.8	1.7	7.3	
Average 2005-10	5.3	7.8	13.2	8.5	5.2	3.1	10.0	5.2

(Source: Handbook of Statistics on the Indian Economy 2009-2010, RBI)

1. Commodity production level in metric tonnes.

2. PFCE denotes Private Final Consumption Expenditure

3. CPI (IW) is the CPI for Industrial Workers.

We can broadly infer there are somewhat *independent production* shocks and *price* shocks, not supply shocks per se. By contrast there could be many reasons for price shocks per se – the impact of global prices, changes in import policy, the impact of the procurement and more crucially buffer stocking for some items (cereals) complicate the impact of underlying supply and demand.

Much of the increase in food prices in the last three years seem to have been driven by increases in the Minimum Support Prices (MSPs) or procurement prices, as the Economic Surveys of the last two years have pointed out, and as Table 6 below indicates.

Table 6: Growth Rates in Minimum Support Prices and WPI

		Average Annual Growth Rate	
Commodity		*2003-04 to 2006-07*	*2007-08 to 2009-10*
Paddy	MSP	2.3	18.3
	WPI	2.0	10.9
Wheat	MSP	5.1	14.4
	WPI	5.5	6.7
Tur	MSP	1.7	18.0
	WPI	3.9	26.3
Moong	MSP	3.4	23.2
	WPI	11.3	13.2

Source: "Inflation Dynamics in India: Issues and Concerns" by Deepak Mohanty(2010a)

Neither is the data indicative of straightforward demand overheating, as will be discussed in the next section, based on a comparison of different inflation measures. However, it should be pointed out that there may be indirect demand overheating. As inflation rises, so does the cost of inputs. Farmers accordingly demand and get compensation for inflation via higher procurement prices. [17] What appears to be a procurement price shock may be a response to rising inflation, along EAPC lines.

The single most noteworthy feature of the data is the *extremely low trend growth* in agricultural production. During this decade and the previous one (the 1990s too, corresponding to the post 1991

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[17] In the above cited article, Deepak Mohanty (2010a) discusses this phenomenon. Populist policies also *hugely influence* procurement prices – Uttar Pradesh has had the biggest increases of late.

liberalization), the CAGR for foodgrains has been 1.4% and 2.0% respectively Table 5A). Comparing growth rates from GDP data, the agriculture sector has grown by 2.5%, while the rest of the economy has grown by 8.5% (Table 5B). Over the last three years the agriculture sector growth has averaged 2.1%, while the non agriculture sector has grown five times as fast. Agriculture's performance can thus be described as the G*reat Limitation* (our term). The effect of this low growth for the economy and overall economic welfare needs to be assessed.[18]

Obviously raising agricultural growth, preferably by raising productivity, should be India's top priority for overall economic policy.[19] However, this issue is outside the purview of monetary policy. The economy is now food supply constrained. The conduct of monetary policy in such an economy needs to be carefully analyzed. A supply *limitation* has vastly different *policy implications* than a supply shock. A pure supply shock is self reversing and can be ignored, as a first approximation. However a supply limitation is *ongoing* and the problems it poses need to be incorporated into the formulation of policy. It is sometimes described as a recurring supply shock. But "recurring shock" is a misleading term since the term shock itself implies an *intrinsic randomness* about which nothing can or should be done. Statements by RBI officials indicate an awareness that unlike a self reversing supply shock, a supply limitation cannot be ignored. Dr. Subir Gokarn has provided a fine exposition of this issue in an inaugural address,

> "… the conventional view of food prices, is that surges are temporary, driven by supply disruptions that at worst last one season. As conditions return to normal, as they usually do, the price surges are expected to recede. Transmission lags in monetary policy are generally seen to be longer than the typical agricultural season, so, if monetary instruments are used to deal with such price shocks, they have no impact on the immediate cause of the problem, while possibly doing damage to growth prospects down the road. … But, when we begin to consider the impact of structural food price shocks, such as the ones we appear to be experiencing in the Indian context, the policy implications become complex." (Gokarn 2010, RBI Bulletin pg. 2321)

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[18]While senior officials have been expounding on the Great Moderation in world inflation at international meetings, in India the Great Limitation (in food supply) has led to moderate escalation in inflation.

[19] While imports in general can increasingly substitute for domestic production, this is a risky strategy for two reasons. First with a large current account deficit, unlike our Asian counterparts, the scope for imports is limited. Second while globalization provides access to cheap imports, increasingly prices are subject to sharp swings as commodities have become an "asset class" attracting hedge funds and pension funds. The rise in oil to $140 a barrel in mid 2008 and drop to $30 a barrel by year end shows the risks of dependence on commodity imports.

However, Gokarn provides little clarity as to concrete monetary responses to what he calls "structural food price shocks", another misleading euphemism for what we have plainly called a supply limitation.[20]

7 Choice of Inflation Measure for Policy

In most countries there is one unique well defined and accepted measure of inflation that is used in policy, whether or not a policy of direct inflation targeting is followed.[21] By contrast, in India monetary policy is being conducted by looking at various inflation indicators, a policy that the RBI has stressed is suited for the complex economy. Nevertheless, it is fair to describe the WPI as the price index that has been and still is the primary focus of policy. In a recent speech, discussing the switch to a new base year 2004-05 for the WPI, the RBI's Executive Director Deepak Mohanty has clearly stated,

> "WPI is taken as the headline inflation in India. The Reserve Bank's policy articulation and policy projection is in terms of WPI." (Mohanty 2010b, RBI Bulletin, p. 1979)

By contrast we have been stressing that there is no justification for not using the CPI as the policy target (Moorthy 2001, Moorthy & Kolhar, 2007). Further, updating of the WPI weights in late 2009 has delayed the vital task of focusing upon the CPI (Moorthy, 2009). Failure to do so harms economic agents in the economy by making it difficult for them to enter into and adjust nominal contracts to the cost of living.

Recently, policy economists have acknowledged the various limitations of the WPI as the main inflation measure. Nevertheless there is a pronounced reluctance to replace the WPI with the CPI. Instead, to capture items not present in the WPI, the focus of policy makers is turning to broad based inflation measures from the GDP accounts: the overall GDP deflator and the deflator for Private Final Consumption Expenditures (henceforth PFCE) component of GDP. This PFCE index constitutes a broader bundle of goods than the CPI, while ignoring items in GDP such as machines that obviously

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[20] Indeed, subsequently Gokarn has stated, "It (monetary policy) is not going to solve the problem because we need a supply response to solve the problem…The monetary response is to ensure that expectations are anchored and that we do not allow the food pressures to translate into wider inflationary pressures and that is what we have been doing all along" as cited in 'Food inflation beginning to look structural: Gokarn' December 2, 2010, Business Standard.

[21] For instance, the ECB formulates its policy by looking at the Harmonized Index of Consumer Prices (HICP) while the Bank of England, after the financial crisis period, has gone back to targeting the CPI.

should not be counted when measuring inflation for consumers.[22] The inflation rates for these two GDP based measures alongside the conventional WPI and CPI are presented below (and also in Table 5 B).

Table 7: Various Inflation Measures in India

Year	WPI	CPI	GDP Deflator	PFCE Deflator
2005-06	4.4	4.2	4.2	3.2
2006-07	5.4	6.8	4.9	6.0
2007-08	4.6	6.4	4.9	3.6
2008-09	8.4	9.0	7.0	7.0
2009-10	3.8	12.5		6.4
Average	5.3	7.8	5.2	5.2

The higher inflation rates for the CPI(IW) and the PFCE deflator are not surprising. Both have higher weights for food items and services than the WPI. Hence, the inflation rates in CPI(IW) and PFCE are higher than the WPI and GDP deflator. Even after the weights revisions in 2006, to base year 2001, food items continue to make up close to half (46%) of the CPI (IW), while they comprise only 26% of the WPI.

The latest Economic Survey has stressed the PFCE in lieu of WPI and CPI as a suitable inflation measure,

> "The PFCE measures the average change over time in the price paid for all consumer purchases. For this reason, the PFCE deflator measures changes in the cost of living, and because it measures the price paid for all consumer purchases, versus just a basket of goods, it is considered a more accurate measure of inflation than the CPI….PFCE inflation is at a lower level than CPI (IW) during *all four* years 2005/06 to 2008/09" (Government of India, 'Economic Survey 2009-10' Pg 72, emphasis added).

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[22] The PFCE category of GDP in India is equivalent to the PCE (Personal Consumption Expenditures) component of GDP in the U.S. economy. The Federal Reserve has been gradually moving away from the CPI to emphasizing the PCE deflator – initially the fixed weight deflator and since 2000 the chain weighted deflator, with its rolling base period. It is beyond the domain of this paper to assess the merits of switching to the PCE deflator versus the CPI for U.S. monetary policy. However, using the PFCE deflator in India without first assessing its relevance should be avoided.

The above conclusion that the PFCE deflator is a more accurate measure of inflation than the CPI is not warranted. The PFCE deflator calculated from the CSO is an implicit deflator, like the implicit GDP deflator in Table 7. Implicit deflators are obtained by dividing nominal by real GDP, whether for the aggregate or for some component of GDP. National income statisticians stress that implicit deflators, derived from actual GDP whose composition is changing, are not a measure of price change since they do not correspond to a fixed bundle of goods. It is plainly erroneous for the Economic Survey to suggest that these deflators be used in lieu of the CPI. The RBI has also done so. In a speech, RBI Executive Director Deepak Mohanty presents data for the implicit deflator back to 1970 and also states that "it is a comprehensive measure of inflation." February 2010, RBI Bulletin, p. 299-307

Over the last five years the CPI has averaged 7.5% (Table 5B), well above the RBI's stated zone of 4.5-5% and much higher for the last year. To ensure that expected real rates are not negative, as at present requires the reverse repo and repo rates to be in at least a 8.5% to 9.5% range. An aggressive, immediate tightening of 300 to 400 basis points from the current 5.5% to 6.5% range (as of end January 2011) for the repo corridor is called for, unlike the recent "baby steps" that leaves the RBI way behind on the inflation curve.

8 Simulating Impact of Rising Food Prices on Inflation, Growth and Welfare

In recent years the agricultural sector has grown very *slowly* with *high* inflation, while the non agricultural sector has grown very *fast* with *low* inflation.[23] The standard monetary policy prescription is that if overall inflation is on target, then differential inflation rates across sectors can be ignored. Monetary policy should not target, and cannot in the long run target, relative prices. It should only target nominal values.

At present, since CPI (IW) inflation has averaged 7.5%, way above target, this dilemma does not arise. However, this dilemma is likely to arise in the future. As the share of agriculture in GDP falls due to its lower projected growth rate, so will its weight in the price indices. Some years from now, suppose the

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[23] The average inflation rate over last five years for Food Group in CPI(IW) is 9.9% while for Non Food group it is 5.9%. Correspondingly, the growth in GDP for Agricultural is 3.1% and GDP for Non-agricultural is close to 10% (Table 5B).

share of food in CPI (IW) has fallen to 20%.[24] Now, assume sectoral inflation rates stay roughly at recent averages. Then CPI inflation can converge to target although food inflation remains high. Let Π denote inflation. Then Π (future) = 0.2*Π (food) + 0.8 Π (non food) = 0.2*15 + 0 .8*3 = 5.4% which is roughly on target. Going by the standard recommendation as discussed, monetary policy should adopt a *neutral stance* since inflation is on target. [25] However, this standard policy may not be appropriate. As food prices rise, those whose consumption basket is heavily weighted with food get affected adversely.

A static, two person (rich and poor) two good (food and nonfood) economy is developed below, *meant to capture* some crucial aspects of India's current situation and the above policy dilemma:

i) Ongoing divergence between CPI inflation and GDP inflation, which is much lower.

ii) High growth and low inflation in the nonfood sector, coupled with low growth and high inflation in the food sector. [26]

iii) Rising food prices and falling non food prices may be lowering welfare (utility) although GDP is rising.

In this static, closed economy, Consumption = Income for both rich and poor consumers. To begin with P food = 1, P nonfood = 1. Nominal Income Y (poor) = 20, Y (rich) = 80. With initial prices of both products being 1, the CPI equals 100.

It is assumed that demand for food is *completely price inelastic* i.e. food is a necessity – a certain calorific input is required and no more is consumed. *All extra income i*s spent on non food items.[27]

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[24] The share of food in the CPI (IW) has been lowered from 57% to 46.2% during the revision of CPI to 2001 = 100 from 1982 = 100. During this period the share of agriculture in GDP has fallen from 33 % to 21 %.

[25] Even if overall CPI inflation were on target, the lagged response of inflation to demand overheating that occurs in the non food sector, as Okun (1981) emphatically stressed, suggests that preemptive monetary policy tightening may be called for

[26] India's economy is classified into agriculture and allied activities, manufacturing and services. The agricultural sector mostly comprises of food and we can ignore the non food component, which is small. Technical progress in manufacturing is leading to rapid growth and low manufacturing inflation. For analytical convenience we are subsuming services along with manufacturing under non food and assuming low inflation in non food as a whole.

[27] This corresponds to the an extreme form of the Stone (1954) and Geary (1950) demand function with its hierarchical preference for food, vastly different from the usual Constant Elasticity of Substitution (CES) functions in which expenditure shares on goods are constant as income rises and price substitution always holds. This approach has been recently used by Gollin et. al. (2002).

Exogenous Variables:

(i) Constant level of food consumption: Q_F

(ii) Constant nominal Income: Y(poor) and Y(rich)

(iii) Price of Food: P_F (which increases over time)

Endogenous Variables:

(i) Price of Non-food: P_{NF} (derived from the imposed constraint that aggregate CPI remains at 100)

(ii) Quantity of Non-food consumed by poor and rich: Q_{NF}(poor) and Q_{NF}(rich)

The initial values are shown in the left hand side of Table 8. The quantity weights to calculate the CPI are based upon the expenditure of two individuals, who *also comprise* the population. Hence, the aggregate CPI in this example is effectively calculated on a *population weighted basis*. The model has been *devised to yield* offsetting movement in P_{NF} in response to changes in P_F, such that the aggregate CPI remains (on target) at 100.[28] Now suppose P_F rises to 1.10 in period 2. The right hand side of Table 8 calculates all relevant variables. The derived P_{NF} falls to 0.95. The CPI (poor) rises by 2.73% and that for the rich falls by 2.73%.

Table 8: Inflation, GDP and Utility in a Two Person, Two Commodity Economy

	Poor	Rich	Total	Poor	Rich	Total
Price of Food	1	1	1	1.10	1.10	1.10
Quantity of Non-Food Consumed	10	70	80	9.43	72.29	81.71
Nominal Income/Or Expenditure	20	80	100	20	80	100
Consumer Price Index	100	100	100	102.73	97.27	100.00
(Individual) Real Income	20	80	100	19.47	82.24	101.71
Implicit deflator = Nominal GDP/Real GDP			100			98.32
Utility from Income (100*(1-exp(-Real Income/20))	63.21	98.17	161.38	62.22	98.36	160.59
Change in real income				-0.53	2.24	1.71
Change in Utility				-0.99	0.19	-0.80

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[28] If we think of rising food prices in this model as constituting a supply shock, in response then relative prices change but not the price level, as discussed in Section III.

Aggregate real income goes up despite the adverse distributional effects. Each person's real income is nominal income divided by their respective CPI. Thus the real income of the poor falls to 19.47 while for the rich it rises to 82.24 and thus real GDP/income in the economy rises to 101.71, while nominal GDP is the same. The implicit deflator defined as Nominal/Real GDP, as is computed in the national income accounts, equals 98.31. Thus the implicit deflator has fallen by 1.69%. The divergence between inflation rates in CPI (zero) and the implicit GDP deflator (-1.69%) is thus 1.69%. (More details about the model along with numerical results are presented in the Appendix B.)

Overall real GDP is rising with the implicit deflator falls relative to the CPI. Since the GDP deflator is *transactions weighted*, it reflects the impact of falling non food prices on the consumption of the rich, whose volume and value of transactions are much higher. By contrast, the CPI being *population weighted*, reflects the rise in food prices.

To assess the welfare implications for the consumers, it is necessary to convert real income into utility using a utility function based on diminishing marginal utility of income. With the specific function U = 100*(1-exp(-Real Income/20)), the respective utility of both poor and rich before and after the price changes are outlined in the Table below. The utility of the poor has fallen by 0.99 and that of the rich has risen by 0.19 units.

Total utility in the economy is the sum of individual utilities. Thus due to the distributional effect of the food price rise on real incomes, total utility falls from 161.38 to 160.59 although real GDP has risen in this example. [29] Further, in this static example, the implicit deflator is falling while the CPI is rising. (For analytical convenience, in this static example, nominal incomes are fixed with a target price level when relative prices change. A more realistic example would assume a fixed growth rate of nominal GDP leading to a certain target overall inflation rate, with differential inflation rates across sectors.)

How relevant is the above example to India at present? Answers to this are bound to vary widely. To begin with, nominal income of the poor (or most of the poor) may be rising rapidly, so their real income is going up despite rising food prices. We do not rule out this possibility. The situation is likely

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[29] Note however this result may not always hold – it is predicated not just on the diminishing marginal utility of income but on the specific functional form for utility chosen here.

to differ by states and regions across India, depending on the extent of the National Rural Employment Guarantee Act (NREGA). Secondly if rising food prices are determined mainly by global influences and procurement policy, then squeezing GDP growth via tight monetary policy to reduce food prices would be a mistake. These questions need to be empirically investigated at various levels of aggregation.

Going back to the simulation, it implies that *population weighting* of the price index is more important than updating the index to reflect the changing basket of goods. In the implicit GDP deflators, such updating automatically takes place. However, since GDP data are *transactions weighted* they are not representative of the situation for individuals. When it comes to accuracy of inflation data, policy makers have been too concerned with updating the indices. While such updating is desirable, it is more important to have an index relevant for the whole population, even if it is somewhat outdated.

This issue requires elaboration. Most often we look at the components of the actual CPI (e.g. food, housing etc) at a *national* level. Alternatively, the CPI is also calculated by region, and the national CPI is a weighted average of the *regional* aggregate CPIs. In actual data, the prices vary across regions, while the component weights (e.g. food and non-food) may be the same or may vary across regions. By contrast in *our model*, if we think of the categories of rich and poor as two regions (with equal population, assumed for convenience), then prices are the same across regions, but component weights (food and non-food) vary across regions.

The strong conclusion that can be drawn from the above is that an all India *population weighted CPI* should be the focus of monetary policy, as we have argued earlier (Moorthy & Kolhar, 2007). In discussing this issue, in an important speech, RBI Governor Dr. Duvvuri Subbarao stated,

> "In India, given the heterogeneity of the economic structure and large differences in consumption baskets, we have four consumer price indices, apart from the wholesale price index….Thus differences in the weights of the items included in the various indices, along with divergent price movements, not only create a wedge between the different inflation measures, but also move them in different directions … Such divergences in alternative inflation measures complicate the conduct of monetary policy in India. Accordingly the Reserve Bank looks at all the measures of inflation, both overall and disaggregated components, in conjunction with other economic and financial indicators, to assess the underlying inflationary pressures." (Subbarao, 2009, p. 1322)

Although this speech points to the diversity of consumption baskets, his conclusions, in our opinion, are not valid. To begin with, as Kolhar (2010) has pointed out, and as is apparent by merely looking at the data, the various CPIs measures now in use *move together* reflecting their high weightage for food (as of 2010, the weight of food in the various CPIs varied between 46% and 70%, see Table 9).

Table 9: Weight of Food Group in various CPI's

Consumer Price Index	*Base year*	*Weight of Food Group*
CPI for Industrial Worker	2001	46.2%
CPI for Agricultural Labourers	1986-87	69.2%
CPI for Rural Labourers	1986-87	66.8%

Source: RBI Annual Report 2008-2009, pg. 107
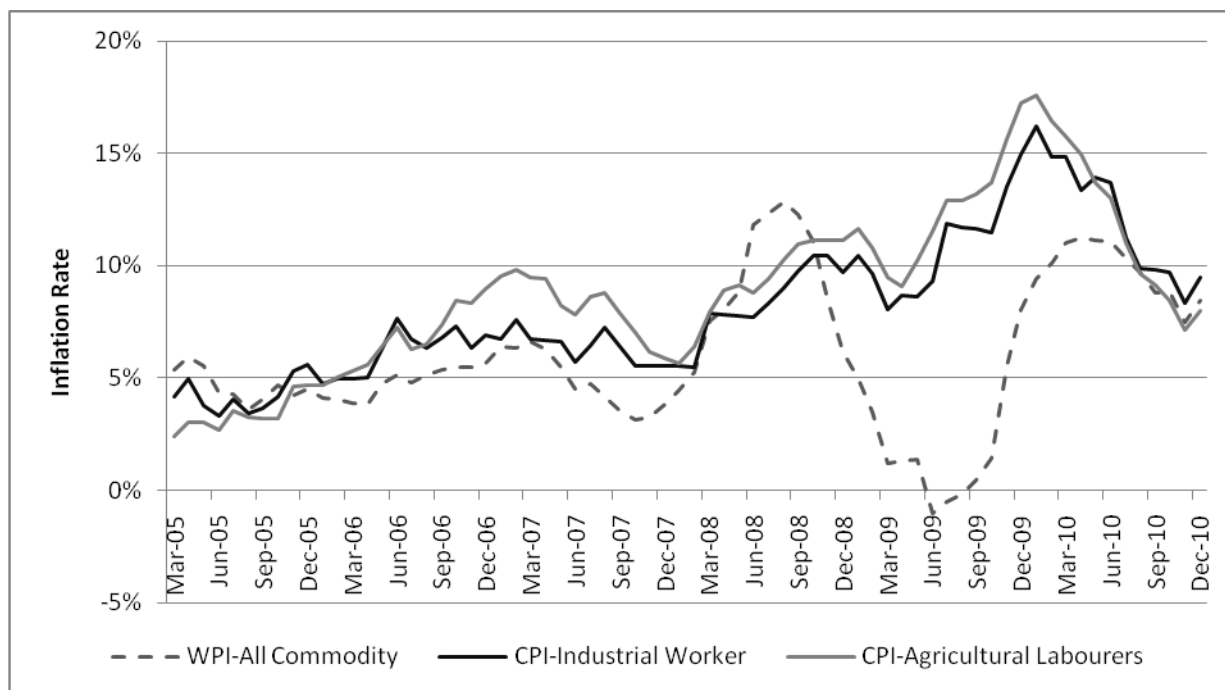
Data Source: RBO Database on Indian Economy (http://dbie.rbi.org.in)

Chart 1: Divergence between WPI and CPIs

The notable divergence is only between the movements in the CPIs and the WPI (see Chart 1). Randomly choosing any one of the CPIs should lead broadly to the same monetary policy decisions.

For simplicity the CPI (Industrial Workers) that is used for wage and other adjustment could be the focus of policy. If the various CPIs diverged, then policy could be based on a simple or weighted average of them.[30]

9 Conclusion and Suggestions

At present, since the divergence between different CPI inflation measures is minimal, there is an unequivocal case for much tighter monetary policy. Looking ahead, as the composition of the GDP changes notable divergence between different CPI inflation measures may arise. However, a population weighted CPI, if calculated, would then provide an overall accurate indicator of inflation. Hence, the dilemma of how to react to notable divergence between inflation measures, will not arise.

Two immediate avenues for future research are suggested by this paper. First, examining the links between inflation and procurement price hikes, using a combination of statistical and event study methodology. Second, the impact of supply shocks should be investigated by carefully examining the links between abnormal rainfall and weather and output and prices on a commodity by commodity basis, for which good data exists in India. More broadly, various matters pertaining to obtaining a unified consumer price index representative of the population need to be given their long overdue attention.

References

Balakrishnan, Pulapre (1991), *Pricing and inflation in India*, Oxford University Press.

Barsky, Robert B., and Lutz Kilian (2002), 'Do we really know that oil caused the Great Stagflation? A monetary alternative.' In NBER Macroeconomics Annual 2001, eds. Ben S. Bernanke and Kenneth Rogoff, pp. 137-183.

--- (2004) 'Oil and the Macroeconomy Since the 1970s' *Journal of Economic Perspectives,* **18**(4), pp. 115-134.

Bruno, Michael & Sachs, Jeffrey (1985), *Economics of Worldwide Stagflation*, Harvard University Press.

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[30] Thus if CPI(IW) is 7%, CPI (AL) is 12%, a big divergence, and the shares of industrial workers and agricultural labour in the population are 40% and 60% respectively, the composite CPI would be 7% (0.4) + 12% (0.6) = 10%..

Dornbusch, Rudiger and Fischer, Stanley, *Macroeconomics,* various editions, McGrew-Hill, Inc.

Frankel, Jeffrey and Chinn, Menzie (1995), 'The stabilizing properties of a nominal GNP rule' *Journal of Money, Credit & Banking*, **27**(2), pp. 318-334.

Friedman, Milton (1966), 'What Price Guideposts?', *in* G.P. Shultz & R.Z. Aliber, ed., 'Guidelines: Informal Controls and the Market Place', University of Chicago Press, pp. 17-39.

Friedman, Milton (1968), 'The Role of Monetary Policy', *American Economic Review,* **58**(1), pp. 1-17.

Friedman, Milton (1975), 'Perspectives on Inflation', Newsweek, June 24, pg. 73.

Geary, Roy (1950), 'A Note on "A Constant-Utility Index of the Cost of Living"', *Review of Economic Studies,* **18**(1), pp. 65-66.

Gollin, D, & Parente, S. L. & Rogerson, R. (2002). 'The Role of Agriculture in Development', *American Economic Review*, **92**(2), pp. 160-164.

Gokarn, Subir (2010), 'The Price of Protein', *RBI Bulletin*, November 2010.

Gopinath, Shyamala (2010), 'Current Macroeconomic Developments in India', *RBI Bulletin*, January 2010.

Government of India (2000). *Economic survey 2009–2010*. Ministry of Finance, New Delhi

Hilton, Spence & Moorthy, Vivek (1990), 'Targeting Nominal GNP', Intermediate Targets and Indicators for Monetary Policy, Federal Reserve Bank of New York, Staff Publication, pp. 232-273

Kolhar, Shrikant (2010), 'Occasionally Unchanging CPI: Some Methodological Issues', *Indian Economic Journal,* **57**(4), pp. 100-117.

Mankiw, N. Gregory, *Macroeconomics*, various editions, Worth Publishers

Mohanty, Deepak (2010a), 'Inflation Dynamics in India: Issues and Concerns', *RBI Bulletin*, April 2010.

Mohanty, Deepak (2010b), 'Perspectives on Inflation in India', *RBI Bulletin*, October 2010.

Moorthy, Vivek (2001), 'Setting Small Savings and Provident Fund Rates', *Economic and Political Weekly,* **36**(41), pp. 3941-3949.

Moorthy, Vivek (2006), 'Understanding the Seventies Stagflation', Chapter 6, macroeconomics text in progress, mimeo.

Moorthy, Vivek (2008a), 'Dissecting our inflation target', mint, July 29.

Moorthy, Vivek (2008b), 'Debunking supply shock myth', mint, September 16.

Moorthy, Vivek (2009), 'It's time to Downgrade WPI', mint , November 18.

Moorthy, Vivek & Kolhar, Shrikant (2007), 'Overheating and undereating', Business Standard, August 11.

Okun, Arthur (1981), *Prices and Quantities: A Macroeconomic Analysis*, Brookings Institution, Washington D.C.

Phelps, Edmund (1968), 'Money-Wage Dynamics and Labor-Market Equilibrium', *Journal of Political Economy* **76**(4), pp. 678-711.

Reserve Bank of India (2010), *Annual Report 2009-2010*, Reserve Bank of India, Mumbai.

Reddy, Y. V. (2007), 'Monetary Policy Developments in India: An Overview', RBI Bulletin, October 2007.

Samuelson, Paul & Solow, Robert (1960), 'Analytical Aspects of Anti-Inflation Policy', *American Economic Review* **50**(2), pp. 177-194.

Stone, Richard (1954), 'Linear expenditure systems and demand analysis: an application to the pattern of British demand', *Economic Journal* **64**(255), pp. 511-527.

Subbaro, Duvvuri, 'Inagural Address. Third Annual Statistics day Conference', RBI Monthly Bulletin, August 2009, pp 1319-1324.

Trehan, Bharat (1986), 'Oil Prices, Exchange Rates and the U.S. Economy: An Empirical Investigation', *Federal Reserve Bank of San Francisco Economic Review*(Fall), pp. 25-43.

Appendix A: Scatter plots – Production Growth vs. Inflation Rate in major Food Groups
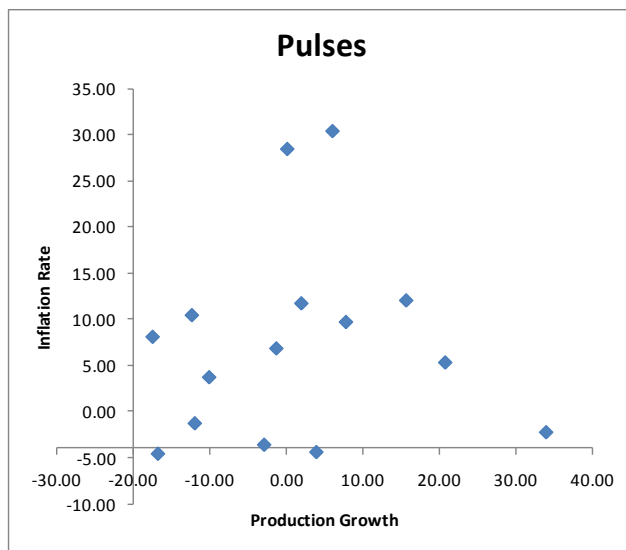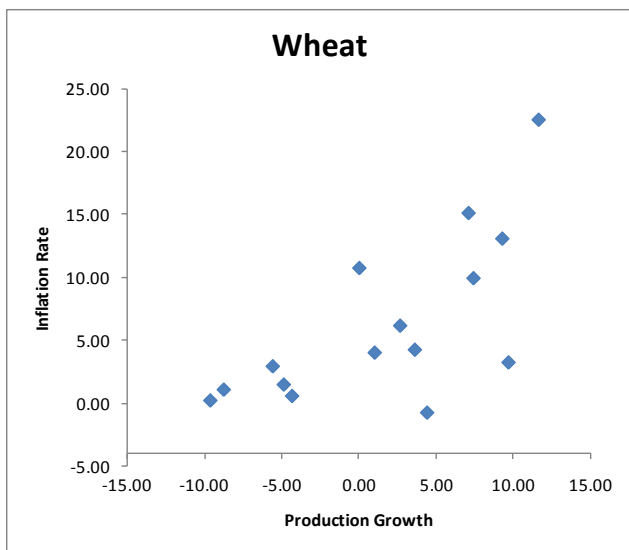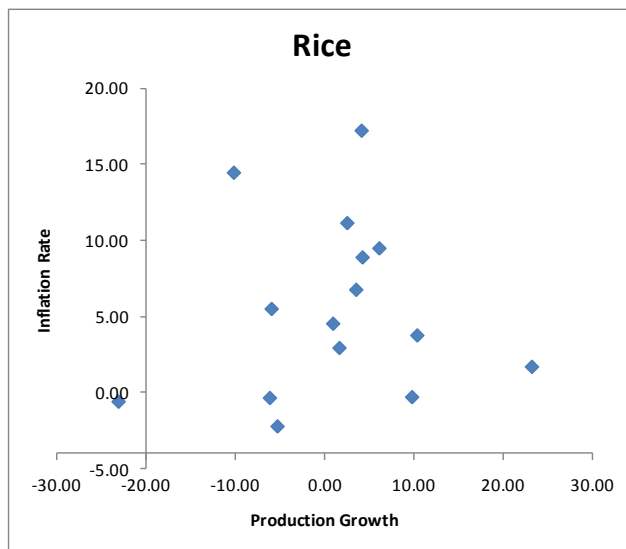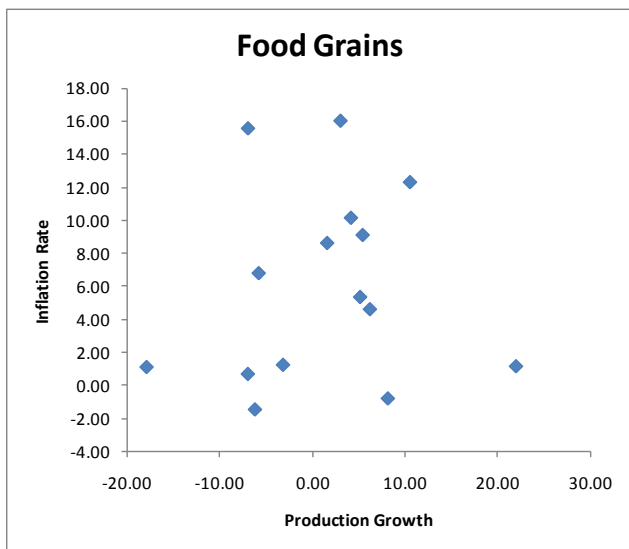
Appendix B: Simulation Model

Individual nominal incomes are given as $Y(poor) = 20$ and $Y(rich) = 80$ and $Q_F = 10$ is the fixed amount consumed of food per person always, in both the first and second period.

In the first period, $P_{F1} = P_{NF1} = 1.00$ such that

$$CPI = CPI\ (poor) = CPI\ (rich) = 100$$

And the Quantity of Non-food consumed is given by

$$Q_{NF1}(poor) = [\ Y(poor) - P_{F1}\ Q_F\ ]\ /\ P_{NF1} = (20 - 10)/1 = 10$$
$$Q_{NF1}(rich) = [\ Y(rich) - P_{F1}\ Q_F\ ]\ /\ P_{NF1} = (80 - 10)/1 = 70$$

In period 2, the price of food P_F rises to 1.10. Therefore the expenditure on Non-food decreases to

$$P_{NF2}\ Q_{NF2}(poor) = Y(poor) - P_{F2}\ Q_F = 20 - 11 = 9$$
$$P_{NF2}\ Q_{NF2}(rich) = Y(rich) - P_{F2}\ Q_F = 80 - 11 = 69$$

The price of Non-food is derived from the model constraint of keeping the CPI constant as follows:

$$CPI\ (poor) = 100 * [\ P_{F2}\ Q_F + P_{NF2}\ Q_{NF1}(poor)\ ]/\ [\ P_{F1}\ Q_F + P_{NF1}\ Q_{NF1}(poor)\ ] = 100\ [11 + P_{NF2} * 10]/20$$
$$CPI\ (rich) = 100 * [\ P_{F2}\ Q_F + P_{NF2}\ Q_{NF1}(rich)\ ]/\ [\ P_{F1}\ Q_F + P_{NF1}\ Q_{NF1}(rich)\ ] = 100\ [11 + P_{NF2} * 70]/80$$

Therefore, the aggregate CPI is given by

$$CPI = [\ CPI\ (poor) + CPI\ (rich)\ ]/2$$

Solving for P_{NF2} by imposing the aggregate CPI $=100$, we get

$$P_{NF2} = (160 - 50\ P_{F2})\ /110 = 105/110 = 0.95$$

The following table presents the results for different values of food price in period 2.

P_F	P_{NF}	CPI_{Poor}	CPI_{Rich}	Real GDP	GDP Deflator	Inflation Divergence	Utility Poor	Utility Rich	Total Utility
1.10	0.95	102.7	97.3	101.7	98.32	1.69	62.22	98.36	160.59
1.20	0.91	105.5	94.5	103.6	96.53	3.47	61.26	98.55	159.81
1.30	0.86	108.2	91.8	105.7	94.62	5.38	60.32	98.72	159.04
1.40	0.82	110.9	89.1	108.0	92.59	7.41	59.41	98.88	158.29
1.50	0.77	113.6	86.4	110.6	90.43	9.57	58.52	99.03	157.55

Divergence between Inflation in CPI and GDP Deflator

Real GDP and Utility