WP-2012-022

Characterizing Food Prices in India

Andaleeb Rahman

Indira Gandhi Institute of Development Research, Mumbai
September 2012
http://www.igidr.ac.in/pdf/publication/WP-2012-022.pdf

Characterizing Food Prices in India

Andaleeb Rahman

Indira Gandhi Institute of Development Research (IGIDR)

General Arun Kumar Vaidya Marg

Goregaon (E), Mumbai- 400065, INDIA

Email (corresponding author): andaleeb@igidr.ac.in

Abstract

This paper seeks to improve our understanding of the behaviour of wholesale price index (WPI) of 24 selected food products in India over a long period of time. The hypothesis of declining trend in prices is not found for all commodities although we do find that price of food grains exhibit a negative trend as a result of positive productivity shock. Two main finding of this paper in the context of cyclical behaviour of prices are: asymmetry in the duration spent in boom and slump and the fact that the price cycle does not have a consistent shape. This has implications for formulating counter cyclical policies.

Keywords: Price level, Cycles

JEL Code: E31, E32

Acknowledgements:

I am grateful to S. Chandrasekhar, Shubhro Sarkar, Mousumi Das and M. Srinivasan for useful comments and discussions. I thank Martin Everts for sharing the MATLAB codes for the Bry-Boschan algorithm. I also thank seminar participants at the Indira Gandhi Institute of Development Research, Mumbai for their valuable feedback.

Characterizing Food Prices in India

Andaleeb Rahman

1. Introduction

An adequate understanding of the time-series properties of commodity prices is essential from the viewpoint of risk management and price forecasting. A variety of modelling techniques are available to explain the price behaviour for a time series. One approach is to estimate the structural demand-supply system of equation where price and quantity are linked recursively with a number of other factors which explain the price behaviour (Tomek and Myers, 1993). However, the structural approach requires a lot of data and the model predictions are often sensitive to restrictive assumptions (Tomek and Robinson, 2003). The other approach is to model commodity prices in a reduced form manner by using univariate or multivariate time series methods. Since this paper is concerned with the behaviour of individual time series properties of different commodity prices, we use the reduced form univariate time series methods. According to Enders and Holt (2012), this approach allows to model a large number of price series in consistent manner.

The extant literature on the univariate time series properties of the commodity prices has been mainly concerned with the trend and cyclical behaviour of the commodity prices (Cuddington and Urzua, 1989; Cashin et al., 2002; Deaton and Laroque, 2003, Kellard and Wohar, 2006; Balagtas and Holt, 2009). Trends and cycles are the two most dominant feature of a commodity price series. While the trends represent permanent component of the price series, cycles are temporary deviations around it. Trends are a structural component of the price series and reflect the changing patterns of demand and supply in the country. They also represent the effects of changing technologies and productivity in agriculture (Miljkovic et al., 2008). It is expected that a rise in productivity would lead to a decline in relative prices, which is extremely crucial from a policy perspective. On the other hand, cycles arise often as a result of temporary shocks to the economy. They are characterized in terms of their duration and amplitude. For a policymaker, characterizing price cycles is essential to design countercyclical price policy and evaluating the efficacy of price stabilization schemes (Cuddington and Urzua, 1989). Certain stylized facts to come out of the existing literature on the trend and cyclical behaviour of commodity price series are: (i) trend is dominated by the cyclical variations; (ii) declining trend is not a general phenomenon across all commodities; (iii) there is no consistent shape to the price cycles; (iv) the duration spent in boom and slump is asymmetric; and (v) duration spent either in the boom or slump is independent of the price change during their duration of stay.

In light of the recent increase in food prices there is renewed interest in understanding their long term behaviour. This article examines the price behaviour of 24 selected food products in India using monthly data on wholesale price index since 1950. We group the commodities into 4 groups based on their characteristics: those with effective minimum support price (MSP); those where MSP exists but not effective, perishable products such as fruits and vegetables and internationally traded crops (Table 1). Each of these products vary not only in their nature of production and climatic condition but also their demand and supply characteristics, price elasticity, input intensity and market structure. Hence, we expect the price behaviour of the commodities to vary across the groups. Of course, there may be variations within each of these four groups.

The outline of the paper is as follows. In section 2, we discuss the literature on trends and cycles in commodity prices. In section 3, we describe the data and present summary statistics. Price trends and cycles are modelled in section 4 and the analysis is concluded in section 5.

2. Trends and Cycles

In the literature, the discussion on price trends has been mainly in the context of Prebisch (1950)-Singer (1950) hypothesis which states that the long-run primary commodity prices fall with respect to the price of manufactured products. The arguments by Prebisch (1950) and Singer (1950) challenged the earlier view put forth by classical economists David Ricardo and John Stuart Mill who believed relative price trends should be positive since the supply of primary commodities is constrained by the amount of land which is fixed while the supply of manufactured goods could be augmented with technical progress and advancement. The Prebisch-Singer hypothesis is based upon the argument that food products have low income elasticities, technological change happens faster in the case of manufacturing which have less competitive market structure. Therefore, the hypothesis states that those countries which are primarily exporters of primary commodities see a secular decline in their relative terms of trade.

Deaton (1999) points out that the Prebisch-Singer hypothesis does not have a well worked out theoretical framework. He suggests the seminal paper of Arthur Lewis (1954) on unlimited labour supplies which provides a much better argument for a secular decline in relative commodity prices. According to Lewis, wages cannot grow when there is unlimited supply of labour at the subsistence wage. This implies that any productivity growth in agriculture would lead to a reduction in the market prices. He cites the example of sugar industries in West Indies where productivity gain did not lead to any decline in the real wages of the workers. The benefits of the decreased price as a result of decreased cost went to the consumers in the richer countries who were the bulk purchasers of sugar. Lewis (1954) contrasts the West Indies experience with the Canadian wheat farms. In Canada, where labour supplies are limited and majority of the workers are in the industrial sector, any productivity enhancement leads to an increase in the wages as well. Hence, in the poor countries, relative prices in the long-run cannot rise since the long-run marginal cost of production is constant. Deaton (1999) further points out that the declining relative price is not only a developing country phenomenon, but the same holds for developed world as well. His argument was opposed to what Lewis (1954) suggested. Deaton (1999) says that relative prices of primary products in the richer countries also exhibit a declining trend since the rise in farm productivity there has been greater than in the developing countries. Larger increase in agricultural productivity takes care of the increasing marginal cost of higher wages. The broad agreement is that agricultural commodity prices whether relative to manufactured products (Prebisch-Singer hypothesis) or the overall price level show a decline in the long-run. Empirical testing of the above conjecture though has thrown up mixed results with no consensus over trend being rising or declining. Deaton and Laroque (2003) build a theoretical model based upon the Lewis (1954) paper. Following this they empirically test for the model prediction of relative primary commodities and test for the presence of trend. They find that there exists no long run trend in relative commodity prices. In the Indian context, Bhalla (2007) finds that the relative price of agricultural prices from 1950-51 to 2004-05 have varied with the changes in policy stance and technological shifts.

When it comes to studying trends, the definition of “relative” prices is also not consistent across all studies. Those testing for the Prebisch-Singer hypothesis, consider the ratio of primary commodity indices and the manufacturing unit value index as the relative price. Others such as Deaton and Laroque (2003) who are more concerned with the prices of primary goods with respect to the overall inflation in the economy consider an overall economy wise price indicator as the deflator. In the analysis, they use the index numbers of average prices for cocoa, coffee, rubber, rice, sugar and tin deflated by the U.S. Consumer price index (CPI) from the World Bank Commodities Division. Jayne et al. (1996) divide the retail prices of important cereals by the CPI. Sumner (2009) uses CPI for urban consumers as the deflator while Alston et al. (2009) uses the price received by the producer as the deflator. Amongst these studies, Jayne et al. (1996) observe declining relative food prices in the six African countries. Deaton and Laroque (2003) do not find evidence of trend in relative commodity prices. Sumner (2009) finds that the relative price of rice and wheat fell from 1866 to 2008 in USA. Using data from 1924 to 2008 for U.S., Alston et al. (2009) find that there is a trend decline in the price of food and feed products. They attribute the reason for this decline in prices to increases in agricultural productivity. The results are often mixed with no consensus on whether we should expect a positive or negative trend.

Next, we discuss the short-run cyclical characteristics of food prices. Long-run trends are often overwhelmed by a high degree of price variability. Deaton (1999) points out that the lack of trend in the commodity price is compensated by the presence of a higher variance. Several peaks and troughs appear frequently in the price series only to revert to a long-run average or temporary variation around mean is understood as a cycle. Cashin et al. (2002) define a cycle as an episode of absolute rise in prices followed by an absolute decline. Cycles in commodity prices exist owing to differences in the demand and supply elasticities and the time required for adjustment to equilibrium (Labys and Kouassi, 1996). Uncertain information flow and persistence of shocks are the other factors which also lead to cycles in the price series. Commodity price cycles are characterized in terms of their amplitude and phase. Phase is the amount of time spent either in boom or slump. Amplitude is the percentage change in the prices during each of the phase. To measure the amount of variation in commodity prices, we need to identify the phases and measure the amplitude of the cycles (Cuddington and Urzua, 1989). Cashin et al. (2002) mention that cycles being a prominent feature of commodity prices, empirical literature on the same is limited. Accurate estimates of the amplitude and duration of the cycles are important for policymakers to stabilize prices and adopt countercyclical policies to tackle booms and slumps. Studying the long-run price behaviour of 36 commodities, Cashin et al. (2002) document the existence of such cycles in commodity prices and also identify the duration and amplitude of each phase. They find that the average duration of a cycle is 68 months. They also find asymmetry in the amplitude with price falls during slumps (46%) being larger than the price rise during a boom (42%). There are other papers which dissect a commodity price series into trend and cyclical component. Labys et al. (2000) find that the cycles are stochastic in nature and of much shorter durations that what Cashin et al. (2002) suggested. Others such as Arango et al. (2008) and Wang et al. (2010) also document the existence of cycles in commodity prices.

3. Data

We use the monthly wholesale price index (WPI) series for different commodities as provided by the Ministry of Commerce and Industry, Government of India. The ministry also provides disaggregated WPI for individual commodities which is used here in our analysis. These indices are revised periodically to account for undergoing structural changes in the economy. For the study, we have selected 22 individual commodity prices indices and 2 composite indices: oilseeds and edible oils. These commodities differ widely in their nature of production, demand structure and marketing channels. For rice, wheat, jowar, bajra, gram, black pepper, chillies, turmeric, tea, coffee, edible oil and sugar, the data is available for the period April 1947 to August 2011. For maize, moong, masur, urad, potato, onion, banana, milk, eggs, cardamom and edible oil, price series starts from April 1953 onwards, while the data for arhar is available from August 1947. The data series has undergone three base year revisions in 1981-82, 1993-94 and 1999-00. All the series have been converted at 1981-82 base year with the help of splicing method. Splicing technique involves linking series with two different base years by using the information for the month when the change came into effect. The month when the base year is changed has the price index from the older series and the revised series. We divide older index by the revised index and we divide all the values of the older series by this factor to get the whole series at the latest base year.

As discussed above, long-run behaviour of the individual prices have been studied relative to the overall prices, which we call as the relative prices. Price movement in relative rather than the nominal terms is important since the performance of one sector cannot be studied in isolation from other sectors (Jin and Miljkovic, 2010). Also, the relative prices move together with the aggregate inflation (Mishra and Roy, 2011). Here we have divided the individual price series by the overall WPI to get the relative price for individual commodities. The 24 relative price series are depicted in Figure 1 while Table 2 reports their summary statistics. A visual inspection of the 24 series shows that the price of cereals exhibits a declining trend, while that of pulses are rising upwards. For other commodities the results are somewhat mixed. Though a casual glance might suggest a declining trend, we need a formal analysis to confirm it statistically. Cashin and McDermott (2002) are of the view that even though a visual inspection suggests the existence of trend, statistical tests are essential to accept or reject such a hypothesis.

4. Empirical Estimation

4.1 Trends

The estimation technique follows from the empirical literature on the Prebisch-Singer hypothesis. Cuddington (1992) used the trend stationary (TS) and difference stationary (DS) models to test for the existence of trends. For the trend stationary series, we use the TS model as given by equation (1). The coefficient β, is a measure of the growth rate. A positive β represents increase in the relative prices or a positive trend. Similarly, a negative β implies a negative trend. The error term, e_t in equation (1) represents a white noise process.

$$\log y_t = \alpha + \beta * time + e_t \tag{1}$$

For the price series which contain a unit root and hence are non-stationary, we use the DS specification as given by equation (2). Here as well, e_t is the error term and represents a white noise process. A negative α would imply, a negative trend while a positive sign represents a positive trend.

$$\Delta \log y_t = \alpha + e_t \tag{2}$$

Chu and Morrison (1984), Leon and Soto (1997), Kellard and Wohar (2006) have pointed out that the commodity price series often contain structural breaks. In the presence of structural breaks, the stationary tests are often biased (Perron, 1989). In that case, the above specifications in equations (1) and (2) are not valid. Leon and Soto (1997) propose the use of Zivot and Andrews (1992) test which allows for an endogenously determined break point in both trend as well as intercept while checking for the existence of a unit root. The Zivot-Andrews (1992) determines the break point endogenously and gives the appropriate break date. After identifying the date of break, we can create a dummy variable take the value of 0 before and 1 after the break and regress the series on the time trend and the break dummy, as represented by equation (3).

$$\log y_t = \alpha + \beta * time + dummy + e_t \tag{3}$$

We adopt similar approach in our analsysis. First, we de-seasonalised it take a log transform of it. Then, we check for the unit root properties of the individual series use the standard Augmented-Dickey Fuller (ADF) and Phillip-Perron (PP) unit root tests to check for both the stationarity in levels as well as trend-stationarity. The results are presented in Table 3. Without taking trend into account, the ADF test shows that the price series for potato, banana, onion, milk, chilli, tea, coffee and oilseeds are stationary at 5 percent levels of significance. The PP test also gives similar results. When we take trends into account, the PP test shows that barring black pepper, and coffee, all the price series are stationary at the 10 percent level of significance. It means that most of the series are trend stationary implying that along a trend most of the shocks are temporary in nature. But, the results here need a careful scrutiny. As pointed by Perron (1989), if structural breaks are present in the price series, the unit root tests may be spurious. Hence, we apply the Zivot-Andrews unit root test and the results are presented in Table 4. All the price series except for milk, egg and coffee are stationary taking into account breaks in them. After finding out that which of the series is stationary taking into account the endogenously determined break, we regress the series on the time trend and the dummy variables for the identified break points in the slope and intercept. The regression results are reported in Table 5.

Except for rice, the other cereal prices show a simultaneous break in the level and slope during the seventies, though rice prices do have an intercept shift in 1975. After we regress the rice price series on time and the break dummy, we find that it exhibits a significant negative trend. Similarly, wheat also exhibits a declining long term trend but the slope change is not significant during the 1970s. In the case of coarse cereals, though jowar prices show a negative trend, it is not statistically significant. But, we do see a significant decline in the intercept after 06:1975. Similarly, the trend is not significant for bajra, but there is significant level shift downwards after 05:1975. The negative trend for maize is significant with a downward level shift after 09:1975. The general feature which we could discern from the price behaviour of cereals is that they show a level shift downwards during the 1970s. In the case of pulses, gram shows a break in both the slope and intercept in 11:1963 with the other pulses exhibit a stationary behaviour taking into account either a break in trend or intercept. While, the cereal prices exhibit a negative trend with a significant level shift downwards after the 70's, the price of pulses show a secular increasing trend. These contrasting results could be explained by the positive productivity shock owing to better irrigation facilities, intensive use of fertilizers and better seed varieties, popularly known as the Green Revolution. Green revolution which started during the 1960s, had completely set in with full effect by 1975. Chopra (1981) considers 1975 as the *Annus mirabilis*, or the year of miracle for Indian agriculture, as the food production reached an all time high that year. During the same time, we have the shift in the price level to a lower one for all cereals. One may contest this by arguing that the productivity gains from the green revolution were mainly restricted to rice and wheat only, then what explains the decline in the real prices of coarse cereals. While it is true that the green revolution affected the productivity of rice and wheat largely, the decline in the price of coarse cereals is not due to completely unrelated reasons. With huge productivity gains and assured irrigation in many parts of the country, the cultivation of rice and wheat became extremely lucrative. This led to shifting of land away from the production of coarse cereals towards rice and wheat. At the same time, consumption habits were changing and people started shifting from the consumption of coarse cereals towards more starchy rice and wheat. Thus, the lack of demand and a decline in the area under the cultivation brought about a decline in the price of coarse cereals. There has been no positive productivity increase in the case of pulses as the green revolution bypassed any increase in the pulses productivity leaving the supply of pulses stagnant. The rise in the price of pulses is a structural problem arising out demand and supply mismatch. With increasing income and greater affluence, there has been a shift in the dietary pattern with higher consumption of pulses in the country, but the supplies have not kept pace with the rising demand (Gokarn, 2011). These results are consistent with the Lewis (1954) thesis as discussed above that productivity shifts would lower the relative price of primary products.

Perishable products like potato, onion and banana are found to be trend stationary with a small but positive trend coefficient. It implies that all the shocks are temporary and get absorbed soon. This is understandable since these products are highly seasonal in nature and their price reach a very low level immediately after harvest to recover back after some month and the same cycle is repeated each year. Amongst the internationally traded commodities, all of them show a positive trend with tea being the only exception. Tea prices saw a sharp decline for two decades till 1969 when the major producing countries decided to impose voluntary trade quotas to arrest this decline[1]. Milk and eggs exhibit a non-stationary behaviour when taking into account endogenously determined structural breaks. For chilli, there is a level shift downwards from 07:1969, with an overall significantly positive trend. Similarly, the turmeric and cardamom prices have a positive slope. The real price of sugar shows a marked decline till 1991, after which they have increased by a small amount, though the overall trend remains negative and significant. Edible oils also exhibit a negative trend with a downward level shift in 1981 and a negative slope after 1970. From our analysis, we find that out of the 24 price series selected, 7 trend downwards, 13 have an upward trend, 1 series is non-stationary and for 3 price series, we find no statistical evidence for the existence of trend. Hence, we can say that theory of declining food prices holds true in the case of cereals and pulses, but it cannot be ascribed a general phenomemon.

4.2 Cycles

Cycles are a permanent feature of most of the macroeconomic time series. Cuddington and Urzua (1989) and Rienhart and Wickham (1994) use the Beveridge-Neslon (BN) decomposition to decompose the price series into trends and cycles. Rienhart and Wickham (1994) further use the Structural Time Series technique to separate cycles and trend for

[1] Refer to www.maketradefair.com/assets/english/TeaMarket.pdf

robustness check. Labys *et al.* (2000) use the Structural Time Series techniques to identify short-term cycles for 21 monthly commodity price series. Cashin et al. (2000) use a slightly modified version of the business cycles turning point algorithm as developed by Bry and Boschan (1971) to date the periods of rising and falling prices for 36 real commodity price series for the period Jan-1957 to Aug-1999[2].

Since, our objective here is to identify cycles and turning points in the classical sense, we use the Bry and Boschan (1991) technique. The advantage of this over other techniques is that it does away with the subjective choice of de-trending (Cashin and McDermott, 2002). The NBER Bry and Boschan (1991) technique has been largely used to date cycles in the real economic activity. Pagan (1999) applied a variant of it to date bull and bear phases in the equity market prices, before their adaptation to the commodity markets by Cashin et al. (2002), Arango *et al.* (2008) and Wang et al. (2010).

The Bry-Boschan algorithm identifies turning points in the series and then gives us the dates when the series hit a peak or a trough. Trough and peak are always alternating and together they complete one cycle. The amount of time which a series takes to go from peak to trough or vice-versa is called as a phase. Two such phases constitute a cycle. In order to identify a turning point (peak or a trough), not every change is taken as a turning point rather a local maxima or minima is selected based upon a criteria that a certain number of points after the selected point follow the same pattern. From the identified dates, we can calculate the duration spent in each state and the percentage change in the phase which is known as the amplitude. A detailed description of the Bry-Boschan algorithm is provided in the Appendix

[2] Cashin *et al.* (2002) use a modified version of the algorithm, where they limited the minimum length of a phase and cycle to 12 and 24 months respectively from the standard 5 and 12 months sine the nature of production of agricultural products is annual.

I. We run the algorithm to the relative prices of the selected 24 products. We do not make any change in the algorithm since the visual inspection of the turning points appears satisfactory. Results from the Bry-Boschan algorithm are summarised in Table 5.

We can see that the number of cycles vary with the products which is obvious given their different production and other characteristics. Using a scatter plot, we find no relationship between the amplitude and duration of the price cycles (Figures 2 and 3). It means that the duration of stay in boom or slump is independent of the extent of price changes in that particular period. Hence, we observe no consistent shape to the price cycles. Lack of consistent shape to the price cycle implies that there is no specific periodicity to the occurrence of boom and slump which makes it difficult to design an appropriate countercyclical policy. The results are consistent with what Cashin et al. (2002) found for world commodity prices. In contrast to Cashin et al. (2002), who find that the commodity prices spend greater time in slump than in boom, we find that the duration spent in boom and slump, are almost equal. But, when we look at the individual commodity level, the results are mixed and we cannot discern a pattern (Fig. 4). Similarly, if we look at amplitude during booms and slump, asymmetry is evident with prices increase (75 percent) during boom being larger than price fall (33 percent) in slump (Fig. 5). This is so since to return back to the same point after a hitting the peak, prices need to come down by a fewer percentage point than they did while going up to the peak from a trough.

Mean duration of the cycle for rice and wheat are 50.4 months and 40.3 months respectively. The average amplitude for rice and wheat are 16.9 and 28 percent in boom respectively, while it is 15.3 and 23.2 percent in slump. When we compare the same numbers for the coarse cereals, we find that the duration of the cycles for them is smaller while the amplitude is larger. In case of pulses, both the duration of the cycle as well as the amplitude is larger than rice and wheat. Large amplitude together with a smaller duration of the cycle implies that the prices undergo large fluctuations with frequent peaks and troughs. Hence, we see that the price variations in commodities with a MSP, *i.e.* rice and wheat are low as compared to the other products. Asymmetry in the duration spent in the boom and slump is most pronounced in the case of pulses as they spend a greater duration in boom as compared to slump. The mean amplitude of price cycle during boom is quite high for pulses, in the range of 50-75 percent while it is 25-40 percent in the cast of a slump, in fact highest amongst all cereals. These results confirm the frequent episodes of high pulses price we have faced over the years.

Price of fruits and vegetables are interspersed with frequent booms and slumps. The mean duration of cycles for onion, potato and banana are 31.2, 35.6 and 37.2 months respectively. Similarly, the average amplitude during a boom for potato and onion are 182 and 217 percent respectively. It implies that the prices almost treble up in the expansionary part of a cycle and that too within a short duration. High amplitude for potato and onion prices is mainly due to the *harvest effect*. This is reflected in the larger number of cycles they exhibit. Fruits and vegetables, which are seasonal and highly perishable in nature, the storage facilities are inadequate. Immediately after the harvest, there is a glut in the market causing prices to plummet to extremely low levels. Subsequently, when the supplies dry up during the post harvest season, the prices recover and rise until the next harvest arrives. Also, since there is no government interference in their marketing channel, there is no price stabilization program and hence high price variability.

Commodities which are actively traded in the international market, we do not observe a consistent result in terms of the number of cycles or amplitude. While black pepper and turmeric exhibit only 11 cycles, chilli and tea exhibit 17 and 18 cycles respectively. Similarly, the amplitude during a boom is as low as 32 percent for edible oils, whereas cardamom and chilli, it rises to close to 200 percent. Spices and condiments, on an average stay in the state of boom and slump for a relatively longer duration. Also, the percentage change during that period is quite large. This is mainly because of fewer producers in the international market. Almost 90 percent of the total spice production and exports comes from tropical Asian countries, changes in the supply or demand conditions has a cascading effect on the price and output in all the major trading countries. This is quickly reflected in the domestic price. That could be one of the reasons why the price of spices has higher phase. Another plausible reason for the higher amplitude could be global market uncertainties. The same explanation should lead to higher amplitude for tea and coffee prices, which we do not observe since they are also produced majorly for exports. These prices show similar characteristics, with the mean duration of the cycle being three and a half year. The asymmetry in the phases are also not much pronounced for these commodities. Amplitude is much less than that of the spices, but still greater than that of cereals.

Mean amplitude for milk during boom and slump is close to 15.2 and 12.5 percent respectively, the lowest amongst all the commodities under study here. Since the milk prices do not change frequently, we observe low fluctuations. Similarly, eggs also show less fluctuation since the demand is highly seasonal in nature. Oilseeds, sugar and edible oil have a mean duration of the cycle of about 4 years, and the mean amplitude is again less than that of onion or the spices but greater than the cereals.

5. Conclusion

This article focuses on the empirical characteristics of WPI of food products in India. Using univariate time series techniques, we examine the trend and cyclical properties of the selected price series. Rice and wheat, commodities with an effective MSP are characterized by smaller amplitude and phase suggesting that the government intervention in the cereals market lowers price variability. Relative price of rice and wheat shows a significant decline owing to positive productivity shift. Amongst other food products where MSP exists but procurement does not take place, the coarse cereals have shorter cycles since they are short duration crops. Pulses exhibit periods of boom more regularly than slumps. Also, they display a secular upward trend. Highly perishable products such as fruits and vegetables exhibit greater price variability, mainly attributed to greater amount of seasonality and lack of adequate storage facilities. Internationally traded food products such as spices and condiments are highly volatile owing to larger amplitude and cycle duration. A common feature which we find across all commodities is there is asymmetry in the duration spent in boom and slump. More importantly, it is found that the price cycles do not have a consistent shape i.e. the extent of price change during boom and slump is independent of the duration spent in that state. Forecasting prices in that case becomes almost impossible since it the direction and magnitude of any future shock is unpredictable. Hence, it becomes difficult to prescribe appropriate countercyclical policy prescriptions and timing of government intervention.

References

Alston J.M., Beddow J.M. and P.G. Pardey (2009). "Agriculture. Agricultural Research, Productivity, and Food Prices in the Long Run". *Science*, Vol. 325, pp. 1209–1210.

Balagtas, J.V. and M.T. Holt. (2009). "The Commodity Terms of Trade, Unit Roots, and Nonlinear Alternatives: A Smooth Transition Approach." *American Journal of Agricultural Economics,* Vol. 91, pp.87–105.

Bhalla, G. S. (2007). *Indian Agriculture Since Independence*, National Book Trust, India.

Bry G., and C. Boschan (1971). *Cyclic Analysis of Time Series: Selected Procedures and Computer Programs*. National Bureau of Economic Research, New York .

Burns, A.F. and W.C. Mitchell (1946). *Measuring Business Cycles*. In NBER Studies in Business Cycles, Vol.2,. New York: Natinal Bureau of Economic Research.

Cashin P., C.J. McDermott and A. Scott (2002). "Booms and Slumps in World Commodity Prices", *Journal of Development Economics*, Volume 69 (1), pp. 277-296.

Cashin, P. and C.J. McDermott (2002). "The Long-Run Behavior of Commodity Prices: Small Trends and Big Variability," *IMF Staff Papers*, Palgrave Macmillan, Vol. 49(2), pages 175-199.

Chopra, R.N. (1981), *Evolution of Food Policy in India*, Macmillan India Limited, New Delhi.

Chu, Ke-Young, and T.K. Morrison (1986). “World Non-Oil Primary Commodity Markets: A Medium-Term Framework of Analysis”, *IMF Staff Papers*, Vol. 33 (1), pp. 139-184.

Cuddington, J.T., and C.M. Urzua (1989). "Trend and Cycles in the Net Barter Terms of Trade: A New Approach," *Economic Journal*, Vol. 99, pp. 426-42.

Deaton, A. (1999). "Commodity Prices and Growth in Africa", *Journal of Economic Perspectives*, Vol. 13(3), pp. 23-40

Deaton, A. and G. Laroque (1992), “On the Behaviour of Commodity Prices”, *The Review of Economic Studies*, Vol. 59(1), pp. 1-23.

Deaton, A. and G. Laroque (2003). “A Model of Commodity Prices after Sir Arthur Lewis", *Journal of Development Economics*, Vol. 71(2), pp. 289-310

Enders, W. and M.T. Holt (2012). “Sharp Breaks or Smooth Shifts? an Investigation of the Evolution of Primary Commodity Prices”, *American Journal of Agricultural Economics*, Vol. 94(3),

Everts, Martin, (2006). “Duration of Business Cycles”, MPRA Paper, University Library of Munich, Germany, http://EconPapers.repec.org/RePEc:pra:mprapa:1219.

Gokarn, Subir (2011). "The Price of Protein", *Macroeconomics and Finance in Emerging Market Economies*, Vol. 4 (2), pp.327-335.

Ghoshray, A. (2010). “A Re-examination of Trends in Primary Commodity Prices*”, Journal of Development Economics*, available on doi:10.1016/j. jdeveco.2010.04.001.

Jayne, T. S., M. Mukumbu, J. Duncan, J. M. Staatz, J. Howard, M. Lundberg, K. Aldridge, B. Nakaponda, J. Ferris, F. Keita and A. K. Sanankoua. (1996). “Trends in Real Food Prices in Six Sub-Saharan African Countries”, mimeo: United States Agency for International Development, Washington, DC.

Jin, H.J. and D. Miljikovic (2010). "An analysis of multiple structural breaks in US relative farm prices", *Applied Economics*, pp. 3252-3265.

Kellard, N. and M.E. Wohar (2006). “On the prevalence of trends in primary commodity prices”, *Journal of Development Economics*, Vol. 79(1), pp. 146-167.

Labys, W.C. and E. Kouassi (1996). “Structural Time Series Modelling of Commodity Price Cycles”, Research Paper 9602. Regional Research Institute, West Virginia University.

Labys, W.C., Kouassi E. and M. Terraza (2000). “Short-term Cycles in Primary Commodity Prices”, *The Developing Economies*, Vol. 38(3), pp. 330-42.

Lee, J. and M. Strazicich (2003). “Minimum LM Unit Root Test with Two Structural Breaks”, Review of Economics and Statistics, Vol. 85, pp. 1082–1089.

Leon, J. and R. Soto (1997). “Structural Breaks and Long-run Trends in Commodity Prices”, *Journal of International Development*, Vol. 9, pp. 347-366.

Lewis, W.A.(1954). “Economic Development with Unlimited Supplies of Labor”, *Manchester School of Economic and Social Studies*, Vol. 22, pp. 139-91.

Lumsdaine, R.L. and D.H. Papell (1997). “Multiple Trend Breaks and the Unit-Root Hypothesis”, *The Review of Economics and Statistics*, Vol. 79, pp. 212-217

Mellor, J. W (1968). "The Functions of Agricultural Prices in Economic Development," *Indian Journal of Agricultural Economics*, pp. 23-37.

Miljkovic, D., H.J. Jin and R. Paul (2008). "The role of productivity growth and farmers’ income protection policies in the decline of relative farm prices in the United States", *Journal of Policy Modeling*, Volume 30(5), pp. 873-885.

Mills, T.C.(2009), "Modelling trends and cycles in economic time series: historical perspective and future developments", *Cliometrica*, Vol. 3, pp. 221–244.

Mishra, P. and D. Roy (2011). “Explaining Inflation in India: The Role of Food Prices”, mimeo: IMF and IFPRI, Washington, D. C.

Pagan, A. (1999). " Bulls and bears: A tale of two states. The Walbow-Bowley lecture. North American Meeting of Econometrics Society. Montreal, June 1998.

Prebisch, R. (1950). The Economic Development of Latin America and Its Principal Problems (New York: United Nations).

Reinhart, C. M. and P. Wickham (1994). “Commodity Prices: Cyclical Weakness or Secular Decline?”, *IMF Staff Papers*, Vol. 41 (2), pp. 175-213.

Singer, H.W. (1950). "The Distribution of Gains Between Investing and Borrowing Countries”, *American Economic Review*, Papers and Proceedings, Vol. 40, pp. 473-85

Sumner, D.A. (2009). "Recent Commodity Price Movements in Historical Perspective." *American Journal of Agricultural Economics*, Vol. 91(5), pp. 1250-1256.

Tomek, W.G. and R.J. Myers (1993). “Empirical Analysis of Agricultural Commodity Prices: A Viewpoint”, *Review of Agricultural Economics*, Vol. 15(1), pp. 181-202.

Tomek, W. G. and K. L. Robinson (2003). *Agricultural Product Prices*. Ithaca, NY: Cornell University Press.

Wang, J.Y.C. (2010). Cycle Phase Identification and Factors Influencing the Agricultural Commodity Price Cycles in China: Evidences from Cereal Prices. International Conference on Agricultural Risk and Food Security 2010, Agriculture and Agricultural Procedia 1, pp. 439-448.

Zivot, E. and D.W.K. Andrews (1992). “Further Evidence on the Great Crash, the Oil-price Shock, and the Unit Root Hypothesis”, *Journal of Business and Economic Statistics*, Vol. 10, pp. 251-270.

Figure 1: Relative WPI

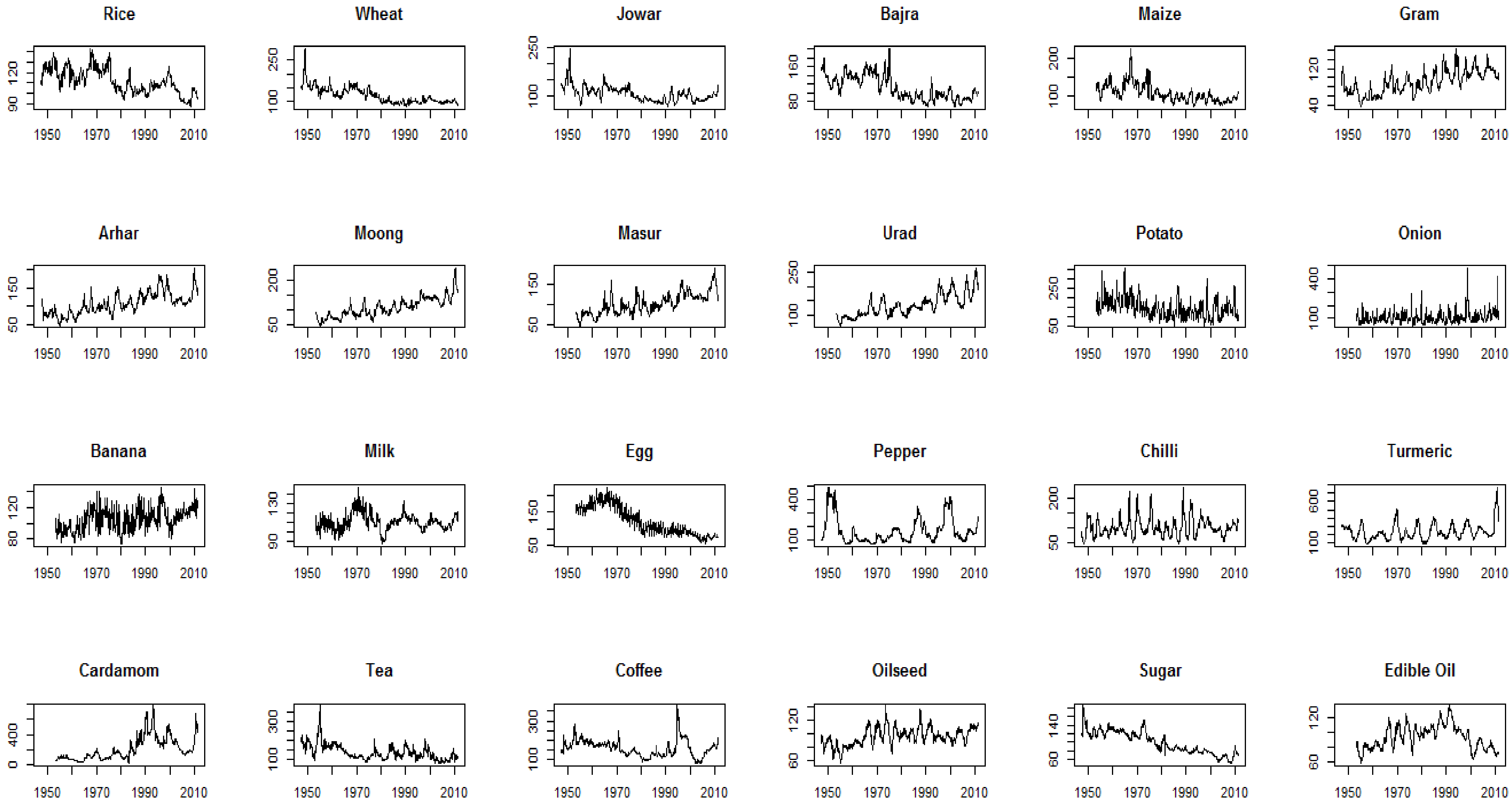
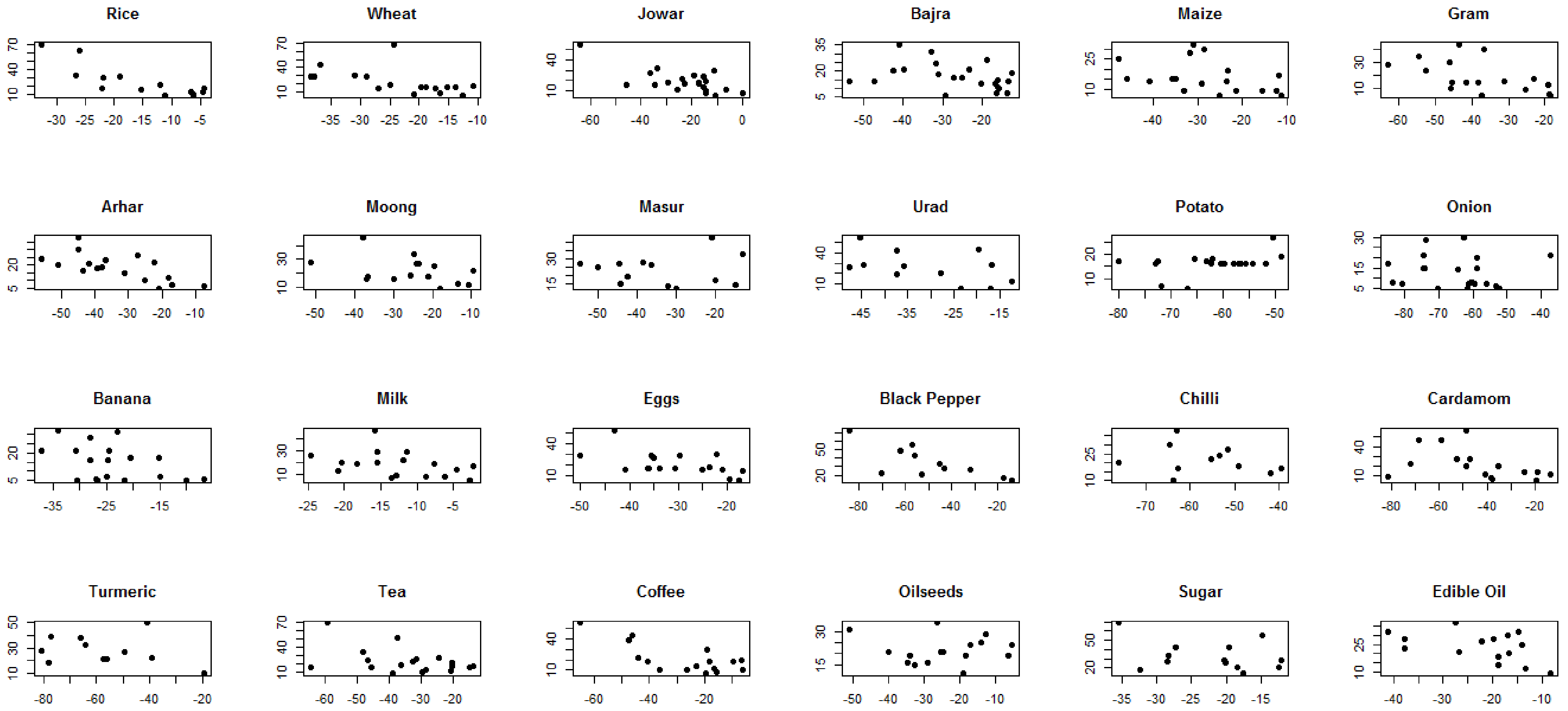
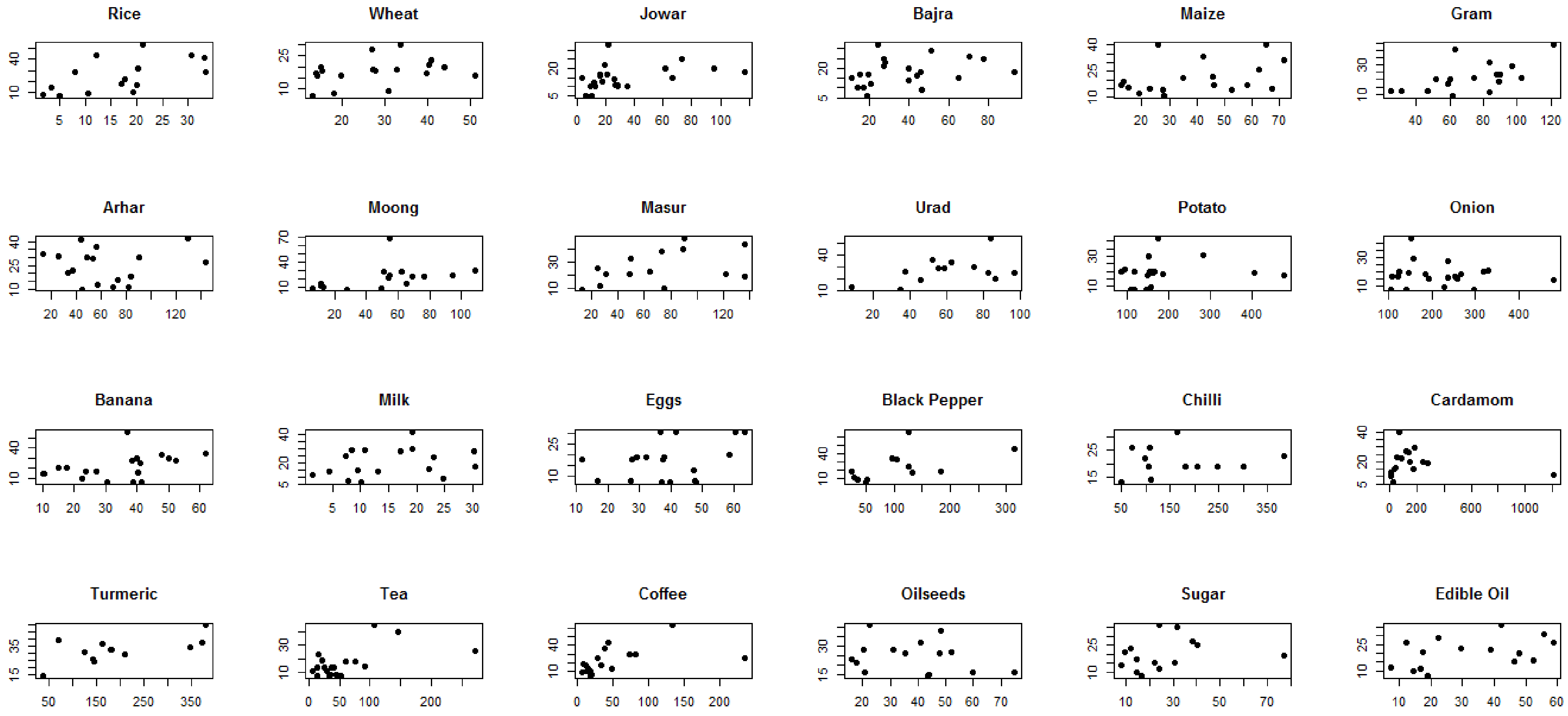


Figure 2: Peak to Trough Scatter Plot



Note: The amount of time spent in slump is on the Y-axis, while the amplitude is on the X-axis.

Figure 3: Trough to Peak Scatter Plot



Note: The amount of time spent in slump is on the Y-axis, while the amplitude is on the X-axis.

Figure 4: Average duration spent during boom and slump

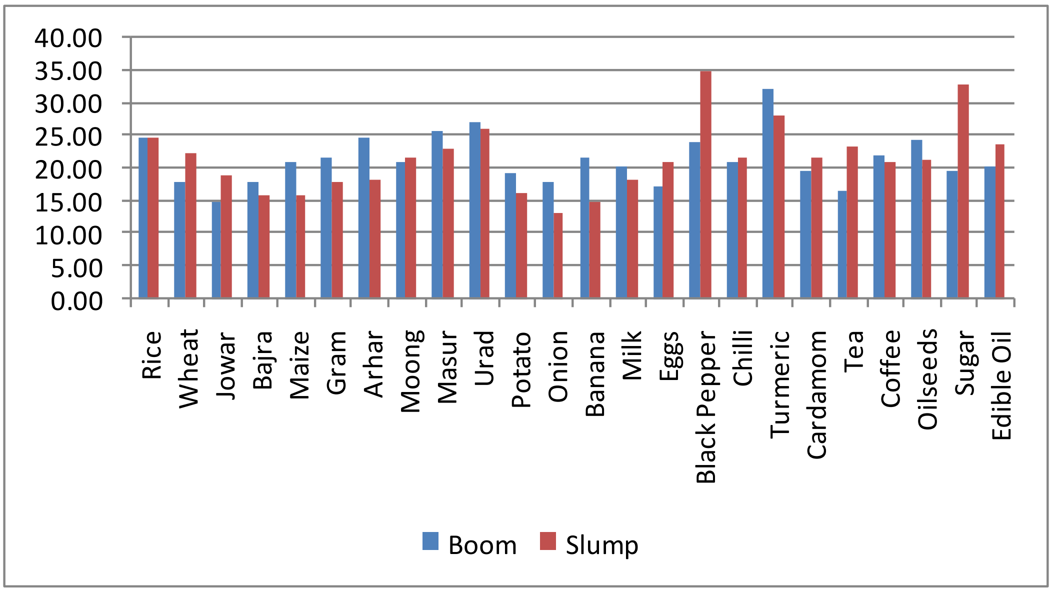


Figure 5: Average percentage change (amplitude) during boom and slump

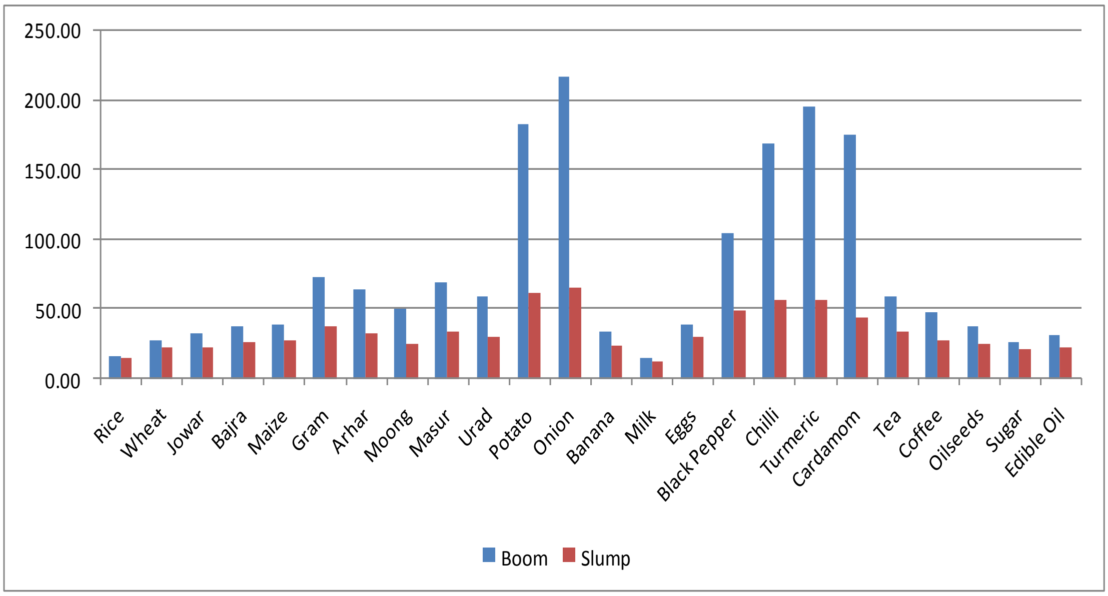


Table 1: Commodity Classifications

Effective MSP	Rice, Wheat
MSP exists	Jowar, Bajra, Maize, Gram, Arhar, Moong, Masur, Urad, Sugar, Oilseeds, Edible Oil
Internationally Traded	Black Pepper, Chillies, Turmeric, Cardamom, Tea, Coffee
Fruits and Vegetables	Potato, Onion, Banana
Others	Milk, Eggs

Table 2: Summary Statistics of the relative WPI series

	N	Mean	Std. Dev.	Skewness	Kurtosis
Rice	773	110.48	11.43	0.34	2.47
Wheat	773	116.18	22.13	0.71	2.49
Jowar	773	101.85	18.52	0.37	2.50
Bajra	773	109.03	27.78	0.74	2.68
Maize	701	107.76	23.63	1.24	5.03
Gram	773	91.25	25.56	0.08	2.38
Arhar	769	109.29	30.01	0.39	2.95
Moong	701	108.75	32.80	0.80	4.32
Masur	701	101.80	26.96	0.55	3.11
Urad	701	135.68	39.02	0.78	3.23
Potato	701	144.72	51.06	0.79	3.67
Onion	701	107.15	46.77	2.78	16.94
Banana	701	104.89	13.94	0.14	2.42
Milk	701	110.79	8.65	0.38	3.74
Black Pepper	773	154.96	75.95	1.53	4.94
Chillies	773	102.45	31.12	1.24	5.21
Turmeric	773	230.91	108.32	1.77	7.83
Cardamom	701	212.35	153.50	1.26	4.12
Tea	773	133.40	39.16	1.79	8.79
Coffee	773	155.66	44.27	1.15	6.28
Oilseeds	773	96.11	13.25	0.04	3.36
Sugar	773	96.25	24.24	0.20	1.91
Edible Oil	701	92.29	15.94	0.20	2.36

Note: N is for the no. of observation or months. Std. Dev. Refers to the standard Deviation.

Table 3: Unit Root Tests Statistics

	Without Trend		With Trend	
	ADF	PP	ADF	PP
Rice	-2.005	-2.459	-3.321*	-3.883**
Wheat	-2.039	-2.397	-3.344*	-4.033***
Jowar	-2.947**	-3.559***	-3.035	-3.919**
Bajra	-2.556	-3.136**	-3.279*	-4.257***
Maize	-2.797*	-3.425**	-3.543**	-4.455***
Gram	-2.135	-3.134**	-3.394*	-4.695***
Arhar	-2.152	-2.848*	-3.703**	-4.681***
Moong	-1.463	-2.092	-3.601**	-4.677***
Masur	-2.343	-2.830*	-3.617**	-4.477***
Urad	-1.414	-2.129	-2.754	-3.846**
Potato	-4.235***	-5.147***	-4.834***	-5.873***
Onion	-6.362***	-6.860***	-6.688***	-7.202***
Banana	-6.133***	-5.717***	-7.167***	-6.906***
Milk	-4.811***	-4.059***	-4.812***	-4.060***
Eggs	-1.655	-1.126	-4.773***	-3.868**
Black Pepper	-1.662	-2.270	-1.683	-2.288
Chillies	-3.328**	-5.076	-3.342*	-5.098***
Turmeric	-2.02	-3.179**	-2.315	-3.425**
Cardamom	-2.155	-2.364	-3.046	-3.402*
Tea	-3.503***	-3.500***	-4.190***	-4.266***
Coffee	-2.168	-2.649*	-2.180	-2.656
Oilseeds	-3.595***	-4.794	-3.603**	-4.807***
Sugar	-2.356	-2.285	-3.319*	-3.261*
Edible Oil	-2.011	-2.883**	-2.978	-3.877**

Note: ***, ** and * represent significance at1, 5 and 10 percent respectively.

Table 4: Zivot-Andrews unit root test results

	Both trend and Intercept		Trend		Intercept		
	BP	t-statistic	BP	t-statistic	BP	t-statistic	Lags
Rice	07:1975	-4.903	12:1998	-4.085	07:1975	-4.891**	4
Wheat	03:1979	-5.884***	02:1987	-5.419***	03:1996	-5.623***	5
Jowar	08:1976	-5.928***	11:1987	-5.499***	06:1975	-5.753***	5
Bajra	05:1975	-7.564***	12:2001	-5.611***	05:1975	-7.468***	5
Maize	02:1975	-6.442***	08:1965	-5.275***	09:1975	-5.952***	5
Gram	11:1963	-6.656***	05:2001	-6.113***	11:1963	-6.394***	4
Arhar	11:1999	-5.915***	06:1995	-5.469***	11:1999	-5.879***	5
Moong	07:1973	-6.055***	01:1965	-5.69***	09:1963	-5.758***	4
Masur	03:1968	-5.943***	11:1964	-4.879**	05:1962	-4.966**	3
Urad	12:1972	-5.504**	12:1965	-4.813**	10:1956	-5.037**	5
Potato	04:1974	-7.22***	06:1984	-6.924***	12:1970	-7.201***	4
Onion	02:1980	-10.046***	11:2002	-9.881***	02:1980	-9.948***	1
Banana	07:1974	-6.125***	08:1967	-5.379***	05:1977	-5.921***	5
Milk	03:1976	-3.869	11:1967	-3.065	03:1976	-3.616	3
Eggs	11:1973	-4.099	11:2002	-3.118	11:1973	-4.038	4
Black Pepper	08:1959	-4.283	05:1957	-4.436**	11:1983	-3.458	5
Chillies	12:1978	-7.4***	07:1969	-7.231***	12:1978	-7.409***	5
Turmeric	02:1959	-5.139**	02:1957	-5.057***	06:1982	-5.058**	5
Cardamom	06:1983	-5.263**	06:1990	-3.435	05:1983	-5.054**	5
Tea	01:1983	-5.04	01:1969	-4.483**	01:1983	-5.061**	4
Coffee	01:2000	-3.293	01:1957	-2.688	11:1998	-2.876	1
Oilseeds	12:1995	-6.037***	12:2001	-5.937***	09:1975	-5.929***	5
Sugar	12:1991	-5.223**	09:1985	-4.419	12:1991	-5.222	4
Edible Oil	01:1982	-5.731***	03:1970	-5.071***	11:1981	-5.684***	5

Note: The critical values are -5.57 and -5.08 at 1 and 5 percent respectively. * and ** represent significance at 5 and 1 percent respectively. BP implies the break point dates.

Table 5: Regression Results

	Constant	Trend	Level dummy	Slope dummy	R^2
Rice	2.08999***	-0.00004***	-0.05132***		0.57
	(927.7)	(-4.34)	(-12.27)		
Wheat	2.23463***	-0.00046***	0.09182***	-0.00206	0.73
	(513.9)	(-30.06)	(14.55)	(-0.3)	
Jowar	2.08962***	-0.00003	-0.12500***	0.02532***	0.47
	(353.45)	(-1.31)	(-13.39)	(2.83)	
Bajra	2.13127***	0.00001	-0.17497***	-0.02418***	0.68
	(402.42)	(0.5)	(-18.75)	(-2.87)	
Maize	2.09616***	-0.00014***	-0.12531***	0.08196***	0.61
	(392.74)	(-7.06)	(-15.88)	(11.45)	
Gram	1.77042***	0.00025***	0.08646***	0.01375	0.53
	(259.89)	(8.61)	(7.11)	(1.12)	
Arhar	1.83114***	0.00049***	-0.15286***	0.06440***	0.65
	(300.77)	(27.43)	(-12.93)	(5.43)	
Moong	1.76987***	0.00049***	0.06051***	-0.01337	0.75
	(282.88)	(28.93)	(3.48)	(-0.77)	
Masur	1.78892***	0.00037***	0.04775***	0.00829	0.62
	(252.52)	(20.34)	(3.29)	(0.58)	
Urad	1.88990***	0.00041***	0.02325*	0.03764***	0.65
	(171.26)	(21.46)	(1.8)	(3.85)	
Potato	2.22530***	0.00010**	-0.16870***	-0.04285***	0.33
	(187.22)	(2.08)	(-11.4)	(-2.61)	
Onion	1.89802***	0.00036***	-0.10636***	0.03049*	0.12
	(124.31)	(6.29)	(-5.28)	(1.69)	
Banana	1.93952***	0.00021***	-0.07110***	0.03763***	0.38
	(468.59)	(12.89)	(-11.45)	(6.76)	
Milk	2.04188***	0.00000			0.00
	(727.48)	(-0.48)			
Eggs	2.34660***	-0.00066***			0.87
	(517.58)	(-69.26)			
Black Pepper	2.31621***	0.00045***		-0.37677***	0.05
	(141.89)	(-12.32)		(-16.59)	
Chillies	1.94333***	0.00014***	-0.09749***	0.05482***	0.06
	(196.31)	(3.08)	(-5.46)	(3.31)	
Turmeric	2.33471***	0.00026***	0.054407**	-0.16013***	0.15
	(148.69)	(3.86)	(2.11)	(-6.96)	
Cardamom	1.94464***	0.00013**	0.45480***		0.66
	(100.57)	(1.96)	(16.85)		
Tea	2.28666***	-0.00053***	0.16666***	-0.05061***	0.52
	(337.77)	(-15.32)	(14.22)	(-4.63)	
Coffee					
Oilseeds	1.99847***	0.00003**	-0.03543***	0.01727***	0.07
	(521.16)	(1.98)	(-5.27)	(2.85)	
Sugar	2.09907	-0.00058***	0.12888***		0.80
	(560.44)	(-48.83)	(-22.28)		
Edible Oil	1.99920***	-0.00003*	-0.11746***	0.04610***	0.52
	(472.53)	(-1.79)	(-16.11)	(6.72)	

Note: ***, ** and * represent the significance at 5, 10 and 1 percent respectively. Figures in the parentheses are the respective t-value of the coefficients.

Table 6: Cyclical Features of the Real Prices

	No. of Cycles	Mean Cycle Duration	% of Time in Boom	Amplitude of the the Phase								No. of Months Spent							
				Boom				Slump				Boom				Slump			
				Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
Rice	14	50.4	51.9	16.9	17.7	33.5	1.7	-15.3	-13.7	-32.7	-4.2	24.9	22.0	53.0	7.0	24.7	17.0	70.0	8.0
Wheat	17	40.3	45.8	28.0	27.4	51.2	13.0	-23.2	-20.8	-38.5	-10.7	17.9	18.0	30.0	7.0	22.4	16.0	68.0	6.0
Jowar	21	33.9	45.0	33.0	21.7	117.2	3.6	-22.5	-17.5	-64.1	0.2	15.0	14.5	33.0	5.0	19.1	17.0	54.0	6.0
Bajra	21	34.6	50.5	37.8	27.8	93.8	10.6	-26.6	-24.3	-53.6	-12.4	18.0	17.0	32.0	6.0	16.9	15.5	35.0	6.0
Maize	18	37.3	57.0	39.5	38.7	71.8	12.5	-28.0	-28.9	-47.9	-11.2	21.1	17.0	40.0	11.0	15.9	14.5	32.0	7.0
Gram	17	41.1	53.1	72.2	74.1	121.8	24.8	-37.7	-38.4	-63.0	-18.3	21.6	20.0	44.0	9.0	19.1	15.0	43.0	5.0
Arhar	17	43.5	57.4	64.4	56.3	144.6	13.7	-33.3	-36.8	-56.1	-7.3	24.7	27.0	42.0	10.0	18.4	19.0	38.0	5.0
Moong	15	43.0	50.8	50.5	54.1	109.2	5.7	-25.5	-24.1	-51.3	-9.4	21.0	21.5	68.0	7.0	21.7	18.0	46.0	9.0
Masur	13	47.4	54.6	70.0	68.5	136.3	13.1	-33.9	-36.2	-54.6	-12.8	25.7	21.5	48.0	9.0	23.0	25.0	43.0	12.0
Urad	12	53.2	52.8	59.9	58.9	97.0	8.0	-30.4	-31.9	-47.7	-12.2	27.0	26.0	54.0	11.0	26.2	26.5	55.0	6.0
Potato	19	35.6	54.5	182.5	156.8	478.2	86.6	-61.6	-60.5	-79.9	-48.9	19.3	19.0	42.0	8.0	16.1	16.0	27.0	6.0
Onion	20	31.2	57.1	217.0	211.0	482.0	104.6	-64.9	-61.6	-85.0	-37.1	18.0	17.0	43.0	8.0	12.9	8.0	30.0	5.0
Banana	18	37.2	60.9	34.0	38.5	61.9	10.1	-23.8	-24.8	-37.2	-6.6	21.8	21.0	56.0	6.0	14.8	16.0	32.0	5.0
Milk	16	38.6	52.4	15.2	13.1	30.5	1.5	-12.5	-12.8	-24.6	-2.2	20.2	17.0	42.0	6.0	18.4	19.0	47.0	5.0
Eggs	15	48.3	46.7	39.0	37.7	63.7	11.8	-30.4	-30.8	-50.1	-16.8	17.4	18.0	31.0	7.0	21.0	17.0	53.0	5.0
Black Pepper	11	59.4	43.0	105.2	99.5	315.7	23.3	-48.6	-53.0	-84.1	-13.9	24.1	19.0	66.0	5.0	34.8	28.0	74.0	13.0
Chilli	17	42.1	51.4	168.6	136.7	384.9	49.0	-56.4	-55.2	-76.0	-39.4	20.9	19.0	32.0	13.0	21.5	20.0	38.0	10.0
Turmeric	11	60.4	55.7	196.0	170.9	380.7	37.3	-57.2	-57.6	-80.9	-19.2	32.3	33.0	50.0	14.0	28.0	27.0	50.0	10.0
Cardamom	16	41.5	47.3	175.1	102.4	1215.5	4.7	-44.2	-44.0	-81.3	-13.6	19.5	19.5	40.0	6.0	21.8	17.0	57.0	5.0
Tea	18	40.6	42.5	59.3	38.3	272.0	6.4	-34.1	-32.0	-64.4	-13.6	16.5	13.0	45.0	7.0	23.6	18.5	69.0	9.0
Coffee	16	41.5	52.9	48.4	28.6	235.5	6.4	-27.5	-21.4	-65.1	-6.0	22.1	18.0	63.0	5.0	20.9	18.0	55.0	7.0
Oilseeds	15	46.1	51.5	38.3	41.0	75.1	16.0	-24.4	-25.0	-51.2	-5.1	24.5	26.0	41.0	14.0	21.6	21.0	34.0	11.0
Sugar	13	53.0	39.3	26.0	23.3	77.3	8.0	-22.1	-20.1	-35.6	-11.9	19.8	18.0	36.0	8.0	32.8	28.0	69.0	14.0
Edible Oil	14	44.0	46.1	32.1	29.4	58.9	7.4	-22.3	-18.9	-41.2	-8.1	20.3	21.0	36.0	7.0	23.7	25.0	37.0	9.0
Average	**16**	**44**	**50.8**	**75.4**	**65.5**	**212.8**	**20.0**	**-33.6**	**-32.9**	**-56.9**	**-14.2**	**21.4**	**20.1**	**44.5**	**8.2**	**21.6**	**19.3**	**48.2**	**7.7**

Appendix I

The Bry-Boschan procedure used here is the one used by Martin Everts in his paper "Duration of Business Cycles". We are grateful to Martin Everts for sharing with us the MATLAB codes for this procedure. Description of the codes is as follows (as presented in Everts (2006)):

1. Identifying and replacing extreme values using the Spencer Curve
2. Determination of cycles in a 12 months moving average
    a. Find points higher or lower 5 months on each side
    b. Enforce the conditions that peaks and troughs alternate
3. Identifying the corresponding turning points using the spencer curve after the extreme values are replaced
    a. Identifying the turning points as in step 2 within the new series over 5 months on either side
    b. Enforce the conditions that minimum cycle duration is 5 months by eliminating shorter cycles
4. Determination of the corresponding turns in short-term moving average of 3 to 6 months depending upon the periods of cyclical dominance (PCD)
    a. Identifying the turning points as in step 2 within the new series over 5 months on either side in the spencer curve
5. Indentifying the turning points in the original data series
    a. Identification of the highest (or lowest) value within the PCD term of the selected turning points over 5 months on either side in the original data series
    b. Enforce the conditions that peaks and troughs alternate
    c. Ensure that troughs are less than the peaks
    d. Eliminating cycles with phases less than 5 months
    e. Eliminating cycles with duration less than 15 months
6. Statement of the final turning points