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VOLATILITY OF AGRICULTURAL PRICES – AN ANALYSIS OF MAJOR INTERNATIONAL AND DOMESTIC MARKETS

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Content

Foreword

The price volatility of agricultural commodities assumes critical importance in the context of the ongoing debate regarding agricultural trade liberalisation in India. The arguments against agricultural trade liberalisation are often based on the issue of larger volatility in international markets. In order to make informed judgements about this crucial aspect of agriculture, which has implications for the entire economy, it is essential to study the volatility patterns in international and domestic markets in a comparative framework. The present study by CSC Sekhar is an attempt in this direction.

The study, using monthly price data, finds little evidence to show that the international agricultural prices are uniformly more variable than the domestic prices. The study shows that the intra-year variability is higher in domestic markets while the inter-year variability is higher in the international markets. The current bound rates of duty are generally found adequate in this study except in case of soybean oil and sugar.

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I Introduction *

The issue of price volatility has assumed critical importance today in the context of agricultural trade liberalisation. One of the major arguments advanced against agricultural trade liberalisation is that it would lead to transmission of international price volatility into domestic markets. This, it is argued, will have serious implications for food security of the poor in a country where providing economic access to food is the biggest challenge. The merit of this argument can only be judged by a detailed empirical analysis of agricultural price volatility in international and domestic markets. This study is a step in that direction.

The paper is organised as follows. After a brief introduction in section I, section II outlines the objectives and the methodological framework for the study; section III delineates the comparative picture of domestic and international markets; sections IV and V describe the price volatility patterns in international and domestic markets respectively and Section VI outlines the conclusions.

Extreme volatility in commodity prices, particularly of food commodities, affects poor agricultural labourers and labour engaged in unorganised sector adversely because their wages are not index- linked. Small farmers in countries like India, with low propensity to save and poor access to efficient saving instruments can not cope with the revenue variability resulting from fluctuations in output prices. They do not possess the requisite know-how for crop diversification and also lack access to appropriate technology. Commodity price volatility poses problems also for the governments and exporters of the primary commodity-producing developing countries. For governments,

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unforeseen variations in export prices can complicate budgetary planning and jeopardise attainment of the debt targets. For exporters, price volatility increases cash-flow variability and reduces collateral value of inventories. Both these factors result in increasing borrowing costs.

There is considerable evidence that nominal prices of agricultural commodities exhibit much more variability than those of non-agricultural commodities. Andrews and Rausser (1986) and Frankel (1986) interpret this evidence as a rejection of the 'new classical paradigm' and suggest modelling macroeconomic impacts in a 'flex-price vs fix-price' framework. Traditionally, volatility in agricultural prices has been attributed to

a) low price and income elasticities of agricultural products
b) inherently unstable agricultural production as a result of unforeseeable and unpreventable exogenous shocks like weather
c) the very different nature of agricultural planning process where production decisions for most farm products are made much in advance of the time the product is marketed (Starleaf, 1982)

II Objectives, Methodology and Data Sources

Objectives

(i) to measure the degree of price instability of important agricultural commodities in the major international and domestic markets. The commodities selected for the study are wheat, rice, palm oil, groundnut oil, soybean oil, coconut oil, sugar, cotton, tea and coffee.
(ii) Compare the patterns of variability in international and domestic markets and understand its implications for Indian producers and consumers.
(iii) Make suggestions for policy

Analytical Framework

Massell (1969) showed that the society benefits by stabilising prices of storable commodities through stock policy, provided the storage costs are not excessively high. This model is an interesting amalgamation of the earlier Waugh (1944) and Oi (1961) models. There are both gainers and losers in this model, although the society as a whole is a gainer. However, one group of the society gains more from stability than what the other group loses. Therefore, through some form of compensation, everyone can gain from a stabilisation policy.

In the above model, storage is assumed to be costless. If positive storage costs are introduced, it is no longer optimal to pursue complete price stabilisation (Newbery and Stiglitz, 1981). A more practical approach would be a price band policy, wherein prices are stabilised within a particular band. However, adjusting stocks so as to operate within a specific price band may not be feasible. A more complicated case of imperfect markets has been developed by Bieri and Schmitz (1973), where a marketing firm has both monopsony and monopoly power. This model shows that storage by private firms increases their economic welfare but often at the expense of consumers and/or producers. In this case the price instability can be manufactured. This is opposite to the type of price instability in Waugh, Oi and Massell models where instability is due to natural factors like weather.

Often price stabilisation through storage is not undertaken merely for the purpose of stabilising prices or producer's income. *'The inherent difficulty of operating a buffer stock regime can be amplified by a tendency to tailor price bands to goals other than stabilisation, such as farm-income support (leading to upper limits on stocks which are too large coupled with acquisition prices which are too high)……. It is not uncommon to find runs of several years during which carryover stocks are continually above the mean stock level……'*. (Gardner, 1979) This situation is very similar to what has been witnessed in India in the last decade when ever-rising support prices resulted in large accumulation of grain stocks. International trade, as an alternative policy instrument for

food security, has been gaining prominence mainly because of these problems with the current buffer stock policy.

Agricultural trade policy has two dimensions to it. The producer welfare and the consumer welfare. Producer welfare is enhanced when the exported commodity fetches a higher price in international markets. The consumer welfare is diminished in this case by a rise in domestic prices due to decreased availability in domestic markets. The net social welfare may be positive or negative depending upon which of these effects is larger. Reverse is the case for importables (commodities with lower international prices). The issues in question are food security (for exportables particularly basic food stuffs) and livelihood security (for importables). Exports (imports) can be a good policy in cases where the producer (consumer) welfare is consistently higher than the consumer (producer) welfare and the losers can be compensated by the gainers directly or through some other institutional mechanism.

A consistently higher producer surplus (or consumer surplus) can only be realised when the prices in the international market are reasonably stable (whether higher or lower than domestic prices). Batra and Russell (1974) considered the effects of increasing uncertainty of world prices on social welfare of a trading nation and demonstrated that increased price uncertainty would bring about a reduction in the expected utility. Under conditions of price uncertainty therefore, free trade may not be an optimal policy. It has been demonstrated that the volume and the gains from trade are smaller under uncertainty than under certainty. The modified Ricardian model, by including price uncertainty, also gives a similar result. The expected gains from trade for a risk-averse country, which are positive under price certainty, may become negative even causing the country to cease trading, under conditions of price uncertainty. Feder, Just and Schmitz (1977) show that with increased price uncertainty, risk-averse countries are better-off not trading. On the other hand, Newbery and Stiglitz (1979) and Bigman (1982) contend that liberalised trade smoothens out price fluctuations and in a sense free trade has similar effects as that of a buffer stock scheme and may be a cheaper substitute. Storage by large consuming nations like India, can work to its advantage when facing an export cartel (Nichols and

Zeckhauser, 1977). It would pay these nations to build stocks whose presence might suppress prices in future even if the supply from the cartel were non-random and stationary. By using excess supply and demand curves, Hueth and Schmitz (1972) show that countries taken together prefer price stability even with trade.

In summary, it can be said that in an international trade context, the welfare of all countries taken together is increased by price stability through the use of storage i.e., what the gainers gain is more than what the losers lose. The distributional effects depend upon the source of the instability (whether generated within or outside the country) and the height of tariffs (Hueth and Schmitz, 1972). It is, therefore, necessary to examine price instability in international and domestic markets to understand the welfare implications of domestic stocking and international trade policies.

Methodology for Measuring Price Instability

There are various ways of measuring price instability. There is no consensus as to what constitutes the correct method of measurement. The naïve approach involves treating all price movements as indicative of instability by calculating standard deviation of the price index. This approach does not account for predictable components like trends in the price evolution process thereby overstating the uncertainty. A better and useful method of measuring instability is by using the ratio method. In this method, the instability of the series is calculated by measuring the standard deviation of log (P_t / P_{t-1}) over a period, where P_t is price in period 't' and P_{t-1} is the price in period t-1. The third approach is the one which distinguishes between predictable and unpredictable components of price series, but the price volatility is assumed to remain time invariant.

The fourth approach distinguishes not only between predictable and unpredictable components of prices but also allows the variance of unpredictable element to be time varying. Such time varying conditional variances can be estimated by using a Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model (Bollerslev, 1986).

In the present study, variability of the series has been calculated by measuring the standard deviation of log (P_t / P_{t-1}) over a period, where P_t is price in period 't' and P_{t-1} is the price in period t-1. This is, in other words, same as standard deviation of the growth rates (ratio method). Therefore, monthly growth rates in nominal prices for each of the major commodities in the major international markets have been calculated. The annual Intra-year variability has been calculated as the standard deviation of the 12 monthly growth rates in the year. Then the decadal average is calculated as the average of annual intra-year variability of all the years in the decade.

For calculating the inter-year variability, the methodology is slightly different though. Firstly, the annual average prices are calculated as a simple average of the 12 monthly prices. Then the growth rates of annual prices are calculated as log (P_t / P_{t-1}). The average inter-year variability of annual prices for the decade is then calculated as the standard deviation of the all the annual growth rates in the decade.

In the literature on volatility, the measure most commonly used for price instability is inter-year variability. However, as the prices used in calculating this measure are the annual averages, they tend to conceal short-run fluctuations in prices. For this reason, this study employs both intra-year and inter-year variability measures to analyse international and domestic markets and attempts to draw lessons from a comparative picture of the two.

Apart from these, time varying conditional variances have been estimated by using a Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model (Bollerslev, 1986). model has been used in this study to examine price volatility. A GARCH(1,1) model is described below for the sake of illustration.

$$Y_{it} = a_0 + b_1 Y_{i,t-1} + b_2 Y_{i,t-2} + \varepsilon_{i,t} \; ; \qquad t = 1,2\ldots\ldots\ldots,T$$

$$\sigma_{i,t}^2 = \text{Constant} + \alpha_i \varepsilon^2_{i,t} + \beta_i \sigma_{i,t-1}^2$$

where Y_{it} is the price index in time t of commodity i. $\sigma_{i,t}^2$ denotes the variance of ε_t conditional upon information upto period t-1. The fitted values of $\sigma_{i,t}^2$ give the measure of uncertainty of Y_{it}. The sum of $\alpha_i + \beta_i$ gives the degree of persistence of volatility in the series. The closer the sum to 1, greater is the tendency of volatility to persist for longer time. If the sum exceeds 1, it is indicative of an explosive series with a tendency to meander away from mean value. The GARCH estimates have been used to identify periods of high volatility and volatility clustering.

To understand the degree of divergence between the domestic and international prices, a price wedge of the following form is calculated.

$$\text{Price Wedge} = P_w = \left[(\text{Domestic Price} - \text{International Price}) / \text{International Price}\right] * 100$$

For each commodity, one major international market is selected and the price wedge for all the important domestic markets is calculated with respect to this international market. The wedge calculations have been made both by excluding as well as including the transportation & other incidental costs. In the first case the calculated price wedge gives the maximum possible difference between the domestic and international prices and may serve as the indicative level for binding the tariffs. In the second case, the transportation & other costs serve as implicit protection to domestic production and therefore, the calculated price wedge indicates the level to peg applied tariffs.

Data Sources

The monthly and quarterly price data on agricultural commodities from ERS-USDA, IFS and UNCTAD have been collected for international price data. Of these, the IFS data provides the most comprehensive and comparable time series data on prices of agricultural commodities for international markets. Therefore, IFS data has been used for analysis of international sector. For few commodities where data is not available till

2001, data available for the latest year has been used (not earlier than 1999). For domestic prices, the publications – Agricultural Prices in India and Agricultural Situation in India- have been used.

The period of analysis for international sector is 1970-2001 while for domestic sector it is from 1980-2001. The reason for inclusion of 70's decade in the analysis of international markets is the major food crisis that hit the world markets in 1973-74, 1974-75. Attempt has been made to draw a comparative picture of 80s and 90s with respect to the turbulent 70s. On the other hand, the domestic sector remained virtually unaffected by this food crisis. Also, a reasonably consistent and reliable monthly price database for Indian markets could be built only from early 80s. Therefore, the analysis in the domestic sector is confined to 80s and 90s.

III Patterns in Agricultural Price Variability – A Comparative Picture of Domestic and International Markets

A detailed analysis of the variability patterns, separately for domestic and international markets, is given in the subsequent sections of the paper. The present section gives a brief account of the comparative picture of these two markets (Table 3 and Table 4).

Wheat: The inter-year variability of annual prices is considerably higher for all the international markets compared to domestic markets in both the decades (Table 3). However, the intra-year variability is higher in the domestic markets than the main international markets of Sydney and US Gulf Ports (Table 4). This indicates higher degree of within-the-year fluctuations of wheat prices in Indian markets.

Rice: In case of rice, the inter-year variability of annual prices is substantially lower in all the rice-consuming markets like Kakinada, Patna and Bangalore as compared to all the important international markets. However, the intra-year variability is at a more or less similar level as in the international markets. This shows that Indian rice prices are

equally prone to within-the-year fluctuations although these fluctuations are evened out when the average annual prices are considered.

Sugar: In case of sugar, the domestic markets show a much lower level of variability than international markets. This is true for inter-year variability as well as intra-year variability.

Cotton: Cotton prices are much more variable in the domestic markets than in the international markets. While the inter-year variability is only marginally higher in the domestic markets compared to international markets, the intra-year variability is substantially higher.

Groundnut Oil: The inter-year variability of groundnut oil is substantially lower in the domestic markets than in the international markets. However, the intra-year variability is higher in the domestic markets. This again shows that the average annual prices, perhaps, conceal the true fluctuations in monthly prices due to offsetting movements in opposite directions.

Coconut Oil: The situation is similar to that observed in the case of groundnut oil. The inter-year variability is lower in the domestic markets than international markets while the intra-year variability is higher.

Production Shortfalls, International Prices and Domestic Price Variability

The instability of agricultural prices is generally attributed to the inherently unstable agricultural production processes mainly due to factors like weather. In markets open to international trade, the price movements in international markets may also be an important determinant of domestic price movements. To understand the likely significance of these factors for prices in Indian markets, a regression analysis has been carried out. The annual domestic market prices (nominal) are regressed upon three factors

– level of production, price in a major international market and time trend. The results are presented in Table 1.

The regression results for rice markets show that the variables like production and international prices show expected signs but are not statistically significant while there is a significant trend effect. The international prices are not significant in rice-consuming states like Andhra Pradesh (Kakinada market) and Karnataka (Bangalore) while they are significant in non-consuming regions like Haryana (Karnal). This show that domestic demand, perhaps, plays a relatively more important role in determining domestic price movements than international prices in case of rice.

Results for wheat markets show an unexpected positive sign for production variable although insignificant in some cases. International price is largely insignificant with the expected sign. Time trend is the only variable which shows significant positive effect.

Results for groundnut oil show insignificant effects of output and international prices. The time trend shows a significant effect though. In case of coconut oil, the results are slightly different. The international price shows significant effect but the production is insignificant. Results for cotton are very similar to coconut oil with a significant international price variable and an insignificant output variable.

In case of sugar, three markets have been analysed. In case of Calcutta and Hapur markets, the international price appears significant while in the case of Bombay it is insignificant. Production has an expected sign in all the three markets but is insignificant.

On the whole, it can be said that the time trend shows significant effect on domestic price movements in all cases while international price movements show significant effect in some cases. Output fluctuations have an insignificant effect for most crops.

Table 1: Regression Results

Crop	Market	Production	International Price	Time Trend	R Bar Sq	D-W
Rice	Bangalore	-0.137	0.052	0.095*	0.99	1.65
		(-0.74)	(0.62)	(20.96)		
	Kakinada	0.016	0.135	0.086*	0.97	1.75
		(0.11)	(0.99)	(11.13)		
	Karnal	-0.628	0.423**	0.126*	0.87	1.56
		(-1.56)	(1.71)	(2.91)		
Wheat	Karnal	0.284	0.096	0.080*	0.98	1.73
		(1.21)	(0.79)	(5.15)		
	Hapur	0.890*	0.043	0.065*	0.98	2.08
		(3.01)	(0.40)	(6.22)		
	Bahraich	1.060*	0.063	0.056*	0.97	1.99
		(2.68)	(0.45)	(4.07)		
	Moga	0.277	0.237***	0.080*	0.98	1.87
		(0.86)	(1.74)	(7.84)		
Groundnut Oil	Mumbai	0.006	0.011	0.063*	0.89	1.56
		(0.05)	(0.07)	(5.42)		
Coconut Oil	Cochin	-0.251	0.503*	0.048*	0.74	1.88
		(-0.77)	(3.28)	(1.77)		
Cotton	Abohar	-0.093	0.412***	0.088*	0.86	1.88
		(-0.77)	(1.61)	(11.11)		
Sugar	Bombay	-0.056	0.031	0.106*	0.98	1.64
		(-0.41)	(0.67)	(18.57)		
	Calcutta	-0.019	0.229*	0.062*	0.90	1.57
		(-0.19)	(3.94)	(10.48)		
	Hapur	-0.435	0.314*	0.073*	0.89	1.51
		(-0.96)	(3.21)	(5.22)		

Note : *, **, *** denote significance at 5%, 10% and 15% level respectively.

Divergence Between International and Domestic Agricultural Prices

In order to understand the implications of trade liberalisation, particularly import liberalisation, it is essential to examine the long-term movements of domestic and international prices and, assess the degree of divergence between the two prices. A price wedge - percentage difference between the monthly domestic and international prices for 10 years since 1990 - has been calculated for this purpose. Results of the analysis are given below (see Tables 2(A) and 2(B)). Before turning to these results, let us briefly review India's import policy.

India's import Policy[1]: Since independence, India has virtually banned imports of all agricultural products except basic foodstuffs like cereals, pulses and vegetable oils. Cereals and vegetable oils were subject to quantitative restrictions, administered through a state trading monopoly until the mid-Nineties. Pulses imports were freely permitted. In case of vegetable oils, an import trade monopoly was granted to the State Trading Corporation (STC) or its subsidiary, the Vegetable Oils Corporation, and for cereals to the Food Corporation of India (FCI). These entities did not need a specific license for import transactions.

India had zero duties on the principal cereals, wheat, rice and maize and on milk ever since it made a commitment in GATT in 1947 to eliminate customs tariff on these items. However, the monopoly trading by FCI in rice and wheat has rendered the low-level of duties ineffective as the canalising agency could always control the flow of imports which acted as a *de facto* quantitative restriction. The duties on vegetable oils were however substantial, but for the basic foodstuffs imported through state monopolies, the level of duties hardly mattered. Import transactions of these state monopolies were generally exempted from the application of duties.

After the introduction of economic reforms in 1991-92, the import policy was gradually liberalised, but the restrictions on basic foodstuffs took longer to be phased out. Among the items that were restricted in the pre-reform era, edible oils (other than coconut oil) were the first to be liberalised in 1994. After 1994, when government decided to give up state trading monopoly on all edible oils other than coconut oil and imports were determined mainly by tariffs. Government regulated the customs tariff on these products fairly frequently taking into account the balance of interest between the consumers and producers. It was not until March 2002 that restrictions were phased out on milk and milk products and on cereals.

[1] This part is drawn from Hoda and Sekhar (2003)

Trade Flows: In the early Sixties, imports, mainly of wheat from the USA under the food aid programmes, constituted a big chunk of domestic supplies, accounting for as much as 42 per cent. After the government decision to go in for self-sufficiency, import dependence rapidly declined. Except in period 1974-76 and to some extent in 1983, when large imports were made, the contribution of imports to domestic availability was in no year more than three per cent. In the case of rice, import dependence was very low right from the outset. Imports, as a percentage of domestic availability were never in excess of three per cent even in the early Sixties, at the peak of India's import dependence for food grains. Since then imports have tapered off to negligible quantities.

Increasing reliance on imports to meet the needs of domestic consumption has been a feature of India's edible oil economy. We consider together the four main edible oils (groundnut, rapeseed and mustard, soybean and palm oil) as they are substitutable in the medium and long term. Import dependence of edible oils was in the range of 2-5 per cent in the period 1961-75, when India was constrained by its balance-of-payments problem in making adequate imports. However, with the easing of the balance-of-payments position in the late Seventies imports increased and remained in the range of 36-47 per cent during the period 1976-87. With the tightening of import restrictions in the following years import dependence came down to four per cent in 1993. After liberalisation in 1994, it rose steadily so as to exceed 50 per cent in 1999 and 2000. This was despite the fact that in case of soybean oil there had been a substantial increase in domestic production.

In sum it may be said that in case of major cereals, India became not only self-sufficient but had a large exportable surplus. However, where it was not an efficient producer, as in the case of edible oils, restriction of imports did not result in making India self- sufficient. In fact import dependence of the four major edible oils used in the country, which was two per cent in 1961 had risen to 47 per cent in 1987. Thereafter it came down to four per cent in 1993 after the import policy was tightened. Later, and particularly after the liberalisation in 1994 it rose steadily to reach more than 50 per cent in 2000.

With increasing agricultural trade liberalisation and commitments under WTO for replacing all non-tariff barriers with their tariff-equivalents, it becomes imperative to look at the relative movements of domestic and international prices. The following price-wedge analysis attempts to provide a comparative picture of the movements of agricultural prices in the two markets.

Wheat

(i) Karnal V US Gulf Ports: The domestic prices have been lower than international prices for most of the period. They have been lower tha international prices until 1998, except during June 1990-April 1991. The domestic prices were sometimes as low as 60% below the international prices. But after 1998, the domestic prices started rising above the international prices, and have risen to nearly 60% above the international prices as of August 1999. This may be due to a fall in wheat prices in US due to a 9% increase in planted area after the 1995 price rise in US.

(ii) Hapur V US Gulf Ports: The Hapur market also displays a similar pattern as that of Karnal. The Hapur prices have been lower for most period from Jan 1990 to May 1998, with the exception of a short period from June 1990 to April 1991. The domestic prices started rising after May 1998 and are continually above the international prices till August 1999. The highest peak achieved by domestic prices is 90% above the international prices.

(iii) Bahraich V US Gulf Ports: Bahraich market also displays a pattern similar to those of Hapur and Karnal. The domestic prices are below the international prices till 1998 after which they begin to rise above the international prices. The maximum level reached by domestic prices is about 60% above the international prices.

(iv) Moga V US Gulf Ports : The international prices are higher than the domestic prices from July 1991 to Jan 1998. Thereafter, the domestic prices appear higher than the international prices. The maximum extent to which domestic prices rose in the entire decade of 90s was about 60% above the international prices.

(v) Moga V Australian Wheat : The international prices are higher than the domestic prices from July 1991 to July 1998. From July 1998 to July 2000, the domestic prices were higher than the international prices. From July 2000 to July 2001, the international prices again rose above the domestic prices. The peak to which domestic prices rose in the entire decade of 90s was about 80% above the international prices.

Rice

(i) Kakinada V Bangkok: The domestic prices were continuously lower than the international prices in this market. They have begun to rise above international prices after 1999. The maximum level reached by domestic prices above the international prices is about 40%.

(ii) Karnal V Bangkok : The international prices were continuously higher than domestic prices until Jan 2000. Thereafter, the domestic prices rose above the international pries. The domestic prices have never been more than 35% above the international prices in the decade.

(iii) Patna V Bangkok: In this case, international prices are continuously higher than domestic price.

(iv) Bangalore V Bangkok : In this case, the domestic prices have been continuously higher than the international prices throughout the decade. The peak touched by domestic prices was about 135% above the international prices.

Groundnut Oil

Chennai V Europe: Domestic prices were much higher than international prices until July 1993. Thereafter, the gap narrowed between the two prices. However, the domestic prices continuously remained above the international prices. The maximum limit to which the domestic prices rose was about 120% above the international prices.

Coconut Oil

Cochin V Philippines: The domestic prices have been higher than international prices throughout the decade. The maximum extent to which the domestic prices rose above the international prices was about 525%.

Soybean Oil

Jabalpur V Dutch Ports: The domestic prices have been consistently higher than the international prices for soybean oil. The gap has increased significantly after middle of 1998. The domestic prices reached a very high peak of about 140% above international prices in the last few months of 2000 and early '01.

Coffee

i) ***Coimbatore V Brazil:*** International prices were consistently higher than domestic prices till 1998. Thereafter, domestic prices rose above the international prices. The highest peak reached by domestic prices above the international prices was of about 80%.

ii) ***Coimbatore V Uganda:*** International prices were consistently higher than domestic prices till mid 1998. Thereafter, domestic prices rose above the international prices. The highest peak achieved by the domestic prices was 200% above the international prices.

Sugar

i) ***Bombay V Caribbean Port:*** The domestic prices have been consistently higher than international prices in this market. The domestic prices were significantly higher than international prices from Jan 1990 to June 1991, after which the gap has reduced. The highest peak achieved by the domestic prices is about 150% above the international prices (May 1991).

ii) ***Hapur V Caribbean Port:*** This market also displays a very similar pattern to that of Bombay. The domestic prices are consistently higher. The gap between the domestic and international prices has widened substantially after 1998. The maximum peak achieved is about 200% above the international prices.

iii) ***Calcutta V Caribbean Port:*** This market also displays exactly similar pattern to the other two markets. The domestic prices are consistently higher than the international prices. They were significantly higher from Jan 1990 to June 1991, after which there is a reduction in the price differential. The gap

between domestic and international prices in this market has widened substantially after 1998. The maximum level to which the domestic prices rose above the international prices is 200%.

Cotton

Abohar V Liverpool Index: The international cotton prices have been consistently higher than the domestic prices for this commodity. For most of the period the domestic prices were about 50-70 per cent lower than international prices.

The following table gives a comparative picture of the applied duty, bound duty and the maximum price wedge observed in our study for various commodities. Table 2(a) gives a picture of the price wedge by excluding the transportation and other costs. This gives the maximum level to which domestic prices rose above the international prices during the decade of 90s and this, therefore, may be considered as the indicative level for binding the tariffs (Appendix A). However, the applied duty rates can be different. The transportation, port handling charges and other incidental costs, when included in the international prices, act as implicit protection for domestic producers. Table 2(b) gives the price-wedge calculations by including the transportation and port handling charges. This table gives the indicative level for the applied duty on imports. Since applied duty rates can be changed in accordance with price movements (domestic and international), a shorter time horizon (from 1995) has been considered (Appendix B).

Table 2(a): Maximum Price Wedge, 3s Limits and Bound Duty
(1990 onwards)

Crop	Maximum Price Wedge Observed in the Study	3s limits of Price Wedge	Bound Duty (As on 1-4-2002)
Wheat	90	76	100
Rice	135	175	80
Groundnut Oil	120	110	300
Coconut Oil	525	573	300
Soybean Oil	140	188	45
Sugar	200	204	150
Coffee (Brazil)	80	115	150

Table 2(b): Maximum Price Wedge, 3s Limits and Applied Duty
(1995 onwards)

Crop	Maximum Price Wedge Observed in the Study	3s limits of Price Wedge	Applied Duty (Basic) (As on 1-4-2002)
Wheat	0	22	50
Rice	75	144	80
Groundnut Oil	40	34	75
Coconut Oil	70	130	75
Soybean Oil	100	112	45
Sugar	110	125	60
Coffee (Brazil)	80	115	100

Source: Author's calculations and Agricultural Statistics at a Glance 2002

It may be observed from table 2(a) that, except in the case of wheat, all the price wedges fall well below the 3σ limits. This indicates that, statistically none of the price wedges (maximum) except wheat, is an outlier. The indicative level for tariff (bound) may be taken as the minimum of the two values i.e., maximum price wedge and the 3σ limit. Since state trading has been prevalent for most of the commodities even during the 90s and the international price in this table does not include the cost of transportation and other incidental costs, the observed price wedges are the maximum possible ones. The table indicates that the bound duties are generally adequate except in case of rice, soybean oil and sugar. In case of commodities where the bound duties are much higher than the observed price wedges, the bound rates may be lowered. Such a move should strengthen our case in the negotiations for raising bound duties on certain other commodities, where protecting domestic producers becomes essential.

In case of rice, only one market (Bangalore) has exhibited a price wedge in excess of the bound duty level. With the lifting of domestic restrictions on movements, stocking and distribution in April 2002, the inter-market variation in the country is likely to decline. Therefore, the present level of bound duty (80%) may be adequate.

However, in case of soybean oil, the implications are different. Soybeans are mainly grown by small farmers under rainfed conditions. Dry states like Madhya Pradesh and Maharashtra together account for nearly 90% of soybean production. It is well

recognised that most of the inefficiency in the edible oil sector, soybean being no exception, is due to the inefficiency of the processing sector. Therefore, allowing cheap imports of soybean oil with the very low level of existing tariffs may adversely affect the livelihoods of small farmers in these dry regions. At the same time, the interests of the consumers can not be ignored altogether. Therefore, the bound duty can be set at an intermediate level between the maximum price wedge observed and the existing level.

The case of sugar is slightly different though. Sugar production which stood at an all time high of 16.5 m tons in 1995-96 rose to a record high of 18.6 m ton in 2000-01. In addition, due to a global glut in sugar, even international prices remain depressed, putting further pressure on domestic companies. Sugar used to be an important export commodity. But rising domestic demand coupled with fluctuations in domestic production has resulted in sizeable imports of sugar during some years in the recent past. The significant levels of distortions in the international market mainly due to domestic and export subsidisation by the EEC and USA have also contributed to the extraordinarily low prices in international markets. The international sugar prices need to be monitored closely and presently, higher tariff bindings may be negotiated till the distortions in international prices are corrected.

From Table 2(b), it can be seen that the present level of applied duty is adequate in case of all the commodities except soybean oil and sugar. There is a need to closely monitor the prices of these commodities, particularly of sugar, and raise tariffs if the surge of cheap imports becomes imminent.

Table 3: Inter-Year Variability of Annual Prices (In Percentage)

	1980s	1990s	Overall
WHEAT			
Australia (Sydney)	14.73	14.99	14.47
Australia	20.46	21.20	20.33
United States(US Gulf Pts*)	14.18	15.49	14.54
Argentina	19.31	25.76	22.16
Moga	5.48	11.61	9.10
Karnal	7.03	7.36	7.58
Hapur	6.98	10.44	9.15
Bahraich	9.93	11.94	11.17
RICE			
US (New Orleans)	18.25	12.53	15.12
Thailand (Bangkok*)	20.38	13.51	16.68
Thailand	20.12	14.08	16.77
Myanmar	25.91	11.70	20.50
Kakinada	9.79	9.93	9.65
Patna	12.49	9.80	10.87
Karnal	17.19	29.67	24.22
Bangalore	8.73	8.95	8.63
SUGAR			
EU Import Price*	10.96	5.51	8.44
Caribbean(New York*)	39.32	20.30	30.12
US Import Price*	14.48	5.25	10.44
Brazil	29.50	18.32	23.66
Bombay	8.11	8.63	8.41
Hapur	14.86	7.47	11.58
Calcutta	13.95	6.39	10.67
COTTON			
US(10 Markets)	12.34	20.29	16.68
Liverpool Index*	22.58	19.43	20.53
Egypt (Long Staple)	32.82	39.48	38.11
Egypt (Long Medium)	35.68	32.31	37.57
Abohar	21.60	31.25	26.43
TEA			
Average Auction(London)*	24.55	13.43	19.02
Sri Lanka	21.71	12.15	16.92

(contd…)

	1980s	1990s	Overall
COFFEE			
Other Milds(New York)*	23.95	34.60	29.29
Brazil(New York)*	31.36	35.26	32.70
Brazil	39.86	37.14	37.56
Uganda(New York)*	21.49	36.32	29.51
Coimbatore	7.78	164.19	116.22
COCONUT OIL			
Phillipines(New York)*	44.26	26.63	35.31
Phillipines	43.30	26.71	35.48
Cochin	30.19	22.87	26.03
PALM OIL			
Malaysia(N.W.Europe)*	33.01	23.93	28.09
Malaysia	28.22	16.24	23.88
GROUNDNUT OIL			
Any Origin (Europe)*	32.13	18.82	25.44
Chennai	14.07	15.54	14.89
Mumbai	14.98	14.83	14.45
SOYBEAN OIL			
All Origins(Dutch Ports)*	25.84	17.39	21.26

Table 4: Intrayear Variability of Annual Prices (In Percentage)

	1980s	1990s	Overall
WHEAT			
Australia (Sydney)	3.72	4.50	4.13
Australia	13.16	6.15	9.49
United States(US Gulf Pts*)	3.50	5.43	4.41
Argentina	7.61	8.48	8.00
Moga	6.00	7.22	6.61
Karnal	7.41	9.42	8.36
Hapur	8.01	7.75	7.89
Bahraich	8.25	7.88	8.08
RICE			
US (New Orleans)	3.33	3.70	3.52
Thailand (Bangkok*)	4.82	6.22	5.55
Thailand	6.82	7.48	7.15
Myanmar	14.58	18.85	16.72
Kakinada	5.36	7.06	6.17
Patna	5.74	5.41	5.58
Karnal	4.73	5.07	4.89
Bangalore	4.52	3.83	4.19
SUGAR			
EU Import Price*	3.14	2.17	2.64
Caribbean(New York*)	10.93	6.79	8.76
US Import Price*	2.60	1.78	2.17
Brazil	27.96	13.04	20.14
Bombay	4.27	4.45	4.35
Hapur	6.34	4.23	5.34
Calcutta	5.83	3.76	4.85
COTTON			
US(10 Markets)	4.94	6.01	5.50
Liverpool Index*	4.27	4.39	4.33
Egypt (Long Staple)	18.29	14.36	16.82
Egypt (Long Medium)	11.75	10.84	11.44
Abohar	6.60	14.88	10.74
TEA			
Average Auction(London)*	7.87	7.00	7.42
Sri Lanka	6.98	4.51	5.74

(contd….)

	1980s	1990s	Overall
COFFEE			
Other Milds(New York)*	6.44	8.33	7.43
Brazil(New York)*	8.90	9.02	8.97
Brazil	15.00	8.72	11.71
Uganda(New York)*	6.15	6.86	6.52
Coimbatore	5.31	41.48	23.40
COCONUT OIL			
Phillipines(New York)*	8.02	6.58	7.27
Phillipines	7.51	9.08	8.29
Cochin	7.42	10.19	8.74
PALM OIL			
Malaysia(N.W.Europe)*	8.53	6.04	7.23
Malaysia	7.83	8.10	7.92
GROUNDNUT OIL			
Any Origin (Europe)*	6.93	3.42	5.09
Chennai	7.63	7.39	7.51
Mumbai	6.85	7.05	6.93
SOYBEAN OIL			
All Origins(Dutch Ports)*	6.70	4.55	5.58

IV Agricultural Price Volatility in Major International Markets

1. ***Wheat:*** The markets analysed are US, Sydney market prices (Australia), Australian f.o.b. prices and Argentina. There is a distinct pattern in the intra-year variability of wheat prices in all the markets. Variability was highest in 70's followed by 90's. 80's remained relatively tranquil. The inter-year variability of monthly prices shows a cyclical pattern across decades. The prices are generally stable from January to April after which there is a slight decline till June. The prices again reverse the trend and start rising from June to October after which there is a decline. The GARCH estimates confirm the ratio method estimates - with the conditional variance being highest during May-Aug 1974 and 1995-96 period.

   Australia(Sydney) – The intra-year variability was highest in 70's followed by 90's. In 80 s prices were relatively stable. GARCH results indicate a lot of volatility clustering around 74-76 and again in 96-97. As regards inter-year variability of monthly prices, there is a discernible pattern across decades. Prices at the beginning of the year are generally stable with low positive average growth rates until May. After May, there is a decline in prices until July, indicated by negative growth rates. Subsequent to this there is an improvement in prices till October after which there is again a phase of downward movement till December.

   Australian f.o.b. prices – The intra-year variability of Australian f.o.b. prices is highest in 80's followed by 90 s and 70s. The average variability of prices in the 80's (13%) is more than double that in the 90's (6%) and nearly three times that in 70's (4.7%). This market, therefore, displays a different pattern from that of the other major world wheat markets – US (Gulf Ports) and Argentina. The GARCH results confirm the ratio method estimates. GARCH shows that there is a distinct clustering of volatility, as can be seen from the continuum of peaks, in the mid 80's – particularly during 1984 and 1985 and again during 1989 and 1990. In contrast, 90's, shows a single peak in the mid 90 s during 1996-97. The inter-year variability of

prices does not show any distinct pattern across decades, either viewed in terms of average growth rates or variability of growth rates.

US Gulf Ports – This market shows a pattern very similar to that of Sydney markets. The variability is highest in 70 s followed by 90s. 80 s remained relatively stable. The GARCH results show a huge peak and clustering of volatility in the mid 70's – from 1975 to 1977. Again a similar pattern to a lesser degree can observed in mid 90's during 1996-97. The inter-year variability of monthly prices displays a steady pattern mostly in the last two decades. The pattern is similar to that observed in Sydney markets. The prices are generally stable from January to April after which there is a slight decline till June. The prices again reverse the trend and start rising from June to October after which there is a decline.

Argentina – This market also displays a similar pattern to that of Sydney and US. 70s (1974) show high variability followed by 90 s (1991, 1996). The GARCH results indicate that Argentinian wheat market is relatively more volatile in terms of large spikes, as compared to other markets during the entire study period. The average growth rates of monthly prices shows that the prices generally follow a steady increase from January to June. After this, the prices appear to oscillate from June to October. After October, there is a general decline in prices till December. The standard deviation of monthly growth rates of prices, shows that the variability is generally constant except for a couple of months in 90 s and for the month of January in 70 s.

The volatility of world wheat prices in 70s and 90s, compared to a relatively tranquil 80s, can be understood better if viewed in the backdrop of developments in world wheat markets during these decades. The world wheat markets have experienced three major upheavals during the last four decades[2].

[2] This section is based on Sekhar (2003)

1. The price wars of 1965-66 and 1968-69 and the resultant low world prices.
2. The huge price rise in 1972-73 and 1973-74
3. The high price rise in 1995-96 and a subsequent fall in 1998-99, continuing till present

The price wars of 1965/66 were the result of huge increase in Australian wheat production in the late fifties coupled with the Australian policy of pricing to sell the whole produce. This had a major destabilizing effect on world wheat price, especially in the years of high world production and contracting export markets. The situation was further exacerbated by the US policy of maintaining its market share in export markets even at low prices. The second major price war occurred in 1968/69 and the factors responsible for this were the contraction of export market due to high production in the importing countries and a record 14 million ton Australian wheat crop. This situation reversed in 1972/73, when the carry over stocks of all the three major exporters were depleted, from 40,823 thousand tons in 1971/72 to 22,350 thousand tons in 1972/73, in meeting the episodic demands caused by the crop failures in USSR and some Asian countries. This led to an unprecedented rise in the world cereal prices.

There are two major factors responsible for these developments. First is the inherent difficulty in predicting the world import demand. Second is the likelihood that increases in exportable surplus and contraction in residual (import) market are highly correlated. Subsequent to periods of high prices and low stocks, major exporters expand their production partly because they believe that high prices will persist, as happened after the steep rise in world wheat prices in 1995-96; and partly because if one exporter expands production (exports) alone, then the market shares of others will fall. However, high prices also provide an incentive for importing countries to expand production and decrease reliance on imports. This results in a contraction of the export market at the same time as the exportable surplus is increased. This is exactly the reason for the steep fall in world wheat prices experienced over the past three years. Depending on the size of the relative movements, the major exporters may have to hold stocks to maintain price at the point of unitary elasticity on the residual demand curve facing them. There is

evidence of this phenomenon in the past, particularly during 1968-69 to 1972-73 and it is an important factor in the current decline and future stability of world prices.

It is important to note that the price stability in 60's was achieved during a period of significant variability in world grain production (Johnson, 1975). In fact, the absolute shortfall in production during 1961-62 through 1965-66 was greater than during 1971-72 through 1974-75, 72 million tons compared to 36 million tons. This drastically differing behaviour of prices in the international market can be due to two reasons. The first reason was that the major exporters had held their stocks to a lower level in the 70's than in the 60's. The carry over stocks of all the three major exporters had depleted, from 40,823 thousand tons in 1971/72 to 22,350 thousand tons in 1972/73. There is absolutely no evidence that except for India, any country made any effort to increase stocks as an offset to the decline in North American and Australian stocks. The second reason, more important than the first one, is that a much larger percentage of the world's production and consumption in 70's, than in the 60's, had occurred within the framework of policies to achieve internal price stability through control of imports and exports. It was not so much that the basic policies had changed as it was that either the ability or the will to pursue domestic price stabilization policies more effectively had changed. This is reflected in the fact that after the poor crop of 1963, Soviet Union imported only about one-third of its grain production shortfall. Situation remained the same during the subsequent poor harvest in 1965. But in 1972-73, net grain imports exceeded production shortfalls relative to the previous year by approximately enough to maintain at the trend level for 1972-73. This shows that the consumption in USSR did not adjust to the shortfalls in domestic production, which in turn, led to a sharp rise in international grain prices.

Behaviour of world wheat markets over the last four decades, suggest that the output and stock-holding policies of major exporters in general and US, Canada, Australia and Argentina in particular, hold large implications for price stability in world wheat markets. Production shocks in major exporting/producing countries in 1995 and

the subsequent developments in world wheat markets indicate that few large exporters/producers still hold key to the stability of wheat prices in world markets.

2. ***Rice:*** Markets included are the New Orleans (US) and Bangkok (Thailand). The pattern in rice markets is not uniform in the two markets. In Bangkok market, the intra-year variability is highest in 90's followed by 70's and 80's. In the US market, the intra-year variability is highest in 70's followed by 90's and 80's. The GARCH estimates confirm these results.

   New Orleans (US) - Intra-year variability shows that 70s have been highly variable. 80s and 90s remained relatively stable with just one exception in 1993. The GARCH plots of conditional variance clearly show the high degree of volatility clustering in 70s as compared to 80s and 90s. One exception is the peak in 1993. As for trends in monthly price movements across years, there is no uniform pattern. 70s have been very erratic with high growth rates for the months of February, April and November. The standard deviation of growth rates remained generally high in the 70s for all months. The average growth rates in 80s and 90s have been low. The low average growth rates accompanied by a high S.D. from August to October in 80s and 90s indicate the presence of some years when the growth rates were extremely low.

   Bangkok – The intra-year variability of prices in this market shows that 90s is the most variable decade followed by 70s and 80s in that order. GARCH results confirm this finding. The plots of conditional variance show maximum volatility clustering from 1995 to 1998 in the 90s and from 1974 to 1977. Looking at the inter-year variability, there is no pattern in monthly movement of prices across decades. The inter-year variability is highest in 90's followed by 70s and 80s in that order.

   Thai f.o.b. prices – The intra-year variability analysis shows that the 70's is the most variable decade followed by 80s and 90s. GARCH results indicate volatility clustering during 1974-75. Other than this period, the other two decades are relatively tranquil with occasional peaks. Looking at the inter-year variability trends,

80s and 90s generally show similar pattern. January to March show slightly higher growth rates but from March to August, the prices appear to decline with negative or low positive growth rates. There is a slight increase in growth rates from August to October after which there is a definite dip. The variability in growth rates in 70s is found to be generally higher for all months as compared to other two decades.

Instability in domestic rice prices can originate from three sources. First, fluctuations in domestic production can cause fluctuations in domestic prices. Second, changes in world market rice prices will be translated into changes in domestic prices if private imports are allowed. For example, a downward fluctuation in world rice prices will encourage private sector traders to import cheap rice in order to sell at the relatively high prices on the domestic market. These imports will put downward pressure on domestic prices. The reverse would happen if there was upward movement in world rice prices. Exports would be encouraged, and there would be upward pressure on domestic prices. Thus, price instability on world markets will be translated into price instability on domestic markets. Third, volatility in exchange rate will cause changes in the price of rice in the world market, which will then affect domestic rice prices in rupees just as if the world market dollar price of rice had changed at a constant rupee exchange rate. If the rupee depreciates significantly, the depreciation increases the amount of rupees that a trader can get for exporting rice at a fixed dollar price. Rice exports will tend to raise domestic rice prices, and exchange rate instability will have been converted into domestic rice price instability.

The best strategy to deal with future instability in domestic rice prices depends on many factors, including the evolution of the world rice market, the likely sources of potential future instability, and the evolution of the Indian rice economy.

Trends in World Rice Prices[3]

The world rice markets have been characterised by four distinct phases in the last 50 years.

i) Phase I (1950-1964) – This was a phase of high and stable prices. The stability in prices was mainly a result of commercial orientation of the major rice exporters like Burma, Thailand, Cambodia and Vietnam, despite uneven production. These Asian economies were less diversified and more reliant on rice export-earnings at that time. Any shortfall in world production would be made up by the increased exports from one of these major players – mainly Burma and Thailand.

ii) Phase II (1964-81) – This was a phase of high and unstable prices. A major El Nino event led to a shortfall of 6% in Asian rice production in 1965. Vietnam had banned rice exports by then and did not return till late 80s. Exports from Burma too had fallen from 49% of domestic production in 1957 to 11% in 1967. The commercial orientation of Thailand also decreased during the same time. Its revenues from rice export taxes fell from 10% during 1950-65 to just 1% in 1971. In fact, during the world food crisis of 1973-75, Thailand's exports fell to 10% of its domestic production from a high of 33% during a similar El Nino event in 1957. Thailand banned rice exports for a few months in 1973 and Cambodia, Vietnam and Burma had already exited the world rice market by that time. This led to a situation when there was no rice to be had on world markets at any price. Only India could weather this situation, thanks mainly to its buffer stock policy.

iii) Phase III (1982-85) – This is a short period of transition in world rice markets from a very high price of US $860/ton (constant 1998 prices) in 1950-81 to US $327/ton in 1985-1999. The main reason for this fall in prices is the huge growth in per capita rice production in Asian countries. The production in Indonesia had

[3] This analysis of the world rice market is based on the report of BAPPENAS/USAID/DAI FOOD POLICY ADVISORY TEAM REPORT (1999). For details see http://www.macrofoodpolicy.com/docs/wp/future.pdf

increased by about 16% from 1981 to 1984 and it attained self-sufficiency from being the largest rice importer in the world. Rapid increases in rice production were also witnessed in China, India and Vietnam. A rapid increase in Thai exports was also witnessed due to devaluation of the Thai Baht. Also, the increasing per capita income around this time in several Asian countries had led to a decline in the income elasticity of demand. The major technological breakthroughs led to development of pest and disease-resistant rice varieties like IR 36. The increased proportion of irrigated land under rice cultivation also led to higher and stable production.

iv) Phase IV (1985-99) – This was a phase of low and stable prices. The higher and stable production witnessed during the previous phase continued in this phase too. The magnitude of year to year fluctuations in per-capita rice production in Asia has been markedly lower in this phase than previously observed. The average annual changes in per capita production was 4.4% during 1952-1964, 3.7 during 1965-81 and just 1.9% during 1985-98 (BAPPENAS). Also, there is a renewed commercial orientation of Thailand. The exports from Thailand have increased to 40% by mid to late 80s. The devaluation of Thai Baht further contributed to this surge in exports. Vietnam also reentered world rice market, with exports of about 20% of its production, in the late 90s. The increased exports from countries like India, China and Pakistan have also ensured low world prices. Between 1961 and 1993, world rice trade fluctuated between 3.5% and 5% of total rice production, with an overall average of 4.3%. But since 1994, this ratio has exceeded 5% every single year with an average of 5.9%. This reflects the recent outward-looking policies of most Asian rice economies.

Sources of Future Rice Price Instability and Policy Options

Based on the analysis in the previous section, it seems likely that world prices will generally remain stable in the near future, just as they have during the past fifteen years. None of the trends that led to low and stable prices are likely to be reversed. Although the

growth of irrigation is slowing in Asia, the share of irrigated land in total rice area is still increasing. In addition to these trends, the effect of any given level of rice price instability is much less today.

This is not to suggest that the effects of price instability are now negligible. While the world rice market is likely to be relatively tranquil in the near future, exchange rate instability may increase due to financial market liberalisation. Under free trade, instability in exchange rates translates to instability in domestic prices just as much as instability in world prices.

Instability in domestic rice prices can occur due to fluctuations in world rice markets, a large depreciation of the exchange rate, or a large shortfall in domestic production. Given the above scenario, the first event is relatively unlikely. Yet the latter two events are real possibilities. Perhaps the most likely problem is a shortfall in domestic production. In such a case, price stability may be ensured by allowing private sector to step in with commercial imports. The private sector will be willing to perform this function provided that the tariff on rice is not set prohibitively high. In fact, stabilization for consumers in the face of shocks to domestic production is maximised by very low tariffs. Thus, to meet the objectives of price stabilization, the optimal tariff will need to balance the interests of both farmers and consumers, suggesting that a moderate tariff may be the best policy.

However, a low tariff alone is not adequate to protect consumers from price fluctuations. There is always some lag between the contracting of imports and their arrival at port, and a modest level of domestic food security stocks held by the government is essential in such a situation. Finally, consumers can also be affected by a depreciation of the exchange rate. A very large depreciation could put upward pressure on domestic prices. In such a case, the only remedy is a temporary restriction on exports: either a ban or a prohibitively high export tax. But care should be taken to ensure that such restrictions are imposed only under very unusual situations and are confined to short durations.

To summarize, the world rice market will probably be relatively stable in the near to medium term. The set of policies that meets the objective of averting undue price instability consists of a moderate tariff, food security stocks, and export restriction in unusually low production years or large depreciation in the exchange rate.

3. ***Palm Oil:*** The markets considered are European markets and Malaysian f.o.b. prices. The ratio method indicates that the intra-year variability of prices has been highest in 80's in European markets while the Malaysian f.o.b. prices show higher variability in 80' s and 90's. The GARCH results show high variability in 80's and 90's in both markets. This commodity also shows some pattern in the inter-year variability of monthly prices. In the European markets, prices in July and August months appears to be more variable in all the decades while the Malaysian f.o.b. prices exhibit higher variability in the months of May and September.

N.W.European Markets – 80s is the most unstable decade in terms of intra-year variability, followed by 70s and 90s. GARCH results show that there is clustering of volatility in mid 70s and again in mid 80s. 90s is relatively tranquil. Results on inter-year variability show that the S.D. of monthly growth rates of palm oil prices in this market follow an oscillatory pattern with peaks around January and July-August. The corresponding troughs are May-June and October-November. The avaerage growth rates do not show any uniform pattern across decades.

Malysia – 90s is the most unstable decade in terms of intra-year variability, followed by 80s. 70s remained relatively stable. GARCH results also show extremely high volatility in the 90s and 80s as compared to 70s. The average growth rates of the monthly prices show that the prices are generally stable in 70s and 80s. Even in 90s the average growth rates are not very high except in the month of November. The average growth rates are low in 70s and 80s accompanied by high standard deviation indicating the presence of some extremely low values during these decades. There is no uniform pattern in the variability of monthly prices across decades.

4. ***Coconut Oil***

Philippines (New York) – 70s show high intra year variability followed by 80s. 90 s remained relatively tranquil. GARCH results more or less support this inference. They show volatility clustering around 1974-75 and again in mid 80s. 90s remained less volatile. The monthly price movements show an oscillatory movement in growth rates with peaks around January, April and November and the troughs at February, August and December. 70s is out of phase with 80s and 90s with its peaks generally coinciding with troughs of 80s and 90s and vice-versa. There is oscillatory movement in variability starting with the month of July till December in both 70s and 80s. 90s remained relatively stable.

Philippines –High variability is observed in 70s followed by 90s (particularly in late 90s). The 80s were relatively more stable. The GARCH results show a lot of clustering of volatility in mid and late 70s, mid 80s (1984) and late 90s (2000). The monthly price movements do not display any uniform pattern across decades. 70s had much higher variability for all the months followed by 90s (except May). 80s are relatively tranquil. This pattern is very similar to that of intra-year variability.

5. ***Groundnut Oil:*** The selected market is European market. The groundnut oil prices also exhibit a pattern similar to that of soybean oil market. The variability in 70's and 80's was higher while the 90's were relatively milder. The turbulent years of 1974-75 had affected groundnut oil market too but the prices have stabilised after 1975. The GARCH results are in conformity with the ratio method results. There is no pattern in the monthly movements of prices across decades.

6. ***Soybean oil:*** Dutch ports is the market selected. 90's have been relatively milder with lower average intra-year variability for the decade compared to 70's and 80's. The prices have shown two long streaks of high variability from 1973-78 in the 70's and 1983-88 in the 80's and have since stabilised in the 90's with a much lower

average variability. The intra-year variability is very high in 70 s and 80s. 90s are relatively stable. GARCH analysis shows volatility clustering in mid 70s (1974-75 and 1978-79) and mid 80s (84-86). Monthly movements of prices show that a pattern of peaks around March-April and July. There are corresponding troughs around February, May, August, October-December. The high growth rates of February and July in 70s and April in 80s is accompanied by low standard deviation indicating a consistently high growth rate in these months for most of the years.

7. ***Sugar:*** The prices included in the analysis are EU import price, US import price, Caribbean Sugar (New York Market) and Brazilian Sugar. Overall, 70's exhibit highest variability followed by 80's. 90's have been relatively tranquil. The Brazilian market is an exception to this pattern. It shows highest variability in 80's – which is nearly three times the variability in the remaining two decades. In the sugar markets too, there is no discernible pattern in the monthly movements of prices. The GARCH estimates in general confirm the results of ratio method.

   EU Import Price – The intra-year variability results show high variability in the 70s. 80s and 90s remained remarkably stable. The GARCH results confirm this result with high volatility clustering in 1975-76. The inter-year variability of monthly prices is also quite low in 80s and 90s. The 70s is marked by high standard deviation of growth rates for the months of January, September and November. January and September show a high growth rate while November shows a very low growth rate. This indicates presence of some extreme values for these months in some of the years in 70s.

   Caribbean Ports - Intra-year variability is high in 70s and 80s. 90s decade is relatively stable. The variability is consistently high in 80s but 70s have few extremely high volatile years. This is also confirmed by the GARCH results, which show a huge peak in 1975 and tranquillity thereafter, except for a slight increase in early 80s. Looking at patterns of inter-year variability, the growth rates of monthly

sugar prices appear to rise during May-July period but show a decline around September. After this there is a slight recovery.

US Import Price – Results show that intra-year variability was highest in the decade of 70s compared to 80s and 90s, which were remarkably stable decades with one blip in 1981. GARCH results show a huge spike in 1975 and again some clustering of volatility in early 80s. Analysis of inter-year variability results show that the S.D. is highest for all the months in 70s. This coupled with extremely high and low values of average growth rates, shows the presence of some extreme years. Monthly price movements show some increase in growth rates between June and August months but show a dip in September like Caribbean prices. There is some increase again after September.

Brazil – The Brazilian sugar market presents a picture contrary to the other three major markets. In this market, 80s are marked by the maximum intra-year variability. 70s and 90s show more or less similar patterns of intra-year variability. GARCH results confirm this by showing a high degree of volatility clustering throughout 80s although 70s show some extreme volatility during 1974-76. Coming to the trends in monthly prices across years, there is no uniform pattern in the movement of monthly prices across decades. The inter-year variability is consistently higher for all the months in 80s compared to other two decades.

8. Cotton:

US (10 Markets) – 70s have been highly variable followed closely by 90s. 80s are relatively stable. GARCH results indicate volatility clustering in 1974 and again in 1977-78. As compared to this multiple clustering in 70s, 90s had one major spike around 1995. Inter-year variability is consistently higher in 70s for all the months compared to 80s and 90s. Variability appears to be highest for the month of August in all the decades. The movements in monthly prices are more oscillatory in 90s compared to 70s and 80s.

Liverpool Index – In terms of intra-year variability, 80s display the maximum instability followed by 90s and 70s. GARCH shows consistent volatility clustering all over 80s while 70s and 90s show occasional spikes followed by relatively tranquil periods. The average growth rates of monthly prices across decades display a pattern of declining trend till August and a slight increase thereafter.

Egypt (Long Staple) – Prices show high intra-year variability in 80s and 90s after stable 70s. GARCH results show a very clear increase and clustering of volatility in the middle of 1988 to 1993, after which it remained largely tranquil. When looked at the inter-year variability, a clear pattern emerges. High growth rates in the months of September and November in 80s and July in 90s are coupled with high standard deviations. This is indicative of few extreme years when the prices were high.

Egypt (Long Medium) – In intra-year variability, large spikes of variability are observed during 1973-74 and from 1989 to 1991. 80s remained relatively stable. GARCH results indicate a slightly different pattern with large spikes of volatility between 1989 and 1992. 70 s appear to be totally tranquil. The movements in monthly prices do not show any pattern across years. The average growth rate is oscillatory and fluctuates almost every month except between May and July. This is unformly the pattern in all the three decades.

9. ***Coffee:*** The varieties selected are Brazilian, Uganda and other milds. The market selected is New York. The prices show maximum variability in the 90's compared to 70's and 80's. All the varieties show similar pattern of variability across decades. The fluctuations in intra-year variability appear to have increased in the 90's compared to 80's. One distinct pattern is the movement of monthly prices. The prices appear to show increased volatility in the months of May, July and October in all the three markets in each of the decades. The GARCH results show slightly different results for one variety (Brazilian) where the volatility clustering in the 70's and 80's is not very different from that in the 90's.

Other Milds (New York) – intra-year variability patterns display maximum variability in 90s followed by 70s and 80s. GARCH shows high volatility clustering around 1995 and again around 1998. It shows spikes in volatility during 1977-80 and again during 1986-87. The monthly movements show that prices in June-July appear to be much lower than other months in all the three decades. There is an increase in inter-year variability around March and again in July in all the three decades.

Brazil (New York) – 90s show much larger intra-year variability but do not exhibit any sudden peaks or troughs. This is confirmed by GARCH results, which show a much larger peaks around 1977 and 1986 as compared to 90s. This shows that the prices in 90s have been much more variable than in 70s or 80s. 70s and 80s had some extreme years but otherwise show lower variability. In keeping with the intra-year variability pattern, the monthly prices show a more pronounced oscillatory pattern of growth rates in 90s while in 70s and 80s, they have relatively been stable.

Brazil – The patterns of intra-year variability show that the 80s are much more variable than 70s or 90s. One distinct feature is that early 90s show a much higher variability (1991-94) compared to 70s or 80s. GARCH results show a lot of volatility clustering around 86-87 and to a lesser degree in the early 90s (1991). The low growth rates (mostly negative) in 80s and 90s combined with low standard deviation show that the prices have generally been declining in the 80s and 90s. This is also confirmed by looking at the average growth rates of monthly prices in 80s and 90s, which are mostly negative, as compared to prices in 70s.

Uganda (New York) – The intra-year variability has been more or less similar in all the three decades except for few peaks in 1977, 1986 and 1994. But, these three years appear to be years of large variability across all the major coffee markets in the world and Ugandan market is no exception. GARCH results also show clustering of volatility in these years and lend support to the ratio method estimates. Monthly

prices do not display any uniform pattern in movement except for a slight dip during June-July, which is observed in all the three decades.

10. ***Tea:*** The markets included in the analysis are the Sri Lankan auctions and the London auctions. In London auctions market, the intra-year variability has shown more or less similar pattern in all the three decades. But in Sri Lankan auctions market, 70's and 80's were more variable compared to milder 90's. The year 1977 appears to have caused a major disturbance in world tea markets as both markets display an unusually high intra-year variability for that year. A similar thing is observed in both markets again in the early 80's – 1982 and 1983. These years need a closer scrutiny to understand this anomalous behaviour better. The GARCH results, which show a major spike in these years, support this inference.

    London Auctions – The results of intra-year variability analysis show that 80s and 90s display slightly higher variability compared to 70s. 70s show one year of major instability in 1977. GARCH results show a major spike in conditional variance around 1977-79. There are a couple of minor spikes in mid 80s and late 90s too. But for this, the tea prices in general display a near constant intra-year volatility of prices. As for monthly prices, there is a slight increase in prices between August and October in all the three decades. The standard deviation of the growth rates for all months, except for the month of March in 70s, shows a steady pattern across all the three decades.

    Sri Lankan Auctions – 70s and 80s display a much larger intra-year variability as compared to 90s. GARCH results show clustering of volatility during 76-78 and a huge spike in 1982. But for these, the prices show a smooth pattern. The inter-year variability also shows a stable pattern for all the months except March in 70s and November in 70s and 80s, across all the three decades. The average monthly growth rates show a clear pattern. After an initial increase till March, there is a decline in growth rates till July. After this, the prices recover with a dip again towards December. This pattern is more or less discernible in all the three decades.

The foregoing analysis (see the table at the end of this section) shows that the volatility pattern differs significantly across commodities and, within the same commodity, across markets and varieties. But some common features do emerge. For most of the commodities, 70s in general and mid 70s in particular is the period of high instability in prices. But surprisingly 90s too turned out to be a period of relatively high instability. Mid 90s (1995-98) in particular proved to be a period of high instability for most commodities. 80s remained tranquil for most of the commodities.

For both rice and wheat, 70s is the decade of maximum instability followed by 90s (mid 90s). The monthly prices of wheat show uniform pattern across markets but rice prices do not display any uniformity in movement. A historical analysis of the world wheat markets over the last four decades, suggests that the output and stock-holding policies of major exporters in general and US, Canada, Australia and Argentina in particular, hold large implications for price stability in world wheat markets. Production shocks in major exporting/producing countries in 1995 and the subsequent developments in world wheat markets indicate that few large exporters/producers still hold key to the stability of wheat prices in world markets.

Trends in the level and stability of Asian rice production go a long way toward explaining the trends in world rice prices. The plunge in world prices from 1982-1984 coincided with a sharp increase in per capita rice production in Asia. At the same time that the level of per capita production has increased during the past half-century, it has also become more stable. The magnitude of year to year fluctuations in per capita production has been markedly lower in the past 15 years than it was previously. This improvement in the stability of per capita production is most likely due to two major technological influences. First, the proportion of rice grown under irrigated conditions has increased over time. Reliable supplies of water have substantially reduced production fluctuations relative to a situation where production relies solely on the vagaries of rainfall. Production stability has been further enhanced by the development of modern pests and disease resistant rice varieties.

For palm oil, 80s is the decade of maximum price variability and the monthly prices do not show any uniform pattern across decades. For coconut oil, 70s displayed maximum instability with increase in price volatility in mid 70s and mid 80s. The growth rates of monthly prices do not show any uniform pattern. For groundnut oil and soybean oil markets also, 70s is the decade of maximum instability.

In case of sugar, 70s and 80s recorded high instability in all the markets, particularly in mid 70s (1975-76). The monthly prices do not show any uniform pattern. In case of cotton, except US markets, 80s and early 90s is the period of highest volatility. For US markets however, 70s recorded maximum volatility. In coffee markets, there does not appear to be any uniform pattern either in intra-year variability or in the monthly movements of prices across markets. In case of tea, mid 70s (76-79) has recorded maximum variability in prices. The monthly movements do not show any uniform pattern across the two markets analysed.

Patterns of Price Movements in International Markets

S.No	Crop	Market	Intra-Year Variability	GARCH Results (Years with spikes in conditional variance)	Pattern in Monthly Prices Across Decades
1	Wheat	Sydney	70s > 90s 80s stable	Spikes in 1974-76, 1996-97	Jan-Apr stable. Decline till June. Rise June-Oct Dip after October
		Australian f.o.b prices	80s>90s>70s	1984-85 and 1989-90	No Uniform Pattern
		US Gulf Ports	70s > 90s 80s stable	1975-77, 1996-97	Same as Sydney market
		Argentina	70s > 90s 80s stable	1974, 1991, 1996	Same as Sydney market
2	Rice	New Orleans (US)	Highly variable 70s 80s, 90s stable except 94	70s, 1994	No Uniform Pattern
		Bangkok	90s>70s>80s	1974-77, 1995-98	No Uniform Pattern
		Thai f.o.b. prices	70s > 80s > 90s	1974-75	Jan-March rise Decline Apr-Aug Rise Aug-Oct Dip after Oct
3	Palm Oil	N.W.European Markets	80s > 70s 90s stable	Mid 70s, Mid 80s	Peaks Jan, Jul, Aug Troughs May-Jun, Oct-Nov
		Malaysian f.o.b. prices	90s > 80s 70s stable	90s and 80s	No Uniform Pattern
4	Coconut oil	New York market	70s > 80s 90s stable	1974-75, mid 80s	Peaks Jan, Apr, Nov Troughs Feb, Aug, Dec
		Philippines market	70s > 90s 80s stable	Mid and late 70s mid 80s, late 90s	No uniform pattern
5	Groundnut oil	European market	70s > 80s 90s stable	1974,1976,1984	No uniform pattern

(Contd….)

6	Soybean Oil	Dutch Ports	70s > 80s 90s stable	74-75, 78-79, 84-86	Peaks Mar, Apr, Jul Troughs Feb, May, Aug, Oct-Dec
7	Sugar	EU Import Price	70s most unstable 80s and 90s stable	75-76	No uniform pattern
		Caribbean Ports - New York maket	70s > 80s 90s stable	1975	Peaks May-Jul Troughs Sep
		US Import Price	70s most unstable 80s and 90s stable with one blip in 1981	1975, early 80s	Peaks Jun-Aug Dip around Sep Some increase after Sep
		Brazil	80s > 70s 90s stable	74-76, entire 80s	No uniform pattern
8	Cotton	US (10 markets)	70s > 80s 90s stable	74, 77-78, 95	Highest variability in August
		Liverpool index	80s > 90s > 70s	Entire 80s	Decline till Aug Increase thereafter
		Egypt (long staple)	80s, 90s unstable 70s stable	1988-93	No uniform pattern
		Egypt (long medium)	70s, 90s unstable 80s stable	1989-92	Stable prices between May-Jul Oscillatory growth rates for other months
9	Coffee	New York (other milds variety)	90s > 70s > 80s	95, 98, 77-80, 86-87	Troughs Jun-Jul Maximum variance Mar, Jul
		New York (Brazilian variety)	90s > 70s > 80s	77, 86, 90 s	No uniform pattern
		Brazil	80s > 70s > 90s (early 90s)	86-87, early 90s	Low growth rates in 80s and 90s
		New York (Ugandan Variety)	Uniform	75, 86, 94	No uniform pattern Dip in Jun-Jul
10	Tea	London Auctions	Nearly constant except in 1977	1977-79	Increase between Aug-Oct
		Sri Lankan Auctions	70s most unstable 80s and 90s stable	76-78, 82	Rise till Mar Dip till Jul Increase after Jul with a dip in Dec

V Agricultural Price Volatility in Major Domestic Markets

Rice

i) Kakinada : The average intra-year variability in the 90s (7%) is relatively higher than in the 80s (5%). The inter-year variability does not show any such difference between 80s and 90s, which is about 10%. The average growth rates show a dip between December to February and rise thereafter till July. There is no clear observable pattern after July till December in this market.

In the Kakinada market, the data is trend-stationary. An AR(1) model has been fitted to the data and there is no evidence of volatility clustering. All the diagnostic statistics show the desired results.

ii) Patna: The average intra-year variability does not show much difference between 80s and 90s in this market. However, in 2 years in the 90s (1994, 2000) out of 10 (20%), the intra-year variability was greater than 150% of the decadal average while in the 80s there was none.

The inter-year variability does not reveal much difference between the two decades either. The average growth rates of monthly prices show that there is a general dip in prices between September and December and a continuous increase between April and August. Between December and April, there is no clear pattern.

Data in this market is I(1). A GARCH (1,1) model is fitted and there is evidence of explosive behaviour in volatility patterns in prices (ARCH coefficient >1).

iii) Karnal: The average intra-year variability is not very different for the two decades in this market. But 3 years (1982,1983,1985) out of 11, which is 27%, show higher degree of intra-year variability in the 80s. In the 90s there is only 1 such year.

The inter-year variability of annual average prices shows substantial difference between the two decades. The inter-year variability is much higher in the 90s than in the 80s. The average growth rates are also much higher in the 90s (12%) than in the 80s (5%). The monthly price movements, as can be seen from average growth rates of monthly prices, do not show any specific pattern in 90s. However in the 80s, the prices show positive growth rates for all months except January.

iv) Bangalore: The average intra-year variability in this market is higher in the 80s as compared to 90s. The variability is much higher during 1985, 1986 compared to remaining years in the decade.

In contrast, there is hardly any difference in the inter-year variability of annual average prices between the two decades. The month-wise figures show that the variability is higher at the beginning of the year, particularly during January-March. The average growth rates do not reveal any specific pattern in the monthly price movements.

The data is trend-stationary. An AR(3)-ARCH(2) model fits the data well. The ARCH, GARCH coefficients satisfy the non-negativity constraints and their sum is less than 1.

Wheat

The intra-year variability in Karnal and Moga is higher in the 90s than in 80s while in the other two markets of Hapur and Bahraich, 80s show higher intra-year variability. But, the inter-year variability is consistently higher in the 90s in all the markets, as compared to 80s. One interesting feature is that the inter-year variability is highest for the month of April in all the markets, perhaps due to large scale arrivals of wheat harvests in the markets.

The monthly price movements show a distinct pattern in all the markets. There is a general dip between February and April/May and, then a steady rise, shown by continual positive growth rates, till January after which they again start declining. The observed dip in prices may be due to the arrival of harvests in the wheat markets between February and April.

i) Karnal: In this market, 90s show higher intra-year as well as inter-year variability than 80s. The average growth rates of monthly prices reveal that the prices tend to show a decline between February and May and an increase thereafter till January next, with the exception of August (when there is a slight dip)

The data is trend-stationary. An AR(1)-GARCH(1,1) model is found adequate for this market. Price-tranquillity is observed in this market for the entire study period except for one major spike in 1999.

ii) Hapur: In this market, the intra-year variability is slightly higher in the 80s while the inter-year variability is much higher in the 90s. The inter-year variability is highest for the month of April. The average growth rates of monthly prices show that ther is a general dip in prices between February and April. Thereafter, there is a slight recovery in the months of May-June but the recovery is only marginal. The prices begin to rise in the right earnest only from July and reach their peak in January.

The data is trend-stationary. An AR(1)-GARCH(1,2) model has been found adequate. There is evidence of increased volatility in this market between 1982-84, 1992-94 and 1997-98.

iii) Bahraich: The trend in this market is very similar to that in Hapur. The intra-year variability and inter-year variability is higher in the 90s than 80s. The inter-year variability is highest for the month of April. The monthly growth rates show that there is a dip in prices between February and April, with April recording the

maximum decline in prices. The prices begin to recover from May onwards, first modestly and then quite rapidly to reach their highest level in January next.

The data is I(1). An ARMA(1,1)-GARCH(2,2) model has been fitted. There is an increase in volatility in early 80s. There is a lot of volatility clustering from 1980-1984.

iv) Moga: In this market, the average intra-year variability for the 90s is higher (7.22%) than 80s (6%). However, there appears little difference in the number of years showing higher intra-year variability than decadal average. Both decades have 2 such years each out of a total of 11, about 18%.

The inter-year variability of annual prices is higher in the 90s (12%) than 80s (5%). The average growth rates of monthly prices show a distinct pattern. The prices appear to rise from September to February and then show a dip in March and April. This could be due to glut in the market during the period of harvest.

Groundnut Oil

i) Chennai: The pattern.of intra-variability is similar in both the decades in this market. The inter-year variability is also similar across the two decades. The notable feature is that the inter-year variability is quite high during the months of May to October. The average growth rates of monthly prices also show an oscillatory pattern in this market. Prices show a slight increase in January followed by a dip in February and March. This is again followed by an upward movement from March to August followed by a decline from September to December.

The data is I(1). ARMA(1,1) model fits the data reasonably well. There is no evidence of ARCH effects and volatility clustering in this market.

ii) Mumbai: The average intra-year variability is nearly the same in both decades. The average inter-year variability of annual prices is also the same in both the decades. The inter-year variability of monthly prices rises slightly during the months of June-July. The average growth rates do not reveal any significant pattern in monthly price movements except that the prices appear to dip during the last four months of the year – from September to December.

Coconut Oil

Cochin: The average intra-year variability is higher in the 90s (10%) than 80s.(7%). 1996, 1997 appear to be years of high intra-year variability of 18% and 15% respectively as against a decadal average of 10%.

The inter-year variability of average annual prices is very high for the commodity – 30% in the 80s and 23% in the 90s. The average growth rate of annual prices is also quite high in the 90s (6%) as compared to 80s (1%). The movement of growth rates of monthly prices shows that there is a general dip in the coconut oil prices during the first three months of the year. The prices show an upward movement between June and August. There is no clearly discernible pattern for the remaining months.

The data is I(1). An AR(1)-GARCH(1,1) model fits the data satisfactorily. There is evidence of increased volatility of coconut oil prices after 1996 and there is a lot of clustering of volatility during 1996-97.

Sugar

i) Bombay: The intra-year variability is more or less similar in the two decades. The inter-year variability also follows a similar pattern. There is no discernible pattern in the movements of monthly prices.

The data is I(1). An AR(1,3)-GARCH(1,1) model has been fitted to the data. There is large-scale volatility during 1987, 1991 and 1994-95. However, the largest spike in volatility is observed in 1996.

ii) Hapur: The intra-year and inter-year variability is substantially higher in the 80s than in the 90s. The average growth rates of monthly prices reveal that there is a slight increase in prices during February to June months and a dip during August to December.

The data is I(1). An AR(2)-GARCH(1,1) model is found adequate. One major spike in volatility is observed in the year 1996.

iii) Calcutta: This market also displays a trend similar to that of Hapur market. The intra-year as well as inter-year variability is substantially higher in the 80s than in the 90s. There is an increase in prices during the months of April and May. There is no clear pattern during the remaining months.

The data is I(1). An ARMA(2,1)-GARCH(1,1) model is found to fit the data well. Large increases in volatility are observed in 1991 and 1996.

It may be noted that 1996 turns out to be an year of high volatility for sugar prices in all the three major markets.

Coffee

Coimbatore: The coffee prices show extremely high intra-year variability in the 90s as compared to 80s. The figure for 90s is 41%, which is 8 times more than the figure for 80s, 5%. This is mainly due to the extremely high fluctuations in coffee prices during 1993 to 1999.

The inter-year variability of average annual prices is also extremely high (164%) in the 90s as compared to 80s (8%). The inter-year variability appears particularly high

for the months of April, May, July and August. The average growth rates do not reveal any pattern in the monthly price movements of coffee in this market.

Cotton

Abohar: The average intra-year variability in this market is substantially higher in the 90s (15%) than in the 80s (7%). The years 1991,1998 and 1999 show very high intra-year variability. The annual prices show a high degree of inter-year variability in both the decades – 22% in the 80s and 31% in the 90s. The monthly prices also show a high degree of inter-year variability in the 90s as compared to 80s. There is no pattern in the monthly price movements which can be discerned from average growth rates.

The data is trend-stationary. An AR(1)-GARCH(1,2) model fits the data well. There is evidence of large spikes in volatility in late 90s, particularly after 1998. This may be due to the problems in domestic cotton production, mainly due to pests during this period.

The foregoing analysis can be summarised as follows.

Domestic wheat markets show higher intra-year variability in the 90s than 80s. There is a dip in prices between February and May and a rise between June and January. For rice, the pattern of variability is similar in 80s and 90s. A slight rise in prices is observed between March and July/August. Groundnut oil shows similar patterns of variability in 80s and 90s and show a dip in prices between September and December. On the other hand, coconut oil shows higher variability in the 90s than in the 80s. There is a general dip in prices during January- March and a rise during June-August. In case of sugar, 80s show higher variability than 90s while for cotton and coffee, it is the decade of 90s that shows larger variability in prices. The monthly price movements of none of these commodities display a specific pattern.

Patterns of Price Movements in Domestic Markets

S.No	Crop	Market	Intra-Year Variability	GARCH Results (Years with spikes in conditional variance)	Pattern in Monthly Prices Across Decades
1	Wheat	Karnal	90s > 80s	Generally tranquil prices. One major spike in 1999	Dip between February and May. Increase thereafter till January next
		Hapur	Similar Pattern in 80s and 90s	1982-84, 1992-94, 1997-98	Dip in Feb-Apr. Modest rise in June-Jul Rapid rise after July
		Bahraich	90 s > 80s	1980-84	Dip between Feb-Apr Rise from May to January next
		Moga	90 s > 80s	No GARCH effects	Dip in Mar-Apr Rise from Sep-Feb
2	Rice	Kakinada	90s > 80 s	No GARCH effects	Dip between Dec-Feb. Rise till July. No clear pattern in remaining months
		Patna	Similar Pattern in 80s and 90s	Explosive behaviour in volatility patterns	Rise between April and August. Dip between Sep-Dec. No clear pattern during Dec-Apr
		Karnal	Similar Pattern in 80s and 90s	-	No clear pattern in 90s. In 80s, positive growth rates for all months except January
		Bangalore	80s > 90s	Mid 80s, 89-90, 1993, 1995	No Specific Pattern

S.No	Crop	Market	Intra-Year Variability	GARCH Results (Years with spikes in conditional variance)	Pattern in Monthly Prices Across Decades
3	Ground nut Oil	Chennai	Similar Pattern in 80s and 90s	No GARCH effects	Oscillatory pattern. Slight increase in Jan. Dip in Feb-Mar. Rise from Mar-Aug. Dip in Sep-Dec
		Mumbai	Similar Pattern in 80s and 90s	_	No specific pattern. Slight dip during Sep-Dec.
4	Coconut oil	Cochin	90s > 80s	1996-97	Dip in Jan-Mar. Increase in Jun-Aug. No clear pattern for remaining months.
5	Sugar	Bombay	Similar Pattern in 80s and 90s	1987, 1991, 1994-95, 1996	No discernible Pattern
		Hapur	80s > 90s	1996	Rise in Feb-June Dip in Aug-Dec
		Calcutta	80s > 90s	1991, 1996	Rise in Apr-May No clear pattern in the remaining months
6	Cotton	Abohar	90s > 80s	Late 90s particularly 1998	No clear pattern
7	Coffee	Coimbatore	90s > 80s	1993-99	No clear pattern

VI Summary and Conclusions

The study shows that the decades of 70s and 90s show higher price variability for most commodities in international markets. The period 1972-75 was a period of high price volatility. The policies of major exporters like US, Canada and Australia hold large implications for price stability in international wheat markets (Sekhar 2003). For rice, Asian rice production goes a long way in explaining the price movements in international markets (BAPPENNAS 1997). In domestic markets, 90s have been the decade of higher variability than 80s for most of the commodities. Major cereals like rice and wheat display patterns in monthly movements of prices across markets. Groundnut oil and coconut oil also display such patterns to a lesser extent. Sugar, coffee and cotton do not display any clear pattern in monthly price movements.

On comparing the domestic and international markets, it has been found that the inter-year variability is generally lower in the domestic markets than the international markets. On the other hand, intra-year variability is as high in domestic markets as in the international markets, if not higher. This shows that, by ignoring the short-run fluctuations in prices through taking the annual average prices (as is normally done in calculating inter-year variability), we probably tend to underestimate the degree of fluctuations in domestic markets.

A regression analysis to identify the factors likely to affect domestic price movements shows that the output fluctuations are not significant, contrary to general expectations. The international prices appear significant in some cases. One important determinant of price fluctuations could be market arrivals but owing to lack of reliable data on this variable, such an exercise could not be undertaken.

A comparison of the monthly prices in domestic and international markets from 1990 to 2000, shows that the current bound rates of import duty are adequate for almost all the commodities except soybean oil and sugar. For most of the commodities, they are much higher than what is needed in terms of the wedge between domestic and

international prices. Therefore, for the commodities whose bound rates are much higher than the observed price wedge, the bound rates may be lowered. Such a move would strengthen our case in the negotiations for raising bound duties on certain other commodities like soybean oil and sugar, where protecting domestic producers is necessary.

In case of rice, with the lifting of domestic restrictions in April 2002, the price variation in the country is likely to decline. Therefore, the present level of bound duty is adequate. However, negotiations may be initiated for a moderate raise in bound tariffs in case of soybean oil, mainly on considerations of livelihood security and in case of sugar, for preventing the surge of cheap and subsidised imports. The present applied duty is adequate in case of all the commodities except soybean oil and sugar. There is a need to closely monitor the prices of these commodities, particularly of sugar, and raise tariffs if the surge of cheap imports becomes imminent.

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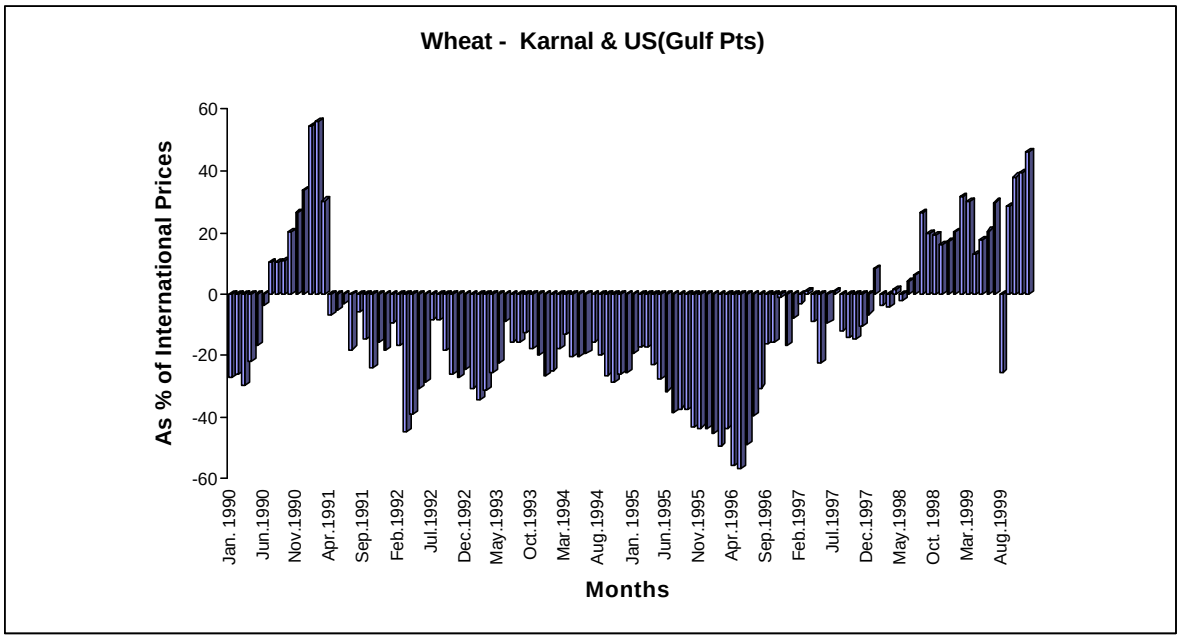
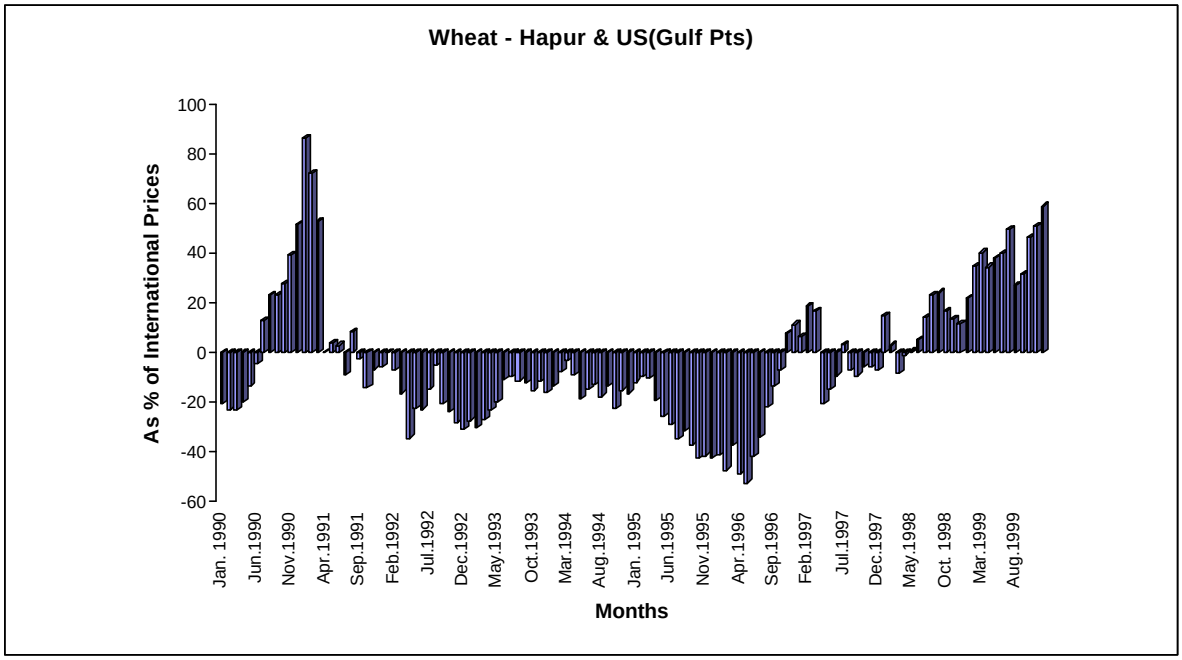
Appendix A

Wedge Between Domestic & International Prices





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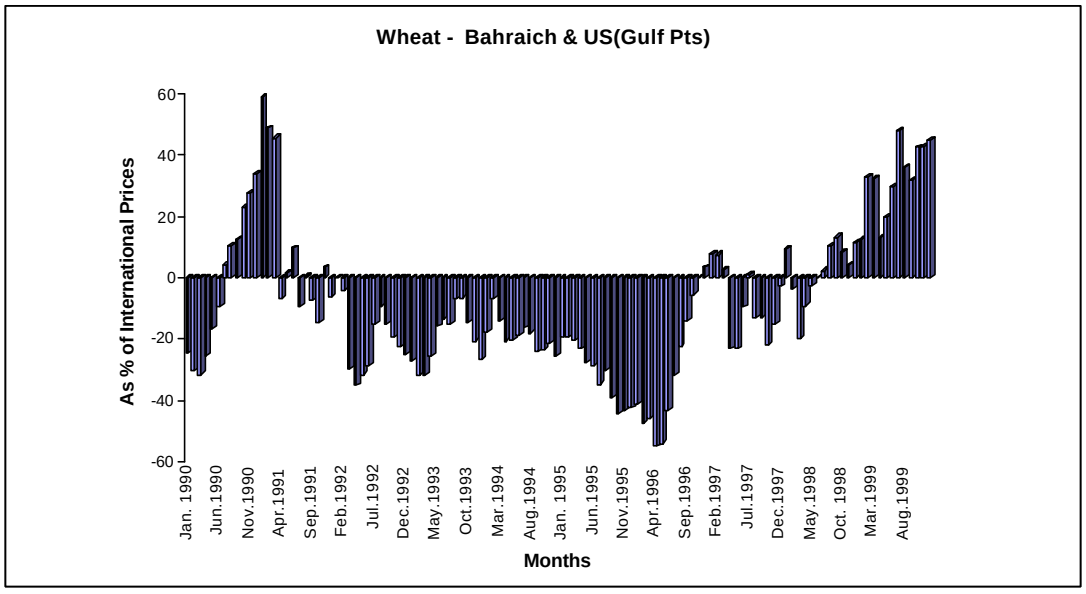

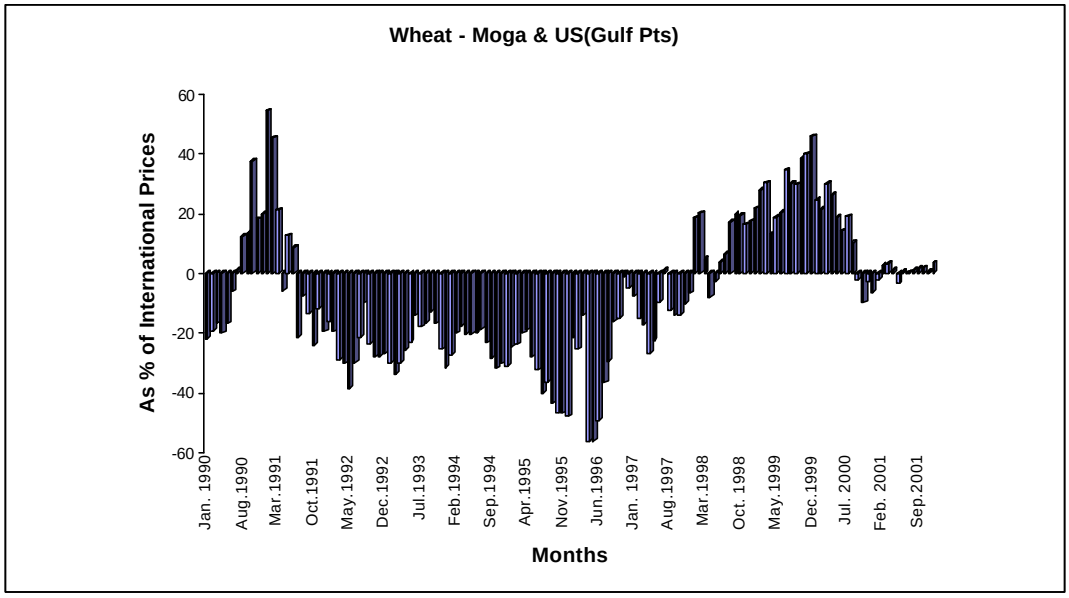

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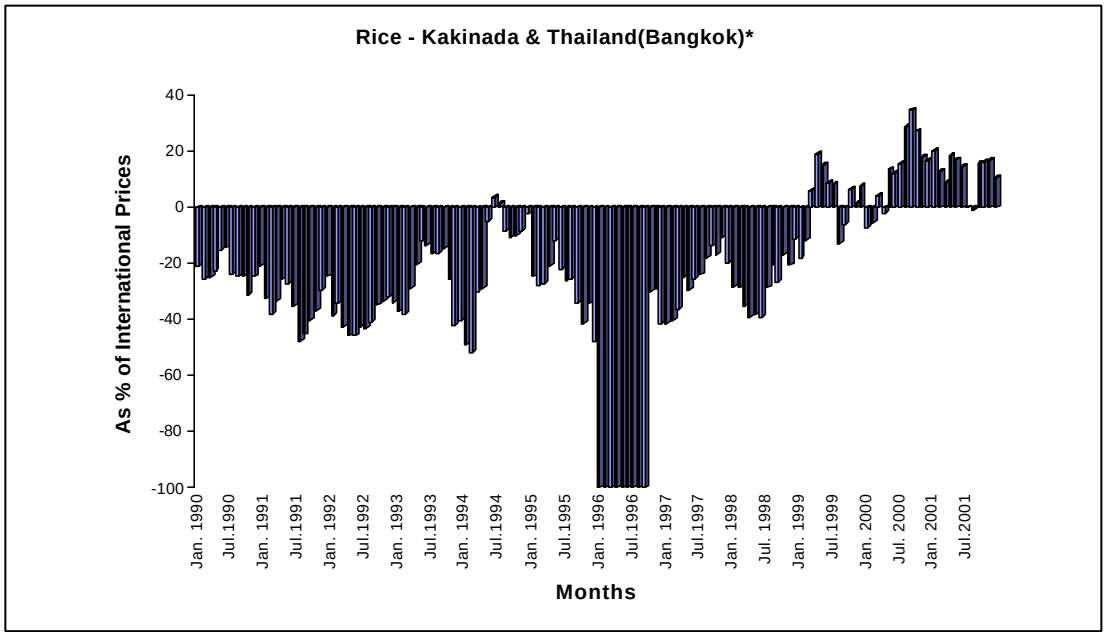

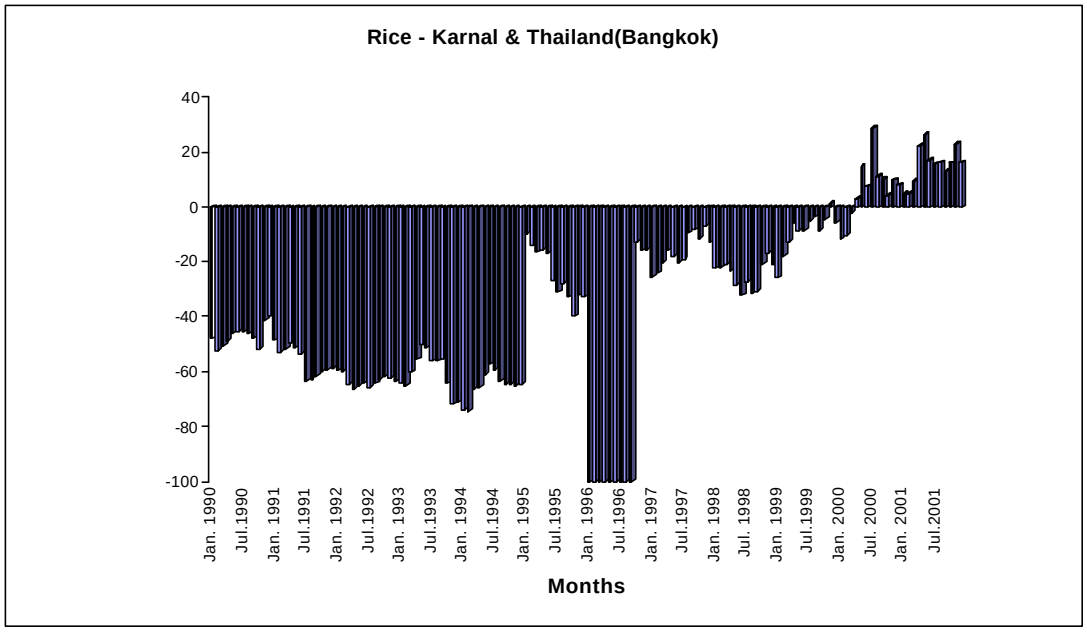

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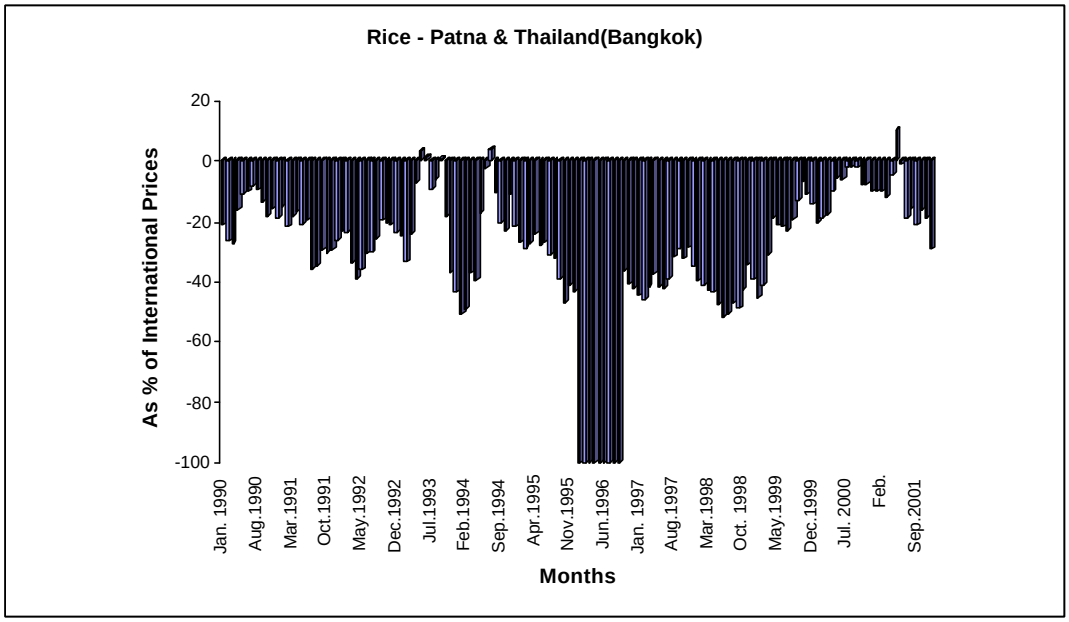

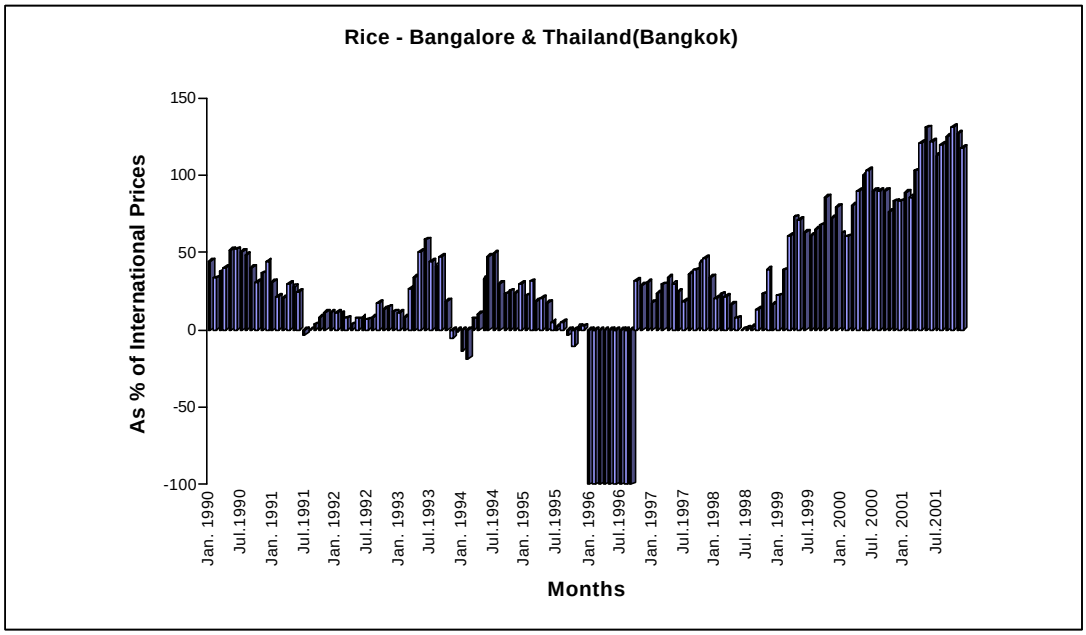

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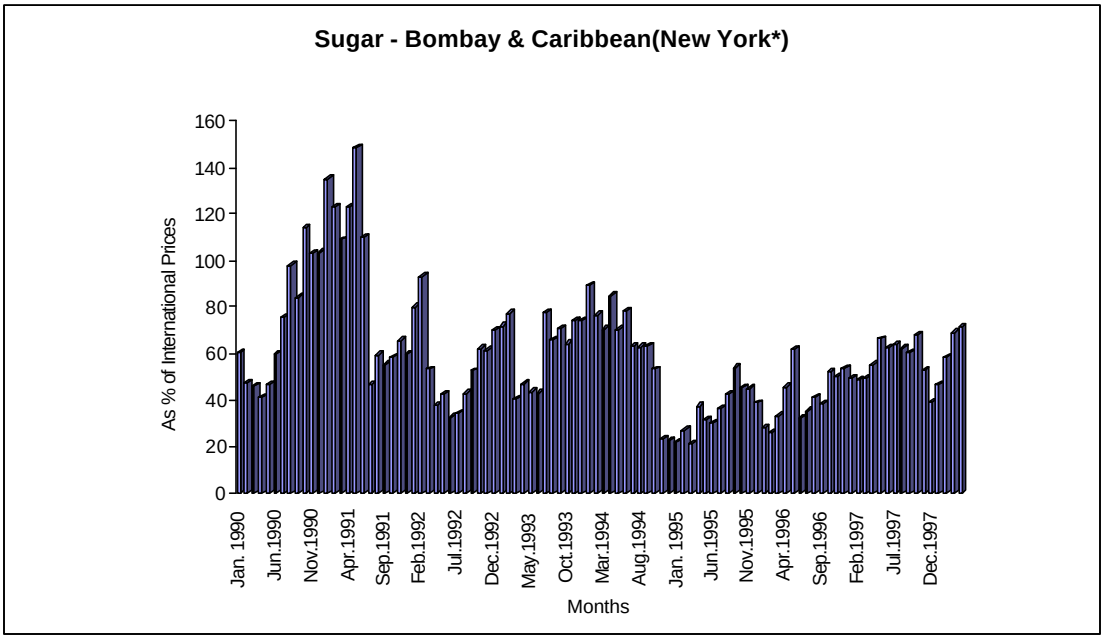

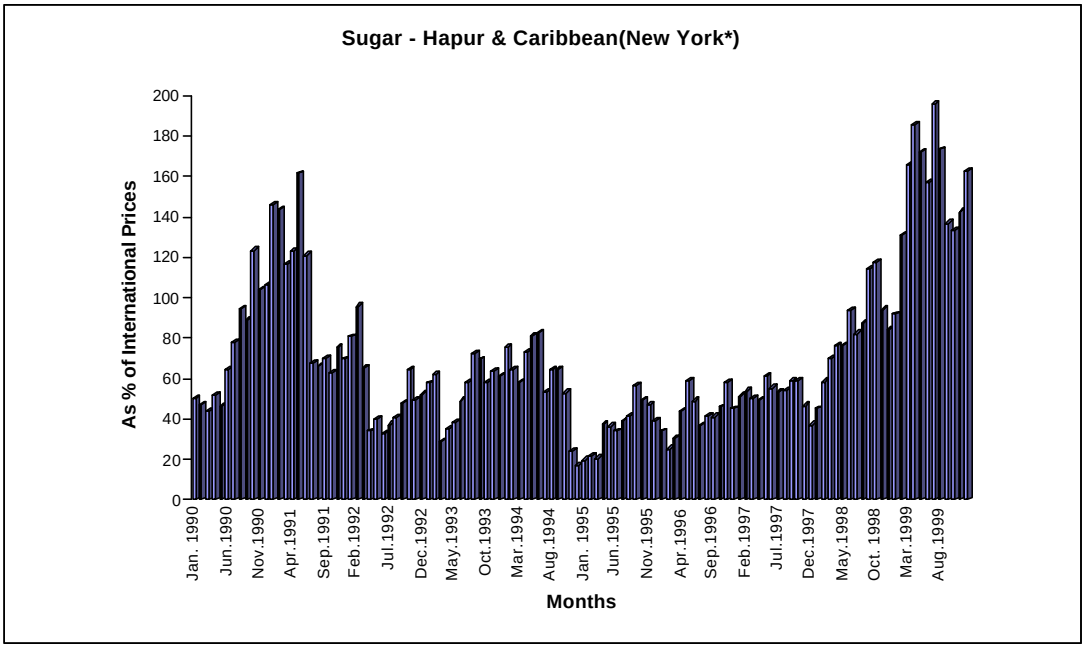

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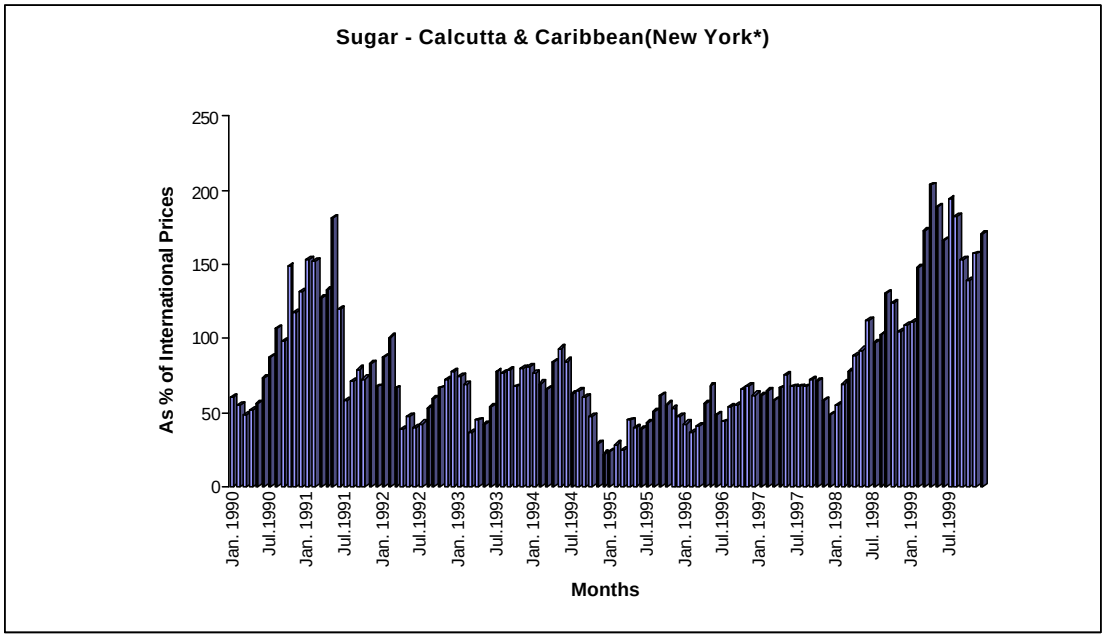

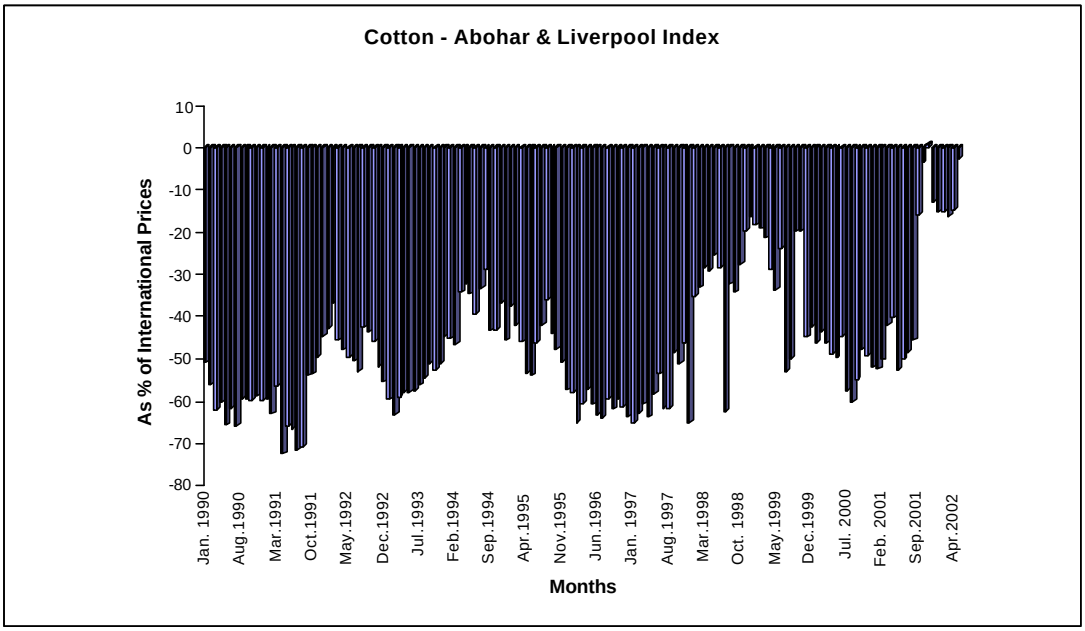

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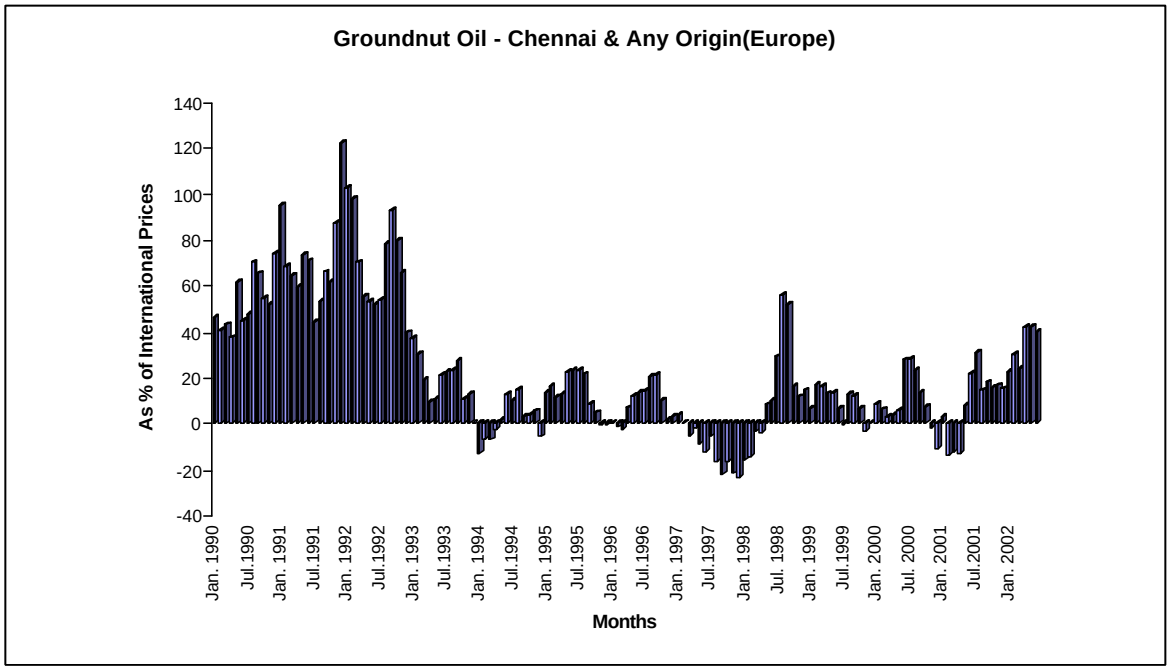

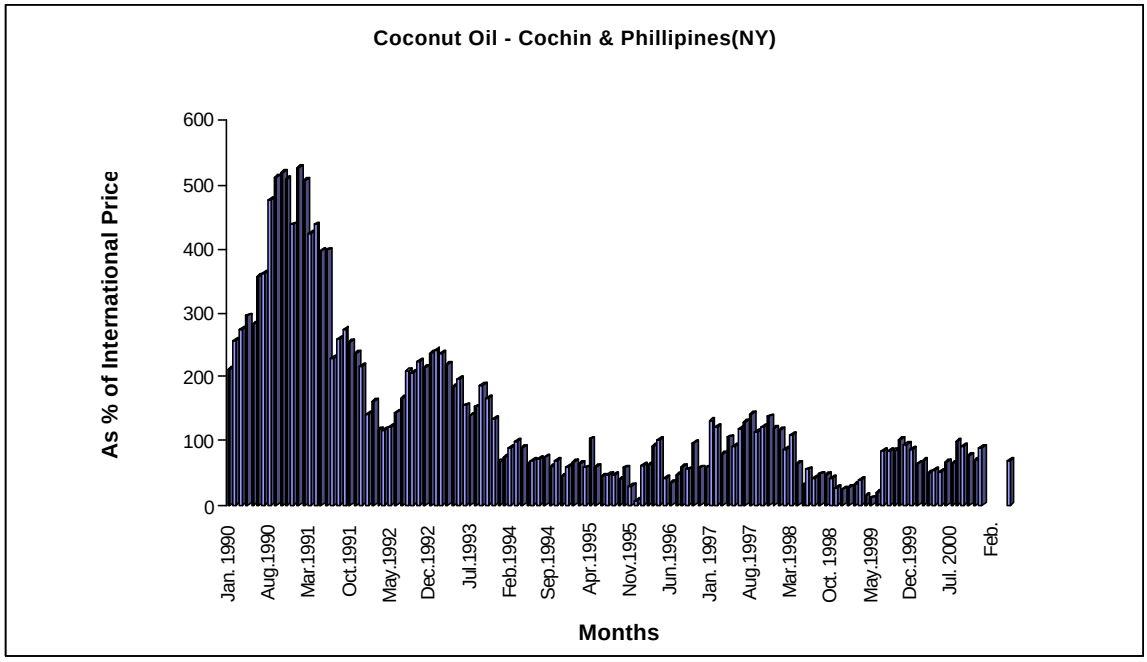

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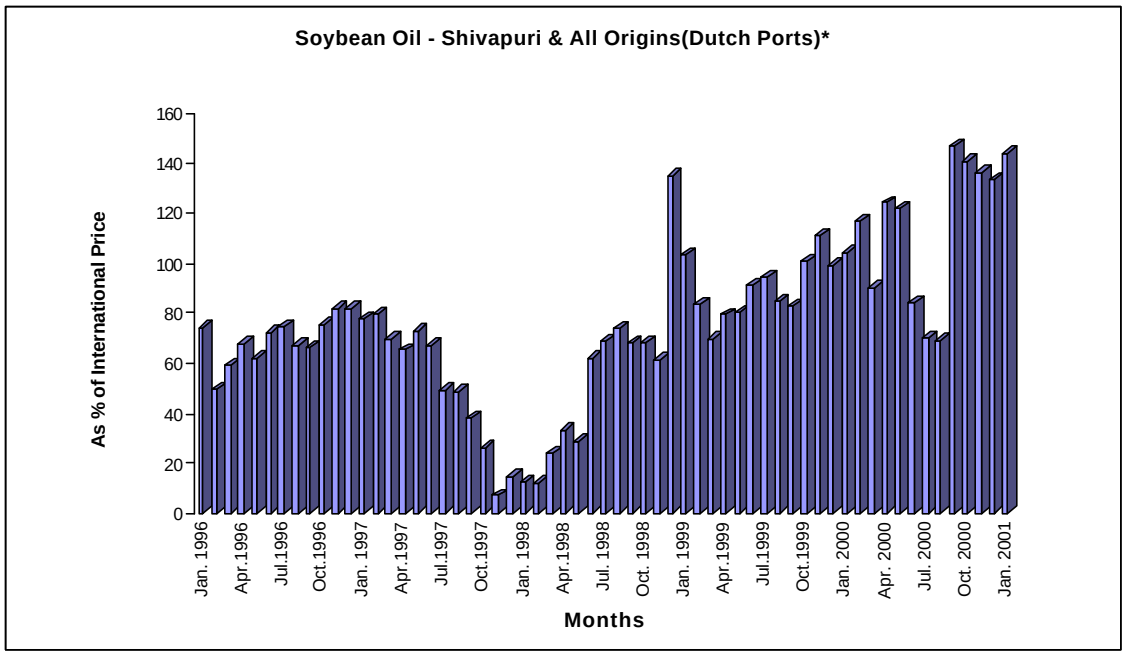
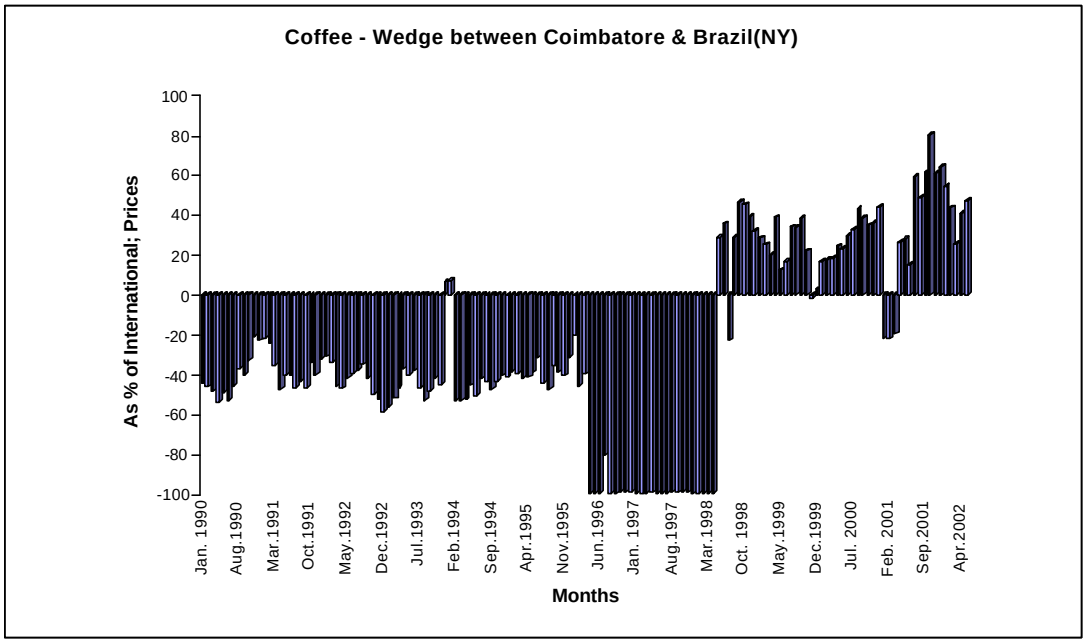
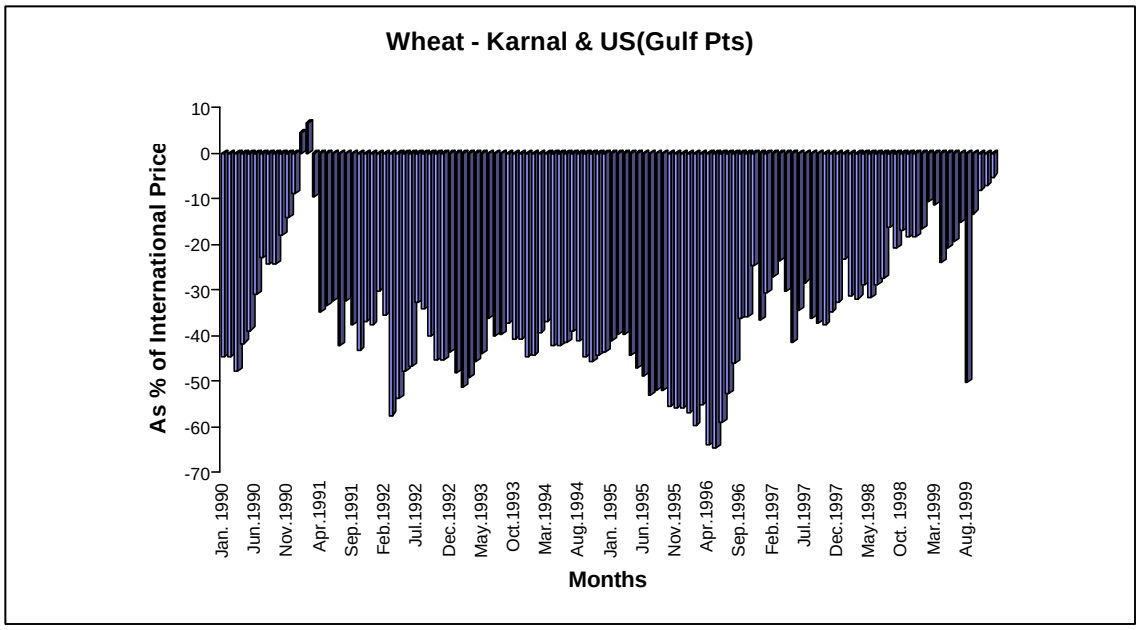
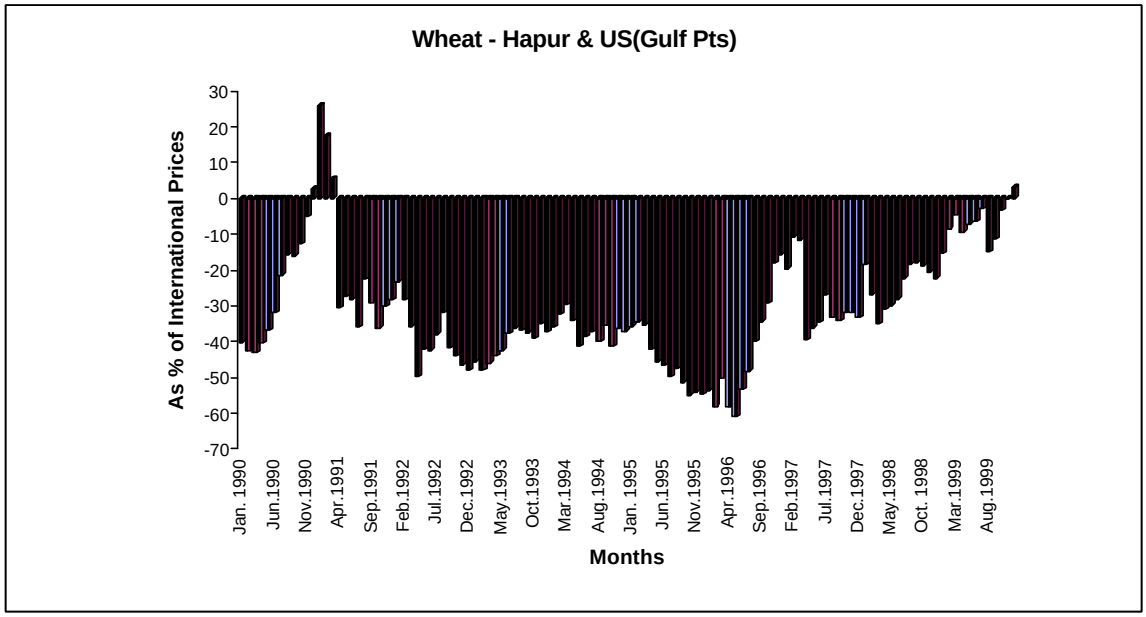




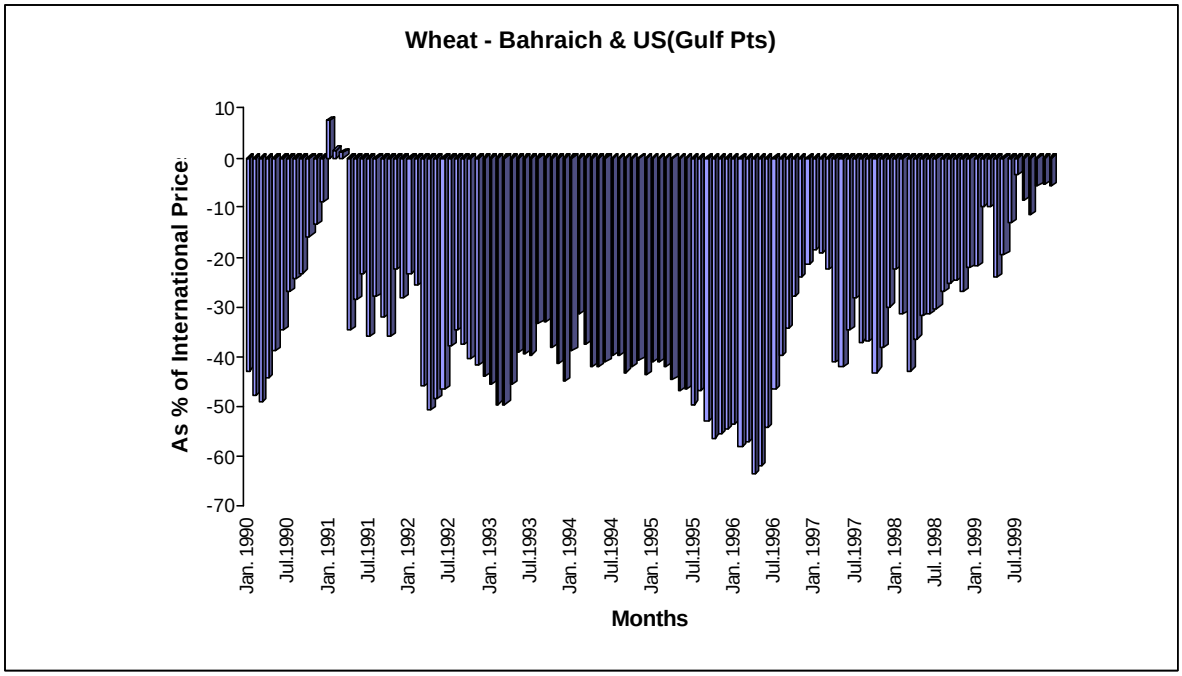
Appendix B

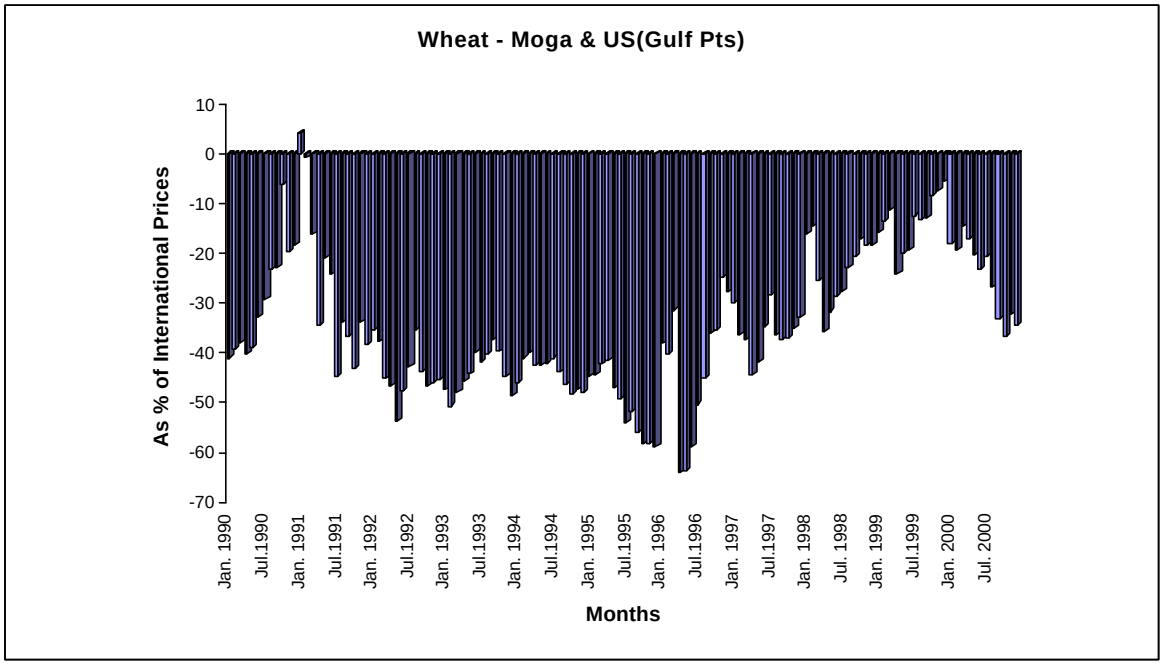
Wedge Between Domestic & International Prices (Freight & Port charges included)



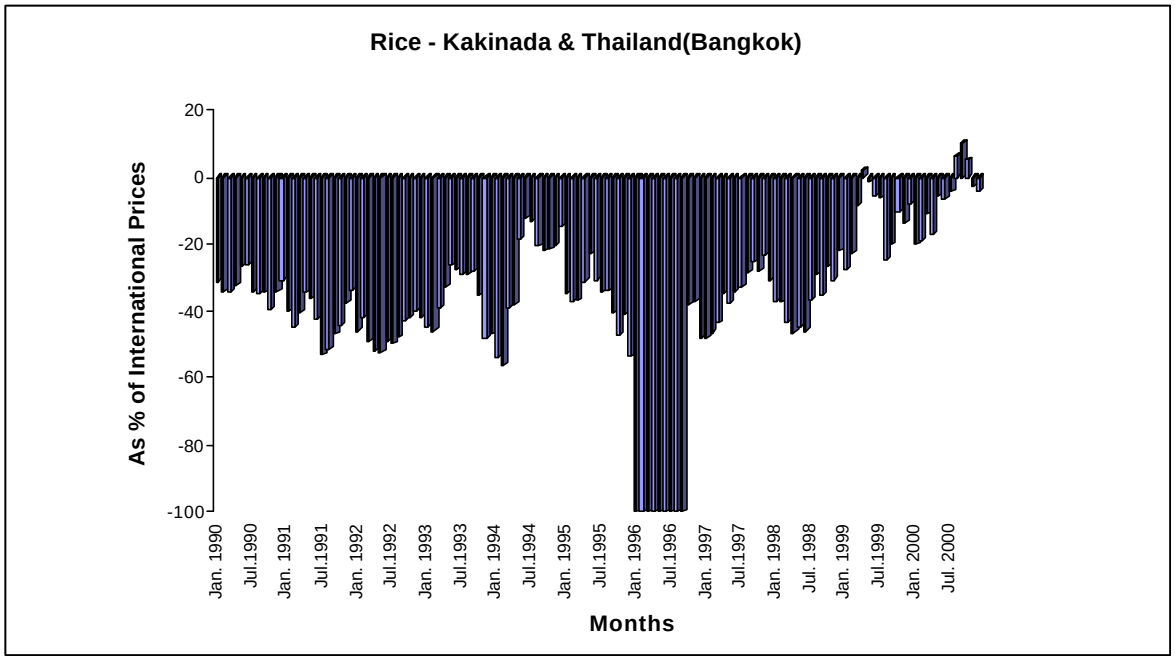


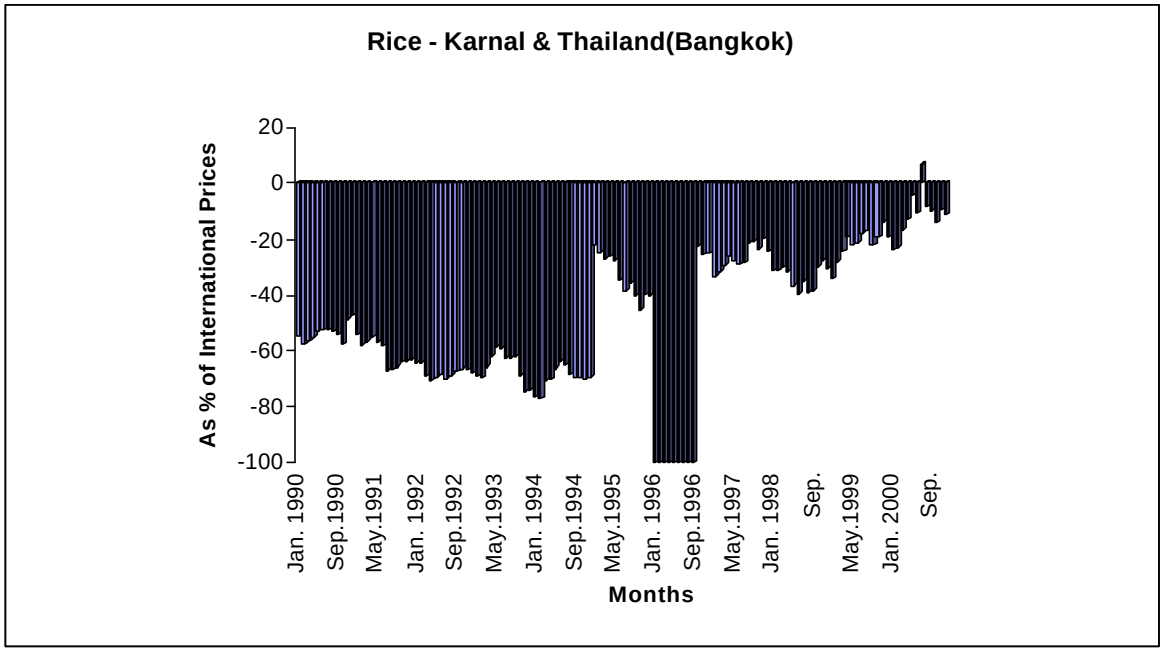
Wedge Between Domestic & International Prices
(Freight & Port charges included)





Wedge Between Domestic & International Prices
(Freight & Port charges included)





Wedge Between Domestic & International Prices
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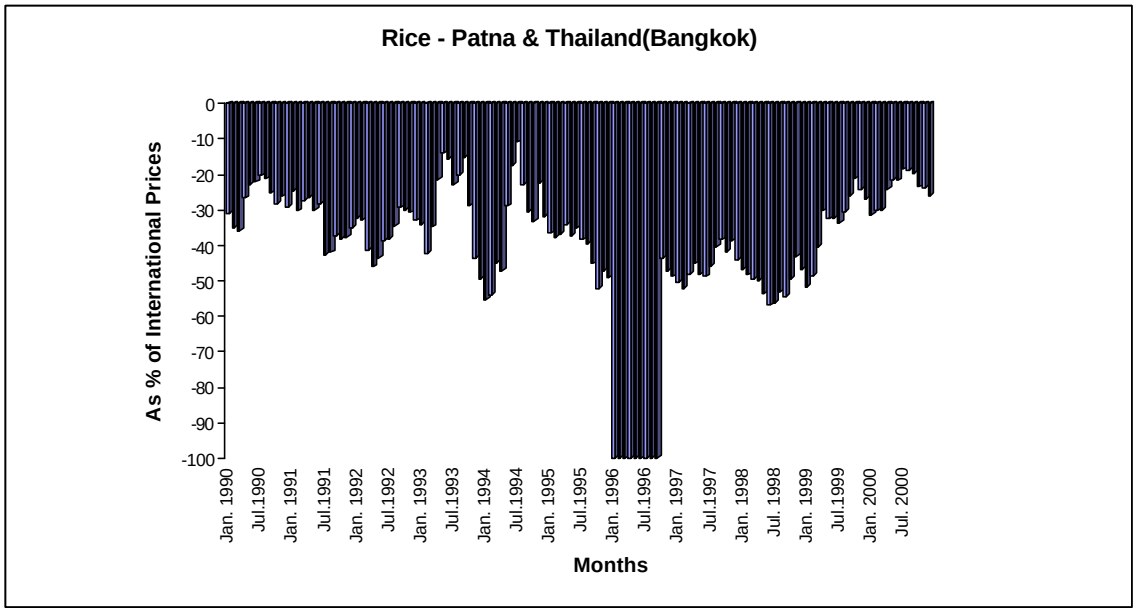

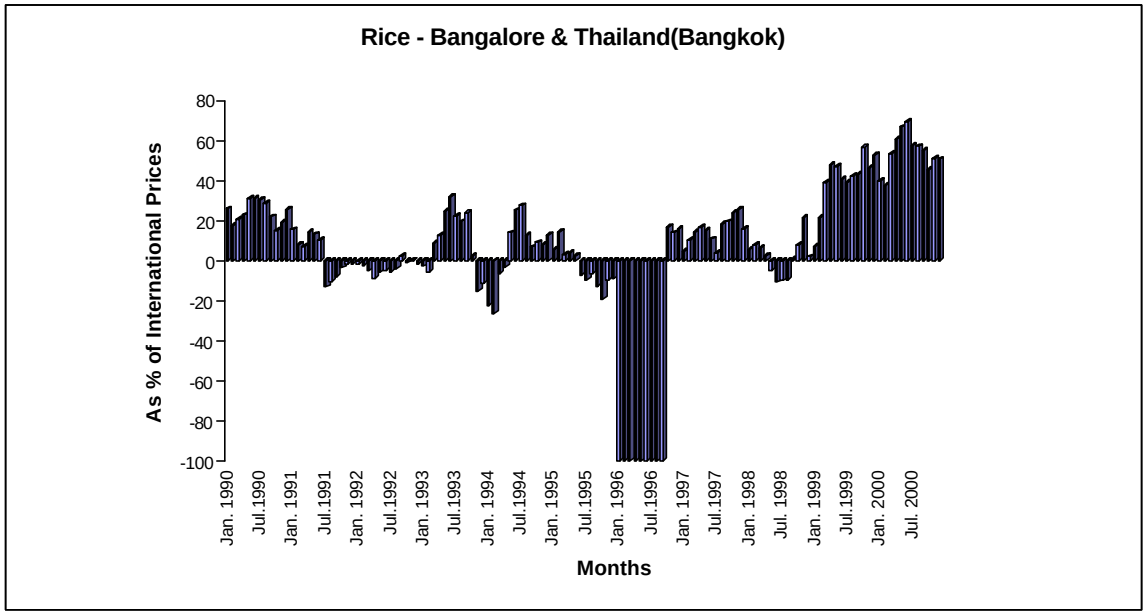

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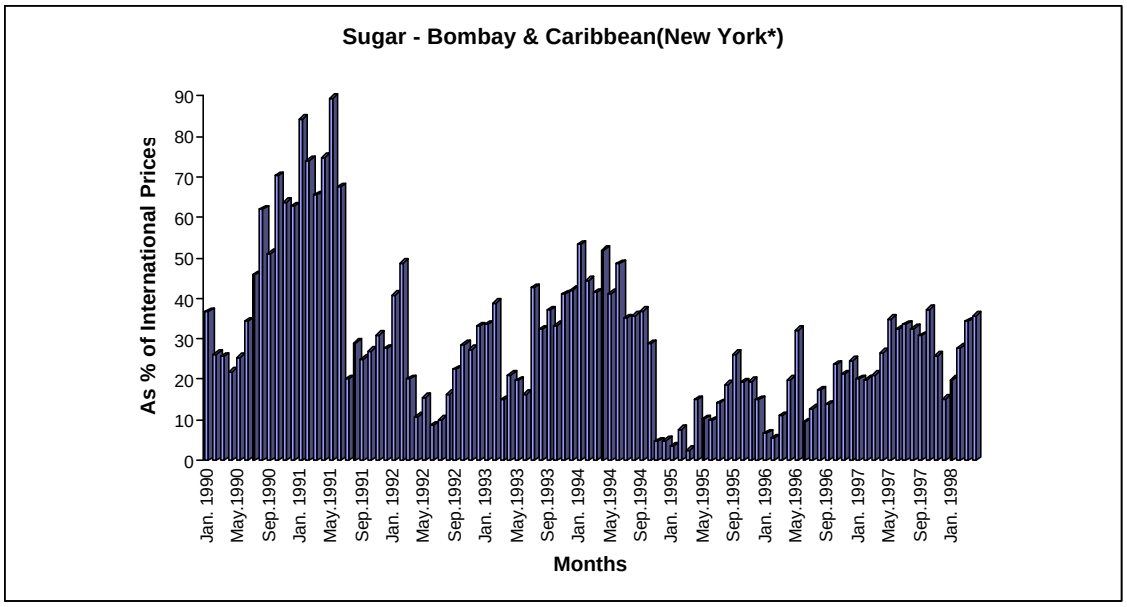
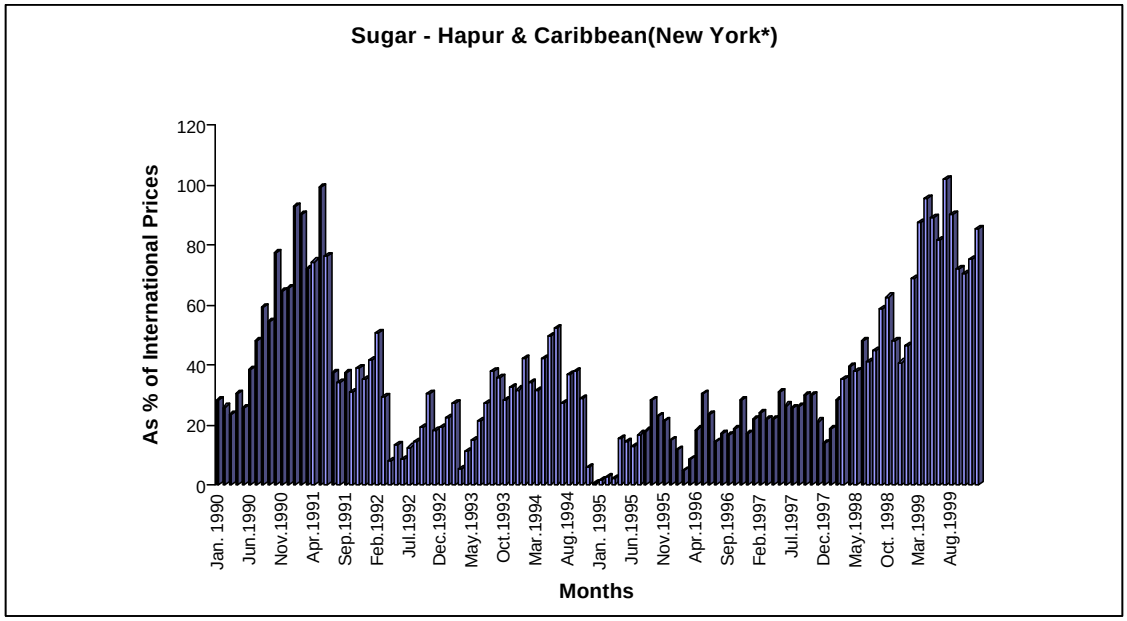
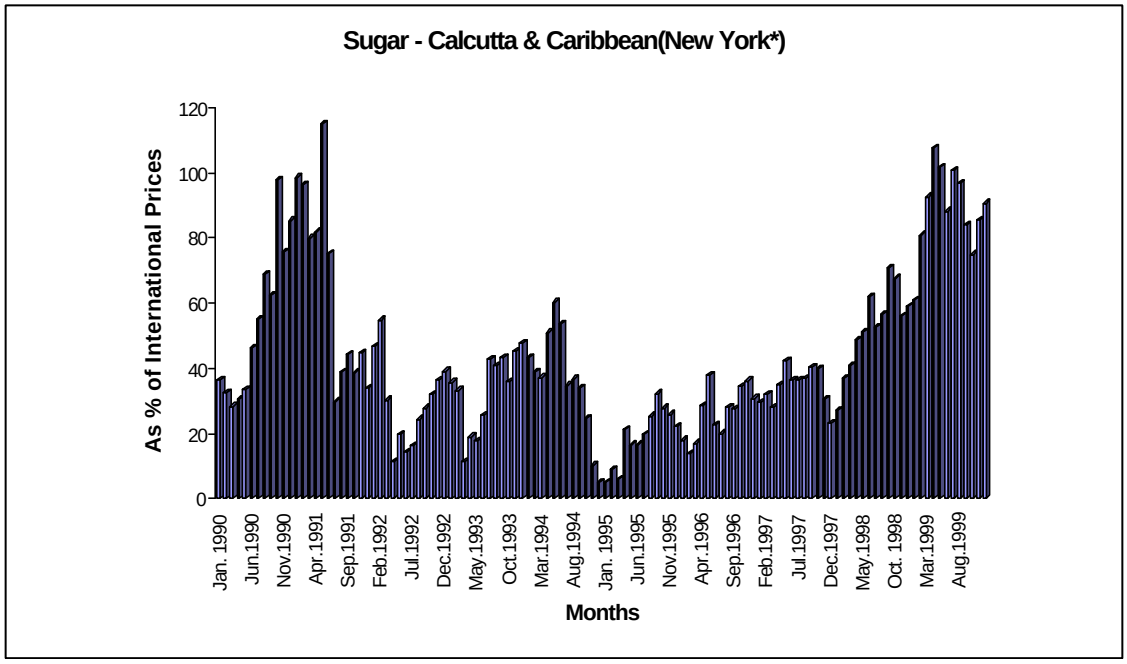
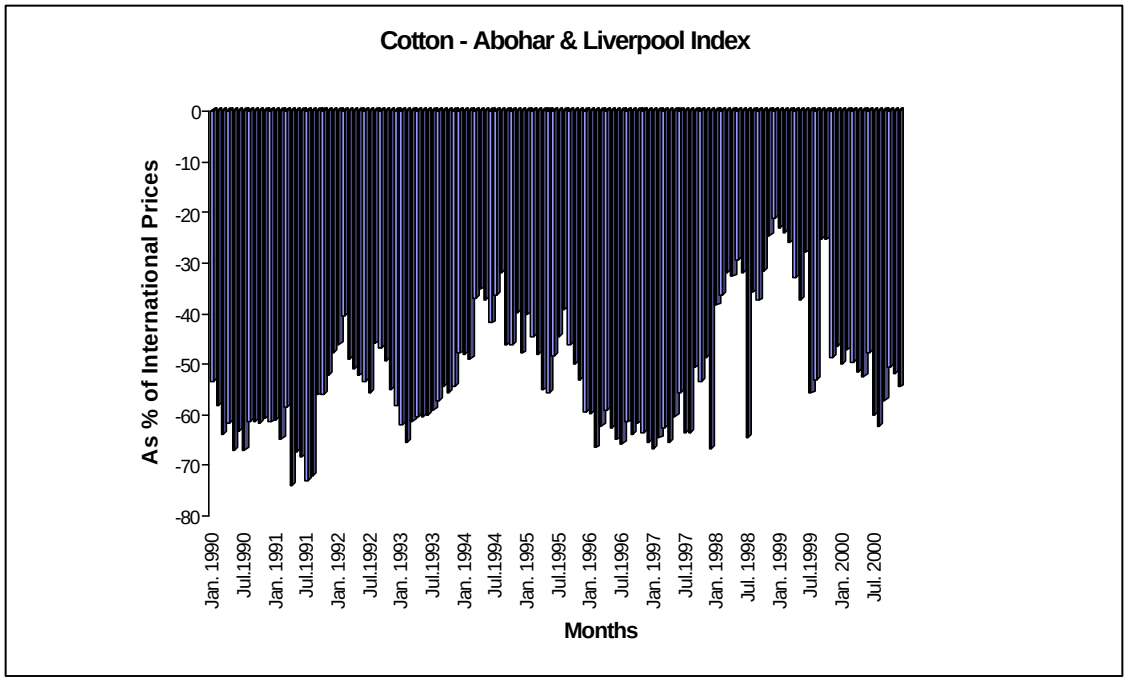
(Freight & Port charges included)



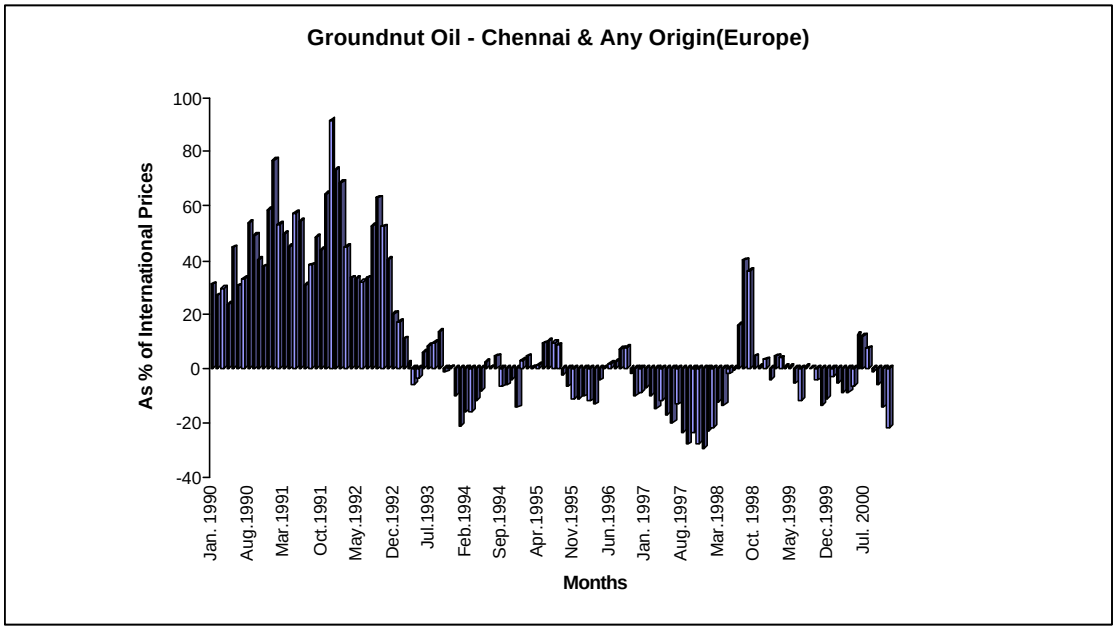


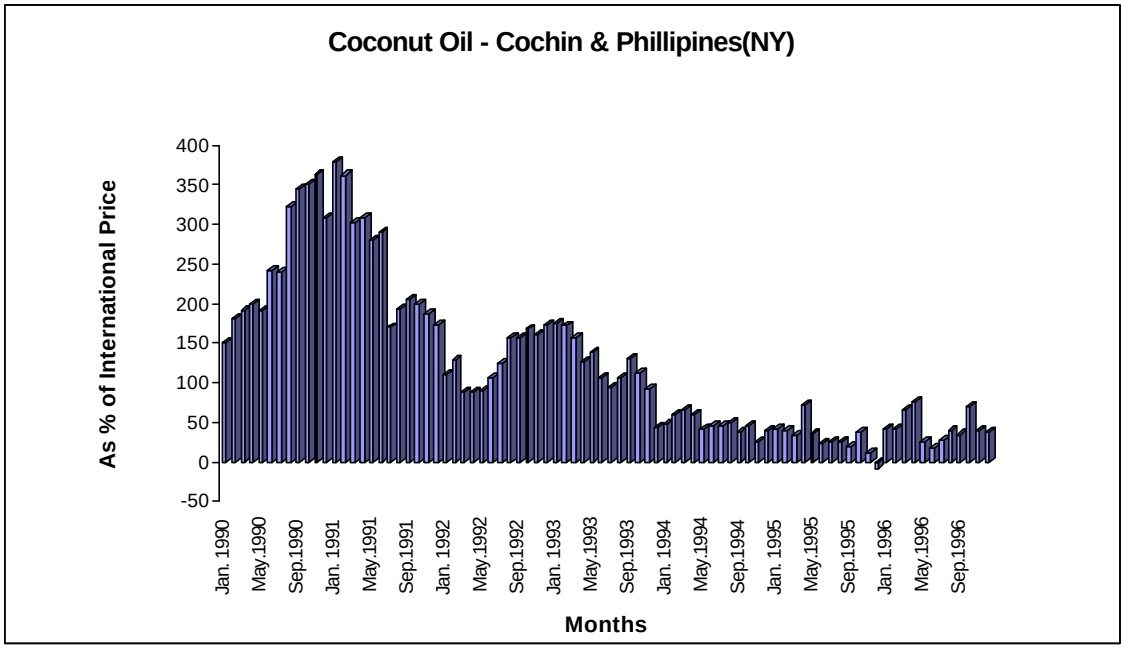
Wedge Between Domestic & International Prices
(Freight & Port charges included)



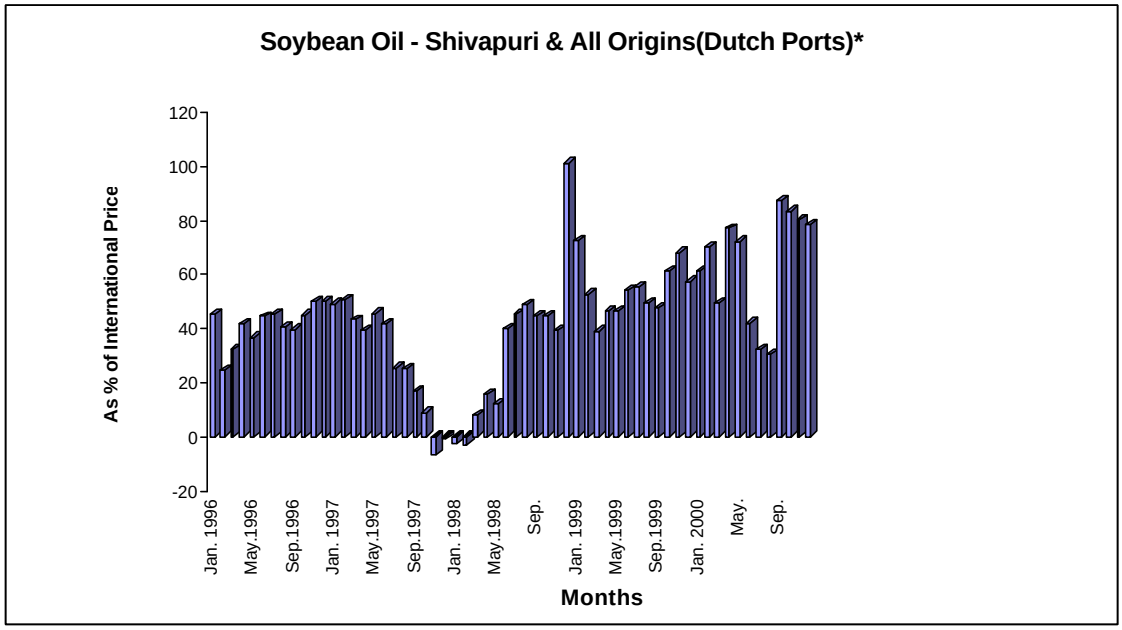


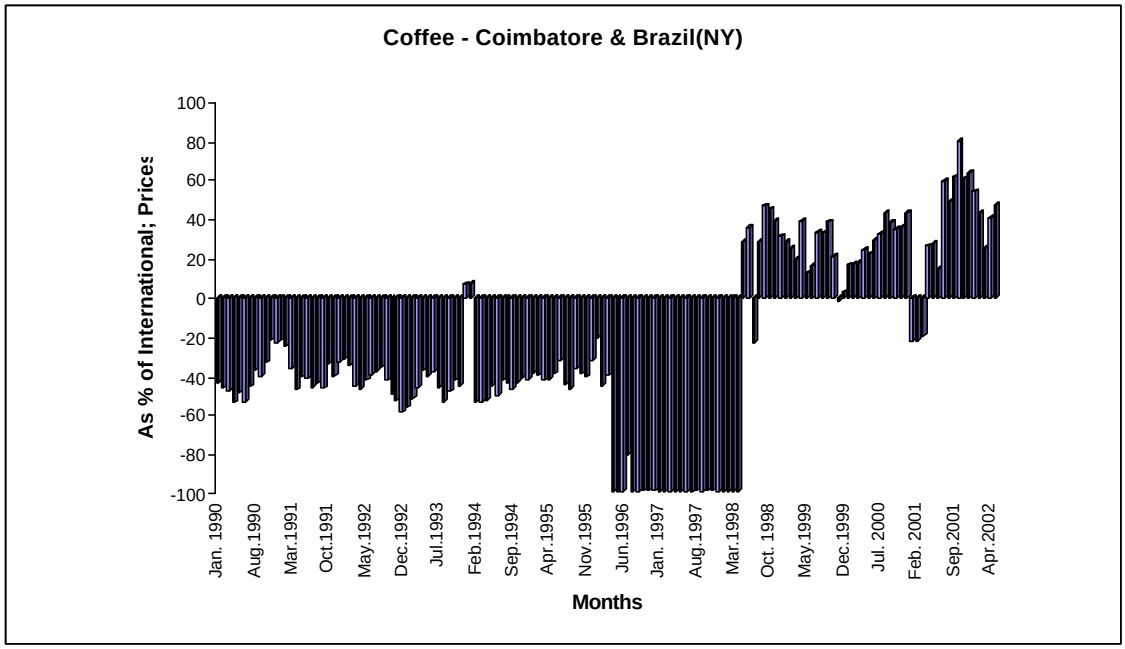
Wedge Between Domestic & International Prices
(Freight & Port charges included)





Wedge Between Domestic & International Prices
(Freight & Port charges included)





Appendix C

Units and Definitions of Varieties Used in the Study

International Sector

Coconut Oil (US cents / pound): Philippines / Indonesia (New York)*: Bulk, c.i.f. Rotterdam (*Oil World*, Hamburg) [1]

Philippines (unit value).

Coffee (US cents / pound): Other Milds* Arithmetic average of El Salvador Central Standard, Guatemala prime washed, Mexico prime washed, prompt shipment, ex-dock, New York (*Patton's Complete Coffee Coverage*, New York). [3]

Brazil (New York): Unwashed arabica, Santos No.4, ex-dock, New York. [3]

Brazil (unit value).

Uganda (New York):* Robusta: Arithmetic average of Angola Ambriz 2BB,Cote d'Ivoire Grade II and Uganda Standard. Prompt shipment, ex-dock, New York. Prior to July 1982 arithmetic average of Angolan Ambriz and 2AA and Ugandan Native Standard (*Patton's Complete Coffee Coverage*, New York). [3]

Cotton (US cents / pound): United States: Domestic grade 41, average of 10 markets, mid-month.

Liverpool Index*: Midd. $1^{3/32'}$,Liverpool Index "A", average of the cheapest five of ten styles; c.i.f. Liverpool (*Cotton Outlook*, Liverpool from January 1968 to May 1981 strict middling, SM $1^{1/16}$'; prior to 1968, Mexican $1^{1/16}$. [1]

Egypt: Giza 45, good/F.G., c.i.f. (from November 1985); --F.G. from December 15, 1983 to October 1985; 68/--F.G. from November 1981 to December 14, 1983: 68 F.G. prior to November 1981, c.i.f. Liverpool (*Cotton Outlook*, Liverpool). [1]

Egypt (unit value): Long staple ($1^{3/8}$ inches and over). Long-medium staple ($1^{1/4}$ inches to $1^{3/8}$ inches).

Groundnut Oil (US $ / metric ton): Any Origin*: c.i.f. Rotterdam (*Oil World*, Hamburg). [1] Prior to 19-4, Nigeria bulk c.i.f. U.K.

Palm Oil (US $ / metric ton): Malaysian/Indonesian*, c.i.f. Northwest European ports (*Oil World*, Hamburg). [1] Prior to 19-4, UNCTAD. [2]

Malaysia (unit value).

Rice (US $ / metric ton): United States: Milled, Zenith No.2, medium grain miller to distributor, f.o.b. New Orleans, mid-month.

Thailand*: White milled 5% broken, nominal price quotes, f.o.b. Bangkok (USDA *Rice Market News*, Little Rock, Arkansas). [1]

Soybean Oil (US $ /metric ton): Dutch f.o.b. ex-mill (*Oil World*, Hamburg). Prior to April 19-3, Dutch crude oil, ex-mill.

Sugar (US cents / pound): EU Import Price*: Unpacked sugar, c.i.f. European ports. Negotiated export price for sugar from ACP countries to EU under the Sugar Protocol (Lome Convention). (EU office, Washington, D.C.). [3]

Caribbean*: International Sugar Agreement prices, calculated in accordance with economic rule 611.3 which is an average on the New York Contract No.11 spot price and the London daily price, f.o.b. Caribbean ports (*Journal of Commerce*, New York, and International Sugar Organization, London). [3] Prior to 19-6, contract No.11, f.o.b. Caribbean and Brazil ports, spot N.Y.

US Import Price*: U.S. futures import price, contract No.14, c.i.f. New York, nearest future month (*Wall Street Journal* and *Dow Jones*, New York). [3] Prior to June 1985, U.S. spot import price contract No.12, c.i.f. New York (*Journal of Commerce*, New York, and *Weekly Review of the Market*, Coffee, Sugar and Cocoa Exchange Inc., New York).

Brazil (unit value): Raw.

Tea (US cents / pound): Average Auction (London)*: Average price received for all teas, c.i.f. U.K. warehouses (International Tea Committee, London). [1]

Sri Lanka (unit value).

Wheat (US $ / bushel): Australia: Australian Wheat Board export price.

Australia (unit value).

United States*: No.1, hard red winter, ordinary protein, prompt shipment, f.o.b. Gulf of Mexico ports (USDA *Grain and Feed Market News*, Washington, D.C.) [3]

Argentina (unit value).

Notes:
[1] Average of weekly quotations
[2] Monthly average
[3] Average of daily quotations

Domestic Sector

Rice

Kakinada – Coarse - Rs/Qtl
Patna –Coarse - Rs/Qtl
Karnal – Begmi – Rs/Qtl
Bangalore – Coarse – Rs/Qtl

Wheat

Karnal – Mexican – Rs/Qtl
Hapur – Dara – Rs/Qtl
Bahraich – FAQ – Rs/Qtl
Moga – Mexican – Rs/Qtl

Groundnut Oil

Mumbai – Ready – Rs/Qtl
Chennai – Expeller – Rs/Qtl

Coconut Oil

Cochin – Ready – Rs/Qtl

Cotton (Lint)

Abohar – Desi – Rs/Qtl

Coffee

Coimbatore – Plantation(a) – Rs/Qtl

Sugar

Mumbai – M 30 – Rs/Qtl
Hapur – Crystal – Rs/Qtl
Calcutta – Medium – Rs/Qtl