

# Seasonality in Indian Commodities Market: Insights for modeling from preceding commodity cycle

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## Abstract

In this study we analyze seasonal behavior of Indian agriculture, energy and metal commodities through the ten years of preceding Super-cycle (2003-13) by considering monthly data for near month futures prices to remove basis variance. The thrust of the paper is to investigate seasonal behavior of selected commodities in India using monthly seasonal dummies. We found seasonal variation in four commodities namely gold, barley, guar and Jeera. In a declining interest-rate scenario and Post-Covid world, there is elevated likelihood that we are going to witness the next commodities super-cycle. It is imperative for hedge fund managers, global investors, commodities traders, high net-worth individuals, market participants and spread-traders to know what to expect based on the preceding super-cycle to strategize better and address seasonality.

**JEL classification numbers:** L61, L94, L95

**Keywords:** Commodity, Spot, Future, Hedging, Seasonality, India

## 1 Introduction

Seasonal variation in commodity prices and its impact on the relationship between spot and future prices are pertinent and are associated to investing in commodity markets. Commonly, it is believed that commodities spot prices are prejudiced by effects of seasonality which is defined as periodic, inveterate and predictable pattern in demand and supply of commodities. Gorton and Rouwenhorst (2006) claimed that seasonality in commodity spot prices will not impact futures returns since seasonal variation is predictable, and thus should already be rooted in the futures prices. Conversely Fama and French (1987) observed that the seasonal nature in the supply and demand of some commodities suggests they will contain seasonality in the basis and thus the term structure. Carter et. al (1999) found substantiation of seasonality in risk premiums and Grauer (1977) found confirmation of seasonality in commodity betas. Fama and French (1987) investigated the seasonal hypothesis for agricultural, wood, livestock, and metal futures. They did not find indication of seasonality in the basis for metals. Nonetheless, they did find strong seasonality for many agricultural commodities including corn, soybeans, and wheat.

In Indian context, Jose and Girish (2020) in their study modeled and forecasted Indian commodities market using state-space specification and Kalman filter providing preeminent estimates for Super-cycle

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period. Commodity futures traded on Indian exchanges are global in nature and are highly associated with global market. Energy, precious and base metals have strong correlation with international futures. In 2010 enormously elevated volatility in international commodities prices were reflected in Indian prices too. Correlation between international prices and Indian prices is reverberated in close inter-connect of Goldman Sachs Commodity Index (S&P GSCI) and Indian Multi commodity index (MCX) - Comdex during 21-month period between January 2009 and September 2010. Maitra (2018) investigated the volatility in commodities spot and futures market and observed the presence of structural shifts in Indian commodities. One of the significant observations is the effect of seasonality on volatility cannot be overlooked as the effects are significant in all commodity prices. Ali and Gupta (2011) explored the efficiency of 12 agricultural commodities by evaluating the connection of futures prices and spot market prices of major agricultural commodities in India. Results of the study exhibited that co-integration occurs significantly in futures & spot prices for chosen agricultural commodities excluding for rice and wheat implying that there is a long-term relationship between futures and spot prices for most of the agricultural commodities like soybean, sugar, pepper, chickpea, black lentil, castor seed, and maize.

In this study we analyze seasonal behavior of Indian agriculture, energy and metal commodities through the ten years of preceding Super-cycle (2003-13) by considering monthly data for near month futures prices to remove basis variance. The thrust of the paper is to investigate seasonal behavior of select commodities in India using monthly seasonal dummies. We found seasonal variation in four commodities namely gold, barley, guar and Jeera. In a declining interest-rate scenario and Post-Covid world, there is elevated likelihood that we are going to witness the next commodities super-cycle. It is imperative for hedge fund investors, commodities traders, high net-worth individuals, market participants and spread-traders to know what to expect based on preceding super-cycle to strategize better and address seasonality. The rest of the paper is structured as follows: In Section 2 we Review the Literature. In Section 3 we describe the Research Methodology and Present our Findings in Section 4 and conclude our study in Section 5.

## 2 Literature Review

Vasicek (1977) highlighted in their study that long term movement in any times-series can be observed by two ways: one is the cyclical trend and other is the seasonal trend. Cyclical effects are non-seasonal in nature and are observable in varying phase mostly more than a year. Vaughn et. al (1981) observed that commodity futures prices anticipate seasonal effects in the demand and supply of commodities and this in-turn is embedded in futures prices. As a result, empirical tests may not observe seasonality in futures data. Geman and Nguyen (2005) studied the inventory and forward curve dynamics of soybean. Seasonality in spot prices and volatility are controlled for by appropriate deterministic function and 'scarcity' as third factor.

Gorton and Rouwenhorst (2006) examined monthly returns of commodities market for 45 years from July 1959 to 2004 in the US equity and commodity market. The study compared commodities with equity and debt market and found that commodities markets offer same sharp ratio as the equity market. The returns of commodities markets are negatively related to equity and bond market and commodity returns are positively correlated to both expected and unexpected inflation. Yet an additional insight from the study is that seasonality in commodity spot prices will not control futures returns because seasonal variation is already entrenched in the futures prices by the market participants. Fama and French (1987) observe seasonality in *basis* in the term structure or the demand and supply of commodities. Carter (1999) established indication of seasonality in risk premiums of commodity prices. Quayyoun (2019) examined the seasonal behavior of crude oil commodities with respect to its returns and examined the presence of effect of trading the day of the week effect.

Varshney (2020) in their study focused on examining the impact of Covid-19 on commodities prices and by assessing the impact of lockdown on perishable (tomato and onion) and non-perishable commodities (wheat) and suggested possible agriculture market reforms for future. Vaughn et. al., (1981) examined seasonal effects in commodities prices using census bureau's X-11 seasonal adjustment program using futures prices. Anderson (1985) and Kenyon et.al (1987) in their study found that seasonality to be more edifying than the maturity of the contract for numerous agriculture futures. Agricultural commodities being perishable in nature incurring carrying cost which is not pertinent for financial futures. Seasonality in agricultural commodities spot prices can also be attributed to harvest cycles whereas Natural gas exhibits seasonality due to increased usage during winter for heating purposes.

Sorensen (2002) in their study explored seasonality component and two state variables for defining commodity spot price. The two state variables are: a) the permanent and b) temporary changes in supply and demand of commodities by using weekly prices of three agricultural commodities corn, soybean and wheat. The study adopts continuous time approach as highlighted by Schwartz (1997) and the seasonal component is modeled as suggested by Schwartz and Smith (2000) while the stationary state variable is modeled using Ornstein-Uhlenbek process. The study found negative relationship between inventories and convenience yield. Chen et. al., (2010) investigated the relationship of forecasting commodity prices by forecasting exchange rates and found it less robust owing to the fact that exchange rates are strongly forward-looking while commodity price variations are due to supply demand imbalances.

### 3 Research Methodology

#### 3.1. Data

The study uses both spot and futures prices of selected Agriculture commodities [Barley, Jeera, Sugar and Pepper], Metal commodities [Aluminium, Copper, Lead and Gold] and Energy commodities [Crude Oil] in Indian Commodity Markets. We take monthly data for time period from January 2003 to December 2013 which is considered as Super-cycle period when commodity prices sky rocketed. Commodity super cycles in general are decade - stretched periods in which commodities usually trade higher than their long-term price trend. The last commodity super cycle was in 2003-13 which has motivated us to mull over the time period for our study. Proxy variable for interest rate is the yield on 91-day Treasury bill on nominal basis. In order to avoid dummy variable trap, we employ 11 seasonal dummies based on months.

#### 3.2. Data Source

Monthly Spot and Futures Data from Multi-Commodity Exchange<sup>3</sup> (MCX) of India for Metal commodities [Aluminium, Copper, Lead and Gold] and Energy commodities [Crude Oil] and data from National Commodities and Derivatives Exchange<sup>4</sup> (NCDEX) for Agriculture commodities [Barley, Jeera, Sugar and Pepper] is used for our study.

#### 3.3. Econometric Model

Similar to cost of carry model of Fama and French (1987) the relationship between basis, interest, storage cost and convenience yield is specified as follows:

$$F_{(t)} - S_{(t)} = S_{(t)} R_{(T,t)} + W_{(T,t)} - C_{(T,t)} \quad (1)$$

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<sup>3</sup> Source: Multi Commodity Exchange of India (MCX) <https://www.mcxindia.com/>

<sup>4</sup> Source: National Commodity & Derivatives Exchange Limited (NCDEX) <https://www.ncdex.com/index.aspx>

Where:  $F_{(t)}$  is the futures price at time  $t$  the expiration of the contract is at  $T$   
 $S_{(t)}$  is the spot price at time  $t$

The cost of carry model elucidates that basis is equal to interest foregone if one has not bought the futures contract (opportunity cost) and the marginal cost of storage less convenience yield.

- $R_{(T,t)}$  is the interest cost
- $S_{(t)} R_{(T,t)}$  is the interest foregone
- $W_{(T,t)}$  is the marginal cost of storage
- $C_{(T,t)}$  is the convenience yield

Dividing by  $S_{(t)}$  equation (1) we will get:

$$[F_{(t)} - S_{(t)}] / S_{(t)} = R_{(T,t)} + [W_{(T,t)} - C_{(T,t)}] / S_{(t)} \quad (2)$$

Equation (2) is the basis. The cost of carry model assumes that seasonal deviation in demand can engender seasonal variation in inventories. Similarly, seasonal deviation is expected in convenience yield. This helps in exploring the existence of seasonality based on the relationship between basis, interest, storage cost and convenience yield. With the help of equation (2), seasonal variation in the commodity market will reflect in the basis.

We follow Fama and French (1987) model for testing the presence of seasonal variation based on basis and seasonal dummies as shown in equation (3).

$$[F_{(t,T)} - S_{(t)}] / S_{(t)} = \sum_{m=1}^{11} \alpha_m d_m + \beta R_{(T,t)} + e_{(T,t)} \quad (3)$$

where ' $d_m$ ' indicates seasonal dummies.

## 4 Empirical Findings

In this study we analyze seasonal behavior of Indian agriculture, energy and metal commodities through the ten years of preceding Super-cycle (2003-13) by considering monthly data for near month futures prices to remove basis variance. The model estimation results for examining seasonality are presented in Table 1 for Agricultural commodities and in Table 2 for Metal and Energy commodities.

We find the presence of seasonality in the cases of four commodities out of nine. Gold, barley, guar and jeera show the presence of seasonal variation. In the case of gold, coefficients of  $D_1$  (January),  $D_2$  (February),  $D_3$  (March),  $D_5$  (April),  $D_9$  (September) and  $D_{11}$  (November) are significant as shown in Table 2. The coefficient of yield is also significant at one percent level. In the case of barley other than  $D_1$  (January),  $D_2$  (February), coefficient of all other month's dummies is significant. Coefficient of yield is negative and significant at 1% level. The model estimation results for guar show that the coefficients  $D_2$  (February),  $D_3$  (March),  $D_6$  (June),  $D_7$  (July) apart from yield are significant. Coefficients of yield and seasonal dummies  $D_{10}$  (October) and  $D_{11}$  (November) are significant in the case of Jeera.

Although the value of the coefficient of determination seems to be low in all the cases, a significant F value highlights the relevance and validity of the estimated model. In order to verify whether  $D_{12}$  (December) has a significant coefficient we ran the regression adding an intercept. However, the intercept coefficients are not significant indicating no influence December dummy separately. In the cases of other commodities i.e. aluminum, copper, lead, crude, and pepper the F values are not significant.

Table 1: Estimation Results of Seasonality in Agricultural commodities

Commodity	Pepper	p-value	Barley	p-value	Guar	p-value	Jeera	p-value
<b>Yield</b>	-0.001	0.506	-0.006	<b>0.00</b>	0.004	<b>0.00</b>	-0.003	0.001
$D_1$	-0.002	0.818	0.007	0.826	-0.013	0.16	0.001	0.912
$D_2$	-0.003	0.712	0.029	0.35	-0.022	0.042	-0.005	0.681
$D_3$	0.011	0.143	0.052	<b>0.02</b>	-0.019	0.071	0.003	0.762
$D_4$	0.006	0.487	0.059	<b>0.00</b>	-0.005	0.643	0.003	0.832
$D_5$	0.001	0.996	0.077	<b>0.00</b>	-0.012	0.15	-0.006	0.666
$D_6$	0.002	0.871	0.077	<b>0.00</b>	-0.017	0.041	-0.002	0.869
$D_7$	0.003	0.654	0.074	<b>0.00</b>	-0.023	<b>0.005</b>	0.009	0.416
$D_8$	0.002	0.793	0.079	<b>0.00</b>	-0.016	0.306	-0.011	0.356
$D_9$	0.005	0.665	0.061	<b>0.00</b>	-0.011	0.185	-0.022	0.081
$D_{10}$	-0.006	0.388	0.041	<b>0.00</b>	-0.014	0.085	-0.016	0.098
$D_{11}$	-0.003	0.68	0.038	<b>0.00</b>	-0.01	0.278	0.001	0.994
<b>R<sup>2</sup></b>	0.022		0.203		0.086		0.055	
<b>Adj. R<sup>2</sup></b>	-0.008		0.172		0.051		0.026	
<b>F</b>	1.296		6.865		2.323		1.786	

Where:

- Adj. R<sup>2</sup> is the Adjusted R<sup>2</sup>
- D<sub>1</sub> to D<sub>11</sub> are the monthly dummies
- Newey-West Heteroscedasticity - Autocorrelation consistent standard errors are used for finding the significance level of the coefficients.

Table 2: Estimation Results of Seasonality in Metal and Energy Commodities

Commodity	Aluminum	p-value	Copper	p-value	Lead	p-value	Crude	p-value	Gold	p-value
<b>Yield</b>	0.0001	0.465	0.001	<b>0.049</b>	0	0.697	0.001	0.199	0.001	<b>0.00</b>
$D_1$	-0.003	0.379	-0.006	0.336	-0.009	0.364	-0.004	0.492	-0.011	<b>0.02</b>
$D_2$	0.005	0.332	-0.006	0.225	0.006	0.454	-0.003	0.48	-0.006	0.062
$D_3$	0.007	0.26	0.0001	0.988	0.01	0.269	0.005	0.216	-0.007	0.06
$D_4$	0.01	0.154	0.002	0.656	0.014	0.25	0.001	0.897	-0.001	0.717
$D_5$	0.001	0.902	-0.004	0.443	-0.008	0.483	0.003	0.63	-0.012	<b>0.00</b>
$D_6$	0.0001	0.93	-0.001	0.798	0.001	0.907	0.006	0.253	-0.001	0.748
$D_7$	0.002	0.491	-0.006	0.401	0.015	0.118	-0.003	0.495	-0.005	<b>0.034</b>
$D_8$	0.002	0.671	-0.009	0.18	0.012	0.156	-0.001	0.877	-0.006	0.104
$D_9$	0.006	0.082	-0.008	0.282	0.002	0.901	0.002	0.502	-0.004	0.098
$D_{10}$	-0.003	0.465	-0.005	0.407	0.0001	0.988	-0.003	0.467	0.003	0.4
$D_{11}$	-0.001	0.707	-0.005	0.325	-0.006	0.579	0.002	0.679	-0.013	<b>0.00</b>
<b>R<sup>2</sup></b>	0.051		0.022		0.028		0.02		0.138	
<b>Adj. R<sup>2</sup></b>	0.02		-0.007		-0.014		-0.009		0.108	
<b>F</b>	1.535		1.091		0.617		0.683		4.274	

Where:

- Adj.  $R^2$  is the Adjusted  $R^2$
- $D_1$  to  $D_{11}$  are the monthly dummies
- Newey-West Heteroscedasticity - Autocorrelation consistent standard errors are used for finding the significance level of the coefficients.
- We use ACF to determine if seasonality is present in time series. The larger the amplitude of seasonal fluctuations, the more pronounced the oscillations are in ACF.

The difference between these two groups is very clear when we analyze and consider the storage/inventory aspect of the commodity. Example: Gold demand has a seasonal influence with respect to festivals. Seasonality of demand in jewelry leads to augmented gold demand in countries such as India and China. Economic development in these countries is causative to both the seasonal changes and increasing demand for gold. With shift in India's middle class to value products owing to Covid-19 slashing spending on expensive goods and disposable income, we could see lesser demand for gold. Owing to Covid-19, Gold demand in India underwent a significant dropdown from 213.2 tons in 2019 to 63.7 tons in 2020 for April to June quarter<sup>5</sup>.

Seasonality is a significant conception for commodity trading participants to be considered while making trading decisions owing to customary patterns of supply and demand exhibited by these markets at unambiguous times of the year. In a declining interest rate scenario and Post-Covid world, there is elevated likelihood that we are going to witness the next commodities super-cycle. Findings of our study will help hedge fund managers, global investors, commodities traders, high net-worth individuals, market participants and spread-traders to know what to expect based on preceding super-cycle to strategize better and address seasonality.

## 5 Conclusion

Seasonal variation in commodity prices has significant economic impact. Practitioners need to model seasonality in several ways to deploy trading strategies like spread trading, crush spread, crack spread to name a few thereby encounter seasonality by smoothening market fluctuations. In this study we analyze seasonal behavior of Indian agriculture, energy and metal commodities through the ten years of preceding Super-cycle (2003-13) by considering monthly data for near month futures prices to remove basis variance. We found seasonal variation in four commodities namely gold, barley, guar and Jeera. In a declining interest rate scenario and Post-Covid world, there is elevated likelihood that we are going to witness the next commodities super-cycle. The findings of the study will help hedge fund managers, global investors, commodities traders, high net-worth individuals, market participants and spread-traders to know what to expect based on preceding super-cycle to strategize better and address seasonality. The present study is limited to preceding Super-cycle. Future Studies can explore deploying high-frequency data post Covid-19 which may fetch a fascinating perspective to commodity modelling literature.

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<sup>5</sup> World Gold Council <https://www.gold.org/>

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