

A STUDY ON ARBITRATION OPPORTUNITY IN COMMODITY MARKET

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Abstract

Arbitrators find out the opportunity from differences in prices of an asset in two different markets. They buy in the market where the prices are low and sell simultaneously in the other market where prices are high. Arbitrage opportunities are available in the derivative markets also. These opportunities are for very short period where no investment is involved. Arbitrage opportunity could be explored comparing spot and future market also. The cost of carry model establishes the relationship between the future price and the spot price of the underlying asset. The relationship between the future price and the spot price would be set in a manner that permits no arbitrage opportunity. The future price must be equal to the spot price of the asset plus the cost of storage of the commodity. If there is a difference then exist the arbitrage opportunity. The present paper is an attempt to find out whether arbitrage opportunity exists in Indian commodity market. Paper is an attempt to analyze the observed future price in relation to the theoretical price (fair price) for the selected commodities [Almond, Chana, Gold, Guarseed, Gur, Jeera, Platinum, Steel (Long), Sugar (M grade), Zinc.] Fair value of the futures is calculated using cost of carry model.

Keywords: arbitrage opportunity, cost of carry model, commodity market

1. Introduction

Commodity market and trading is not a new concept in India. Hundreds of years ago farmers used to sell their crops on a particular day and buyer take delivery in future date. Even wheat and corn, cattle and pigs, were widely traded using standard instruments in the 19th century in the United States.

The global derivative market including the commodity derivative market has shown high growth in recent years. The commodity derivative market has grown along with the financial derivative market. The major centers for commodity trading are London, New York, and Chicago. Commodities comprise of range of diverse products from agriculture, gas, oil to energy. Over the last couple of years, the markets have witnessed emergence of exotic products like weather, carbon emission, telecommunication bandwidth, etc. The geographical share for India in commodity derivative markets is 17 percent. The Indian commodity market requires large investments and enhanced trading activity both in the national as well as the regional commodity markets. The market has expanded with the expansion in demand for commodities both in spot and derivative market. There have been constraints through policy restrictions and at the same time there has been an effort for liberalization of the commodity market to bring them at par with international commodity market. Of late, the Indian equity market has been very volatile.

Existence of liquid and fairly priced commodity market is considered as healthy sign for development of economy. Like any other derivative, commodity future contracts can be used as hedging tool to manage price risks of the commodities.

Arbitrage arises when an asset is selling for different prices in different markets. It is the process of seeking riskless profit without investment by taking advantage of differences in prices in different markets. An arbitrageur, who is a person engaging in arbitrage activities, would buy the asset in the cheaper market and simultaneously sell the asset in the market offering the higher price. He makes a certain riskless profit to the extent of the difference in prices. As both the buying transaction and the selling transaction are assumed to occur simultaneously, there is no investment involved.

People who engage in arbitrage are called arbitrageurs they could be individuals, financial institutions or brokers. Arbitrage opportunity is short lived and will vanish when market is in equilibrium i.e. when for the same asset class same price is available in two different markets.

Arbitrage is possible when one of three conditions is met:

1. The same asset does not trade at the same price on all markets ("the law of one price").
2. Two assets with identical cash flows do not trade at the same price.
3. An asset with a known price in the future does not today trade at its future price discounted value.

4. Arbitrage is not simply the act of buying a product in one market and selling it in another for a higher price at some later time. The transactions must occur simultaneously and only possible with securities and financial products which can be traded electronically.

In the simplest example, any good sold in one market should sell for the same price in another. Traders may, for example, find that the price of wheat is lower in agricultural regions than in cities, purchase the good, and transport it to another region to sell at a higher price. This type of price arbitrage is the most common, but this simple example ignores the cost of transport, storage, risk, and other factors. "True" arbitrage requires that there be no market risk involved. Where securities are traded on more than one exchange, arbitrage occurs by simultaneously buying in one and selling on the other.

Future Pricing Models

For determining the future price of an asset underlying the futures contract, two models are commonly used. These are the Cost-of-Carry model and the Expectation model. A basic assumption used in developing these models is that prices in the market do not provide opportunities for arbitrage profits. That is, the future prices would be determined in the market in such a way that there would be no opportunities for making arbitrage profits as, otherwise, arbitrageurs would engage in arbitrage activities, wiping out arbitrage profits quickly.

As per the suitability Cost-of-Carry model has been used for the study.

Review of Literature

Market Efficiency and Price Discovery in the EU Carbon Futures Market George Milunovich RoselyneJoyeux examined to understand three interrogations under (EU) European Union (ETS) Emission Trading Scheme.

1. If there is a stable long-run relationship between the EU ETS carbons spot price, EU ETS carbon futures price and interest rates. If the answer to this question is yes, then they will proceed to test a stronger assumption by asking the following: Is the long-run link between the spot and futures prices given by a no-arbitrage cost-of-carry model?
2. To test for the existence of convenience yield obtained by holding a spot position.
3. To know the issues of price discovery by analyzing information spillovers between the cash and futures prices by seeking to uncover which market leads the carbon price discovery process.

Co integration analysis of spot and futures carbon prices and interest rates as well as Granger causality and volatility spillover tests were used. They also present a method for measuring and testing for convenience yield within the framework of co integration. They examined the issues of market efficiency and price discovery in the European Union carbon futures market. The findings suggest that none of the three carbon futures contracts examined here are priced according to the cost-of-carry model, although two of the three contracts form a stable long-run relationship with the spot price and interest rates, and hence act as adequate risk mitigation instruments. In terms of information diffusion between the futures and spot contracts, it appeared that the spot and futures markets shared information efficiently and contributed to price discovery jointly.

Early Unwinding of Futures Arbitrage Gilles Desvilles, Conservatoire National des Arts et Métiers, (2008) tried to indigenize the stochastic behavior of the simple arbitrage opportunity given the nature of transaction costs and the structure of the market.

This paper complies with and exploits the future fungibility, notably in the price comparison with the forward, fully characterizes the underlying asset and the cash flows of the implicit unwinding option, proves all results, and derives in an endogenous way the process followed by the arbitrage payoff given those followed by the underlying asset and the future basis, net of its carry.

Lead-Lag Relationship Between The Spot Index And Futures Price For The Turkish Derivatives Exchange

Ülkem Başdaş(2009) examined the lead-lag relationship between the Istanbul Stock Exchange30 (ISE 30) Index and index futures prices at the Turkish Derivatives Exchange. They have used daily observations from February 2005 to May 2008.

It is found out that spot prices lead the futures prices for ISE 30 Index contrary to the results for different countries. The financial theory claims that futures prices would be a function of the spot prices whereas the actual data from several derivatives and spot exchanges points out that futures market leads the spot market for several countries. Nevertheless, this study proves that for Turkey, where the derivatives market has newly founded, the lead-lag relation works reverse; spot markets lead the futures prices. This controversial situation in Turkish Derivatives Exchange is important for arbitrage seekers since new information is firstly recognized in spot markets before futures market.

The Efficacy Of Conditional Cost Of Carry Models In Pricing Oil Futures, Eric Girard Amit Sinha, Rita Biswas developed an empirical cost of carry model for pricing crude oil futures by introducing an exogenously conditioned convenience yield as well as stochastic volatility. The methodology used in this paper is "Conditional Cost of Carry Model with Stochastic Volatility". According to the cost of carry model, futures prices should equal their cost of carry value, i.e.,

$$1. \quad FT-t = E[S(T-t|It)] = St * e^{Ct * (T-t)}$$

Where $FT-t$ is the futures price at time t with a maturity of $T-t$, $E(S(T-t))$ is $T-t$ period's expected spot price at time t , Ct is the time-varying cost-of-carry yield. This pricing relation further implies the convergence of spot and futures prices at expiration. This carry yield includes financing, storage, insurance, transportation, and convenience costs. The spot price and carry rates are both dependent on demand and supply forces affecting the commodity. Hence, in equilibrium, the futures price is determined by the expectations of the fundamentals factors at the time of maturity of the futures contract. Thus, Equation (1) can be refined into:

$$2. \quad FT-t = St * e^{(Rft + wt - yt) (T - t)}$$

Where Rft is the risk free rate (or repo rate) at time t , wt is the time varying storage cost yield, t is the convenience yield, and $wt - t$ is the net cost from holding the commodity at time t . If there is a shortage for the commodity, the spot has to increase relative to the futures price. Alternatively, if there is no concern of shortage for the commodity, the net cost of holding the commodity is positive and the market is in continuo. Thus, as expectations about demand and supply for the commodity are of paramount importance to the pricing of futures, prices are determined jointly by the hedging and speculative trades of investors.

They found that oil futures contracts are more responsive to larger size shocks or volatility clustering (w) than to the direction of the shock (n), indicating that futures markets'

Limited Arbitrage and Speculative Momentum **Charlie X. Cai, Robert Faff, Yongcheol Shin, (2010)** focused on the information content of limited arbitrage by developing a model that distinguishes the error components attributable to the price impact of trades from arbitragers, noise traders and rational speculators and proved Limited arbitrage creates valuable information and has further impact on the price dynamics.

It is found that the coefficient is positive and significant; suggesting that for every one percentage point of unarbitrated error occurring in the last period, there is an additional 37 basis points worth of pricing error in the current period. This finding supports our hypothesis that unarbitrated pricing error is exploited by speculative momentum traders and has an impact on further price movements.

Time-Varying Spot and Futures Oil Price Dynamics **Guglielmo, Maria Caporale**

Davide Ciferri, lessandro Girardi investigated the relative contribution of spot and futures markets to oil price discovery and whether these contributions vary over time by investigating the role of crude oil spot and futures prices in the process of price discovery by using a cost-of-carry model with an endogenous convenience yield and daily data over the period from January 1990 to December 2008.

The futures markets play a more important role than spot markets in the case of contracts with shorter maturities, but the relative contribution of the two types of market turns out to be highly unstable, especially for the most deferred contracts.

The paper investigated the relative contribution of spot and futures markets to oil price discovery and whether these contributions vary over time. The theoretical framework is provided by an augmented cost-of-carry model with an endogenous convenience yield, which assumes that the spot price is equal to the futures price plus a (possibly non-stationary) term depending on a number of factors such as storage and warehousing costs, interest rates and the convenience yield.

Research Gap and Objectives:

The above literature gives an opportunity to study the scope of arbitration on various commodities from the data based on NCDEX by using Cost-of-Carry Model. As very less study has been presented covering this field in detail.

Based on the research gap, the following objectives have been set in the context of future contracts traded on NCDEX for selected Commodities:-

Objective: To identify the scope of arbitrage opportunity using future contracts for commodity market in India.

Methodology: In India, NCDEX is considered as prime national level commodity exchange for agricultural and other commodities and hence for the study ten commodities namely – Almond, Chana, Gold, Guarseed, Gur, Jeera, Platinum, Steel (Long), Sugar (M Grade) and Zinc were selected.

- The data of spot closing price of respective commodities as on respective date was compared with the closing prices of that commodity of future market as on the same date.
- Spot prices from 1st Jan 2011 to 31st Jan 2011 based on the data from NCDEX
- Whereas future prices are also based on the data from NCDEX
- The interest rate of market is 15% annually and is charged on daily basis.
- The Cost-of-Carry cost is assumed as 21% annually including transportation cost, storage cost and transaction cost.

Limitation & Scope for Future Research:

The study was done on the basis of spot and spot future price data available on NCDEX. The spot prices were not the perfectly closing price but were at the time most near the closing time and not the opportunities between the trading periods. Further, this study may not hold true in Cost-of-Carry in imperfect market environment. If Cost-of-Carry is to be tested in imperfect market environment, certain modifications has to be done. This modification has to be done in following terms.

1. Unequal borrowing and lending rates:
2. Restrictions on short selling:
3. Limitations to storage:

Perishable commodities cannot be stored. There may be restrictions from the government to store the commodities.

Assumptions

1. The speculator does not have any capital of his/her own so all the money is borrowed from the market.
2. The money borrowed and invested is risk free.
3. There will be additional storage cost and transportation cost included as Cost-of-Carry cost.
4. Cost of carry for arbitration is assumed in perfect market competition.

Arbitration test of various Commodities

Table-1 Arbitration test of almond

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	360	366.5	405.36	-38.86	U.V	Yes	Sell
3	03-Jan-11	360	366.25	404.352	-38.102	U.V	Yes	Sell
4	04-Jan-11	360	366.25	403.848	-37.598	U.V	Yes	Sell
5	05-Jan-11	360	366	403.344	-37.344	U.V	Yes	Sell
6	06-Jan-11	361	367	403.959	-36.959	U.V	Yes	Sell
7	07-Jan-11	363.5	369.25	406.2476	-36.9976	U.V	Yes	Sell
8	08-Jan-11	358.4	364	400.0461	-36.0461	U.V	Yes	Sell
10	10-Jan-11	371.75	377.5	413.9065	-36.4065	U.V	Yes	Sell
11	11-Jan-11	375	380.75	417	-36.25	U.V	Yes	Sell
12	12-Jan-11	376	381.5	417.5856	-36.0856	U.V	Yes	Sell
13	13-Jan-11	373	378.5	413.7316	-35.2316	U.V	Yes	Sell
14	14-Jan-11	371.65	377	411.7139	-34.7139	U.V	Yes	Sell
15	15-Jan-11	361.5	366.75	399.9636	-33.2136	U.V	Yes	Sell
17	17-Jan-11	365	370	402.814	-32.814	U.V	Yes	Sell
18	18-Jan-11	360.65	365.5	397.5084	-32.0084	U.V	Yes	Sell
19	19-Jan-11	365	370	401.792	-31.792	U.V	Yes	Sell
20	20-Jan-11	361.9	366.75	397.8729	-31.1229	U.V	Yes	Sell
21	21-Jan-11	360.65	365.25	395.9937	-30.7437	U.V	Yes	Sell
22	22-Jan-11	356.5	361	390.9379	-29.9379	U.V	Yes	Sell
24	24-Jan-11	360	364.5	393.768	-29.268	U.V	Yes	Sell
25	25-Jan-11	356.2	360.5	389.1129	-28.6129	U.V	Yes	Sell
27	27-Jan-11	363.35	367.5	395.9062	-28.4062	U.V	Yes	Sell
28	28-Jan-11	352.75	356.75	383.8626	-27.1126	U.V	Yes	Sell
29	29-Jan-11	360	364	391.248	-27.248	U.V	Yes	Sell
31	31-Jan-11	355	358.75	384.82	-26.07	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 2 Arbitration of Chana

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	2420	2499	2724.92	-225.92	U.V	Yes	Sell
3	03-Jan-11	2420	2495	2718.144	-223.144	U.V	Yes	Sell
4	04-Jan-11	2410	2496	2703.538	-207.538	U.V	Yes	Sell
5	05-Jan-11	2390	2486	2677.756	-191.756	U.V	Yes	Sell
6	06-Jan-11	2380	2491	2663.22	-172.22	U.V	Yes	Sell
7	07-Jan-11	2400	2494	2682.24	-188.24	U.V	Yes	Sell
8	08-Jan-11	2405	2501	2684.461	-183.461	U.V	Yes	Sell
10	10-Jan-11	2405	2499	2677.727	-178.727	U.V	Yes	Sell
11	11-Jan-11	2405	2505	2674.36	-169.36	U.V	Yes	Sell
12	12-Jan-11	2427.5	2568	2695.982	-127.982	U.V	Yes	Sell
13	13-Jan-11	2425	2562	2689.81	-127.81	U.V	Yes	Sell
14	14-Jan-11	2430	2586	2691.954	-105.954	U.V	Yes	Sell
15	15-Jan-11	2450	2629	2710.68	-81.68	U.V	Yes	Sell
17	17-Jan-11	2475	2643	2731.41	-88.41	U.V	Yes	Sell
18	18-Jan-11	2450	2629	2700.39	-71.39	U.V	Yes	Sell
19	19-Jan-11	2460	2629	2707.968	-78.968	U.V	Yes	Sell
20	20-Jan-11	2515	2669	2764.991	-95.991	U.V	Yes	Sell
21	21-Jan-11	2600	2764	2854.8	-90.8	U.V	Yes	Sell
22	22-Jan-11	2650	2793	2905.99	-112.99	U.V	Yes	Sell
24	24-Jan-11	2625	2746	2871.225	-125.225	U.V	Yes	Sell
25	25-Jan-11	2565	2706	2802.006	-96.006	U.V	Yes	Sell
27	27-Jan-11	2525	2662	2751.24	-89.24	U.V	Yes	Sell
28	28-Jan-11	2575	2710	2802.115	-92.115	U.V	Yes	Sell
29	29-Jan-11	2527.5	2651	2746.887	-95.887	U.V	Yes	Sell
31	31-Jan-11	2520	2660	2731.68	-71.68	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 3 Arbitration of Gold

Dates	Date	Spot	Feb	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
3	03-Jan-11	20651	20784	22327.86	-1543.86	U.V	Yes	Sell
4	04-Jan-11	20580	20444	22222.28	-1778.28	U.V	Yes	Sell
5	05-Jan-11	20350	20452	21945.44	-1493.44	U.V	Yes	Sell
6	06-Jan-11	20272.5	20415	21833.48	-1418.48	U.V	Yes	Sell
7	07-Jan-11	20150	20364	21673.34	-1309.34	U.V	Yes	Sell
10	10-Jan-11	20263	20408	21709.78	-1301.78	U.V	Yes	Sell
11	11-Jan-11	20303.5	20418	21724.75	-1306.75	U.V	Yes	Sell
12	12-Jan-11	20345	20395	21740.67	-1345.67	U.V	Yes	Sell
13	13-Jan-11	20329.5	20426	21695.64	-1269.64	U.V	Yes	Sell
17	17-Jan-11	20159	20270	21400.79	-1130.79	U.V	Yes	Sell
18	18-Jan-11	20250	20328	21469.05	-1141.05	U.V	Yes	Sell
19	19-Jan-11	20290	20394	21483.05	-1089.05	U.V	Yes	Sell
20	20-Jan-11	20240	20196	21401.78	-1205.78	U.V	Yes	Sell
21	21-Jan-11	20027.5	20080	21149.04	-1069.04	U.V	Yes	Sell
24	24-Jan-11	20035.5	20003	21073.34	-1070.34	U.V	Yes	Sell
25	25-Jan-11	19735	19803	20729.64	-926.644	U.V	Yes	Sell
27	27-Jan-11	19890	19693	20836.76	-1143.76	U.V	Yes	Sell
28	28-Jan-11	19791.5	19591	20705.87	-1114.87	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 4 Arbitration of Guarseed

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	2360	2529	2657.36	-128.36	U.V	Yes	Sell
3	03-Jan-11	2389.4	2575	2683.774	-108.774	U.V	Yes	Sell
4	04-Jan-11	2433.15	2603	2729.508	-126.508	U.V	Yes	Sell
5	05-Jan-11	2425	2585	2716.97	-131.97	U.V	Yes	Sell
6	06-Jan-11	2420	2578	2707.98	-129.98	U.V	Yes	Sell
7	07-Jan-11	2378.15	2542	2657.82	-115.82	U.V	Yes	Sell
8	08-Jan-11	2380	2553	2656.556	-103.556	U.V	Yes	Sell
10	10-Jan-11	2411.25	2571	2684.686	-113.686	U.V	Yes	Sell
11	11-Jan-11	2408.15	2582	2677.863	-95.8628	U.V	Yes	Sell
12	12-Jan-11	2460	2619	2732.076	-113.076	U.V	Yes	Sell
13	13-Jan-11	2465.65	2616	2734.899	-118.899	U.V	Yes	Sell
14	14-Jan-11	2530	2677	2802.734	-125.734	U.V	Yes	Sell
15	15-Jan-11	2566.25	2716	2839.299	-123.299	U.V	Yes	Sell
17	17-Jan-11	2585	2721	2852.806	-131.806	U.V	Yes	Sell
18	18-Jan-11	2575	2711	2838.165	-127.165	U.V	Yes	Sell
19	19-Jan-11	2610.65	2762	2873.804	-111.804	U.V	Yes	Sell
20	20-Jan-11	2650	2795	2913.41	-118.41	U.V	Yes	Sell
21	21-Jan-11	2660	2848	2920.68	-72.68	U.V	Yes	Sell
22	22-Jan-11	2729.4	2870	2993.06	-123.06	U.V	Yes	Sell
24	24-Jan-11	2700	2848	2953.26	-105.26	U.V	Yes	Sell
25	25-Jan-11	2658.9	2824	2904.582	-80.5824	U.V	Yes	Sell
27	27-Jan-11	2659.4	2807	2897.682	-90.6822	U.V	Yes	Sell
28	28-Jan-11	2750	2920	2992.55	-72.55	U.V	Yes	Sell
29	29-Jan-11	2748.15	2881	2986.689	-105.689	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 5 Arbitration of Gur

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	940	1054	1058.44	-4.44	U.V	Yes	Sell
3	03-Jan-11	937.5	1048.5	1053	-4.5	U.V	Yes	Sell
4	04-Jan-11	943.4	1043	1058.306	-15.3061	U.V	Yes	Sell
5	05-Jan-11	941.3	1031	1054.633	-23.6325	U.V	Yes	Sell
6	06-Jan-11	947.75	1021	1060.532	-39.5323	U.V	Yes	Sell
7	07-Jan-11	947.5	1011.5	1058.926	-47.426	U.V	Yes	Sell
8	08-Jan-11	950.4	1008	1060.836	-52.8365	U.V	Yes	Sell
10	10-Jan-11	937.65	977	1043.98	-66.9795	U.V	Yes	Sell
11	11-Jan-11	932.6	991	1037.051	-46.0512	U.V	Yes	Sell
12	12-Jan-11	926.75	974.5	1029.249	-54.7486	U.V	Yes	Sell
13	13-Jan-11	925.75	971	1026.842	-55.8419	U.V	Yes	Sell
14	14-Jan-11	926.45	959.5	1026.321	-66.8213	U.V	Yes	Sell
15	15-Jan-11	926.35	961.5	1024.914	-63.4136	U.V	Yes	Sell
17	17-Jan-11	915.55	945.5	1010.401	-64.901	U.V	Yes	Sell
18	18-Jan-11	918.75	959.5	1012.646	-53.1463	U.V	Yes	Sell
19	19-Jan-11	909.7	956	1001.398	-45.3978	U.V	Yes	Sell
20	20-Jan-11	910.95	947.5	1001.498	-53.9984	U.V	Yes	Sell
21	21-Jan-11	900.65	946	988.9137	-42.9137	U.V	Yes	Sell
22	22-Jan-11	903	944	990.2298	-46.2298	U.V	Yes	Sell
24	24-Jan-11	902.75	946.5	987.428	-40.9279	U.V	Yes	Sell
25	25-Jan-11	905.15	947	988.7859	-41.7859	U.V	Yes	Sell
27	27-Jan-11	902	943	982.8192	-39.8192	U.V	Yes	Sell
28	28-Jan-11	902.55	945.5	982.1549	-36.6549	U.V	Yes	Sell
29	29-Jan-11	900.45	945	978.6091	-33.6091	U.V	Yes	Sell
31	31-Jan-11	893.4	924	968.4456	-44.4456	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 6 Arbitration of Jeera

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	14498	14995	16324.75	-1329.75	U.V	Yes	Sell
3	03-Jan-11	14478.35	15064	16262.08	-223.144	U.V	Yes	Sell
4	04-Jan-11	14475	15132	16238.06	-207.538	U.V	Yes	Sell
5	05-Jan-11	14506.25	15123	16252.8	-191.756	U.V	Yes	Sell
6	06-Jan-11	14518.75	15085	16246.48	-172.22	U.V	Yes	Sell
7	07-Jan-11	14528.1	14961	16236.6	-188.24	U.V	Yes	Sell
8	08-Jan-11	14485.9	14941	16169.16	-183.461	U.V	Yes	Sell
10	10-Jan-11	14405.85	14727	16039.47	-178.727	U.V	Yes	Sell
11	11-Jan-11	14318.2	14834	15921.84	-169.36	U.V	Yes	Sell
12	12-Jan-11	14300	14742	15881.58	-127.982	U.V	Yes	Sell
13	13-Jan-11	14300	14587	15861.56	-127.81	U.V	Yes	Sell
15	15-Jan-11	14320.85	15039	15844.59	-81.68	U.V	Yes	Sell
17	17-Jan-11	14359.1	15382	15846.7	-88.41	U.V	Yes	Sell
18	18-Jan-11	14539	15316	16024.89	-71.39	U.V	Yes	Sell
19	19-Jan-11	14512.5	15385	15975.36	-78.968	U.V	Yes	Sell
20	20-Jan-11	14523.4	15316	15967.03	-95.991	U.V	Yes	Sell
21	21-Jan-11	14537.5	15542	15962.18	-90.8	U.V	Yes	Sell
22	22-Jan-11	14687.5	16092	16106.31	-112.99	U.V	Yes	Sell
24	24-Jan-11	14831.8	15893	16223.02	-125.225	U.V	Yes	Sell
25	25-Jan-11	14829.6	15686	16199.86	-96.006	U.V	Yes	Sell
27	27-Jan-11	14741.65	15127	16062.5	-89.24	U.V	Yes	Sell
28	28-Jan-11	14750	15427	16050.95	-92.115	U.V	Yes	Sell
29	29-Jan-11	14785.6	15256	16068.99	-95.887	U.V	Yes	Sell
31	31-Jan-11	14707.15	15058	15942.55	-71.68	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 7 Arbitration of Platinum

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
3	03-Jan-11	2546.75	2607	2860.51	-253.51	U.V	Yes	Sell
4	04-Jan-11	2567.7	2598	2880.446	-282.446	U.V	Yes	Sell
6	06-Jan-11	2522.35	2582	2822.51	-240.51	U.V	Yes	Sell
8	08-Jan-11	2538.1	2576.5	2833.027	-256.527	U.V	Yes	Sell
10	10-Jan-11	2536.15	2585	2823.749	-238.749	U.V	Yes	Sell
11	11-Jan-11	2541.55	2581.5	2826.204	-244.704	U.V	Yes	Sell
12	12-Jan-11	2570.75	2586.5	2855.075	-268.575	U.V	Yes	Sell
15	15-Jan-11	2652.45	2697.5	2934.671	-237.171	U.V	Yes	Sell
17	17-Jan-11	2661.8	2697	2937.562	-240.562	U.V	Yes	Sell
18	18-Jan-11	2658.3	2705.5	2929.978	-224.478	U.V	Yes	Sell
19	19-Jan-11	2667.65	2701	2936.549	-235.549	U.V	Yes	Sell
20	20-Jan-11	2693.6	2710	2961.344	-251.344	U.V	Yes	Sell
21	21-Jan-11	2672.05	2736	2933.911	-197.911	U.V	Yes	Sell
22	22-Jan-11	2672.05	2713.5	2930.17	-216.67	U.V	Yes	Sell
24	24-Jan-11	2675.5	2712.5	2926.462	-213.962	U.V	Yes	Sell
25	25-Jan-11	2663.5	2715	2909.607	-194.607	U.V	Yes	Sell
27	27-Jan-11	2659.9	2702.5	2898.227	-195.727	U.V	Yes	Sell
28	28-Jan-11	2639.15	2697	2871.923	-174.923	U.V	Yes	Sell
29	29-Jan-11	2648.7	2675	2878.607	-203.607	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 8 Arbitration of Steel (Long)

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	28500	28010	32091	-4081	U.V	Yes	Sell
3	03-Jan-11	28300	27630	31786.56	-4156.56	U.V	Yes	Sell
4	04-Jan-11	28200	27830	31634.76	-3804.76	U.V	Yes	Sell
6	06-Jan-11	29260	28400	32741.94	-4341.94	U.V	Yes	Sell
8	08-Jan-11	30100	29020	33597.62	-4577.62	U.V	Yes	Sell
10	10-Jan-11	31000	29470	34515.4	-5045.4	U.V	Yes	Sell
11	11-Jan-11	31210	29390	34705.52	-5315.52	U.V	Yes	Sell
12	12-Jan-11	31150	29210	34595.19	-5385.19	U.V	Yes	Sell
13	13-Jan-11	30800	29130	34163.36	-5033.36	U.V	Yes	Sell
14	14-Jan-11	30500	28850	33787.9	-4937.9	U.V	Yes	Sell
15	15-Jan-11	30250	28920	33468.6	-4548.6	U.V	Yes	Sell
17	17-Jan-11	30700	29390	33880.52	-4490.52	U.V	Yes	Sell
18	18-Jan-11	30300	29310	33396.66	-4086.66	U.V	Yes	Sell
19	19-Jan-11	30500	29520	33574.4	-4054.4	U.V	Yes	Sell
20	20-Jan-11	30540	29530	33575.68	-4045.68	U.V	Yes	Sell
21	21-Jan-11	30700	29680	33708.6	-4028.6	U.V	Yes	Sell
22	22-Jan-11	31000	29820	33994.6	-4174.6	U.V	Yes	Sell
24	24-Jan-11	30500	29610	33360.9	-3750.9	U.V	Yes	Sell
25	25-Jan-11	30090	29270	32870.32	-3600.32	U.V	Yes	Sell
27	27-Jan-11	30000	28820	32688	-3868	U.V	Yes	Sell
28	28-Jan-11	29600	28780	32210.72	-3430.72	U.V	Yes	Sell
29	29-Jan-11	29600	29100	32169.28	-3069.28	U.V	Yes	Sell

Interpretation:

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitration opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 9 Arbitration of Sugar (M Grade)

Dates	Date	Spot	March	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	3171.5	3133	3571.109	-438.109	U.V	Yes	Sell
3	03-Jan-11	3157	3126	3545.942	-419.942	U.V	Yes	Sell
4	04-Jan-11	3165.45	3072	3551.002	-479.002	U.V	Yes	Sell
5	05-Jan-11	3156	3052	3535.982	-483.982	U.V	Yes	Sell
6	06-Jan-11	3147.75	3021	3522.332	-501.332	U.V	Yes	Sell
7	07-Jan-11	3144	2983	3513.734	-530.734	U.V	Yes	Sell
8	08-Jan-11	3132.5	2952	3496.497	-544.497	U.V	Yes	Sell
10	10-Jan-11	3122.75	2924	3476.87	-552.87	U.V	Yes	Sell
11	11-Jan-11	3118	2919	3467.216	-548.216	U.V	Yes	Sell
12	12-Jan-11	3098.65	2874	3441.361	-567.361	U.V	Yes	Sell
13	13-Jan-11	3088.2	2925	3425.431	-500.431	U.V	Yes	Sell
14	14-Jan-11	3095	2936	3428.641	-492.641	U.V	Yes	Sell
15	15-Jan-11	3085	2918	3413.244	-495.244	U.V	Yes	Sell
17	17-Jan-11	3060.5	2909	3377.568	-468.568	U.V	Yes	Sell
18	18-Jan-11	3053.5	2910	3365.568	-455.568	U.V	Yes	Sell
19	19-Jan-11	3040	2880	3346.432	-466.432	U.V	Yes	Sell
20	20-Jan-11	3026.65	2861	3327.499	-466.499	U.V	Yes	Sell
21	21-Jan-11	3004.45	2922	3298.886	-376.886	U.V	Yes	Sell
22	22-Jan-11	3036.5	2925	3329.826	-404.826	U.V	Yes	Sell
24	24-Jan-11	3024	2847	3307.651	-460.651	U.V	Yes	Sell
25	25-Jan-11	3017.75	2830	3296.59	-466.59	U.V	Yes	Sell
27	27-Jan-11	3008.2	2862	3277.735	-415.735	U.V	Yes	Sell
28	28-Jan-11	3018.2	2889	3284.405	-395.405	U.V	Yes	Sell
29	29-Jan-11	3011.8	2836	3273.224	-437.224	U.V	Yes	Sell
31	31-Jan-11	2997.75	2843	3249.561	-406.561	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitrage opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

Table – 10 Arbitration of Zinc

Dates	Date	Spot	Feb	Fair value	Diff	O.V/U.V	Opp. Yes/No	Buy/Sell
1	01-Jan-11	109	110.5	118.156	-7.656	U.V	Yes	Sell
3	03-Jan-11	108.65	110.1	117.4724	-7.3724	U.V	Yes	Sell
4	04-Jan-11	110.8	112.2	119.6418	-7.4418	U.V	Yes	Sell
5	05-Jan-11	108.9	110.25	117.4378	-7.1878	U.V	Yes	Sell
6	06-Jan-11	110.25	111.6	118.7393	-7.1393	U.V	Yes	Sell
7	07-Jan-11	108.9	110.2	117.1328	-6.9328	U.V	Yes	Sell
8	08-Jan-11	108.9	110.15	116.9804	-6.8304	U.V	Yes	Sell
10	10-Jan-11	108.05	109.25	115.7648	-6.5148	U.V	Yes	Sell
11	11-Jan-11	108.75	109.95	116.3625	-6.4125	U.V	Yes	Sell
12	12-Jan-11	109.95	111.15	117.4926	-6.3426	U.V	Yes	Sell
13	13-Jan-11	110.3	111.45	117.7122	-6.2622	U.V	Yes	Sell
14	14-Jan-11	110.1	111.25	117.3446	-6.0946	U.V	Yes	Sell
15	15-Jan-11	110.1	111.2	117.1904	-5.9904	U.V	Yes	Sell
17	17-Jan-11	111.3	112.4	118.1561	-5.7561	U.V	Yes	Sell
18	18-Jan-11	111.3	112.35	118.0003	-5.6503	U.V	Yes	Sell
19	19-Jan-11	110.15	111.15	116.6268	-5.4768	U.V	Yes	Sell
20	20-Jan-11	106.4	107.35	112.5074	-5.1574	U.V	Yes	Sell
21	21-Jan-11	106.95	107.9	112.9392	-5.0392	U.V	Yes	Sell
22	22-Jan-11	106.95	107.85	112.7895	-4.9395	U.V	Yes	Sell
24	24-Jan-11	103.9	104.75	109.282	-4.532	U.V	Yes	Sell
25	25-Jan-11	101.45	102.25	106.5631	-4.3131	U.V	Yes	Sell
27	27-Jan-11	102.6	103.35	107.4838	-4.1338	U.V	Yes	Sell
28	28-Jan-11	105.2	105.95	110.0602	-4.1102	U.V	Yes	Sell
29	29-Jan-11	105.2	105.9	109.913	-4.013	U.V	Yes	Sell
31	31-Jan-11	107.25	107.95	111.7545	-3.8045	U.V	Yes	Sell

Interpretation

The fair value of each day is negative and is not near to zero so it is predicted that there exists an arbitrage opportunity across the month. So the commodity will be purchased at the present spot price and will be sold at present future price.

2.Conclusion

Arbitrage opportunity exists in the Indian commodity market (NCDEX) in the sample period and for sample commodity between the spot closing price of respective commodities and future prices as per cost of carry model. The actual futures price of an asset in the market may deviate from the theoretical price established by the cost of carry model. The deviation may occur due to imperfection of market. The empirical observations showed the deviation between the future prices and the prices in futures calculated by cost of carry model and so arbitrageurs will buy undervalued and sell overvalued. This process will eliminate the price discrepancy in a short period of time and market will be in equilibrium.

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