IMPACT OF FUTURES TRADING ON SPOT MARKETS - AN EMPRICAL ANALYSIS OF RUBBER IN INDIA

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ABSTRACT

In this study an attempt has been made to appraise the impact of futures trading on spot markets of rubber in India. This impact is investigated by examining the price discovery role of futures markets, the direction of volatility spillovers between the futures and spot markets and the relationship between the futures trading activity and the spot price volatility of rubber. Causality relationships between the rubber prices in the spot and futures markets, rubber price volatilities in the spot and futures market and finally the futures trading activity in rubber and its spot price volatility are assessed using a standard pairwise Granger causality test. The results of the analysis suggests that there is a stronger information flow from the future markets to the spot markets which is an implication of the price discovery happening in the rubber futures markets. A GARCH analysis confirms the volatility persistence in the two markets. The Granger causality test between price volatilities conveys that there exists a bidirectional volatility spillover in the two markets. Also, the Granger causality between futures trading activity and the spot volatility implies that the spot price volatility is both a cause as well as a consequence of futures trading activity in rubber.

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1. Introduction

Futures markets in a competitive and complete information setting is believed to provide a direction to price formation and thereby aid in discovering prices for the underlying spot markets. Futures markets because of their price discovery and risk minimization functions are therefore considered to be highly beneficial. However there are several arguments against futures markets which point out the various flaws and the problems that futures markets might lead to. Arguments against futures trading include, firstly, futures trading might lead to a rise in the spot prices of the commodities. Secondly, futures also might lead to rising price volatilities. Thirdly, the futures markets do not necessarily work in a transparent or costless manner which might give opportunities to large traders to monopolize trading and thereby leaves a little space for other traders in the commodity market.

In India, a mushroom growth of commodity exchanges was observed in the early 20th century. There has been a widespread discussion on futures trading in India especially in the context of rising prices i.e. inflation. While one view is that futures trading tends to accentuate the prices in cash markets because of the excessive speculative activities attached with it and hence leads to a general inflation, the contrary view is that futures trading is not primarily the reason for a price rise. Abhijit Sen committee (2008) highlighted the fact that an acceleration of agricultural price inflation in post- futures is not necessarily an implication of futures trading and this acceleration can perhaps be attributed to a rebound of the past trends or maybe simply a normal cyclical adjustment because the pre-futures was a period of international downturn in commodity prices. In consonance with the above observations the Reserve Bank of India in its annual report for the fiscal year 2010 stated that there was no conclusive evidence to show that futures trading in agricultural commodities leads to a food price inflation.

However, the focus of the available studies in futures trading in agricultural commodities in India is mainly on food crops. There is hardly any attempt to analyze the impact of futures trading in cash crops or plantation crops. The nature and implications of futures trading on spot prices can vary across different products. This necessitates a crop specific and particularly a cash crop specific analysis because of the limited amount of research done in cash crops.

Owing to the importance of rubber in the Indian economy and the limited amount of research conducted in context of the role played by futures trading in cash crops, an attempt has been made in this study to analyze the impact of futures trading in rubber, which is a plantation crop, on its spot markets.

This study makes an empirical scrutiny of three questions –Firstly, does futures trading in rubber help in price discovery? Secondly whether there is a persistence of volatility in spot and futures market of rubber and what is the direction of volatility spillover? Thirdly, whether spot price volatility is a cause or result of futures trading?

Futures trading will have a positive impact on the spot markets if the futures markets evolve as an efficient price discovery mechanism for the spot markets of rubber. Whereas, futures will pose a negative impact if it causes price volatility in the rubber spot markets.

The study is structured as follows: In the second section, a brief history of futures trading in the context of India and the scenario of rubber and rubber futures contracts are discussed. In section 3, a review of the relevant literature is done. Section 4 discusses the theoretical underpinnings of the relationship between the futures and spot prices and futures and expected future spot price. Section 5 will present the data, methodology, the empirical analysis of the research question and the results of the empirical analysis. Finally the summary and conclusions are presented in section 6.

2. Futures Trading And The Rubber Scenario In India

History of Futures Trading in India

History of futures trading in India dates back to 1875 when Bombay Cotton trade Association was established. Bombay Cotton Trade Association was the first formal organized market dealing with trade in cotton contracts. This happened right after the introduction of cotton futures in UK as Bombay was the major hub for cotton trade in the British Empire. This was followed by the formation of the Bombay Cotton Exchange in 1893. After the cotton futures, futures trading also initiated in oil seeds in the ‘Gujarat Vyapari Mandali’ in 1900 in Mumbai which is now known as Bombay Commodity Exchange Limited (BCE).

In 1952, Forward Contract Regulation Act was enacted. In the mid 60’s futures trading in most of the commodities except for Pepper and Turmeric was prohibited and by 1996 there was almost a complete ban of futures.

In 1999, the Government of India took a decision of removing all commodities from the restrictive list of futures trading and permitting all the commodities to trade in futures markets. Such permission was granted considering the benefits of futures like the efficient price discovery mechanism and the price stability promoted by futures. Various Exchanges which are a medium for futures trading were established and were funded and supported by public and private institutions.

National Multi Commodity Exchange was the first formal exchange recognized by the government. It was established on 26th November 2002 and dealt with futures trading in 24 commodities. Multi Commodity Exchange was established in November 2003 and is a leading exchange for trade in bulletin and energy sector. National Commodity and Derivative Exchange was established in December 2003, and it dealt with trading in about 57 commodities.

During the period 1950- 95, the Government of India consulted various committees like the Khusraoo committee and the Dantawala committee for their suggestions on the prevailing impacts of the futures trading and whether futures in some commodities is proving to be beneficial. The reports of these committees helped in revival of futures trading in few commodities.

Indian Rubber Scenario

India occupies the fourth position and contributes in about 9% of rubber produced in the world[3]. However, the country occupies the third position in terms of consumption and the first position in terms of productivity. The productivity of Indian rubber is around 1819 kg per hectare.[4]

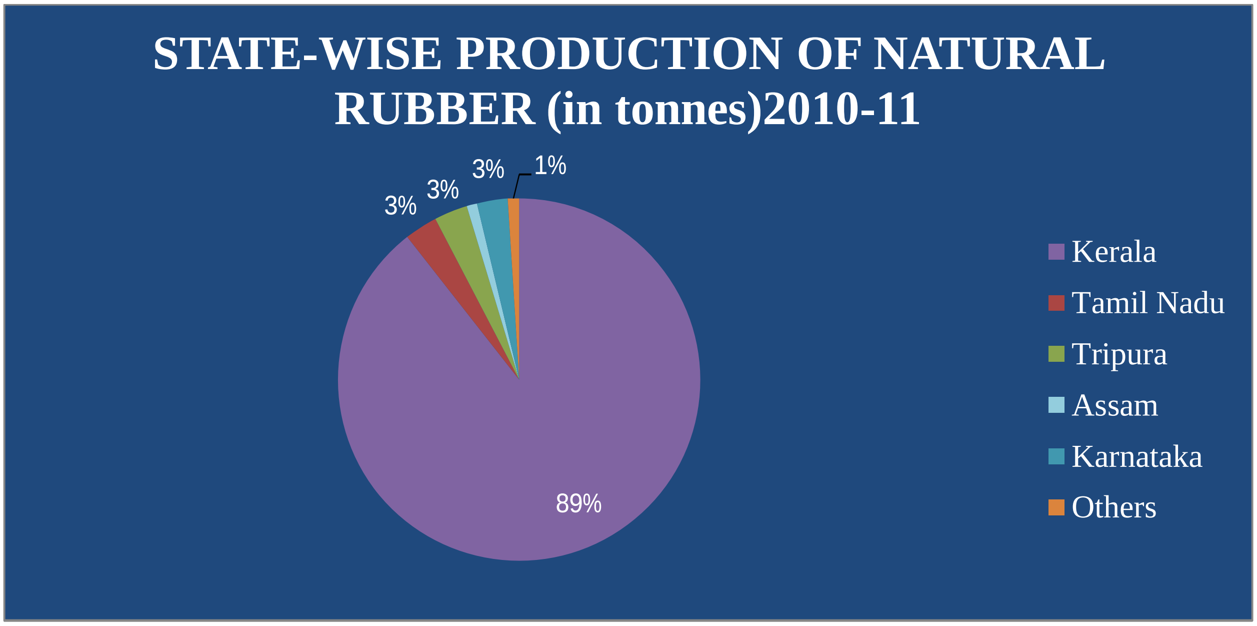
[3] Thailand is the largest producer of rubber and account for about 35% of total rubber production in the world. Indonesia is the second largest producer of rubber and accounts for about 29% of rubber production. Indonesia is followed by Malaysia which contributes in 10% of world rubber production. (Indian rubber statistics).

Of the total natural rubber produced, trading of Ribbed Smoked Sheet (RSS) grades of rubber constitutes about 73% of the total amount of rubber traded in India. The various quality grades in RSS are RSS1, RSS2, RSS3, RSS4 and RSS5 in order of declining quality. However, RSS4 grade of rubber constitutes for more than 50% trade in rubber and futures trading takes place in this grade of rubber. For this reason the present study also makes use of RSS4 grade for the purpose of analysis.

State- wise Production of Natural Rubber

In India, Kerala is the major rubber producing state. Rubber is also grown in the states like Tamil Nadu, Karnataka, Goa, Maharashtra, Andhra Pradesh, Orissa, northeastern states, Andaman and Nicobar Islands etc. (see figure 1). While Tamil Nadu, Tripura and Karnataka contribute in only 3 per cent each of total natural rubber production, Kerala alone contributes about 89 per cent of the total rubber produced in India and an area of 512,045 ha under rubber plantations (NMCE report).

Figure 1: State-Wise Production Of Natural Rubber (in tonnes) 2010-11



Source: Indian Rubber Statistics

[4] In terms of productivity Thailand occupies the second position with a productivity of 1798/ha (Indian Rubber Statistics).

Due to this overwhelming importance of rubber for Kerala economy, the futures trading in rubber also has greater implications for Kerala as compared to other producing states. NMCE in its report on rubber also claims that “The rubber growers of Kerala have heaved a sigh of relief, by getting consistently good prices due to the efficient price discovery and price dissemination contributed by futures trading on the NMCE”

Moreover, 1 million people are directly involved in rubber farming and about 6 million people are indirectly associated with this business. It is due to this fact that rubber prices play a significant role in shaping the livelihood of such a large proportion of farmers in Kerala.

Futures Trading in Rubber in India

Futures trading in rubber initiated on the 15 March 2003 via National Multi Commodity Exchange of India Ltd, Ahmedabad. Rubber futures have widely been used by the rubber industry and the participants of rubber futures trading include traders, exporters, user industry etc. The institutional or regulatory changes in the futures market is reflected in the changes in the specifications of rubber futures contract, which are notified by the Forward Market Commission (FMC).

First rubber futures contract was available for trading with effect from 15th March 2003. However, futures trading in rubber, chana, soya bean and potato were suspended for a period of four months on May 7, 2008 by the Forward Market Commission. The ban was imposed on the grounds of a steep price inflation which India witnessed since 2005. Even though the ban on futures trading in rice and wheat in the previous year did not really contribute in curbing the high prices, a ban on futures in rubber and other commodities was thought to be a corrective mechanism for curbing inflation.

Immediately after two days of ban, on 9th of May it was observed that the price of rubber fell down from Rs 120 per kg to Rs 116 per kg. There were diverging views with respect to the causes for this fall in prices. Some opined that the fall in prices can be attributed to the positive outcome of the suspension of futures trading while others opined that the fall in prices has nothing to do with the suspension of futures trading.

However in, September, 2008 there was a steep rise in prices of rubber. The skepticism revolved around the futures trading, did not allow the government to re-introduce the futures trading. The initial four months ban therefore continued for another 3 months. The prices of rubber continued to be high throughout the ban period. Many believed that the high price of rubber was mainly due to a general high demand for rubber by the rubber industry. Futures trading in rubber was finally resumed in December, 2008.

A resumption of futures trading in rubber, chana and soy oil was announced by NMCE as per the circular number NMCE/2008-09/0058. New rubber contracts for futures trading were issued on the 4th December, 2008. The changes in the contract specifications are mostly in terms the revisions in the price band of the permitted daily price fluctuations.

Although, futures trading in rubber resumed in December 2008, there is still some amount of ambiguity with respect to the actual implications of futures trading on the spot markets. This is also coupled with the fact the empirical analysis for understanding the true implications of futures trading in rubber on spot markets are very limited and this will be evident from the review of studies which has been undertaken in the next section.

3. Literature Review

A plethora of literature, analyzing the impact of futures trading on spot prices for both physical commodities as well as financial instruments exists. There are two strands of literature analyzing the impact of futures trading on spot prices. One segment of the literature analyzes this question by examining the '*impact of introduction of futures trading*' on the spot prices for various commodities. Studies analyzing the impact of introduction of futures trading on spot prices usually make a comparison of the spot price volatilities for periods before and after the introduction of futures trading. Whereas, the other segment of literature focusses on the '*impact of amount of futures trading activity*' on the spot price of various commodities. Studies relating to this question basically examine how the level of futures trading activity which is measured by either the volume or open interest affects the cash market volatility.

Several studies have examined the causality relationships between spot and futures markets both in terms of returns and volatilities pertaining to assets such as equity, agricultural commodities, foreign currency etc. The review of studies undertaken in this section would give more emphasis on agricultural commodities.

There have been some attempts to analyse the impact of futures trading in agricultural markets to assess its effectiveness and necessity. The studies aim at revalidating the misperceptions regarding futures trading. These studies include Pavaskar(1967), Crain and Lee (1996), Singh (2000), Naik and Jain (2002), Yang et al (2005), Lokare (2007), Bose (2008), Nath and Lingareddy (2008), Kumar and Pandey (2009), Hernandez and Torero (2010), Mukherjee (2011), Sen and Paul (2010)

Pavaskar (1967) assessed the nature and extent of bias in futures price forecast in cotton, castor seed and groundnut futures of Bombay. The number of deviations of monthly average futures price from the average delivery month futures price is tabulated and analyzed. The analysis confirmed that the bias in all the three markets was in the favor of lower prices and hence the study concluded that futures markets did not aggravate upward trend in commodity prices. Another study done by Pavaskar in 1970 analyzed the impact of futures trading on the spot price volatility of only groundnut for the period of 1951-52 to 1965-66 by dividing the entire period on pre- futures and post- futures regime. Price fluctuations within a month and within a fortnight were analyzed using ranges which were deflated by average prices in order to ensure effective comparisons. The results of his analysis showed that the price variations were large in the absence of futures trading. So the study concluded that future trading is instrumental in reducing the price volatility.

Crain and Lee (1996) using the Granger causality tests found out that wheat futures market in US performs the price discovery role by transferring the volatility to the spot market.

Naik and Jain (2002) assessed the performance of six commodity futures namely gur, pepper, hessian, cotton, coffee, sunflower, turmeric based of their membership pattern overtime, liquidity, price volatility, basis risk. Co-integration between futures and cash market’s efficiency and lack of bias was examined to see their role in discovering prices. The paper concludes that the Indian futures market for agriculture is not fully developed for efficient mechanisms of risk management and price discovery but have a great potential for better performance.

Yang *et al* (2005) analyzed the impact of futures trading activity and commodity cash price volatility by examining the lead-lag relationship between futures trading activity and cash price volatility for major agricultural commodities in US. These commodities include corn, soybeans, sugar, wheat, cotton, hog and cattle. Granger causality test was used to test for the causality relationship between futures trading activity and spot price volatility. The findings are generally consistent with the destabilizing impact of futures trading on agricultural commodity markets.

Efficiency of Indian commodity indices for both energy and metal products and agricultural commodities as well in terms of price dissemination has been investigated by Bose (2008). The results of the analysis suggest that both energy and metal futures market exhibit informational efficiency and played a significant role in reducing the spot price volatility. But on the contrary agricultural futures markets did not feature either market efficiency or price discovery.

In a comparatively recent study, undertaken by Nath and Lingareddy (2008) the authors have tried to explore the effect of futures trading on spot prices of pulses. Their study suggests that the prices of pulses were higher during the period of futures trading than in the period prior to its introduction as well as after the ban of futures contract.

Kumar and Pandey (2009) examined the hedging effectiveness of four agricultural and seven non-agricultural futures contracts traded in India. Agricultural futures include soybean, corn, castor seed and guar and the non-agricultural goods include gold, silver, aluminum, copper, zinc, crude oil and natural gas. Their findings indicate the fact that Indian futures contract are more effective for hedging exposures to global prices.

In a recent study, Hernandez and Torero (2010) examined the dynamic relationship between spot and futures price of corn, wheat and soybeans. Granger causality test was conducted to know about the information flow between spot and futures markets. The results revealed that there was a significant information flow from the futures to spot markets and that the spot prices are generally discovered in the futures markets for the three commodities. Also, linear and non-linear Granger causality tests were conducted on spot and futures returns and volatilities and it was found that a change in futures price lead to a change in spot price more often than the reverse.

In another recent study, Sen and Paul (2010) examined that if futures in agricultural goods has resulted in price discovery and has helped in reducing the volatility in food prices. A pattern of link between investment in stock market and commodity markets has also been analyzed. Granger test confirmed the causality between the spot and futures and that a futures price uptrend leads to an upward spurt in spot prices. There was a distinct rise in volatility in the months of futures of commodities analyzed. There was a strong negative relation between TSE turnover and individual spot prices in May 2008- May2009.

Lately, an analysis of the impact of futures trading on price volatility of selected agricultural products was done by Mukherjee (2011). The objective of his study was to revalidate the misperceptions regarding the usefulness and relevance of commodity futures in India. The statistical techniques used are multiple regression model, Vector Auto Regression (VAR) model and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. The analysis showed that the price volatility for most of the selected agricultural commodities was higher in pre- futures period and gets significantly reduced after getting listed in futures. The study also found out that the impact of futures volatility on spot returns was not very significant.

In addition to the various studies there also have been various ***committees*** from time to time that have analyzed the performance of futures trading in India. The committees have in general highlighted the importance of futures trading in a price risk management for the agricultural commodities in India. The major highlights of the committees are summarized below.

Dantawala Committee (1966) recognized the importance of commodities futures trading and recommended steps to revive futures trading in agricultural commodities. The recommendations remained ignored by the concerned authorities and the banning process of futures continued till late 70’s. This was followed by the formation of Khusraoo Committee (1980), which recommended steps to revive futures trading in agricultural commodities including potatoes and onions. But the ban on all other commodities continued because of the misconception of destabilizing prices caused by the speculative activities. During the era of liberalization, Kabra committee (1994) under the chairmanship of Prof K.N. Kabra was appointed by the government, which recommended opening up of futures in 17 selected commodities. The committee unanimously recommended that futures should not be resumed for wheat, non-basmati rice, tea, coffee, dry chilly, maize, vanaspati and sugar. In 1996, UNCTAD and World Bank report highlighted the role of futures trading as a market based instrument for managing risk. The National Agricultural Policy (2000) also expressed support for commodity futures. The Guru Committee (2001) emphasized the role of futures trading in managing price risk and in marketing of agricultural products. However, Abhijit Sen Committee (2008) found out that the acceleration of price inflation during the post futures period does not necessarily mean that it is a result of futures trading. Agricultural prices were relatively low in the immediate pre- futures period reflecting an international downturn in commodity prices. The acceleration in the futures period could be a rebound of the past trend. The committee also said that “futures trading has been in operation is too short to discriminate adequately between the effect of opening up of futures markets and what might simply be the normal cyclical adjustment”

In general, the studies have tried to examine the impact of futures trading on cash prices or cash markets of various agricultural commodities. This impact has been investigated by either examining the cash price volatilities for the periods prior to and periods after the introduction of futures trading or by analyzing the impact of futures trading volume on the spot price volatility of the asset. Literature has also tried to examine the relevance and usefulness of futures by examining whether the futures markets cater in an efficient price discovery mechanism for the underlying spot markets.

The studies reveal a highly mixed result. Some studies show that the spot price volatilities decreased after the introduction of futures thereby fulfilling the aim of introduction of futures trading. While, others show that futures perhaps resulted in an increase in or had no significant effects on price volatilities which highlights the price destabilizing effect of futures trading. As far as the question of price discovery is concerned again the literature presents diverging views. Some studies have supported the role of futures markets in discovering prices by establishing a unidirectional flow of information between spot and futures markets. While others have argued that futures have turned out to be an inefficient mechanism for risk management and price discovery.

However, the available studies for agricultural commodities are mainly focused on the food crops and there is hardly any attempt for cash corps or plantation crops. . The impact and the implications of futures trading can vary quite considerably across the products depending upon product characteristics. Therefore, we would tend to believe that a crop specific study, especially a study on rubber which is an important plantation crop is required.

4. The Relationship Between Spot And Futures Prices

Following Pindyck (2001) a close relationship is expected to exist between the price of futures contracts and spot prices. The relationship between the two prices is derived from the Non-Arbitrage theory (Pindyck, 2001). Suppose the present time period is denoted by "t" and the delivery date is denoted by "$t+T$". Let P_t denote the spot price of the agricultural commodity available at time period t and P_{t+T} denote the spot price of the commodity at time period $t+T$. Say $F_{t,T}$ is the futures price of the agricultural commodity decided at time t for delivery at $t+T$, r_T is the risk free T period interest rate, K_T is the per unit cost of storage of the commodity and $\gamma_{t,T}$ be the capitalized flow of marginal convenience yield[5] from t to $t+T$.

Therefore, the stochastic returns from holding the commodity from time period t to $t+T$ is given by, $R_1 = P_{t+T} - P_t + \gamma_{t,T} - K_T$

Whereas the returns from shorting the futures contract for the commodity in time period t is given by, $R_2 = F_{t,T} - P_{t+T}$

So, the farmers total returns at $T = R_1 + R_2 = F_{t,T} - P_t + \gamma_{t,T} + K_T$.

The Non- Arbitrage condition requires that the total returns should be equal to the risk free rate times the price of the commodity at t i.e., $F_{t,T} - P_t + \gamma_{t,T} + K_T = r_T P_t$

On rearranging, we obtain, $F_{t,T} = (1+ r_T)\, P_t - (\gamma_{t,T} - K_T)$ (1)

[5] Convenience yield is the benefits accrued from holding the commodity. Inventory holders obtain extra benefits from holding the commodity during the periods of temporary local shortages. Also, convenience yield increases during the times of high price volatility primarily because the value of keeping the commodity is high when the prevailing price volatility is also high.

To avoid arbitrage opportunities the above condition must hold. This condition has two implications. Firstly, the futures price can be greater than or lower than the net of marginal convenience yield ($\gamma_{t,T}$ - K_T). If net of marginal convenience yield ($\gamma_{t,T}$ - K_T) is negative then it implies that the futures price is higher than the spot price and if it is positive then it implies that the spot price is higher than the futures price. If futures price is lower than the spot price the futures market is said to exhibit "backwardation" and if spot price is lower than the futures price then the futures market is in "contango". Secondly, it also implies that the futures and spot prices should move together in order to avoid any arbitrage opportunities, i.e., it is expected that the price movements in the two markets are correlated.

Following Pindyck (2001) the relationship between futures price and expected future spot price is described next.

Suppose at time *t*, a farmer buys a commodity at price P_t , holds it upto time $t+T$ and then sells it at price P_{t+T} ,which is the prevailing market spot price at time period $t+T$. Let the expectation of the spot price in future date as of today and be denoted by $E(P_{t+T})$. Therefore, the returns of this investment is equal to $E(P_{t+T})$- P_t+$\gamma_{t,T}$+K_T. The expected future spot price is unknown at time *t*, and hence the return from above investment should be equal to the risk adjusted discount rate times the price of the commodity at *t*, i.e., $E(P_{t+T})$ - P_t + $\gamma_{t,T}$ - K_T = ρ_t P_t (2)

Substituting (1) in (2), we obtain the following equation

$$F_{t,T} = E(P_{t+T}) - (\rho_t - r_T)\, P_t$$

The above equation gives the relationship between the futures price and the expected future spot price. It can be clearly seen from the above equation that futures price should account for the positive risk premium. The futures price should typically be lower than the expected future spot price due to the positive risk premium. As pointed out by Pindyck (2001), holding the commodity alone entails risk, and as a reward for that risk, the spot price at $t+T$ is expected to be above the current futures price.

The theoretical underpinnings discussed above portray the explicit relationships between the futures price, spot price and expected future spot price very well. The theory however, does not give us any insight about the direction of causality. To examine the impact of futures trading on the spot market of rubber, it is crucial to determine the direction of causality and information flows between the two markets. This causality is looked at by using the Granger causality tests in the following section.

5. Empirical Analysis

Data Sources

For analysis of the relationship between the spot and futures price, price volatilities and futures volume secondary data is obtained from the historical data of National Multi Commodity Exchange (NMCE). The historical data of the NMCE provides the daily data for futures and spot, monthly and daily volume and value data for rubber futures and daily near month futures data.

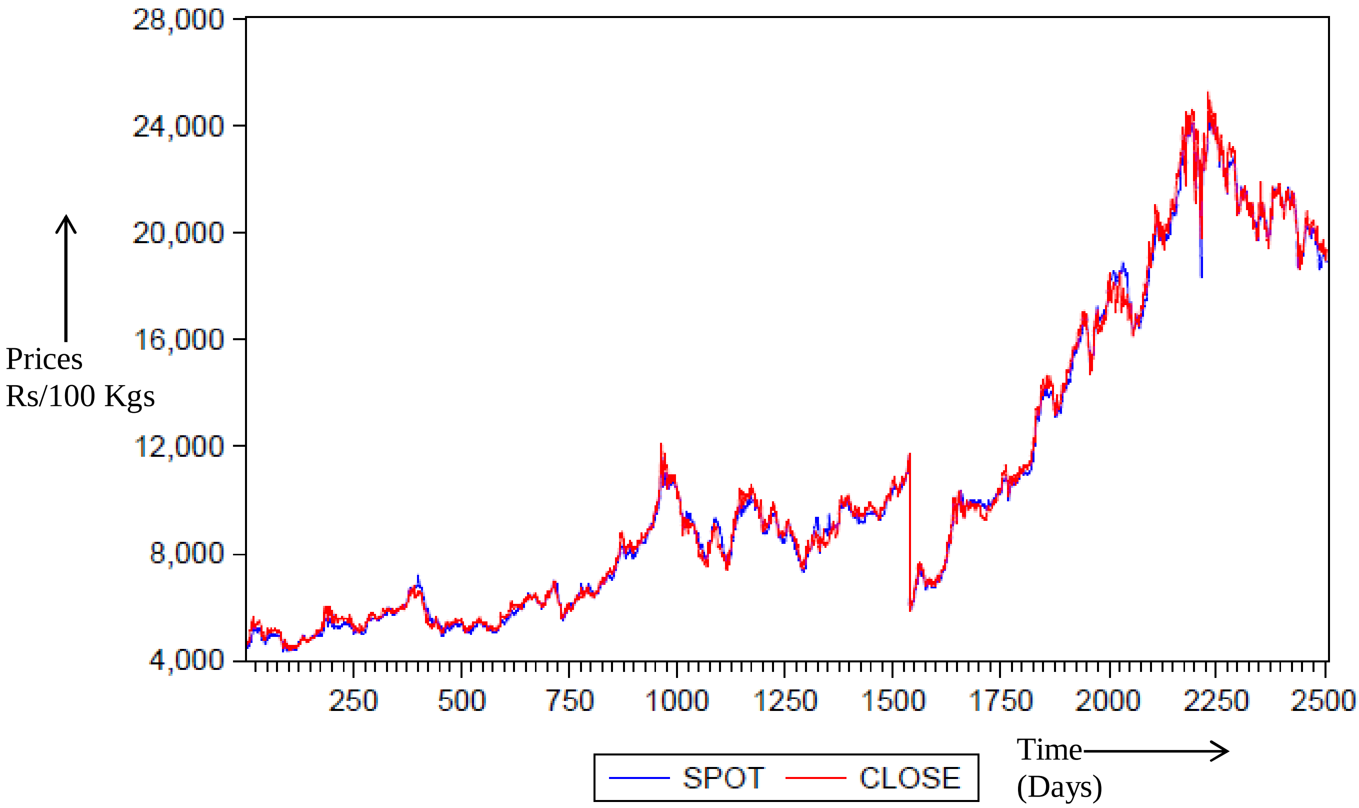
Futures and spot dataset consists of futures and spot data of various rubber contracts from 2003 to 2012. However, the volume and value dataset provides the daily and monthly volume and value data of rubber futures. Finally, the Near Month series dataset gives the detailed daily data of futures and spot prices, futures volume, open interest etc. for all the near- month trading contracts. For the present analysis daily data of closing price, futures volume and spot prices from the near month series dataset is used.

For the futures price, close price of the futures contract is used because closing price is the last price at which a commodity is traded in the futures market before the trade closes for that particular day. Also, trading details of a near month series are used for the analysis. This is primarily because futures contracts with different delivery date are traded every day and the near month contract is the one with the shortest maturity. A near month futures contract is also the most liquid contract. Therefore the relevant data used for the analysis is the daily data of futures price or the close price, futures volume and spot price of the near- month trading data series.

The Trends in Futures and Spot Price trend of Rubber

Figure 2 shows the trends in futures and spot prices of rubber during the time period under study. Two patterns emerge from this graph, first that both the futures and spot prices of rubber are highly correlated. Hence there exist a strong correlation and convergence of the two price series on the settlement date as predicted by the non- arbitrage theory. Secondly, on some days futures price exceeds the spot price, while on other days the spot price exceeds the futures price. At the points where futures price exceeds the spot price, futures price is said to exhibit ‘contango’ and on he points where spot price exceeds the futures price, futures price is said to exhibit ‘backwardation’. So, the trends in the spot and future prices of the rubber gives us an insight to further look into the direction of information flow so as to determine which price series is a cause of the other price series.

Figure 2: Futures and Spot Price trend of Rubber



Methodology

To investigate the impact of futures trading on spot market of rubber the empirical analysis is carried out in two steps. In the first step a preliminary analysis of the spot and futures price is done which includes the test for stationarity. A pre-requisite for the core analysis is that the price series should be stationary. Therefore, the stationarity of the rubber spot and futures prices is checked in the first step using an Augmented Dickey Fuller (ADF) test. The next step is the core analysis of the study in which a GARCH analysis and pairwise Granger causality tests are implemented. The primary need of a GARCH analysis is to confirm the presence of volatility in the rubber futures and spot markets. Whereas the Granger causality tests are carried out to answer the following three questions,

1. Does futures trading in rubber help in price discovery in rubber markets?

2. Are futures and spot market of rubber volatile and if they are volatile then what is the direction of volatility spillover?

3. Is spot price volatility in rubber a cause or a result of futures trading activity in rubber?

The entire time period (2003-2010) for the empirical analysis is divided into two sub time periods, the first one being March 15, 2003 – May 4, 2008 and the second one being December 12, 2008 – February , 2012. Such a partitioning in the data set is done to take care of the ban on futures trading which was imposed on the 7th of May, 2008. So, the first time period includes all the data points, before the ban on futures trading was implemented and the second time period includes the data points after the futures trading was reintroduced in rubber. Therefore, we name the period March 15, 2003 – May 4, 2008 as the pre- ban period and the period December 12, 2008 – February, 2012 as the post- ban period.

For the empirical analysis of the first question a pair- wise Granger causality test is conducted between futures and spot price returns instead of directly on the prices itself. Price returns are defined as the difference between log of present period price and log of last period's price. Accordingly, futures and spot price returns can be represented as follows

Returns $R_t = log\, P_t - logP_{t-1}$

Spot Price Returns: $R_{st} = log\,P_{st} - logP_{s(t-1)}$

Futures Price Return:$R_{ft} = log\,P_{ft} - logP_{f(t-1)}$

Using price returns over normal prices has several advantages. Firstly it compresses the price values thereby, making them more comparable. Secondly, prices in their level forms might be non-stationary, so price returns solves this problem by making the series stationary.

The measure of daily volatility has been adopted from Crain and Lee, 1996. The daily measure of volatility is taken as the absolute deviation of the price returns from the average price returns of the series and is denoted by $|R_t - \bar{R}|$. Futures and spot daily price volatility can therefore be written as,

Spot Volatility: $|R_{st} - \overline{R_{st}}|$

Futures Volatility: $|R_{ft} - \overline{R_{ft}}|$

Here, the modulus of the deviation of price returns from the average price returns is used to measure the volatility because we are interested in knowing about the magnitude of price fluctuations and not the direction of the price fluctuations.

Results of the Empirical Analysis

1. Tests for Stationarity of Prices

As expected both the spot and futures price were non- stationary in their level forms. Therefore, price returns for both the price series were calculated and again tested for stationarity using the standard Augmented Dickey Fuller (ADF) test. The test results of the ADF test for futures price returns and spot price returns are reported in Table 1.

The results clearly indicate that τ statistic of futures price returns and spot price returns for both the pre- ban and the post- ban period are highly statistically significant. The highly significant τ statistic for all the four case implies that the null hypothesis of presence of unit roots and hence non- stationarity of price returns can be rejected even at 1% level of significance.

Table 1: Results of the Tests for Stationarity

	Pre- Ban	Post- Ban
Returns Spot	-10.49***	-11.94***
Returns Futures	-10.82***	-13.79***

*10%, **5%, ***1% significance. F-statistic reported,(probability).

We therefore accept the alternate hypothesis which says about the absence of unit roots and stationarity of price returns. The Augmented Dickey Fuller test hence, confirms the stationarity of the spot and futures rubber price returns.

2. Results of the Granger Causality of Returns

The Granger- Causality test for the price returns series is based on the following equations

$$R_{st} = \alpha_0 + \sum_{k=1}^{p} \alpha_k R_{s(t-k)} + \sum_{k=1}^{p} \beta_k R_{f(t-k)}) + u_t$$

$$R_{ft} = \varphi_0 + \sum_{k=1}^{p} \varphi_k R_{s(t-k)}) + \sum_{k=1}^{p} \emptyset_k R_{f(t-k)} + v_t$$

In the above two equations, R_{st} and R_{ft} are spot and futures price returns in period *t* and $R_{s(t-k)}$ and $R_{f(t-k)}$) are the spot and futures price returns in *k* previous periods, i.e. period *(t-k)*. α_k, β_k, $\varphi_k$and $\emptyset_k$ are the coefficients and u_t and $v_t$are the error terms. For the first equation the null hypothesis $\beta_k = 0$ implies that previous periods futures returns do not Granger- cause present periods spot price returns. However, if the null is rejected using a standard joint test like the F-test then it would imply that past periods futures price returns help in predicting todays spot price returns. Similarly, for the second equation rejection of the null $\varphi_k = 0$ (which means past periods spot prices do not cause today's futures price) would signify the power of the past values of spot price returns in predicting todays futures price returns. The lag order is determined by minimizing the Schwartz Bayesian Criteria[6] (SIC). The chosen number of lags is $k = 9$ for the pre ban period and $k = 5$ for the post ban period. The results of the Granger causality of futures and spot price returns for both pre and post ban periods are presented in Table 2.

[6] For the analysis SIC is chosen over the AIC criteria primarily because of the large number of observations. SIC is believed to give more reliable results as compared to the AIC when there are large numbers of observations.

Table 2: Results of the Granger Causality of Returns

	H_0: ***Futures Returns does not Granger-cause Spot Returns***		H_0: ***Spot Returns does not Granger- cause Futures Returns***	
Lags	**Pre- Ban**	**Post- Ban**	**Pre- Ban**	**Post- Ban**
1	310.264(2.E-63)***	425.305(1.E-78)***	3.441(0.0638)*	0.01176(0.9137)
2	203.532(4.E-79)***	242.190(7.E-86)***	1.21549(0.2969)	0.71602(0.4890)
3	152.956(1.E-86)***	164.481(6.E-86)***	1.28917(0.2765)	0.59205(0.6203)
4	120.778(1.E-89)***	122.587(2.E-84)***	1.19045(0.3131)	1.76458(0.1338)
5	97.8360(2.E-89)***	**100.497(4.E-85)******	1.72750(0.1251)	**1.49183(0.1898)**
6	81.5645(1.E-88)***	84.6064(7.E-85)***	1.53092(0.1642)	2.44847(0.0235)**
7	71.7428(1.E-89)***	71.2166(1.E-82)***	0.73445(0.6428)	2.20655(0.0316)**
8	62.6056(1.E-88)***	62.9305(2.E-82)***	0.96601(0.4609)	2.08309(0.0349)**
9	**55.9222(4.E-88)******	55.8278(2.E-81)***	**1.12744(0.3396)**	2.30121(0.0147)**
10	50.5096(1.E-87)***	49.7674(7.E-80)***	1.04899(0.3993)	3.14666(0.0006)***

Notes: The Schwartz Bayesian Criterion (SBC) suggests lag structures of 9 and 5 for Pre- Ban and Post-Ban periods respectively
H0 = null hypothesis
*10%, **5%, ***1% significance. F-statistic reported, (probability).

For the pre- ban period a unidirectional causality exists from the futures returns to the spot returns uniformly for all the lags except for lag 1. A lag of one day suggests bidirectional causality between the spot and futures price returns of rubber but only a weak causal feedback from the spot returns to futures returns. The chosen lag order however is of nine days. The null hypothesis of “futures returns does not Granger- cause spot returns” can safely be rejected because of a highly significant F-statistic (significant even at 1% level of significance) at the lag order of 9. Whereas for the same lag order, the F-statistic of the null hypothesis “spot returns does not Granger- cause futures returns” is insignificant and accordingly this null can be rejected. At lag order of nine days, therefore there runs a unidirectional causality from the futures returns to spot returns. Hence, the result indicates that nine days previous rubber futures price returns contain the information which contribute in predicting present period’s spot price returns of rubber. This implies that there is an information flow from the futures market of rubber to the spot market of rubber because today's spot returns or prices are a result of previous nine days futures returns or prices.

Similarly, for the post ban period, for the chosen lag order of five days there exists a unidirectional causality from futures returns to spot returns. The F-statistics indicate that the null hypothesis "futures returns does not Granger cause spot returns" can be rejected while the null hypothesis "spot returns does not Granger cause futures returns" cannot be rejected. This in turn implies that futures returns Granger causes spot returns. Therefore, it can be stated that previous five days futures returns contain the necessary information over and above the lagged values of spot returns itself which abet in predicting the present period's spot returns.

The results of the Granger causality of price returns for both the pre- ban and post- ban periods demonstrate a unidirectional causality flowing from the rubber futures price returns to the rubber spot price returns. This also implies that there is an information flow from the futures market of rubber to the spot market of rubber. Such results reveal that futures market of rubber give a direction to the spot markets of rubber to formulate the rubber prices, which approves the price discovery role of rubber futures markets.

3. *Results of the GARCH (1, 1) Analysis*

It is crucial to check for actual presence of volatility in the spot and futures markets of rubber before conducting any causality tests between the price volatilities or futures volume and volatility. The presence of volatilities is confirmed using the GARCH (1,1) model. The GARCH (1, 1) analysis is based on the following equations

$$R_t = logP_t - logP_{t-1} = c + \varepsilon_t$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

Here, in the first equation which is also called as the mean equation, price returns both futures and spot are regressed on a constant and using the residuals from the first equation the forecast variance of the present time period is predicted in the second equation which represents the conditional variance equation. If the sum of the coefficients of the ARCH (α) and the

GARCH (β) term is close to unity it implies a persistence of volatility. Table 3 shows the results of the GARCH (1, 1) analysis.

Table 3: GARCH Results

Coefficients	Pre- Ban		Post- Ban	
	Spot	Futures	Spot	Futures
Α	0.103488***	0.149357***	0.298547***	0.124193***
Β	0.855367***	0.787905***	0.566675***	0.804138***

Notes- α is the ARCH coefficient, Β is the GARCH coefficient
*10%, **5%, ***1% significance

The results reveal that the sum of ARCH and GARCH coefficients $(\alpha + \beta)$ for both futures and spot market of rubber in the pre as well as the post ban period is close to one. The sum of the coefficient is close to one, which indicates a persistence of volatility. Therefore, persistence of price volatility is affirmed by the GARCH (1, 1) specification. The results also imply that large changes in price returns in previous period are like to be followed by further large changes. Hence it can be said that the prices in rubber spot and futures markets are volatile for the pre-ban as well as the post- ban periods

4. Results of the Direction of Volatility Spillovers

After affirming the presence of volatility in the futures and spot market of rubber using the GARCH (1, 1) model, the next step is to check for the direction of the volatility spillover. The Granger causality test between the price volatilities would advocate in establishing whether the spot price volatility is a result of futures price volatility or it leads to the volatility in the futures prices. The Granger causality tests for the spot and futures price volatility (for both pre and post ban periods) is based on the following equations:

$$V_{st} = \alpha_0 + \sum_{k=1}^{p} \alpha_k V_{s(t-k)} + \sum_{k=1}^{p} \beta_k V_{f(t-k)} + u_t$$

$$V_{ft} = \varphi_0 + \sum_{k=1}^{p} \varphi_k V_{s(t-k)} + \sum_{k=1}^{p} \emptyset_k V_{f(t-k)} + v_t$$

V_{st} and V_{ft} are spot and futures price volatilities in period t and $V_{s(t-k)}$ and $V_{f(t-k)}$) are the spot and futures price volatilities in k previous periods, i.e. period *(t-k)*. α_k, β_k, φ_k and $\emptyset_k$ are the coefficients and u_t and $v_t$are the error terms. The lag order is suitably chosen by minimizing the SIC criteria and is $p = 1$ for both pre- ban as well as the post- ban periods. The null hypothesis $\beta_k = 0$ for the first equation implies that lagged values of futures volatility is not a cause of present spot volatility and the null hypothesis $\varphi_k = 0$ for the second equation implies that lagged values of spot volatility is not a cause of present futures volatility. The results of direction of volatility spillovers up to 10 lags are shown in Table 4.

Table 4: Results of the Direction of Volatility Spillovers

	H_0: Futures Price Volatility does not Granger-cause Spot Price Volatility		***H_0: Spot Price Volatility does not Granger-cause Futures Price Volatility***	
Lags	**Pre- Ban**	**Post- Ban**	**Pre- Ban**	**Post-Ban**
1	**58.5305(4.E-14)*****	**158.143(1.E-33)*****	**15.3331 (9.E-05)*****	**39.7954 (4.E-10)*****
2	30.6384 (9.E-14)*******	72.5205 (5.E-30)*******	6.03927(0.0024)*******	15.1260 (3.E-07)*******
3	20.5503(5.E-13)*******	46.6727(4.E-28)*******	2.46571 (0.0607)*****	11.9970(1.E-07)*******
4	14.7925 (7.E-12)*******	33.0381(8.E-26)*******	2.20438 (0.0664)*****	8.91619 (5.E-07)*******
5	11.6731 (4.E-11)*******	26.0935(9.E-25)*******	1.78145(0.1135)	6.04454 (2.E-05)*******
6	9.98175 (8.E-11)*******	22.2297 (1.E-24)*******	1.69101(0.1195)	5.69501 (8.E-06)*******
7	8.33329(5.E-10)*******	18.4462 (4.E-23)*******	1.30763 (0.2427)	4.95631 (2.E-05)*******
8	8.09115 (1.E-10)*******	16.1519 (2.E-22)*******	2.80693 (0.0043)*******	4.29742 (4.E-05)*******
9	7.57917(6.E-11)*******	14.4281 (5.E-22)*******	2.68900(0.0042)*******	3.95421(6.E-05)*******
10	6.62903(4.E-10)*******	12.8612(3.E-21)*******	2.57144 (0.0044)*******	4.05176 (2.E-05)*******

Notes: The Schwartz Bayesian Criterion (SBC) suggests lag structures of 1 for both the Pre- Ban and Post- Ban periods.
H0 = null hypothesis
*10%, **5%, ***1% significance. F-statistic reported,(probability)

At a lag order of one day bidirectional causality between futures price volatility and spot price volatility exists for both the time periods considered in the empirical analysis. The highly significant F-statistic confirms the rejection of both the null hypotheses. For rubber therefore, yesterday's volatility in the futures market plays in significant role in causing todays volatility in the spot price and yesterday's spot price volatility also causes todays futures price volatility.

Therefore the spot price volatility can be inferred as both the reason and result of futures price volatility in rubber.

5. Results for the Causality between Futures Volume and Spot Price Volatility

Granger causality between the futures trading activity represented by futures volume and the spot price volatility is imperative to apprehend the relationship between futures trading activity and the spot price volatility of the rubber market. This Granger causality will accordingly answer the question of spot price volatility being a cause or a consequence of the futures trading in rubber.

The Granger causality test between the spot price volatility and the futures trading volume is illustrated by the following equations:

$$V_{st} = \alpha_0 + \sum_{k=1}^{p} \alpha_k V_{s(t-k)} + \sum_{k=1}^{p} \beta_k Vol_{f(t-k)}) + u_t$$

$$Vol_{ft} = \varphi_0 + \sum_{k=1}^{p} \varphi_k V_{s(t-k)} + \sum_{k=1}^{p} \emptyset_k Vol_{f(t-k)} + v_t$$

In the above two equations, V_{st} represents the spot price volatility in the rubber spot market at period t and Vol_{ft} represents the volume of rubber futures contract being traded in the rubber futures market at time period *t*. $V_{s(t-k)}$ and $Vol_{f(t-k)})$ represents the spot price volatility existing in the rubber spot market and volume of rubber futures contracts in k previous time periods, where *k=1,..,p* The null hypothesis of the first equation is given by $\beta_k = 0$, which signifies that past values of futures volume are not a cause of the present period's spot price volatility. While the null hypothesis of the second equation represented by $\varphi_k = 0$ implies that the past values of the spot price volatilities do not help in the prediction of present volume of futures contracts of rubber. The rejection of the first null hypothesis would imply that the past values of futures contract volumes play a crucial role in forecasting present period's spot price volatility. If this holds then the spot price volatility can said to be a result of futures trading activity. However the rejection of the second null hypothesis $(\varphi_k = 0)$ signifies that present period's volume of futures contract is caused by past values of the spot price volatility. This, in turn would imply that futures trading activity is a result of the spot price volatility or in other words, the past spot price volatilities is the cause behind present futures trading activity.

A lag order of *p = 1* for the pre-ban period and *p = 3* for the post- ban period for this granger-causality test is suggested by minimizing the SIC criteria. The relevant null hypotheses are tested using the F- test. The F-statistics along with the probability value (in the parenthesis) for lag orders of up to ten lags is reported in Table 5.

Table 5 Results for the Causality between Futures Volume and Spot Price Volatility

	H_0: *Futures Volume does not Granger- cause Spot Price Volatility*		H_0: *Spot Price Volatility does not Granger- cause Futures Volume*	
Lags	**Pre- Ban**	**Post- Ban**	**Pre- Ban**	**Post-Ban**
1	**5.62092 (0.0179)****	5.42053 (0.0201)**	**6.57828 (0.0104)****	2.89084 (0.0894)*
2	2.61857(0.0732)*	6.79623 (0.0012)***	2.70698 (0.0671)*	2.56556 (0.0774)*
3	2.21007 (0.0851)*	**5.28303 (0.0013)*****	1.61871 (0.1831)	**2.27015 (0.0789)***
4	2.15723 (0.0716)*	3.61749(0.0062)***	0.92935 (0.4459)	1.27127 (0.2795)
5	1.76488 (0.1170)	3.14078 (0.0081)***	1.48579 (0.1914)	1.64934 (0.1443)
6	1.48002 (0.1813)	2.59646 (0.0168)**	1.29610 (0.2557)	1.65630 (0.1286)
7	1.63123 (0.1223)	2.44579 (0.0173)**	1.36551 (0.2159)	1.63671 (0.1214)
8	2.36024 (0.0160)**	2.32251 (0.0180)**	1.20745 (0.2906)	1.40164 (0.1916)
9	2.35111(0.0124)**	2.09709 (0.0273)**	1.04788 (0.3991)	1.78306 (0.0675)*
10	2.12708 (0.0199)**	1.93017(0.0380)**	1.11306 (0.3483)	1.66668 (0.0839)*

Notes: The Schwartz Bayesian Criterion (SBC) suggests lag structures of 1 and 3 for Pre- Ban and Post-Ban periods respectively
H0 = null hypothesis
*10%, **5%, ***1% significance. F-statistic reported,(probability).

On an examination of the results very peculiar trends of causality emerge at different lags. The results clearly point out the sensitivity of Granger causality to different lag lengths. In the pre-ban period of futures trading in rubber, there is an existence of bidirectional causality between futures trading volume and spot price volatility at lag 1. However, at lag length of 3 days, the causality becomes unidirectional flowing from the futures volume to the spot price volatility. This implies that three day's previous volume of futures contracts of rubber are a cause of present day's price volatility in the spot market. Whereas for lag length of five days, there is no causality between the two variables. Implication of this is that the decision of the volume of futures contracts of the participants of the rubber futures markets is independent of the previous five day's volatilities of the rubber spot market. Similarly, the spot price volatility in the rubber market is independent of the previous five day's volumes of rubber futures contracts traded in the futures markets. Moreover there is a re-occurrence of a unidirectional causality from the futures volume to spot volatility eighth lag onwards signaling that eight day's previous futures volumes of rubber contracts play a significant role in causing the prevailing price volatility in the rubber spot market.

Similar sensitivities of Granger causality to different lag order can be observed for the post- ban period. In the post- ban period, the causality shifts from bidirectional causality (till lag length of three) to a unidirectional causality (from the fourth to eighth lag) and then a reoccurrence of a bi-directional causality for ninth and the tenth lag.

Different causalities at different lag lengths is an indication of the decision of traders to enter into futures trading by perceiving the price volatilities of different time lags. Some traders might just consider the previous day's volatility as a sufficient reason for the price risk that they might have to face and therefore prefer locking themselves into certain prices by entering into futures trading. While, some traders (may be the ones with a comparatively higher risk appetite) might look at a considerably greater number of previous day's spot price volatility before deciding their entry in the futures markets.

However, the chosen lag length by minimizing the SIC criteria is lag 1 for the pre- ban and lag 3 for the post- ban period. The interpretation of the results is as follows:

For the pre- ban period at lag length of 1 there exists a bi directional causality. Such causality implies that present day's futures volume emerges as a result of yesterday's price volatility in the spot rubber market and present day's volatility emerges as a result of yesterday's futures trading activity in rubber futures market. The participants of rubber futures market therefore decide to trade in the rubber futures markets based on the price volatility in the spot market that was observed the previous day and, yesterday's futures volume of rubber is also in turn a cause of present periods spot price volatility. Therefore today's spot price volatility and futures volume of rubber emerges as a result of the previous day's futures volume and spot price volatility respectively.

Similarly for the post- ban period, instead of one day, the volatility and volume of the present day is a result of three day's previous volumes and volatilities respectively. This implies that today's spot price volatility in the rubber market is a result of three day's previous futures volumes and todays futures volume is a result of three day's previous price volatilities prevailing in the spot market of rubber. This result also signifies that trader's decision to participate in futures trading in futures markets is influenced by the price volatility prevailing in previous three days in the spot markets of rubber. Also, the previous three days futures volume is also the cause of the price volatility in the spot market of rubber on the present day.

The result of this causality therefore, indicates that the price volatility in the spot market of rubber is both a cause as well as a result of futures trading in rubber.

6. Concluding Observations

The major objective of the present study was to investigate the impact of futures trading on spot markets of rubber by examining firstly the price discovery role of futures markets of rubber and thereby seeing whether it is useful mechanism for the spot market, secondly the direction of volatility spillovers between spot and futures markets and thirdly the question of spot price volatility being a cause or a result of futures trading activity? The answers to these hypotheses were determined by testing for causality relationships between price returns, volatilities and futures volumes using pairwise Granger causality tests.

The result of the Granger causality between futures and spot price returns suggested that futures market dominates the spot market of rubber and that the spot price of rubber is discovered in the futures market. This result holds true for both the time periods considered in the analysis. The results therefore, highlight the comparative advantage of futures market of rubber in disseminating information and thereby leading to a significant price discovery and risk management which would further help the underlying spot market of rubber to develop successfully. The causation from futures to spot markets showed a stronger flow of information from the futures to spot market and confirmed the efficiency of futures market in discovering the prices for spot markets for rubber. As far as the volatility is concerned, the results of a GARCH analysis showed a persistence of price volatility. The results of the Granger causality tests between the futures and spot price volatilities of rubber showed a bidirectional flow of volatility between spot and futures prices for both the time periods.

The result of the third causality which is between the spot price volatility and futures volume also suggested bidirectional causality in the pre- ban as well as in the post ban period. This result therefore signifies that spot price volatility was both a cause as well as the result of futures trading in rubber in both the time periods considered in the analysis.

To sum up, the futures trading in rubber has evolved as a useful mechanism for price discovery. Therefore futures trading in rubber can be said to have a positive impact on its spot markets because of its price discovery function. However, the volatility spillovers occur from both futures to spot as well as spot to futures. Also, spot price volatility in rubber market is both a cause as well as a consequence of futures trading. This implies that the direction of causality between futures price volatility and spot price volatility, and futures trading activity and spot price volatility is bidirectional and not unidirectional. Therefore nothing conclusive can be inferred about the adverse impact of futures trading on the spot markets of rubber.

There have been several changes in the contract specifications of rubber futures imposed by the regulatory authorities. The changes have been in terms of the price bands which convey about the permitted daily price fluctuation of rubber contracts. A general tendency of narrowing of the price bands has been observed. Therefore there is scope for further research of examining the impact of price limits on trading volumes and price volatilities in rubber markets.

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