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TAPMI WORKING PAPER SERIES NO. 2008/01

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Abstract:
The Indian commodity futures markets recorded a 373% growth during 2005-06. Despite this growth rate there are quite apprehensions about the effect of commodity futures on its underlying assets in India. To empirically examine the above issue, this study investigated the role of commodity futures market in performing the function of price discovery. The significance of price discovery depends upon a close relationship between futures and spot prices. The price linkage between futures market and spot market has been investigated using cointegration (Johansen, 1991) analysis. The cointegrating vectors define the long run equilibrium while error correction dynamics characterize the price discovery process, whereby markets attempt to find equilibrium. To perform the cointegration and error correction dynamics, this study used four futures and spot indices of Multi-Commodity Exchange (MCX), Mumbai. The results show that futures and spot markets in MCX are cointegrated and sharing a long run relationship. There is a causality flow from futures markets towards spot markets indicating information flow from futures

¹ Pratap Chandra Biswal is ICICI Bank BFSI Chair Professor at T.A.Pai Management Institute, Manipal, Karnataka, India. Author acknowledges the ICICI Bank for financial support and thanks Mr. Raghavendra Badaskar for his valuable support during the preparation of the paper.

The initial versions of this paper were presented at National Workshop on Commodity Research, organized by NCDEX, 10th October, 2007, India International Centre, New Delhi and 44th Annual Conference of the Indian Econometric Society, 3-5 January 2008, University of Hyderabad, India.
to spot markets. At the same time, there is also a reverse information flow happening in case of metals signifying price discovery in both futures and spot markets.

I. Introduction

The Indian commodity futures markets recorded a 373% growth during 2005-06 and a total value of trade during the year was Rs. 2134000 crore\(^2\). The share of tow National Exchanges in the total value of trade includes Rs. 1046000 crore of the National Commodity and Derivatives Exchange of India Ltd. Mumbai (NCDEX) and Rs. 962000 crore of Multi Commodity Exchange of India Ltd., Mumbai. Despite all these mind boggling numbers there are quite apprehensions about commodity futures market in India. It is said that no market in the economic system perhaps so narrowly viewed and seen with so much doubts / apprehensions as commodity futures market. Politicians have constantly frowned on the concept of futures and forward trading. The exchanges and analysts attempt at allaying all apprehensions about forward and futures trading. So there has been widespread interest in the relationship between commodity futures market and its underlying spot trading among academicians, practitioners and policy makers.

The Finance Minister P Chidambaram expressed strong conviction about the forwards/futures market and urged all political parties to support Forward Contracts (Regulation) Amendment Bill 2006. However politicians from CPM and JD (U) opposed the bill, the CPM wanted essential commodities to be banned from futures trading whereas JD (U) suggested that the commodities exchange Act should be repealed. The CPM expressed that the forward trading was leading to speculation and allowing big traders and companies to “corner” stocks, hoarding, and profiteering, and “push up” prices. With constant pressure from left parties, central government banned the futures trading in Tur and Urad. The left parties blamed the forward trading as the reason for the rise in the underlying commodity prices. Subsequently the government banned forward trading in wheat and rice in the Union Budget 2007-08. The views of the left parties were bolstered by the press release by the chairman of NECC (National Egg Co-ordination Company). The NECC chairman expressed that the forward trading of maize had led to unprecedented rise in the price affecting poor poultry farmers across the country. Amidst all the apprehensions about the increase in the price due to forwards trading the government ruled out the possibility of allowing banks and mutual funds to trade in commodity futures in the short term.

Unlike the views expressed by the policy makers, operators and regulators of commodity markets offered a different perspective. Task force headed by Mr. N. Rangachari, in its report submitted to the Government suggested that growers with holdings less than 10 hectares should be able to utilize derivatives and options in various multi-commodity exchanges in the country. The report said “There is a need to attend to this issue in far greater detail. This is because the conventional instruments for price intervention are fiscally unsustainable, particularly when it is applied to commodities that have long durations of price shocks as in case of rubber, pepper, and coffee”. The National Commodity and Derivatives Exchange (NCDEX) expressed that the commodity price rise is due to pure supply side problem and forward trading has not aggravated prices. The exchanges further added that the prices of commodities not traded have increased more than the commodities under the forwards market. For example, the NCDEX study on prices on various food items showed that the price of Moong Dal, which was not traded in the forward market, rose by nearly 36%, while that of Arhar and Masoor, which are traded, increased by 8.5% and 2.3% respectively. Additionally, the exchange said that the production of wheat and pulses has been stagnant for the past seven years. Commodity exchanges and analysts believe that Government should take long-term measures to improve farm productivity rather than blame futures trading for price spike.

II. Development of Commodity Futures Market in India

Commodity futures trading existed in India since 1875. However the commodity futures have been in the state of hibernation for the past few decades owing to a lot of government restrictions. Significant developments took place in 2003-04 in terms of commodity futures market. The government issued a Notification on April 1, 2003 rescinding all previous notifications which prohibited futures trading in a large number of commodities in the country. This was followed by a Notification in May 2003 revoking prohibition on non-transferable specific delivery forward contracts. The futures market was opened in anticipation of sound market institutions and market design. In order to set up proper markets Government of India (GoI) on recommendation of Forward Market Commission (FMC) granted recognition to National Multi Commodity Exchange, Ahmedabad (NMCE); Multi Commodity Exchange, Mumbai (MCX); National Commodity and Derivative Exchange, Mumbai (NCDEX) as nationwide multi-commodity exchanges. Trading commenced at MCX in November 2003 and at NCDEX

3 The other members of the task force were Dr. Vijay Kelkar, former finance secretary; Dr. Subhashish Gangopadhyay, Professor, India Development Foundation, New Delhi; and Dr. Bharat Ramaswami, Professor, Indian Statistical Institute, New Delhi.
in December 2003. FMC applied high standards to the market design. All the three exchanges were required to ensure anonymous order-matching. Prior to these exchanges trading typically took place in small groups who knew each other however new exchanges offered electronic clearance scheme. The centralized nature of electronic system would overcome the difficulties of fragmented and non-transparent price discovery. FMC also drew upon the learning of equity markets in terms of favoring the demutualised governance structure for the new exchanges. Setting up futures markets was not simple owing to the fact that there is no properly developed spot market. The spot market is fragmented geographically spread across the country. NCDEX for example had to introduce a polling mechanism for spot prices from across mandis. Every commodity had a different set of mandis to be polled depending upon the proportion of spot market trade. As a result, the number of commodities traded increased from 59 in 2005 to today trade in excess of 94 commodities. The volume of trade rose from Rs. 129000 crore in 2003-04 to Rs. 2739000 crore in 2006-07. The volume growth in trade is primarily propelled by MCX and NCDEX. These two exchanges also account for a large number of contracts traded.4

Amidst all these mixed views and results, the Government of India has established organized futures market for various commodities with the following objectives:5

1. To enable various trading interests to shift the risk arising out of adverse price fluctuation through hedging.
2. Establish a price reference for producers and exporters; and perform the function of price discovery.
3. Enable the producer to undertake proper crop planning in lieu of the information available from the futures market.

Drawing the cue from the above objectives, in this study we examine the role of commodity futures market in performing the function of price discovery in India. The price discovery function depends on whether new information is reflected first on futures or spot prices. If information is reflected first on futures prices and subsequently on spot prices, futures prices should lead spot prices, indicating that the futures market performs the price discovery function well. The objective of this study is to add to the empirical

5 Government of India (September 1994), Report of the Committee on Forward Markets (Kabra Committee), Ministry of Civil Supplies, Consumer Affairs and Public Distribution, New Delhi.
evidence and to examine to what extent varied views are justified in Indian context. In the next section we present the opposing theoretical arguments as to the role of commodity futures market in performing the price discovery function. This is followed in the fourth section by a brief review of previous empirical studies which have investigated the issue for a number of different markets. The fifth section outlines the methodologies and data used in this paper. The results from our tests are presented and discussed in the sixth section. The final section provides a summary and conclusions.

III. Theoretical Views of the Role of Commodity Derivatives Market

A well developed and effective commodity futures market, unlike physical market, facilitates offsetting the transactions without impacting on physical goods until the expiry of the contract. Futures market attracts hedgers to minimize their risks, and encourages competition from other traders who possess market information and price judgment. While hedgers have long-term perspective of the market, the traders, or arbitragers as they are often called, hold an immediate view of the market. A large number of different market players participate in buying and selling activities in the market based on diverse domestic and global information, such as price, demand and supply, climatic conditions and other market related information. All these factors put together result in efficient price discovery as a result of high liquidity in market. At times, however, price behavior of a commodity in the futures market might show some aberrations reacting to the element of speculation inherent in any market, but quickly reverts to long-run equilibrium price, as information flows in, reflecting fundamentals of the respective commodity. It is apparent from the previous statement that by virtue of the linkages between futures and spot market, the information in one market is expected to flow into another market. Therefore the essence of price discovery is to establish a competitive reference (futures) price from which the spot price can be derived and hinges on whether information is reflected first in changed futures price or in changed spot price. The futures price serves as the market’s expectation of subsequent spot price (Garbade et. al., 1983; Gardner, 1976).

The significance of price discovery depends upon a close relationship between futures and spot price. The extent to which futures market performs this function can be measured from the temporal relation between futures and spot price. If information is reflected first in futures price and subsequently in spot price, futures price should lead spot price, indicating that the futures market performs the price discovery function. In an efficient market where all available information is fully and instantaneously utilized to determine market price, futures price should move concurrently with its corresponding spot price without any lead or lag in price movement from one market to another. In the absence of market friction, price in the futures market and its corresponding spot market should move contemporaneously in response to arrival of information. Since futures and
spot market represent the same commodity, their price should exhibit a mutual (similar) response to a given information event, a process facilitated by arbitrage (Foster, 1996).

IV. Previous Empirical Works

Futures market is step for two primary objectives risk management by hedging and price discovery of the underlying asset. Price discovery means that futures price serves as market’s expectation of subsequent spot price (Garbade and Silber, 1983). Many empirical studies are published studying the relationship between financial futures market and the underlying spot market. Majority of the findings suggest futures market as the centre of price discovery and exhibit a stronger response to disequilibrium (Wahab and Lashgari, 1993; Chan et. al., 1991). In this section we provide a brief review of past empirical work which has attempted to provide evidence of price discovery function and information sharing between commodity futures and commodity spot markets.

Garbade and Silber (1983) applied their model to seven different commodities (wheat, corn, oats, orange juice, copper, gold and silver). They found that while futures market dominated spot market in price discovery, spot markets also played a role in performing this function. They also found that significant inter-commodity differences in the correlation of short-run price changes and in the substitutability of the futures contracts for the physical commodities. They attribute the finding to the fact that transaction and storage costs in precious metals are relatively low as compared with other commodities such as grain. Oellermann and Farris (1985) examined the feeder cattle market and found that futures market was the centre of price discovery. They also found that futures prices lead spot prices but that the strength of this lead became weaker in more recent periods. Brorsen et. al. (1989) investigated the direct impact of futures trading on the live cattle spot market. They conclude that the introduction of futures trading in live cattle improved spot market efficiency, but also increased short run spot price risk. Oellermann et. al. (1989) found that feeder cattle futures price led spot price in incorporating new pricing information indicating that the futures market serves as the centre of price discovery for feeder cattle.

Koontz et. al. (1990) concluded that the price discovery process is dynamic in nature and dependent on the structure of futures and spot market. The authors conclude that the spot market was becoming less reliant on futures market for price discovery. Quan (1992) used monthly crude oil price in a two step procedure to study price discovery and found contrasting results with respect to the price discovery function. His finding implied that the futures market does not play any role in the price discovery process. This finding was however questionable due to the frequency of data used (Schwarz and Szakmary, 1994).

Foster (1996) studied the behaviour of crude oil futures and spot market in the USA and the UK during the 1990–91 Gulf conflict to examine price discovery with emphasis on its
time varying nature. The results indicate that such relationship is strongly temporal and market conditions affect the price discovery process. Silvapulle and Moosa (1999) examined the lead lag relation between futures and spot crude oil price using both linear and non linear causality tests. Their study concluded that though the futures market plays a bigger role in the price discovery process, the spot market also plays a role in performing this function.

Though there are various studies in developed countries on this particular issue of price discovery, we do not find many studies in India. We provide below brief reviews of two studies done on Indian markets. Thenmozhi (2002) examined the effects of futures trading on the volatility of NSE index and price discovery objective of futures on NSE index. Price discovery and information flow across futures and spot market was examined through the lead-lag relationship. The study showed that the information flows from futures market to spot market and futures market is fast in processing the information. Futures lead the cash by one day and no information flow happened from spot to futures. In case of commodity futures, Karande (2006) studied the Indian castor seed market in Mumbai and Ahmedabad. Using cointegration technique he showed that the future and spot markets are mostly cointegrated. There is causality and information flow from futures to spot market at both Mumbai and Ahmedabad. Futures leading the spot imply futures market meets the objective of price discovery. He emphasizes the fact that due to increased availability and lower cost of information futures assimilate more information than spot.

V. Methodology and Data
The introduction of new information results in price difference for short intervals of time between futures and spot market due to positive information and communication cost. Due to increased availability and lower cost of information, a futures market assimilates information faster than a spot market (Koontz et. al., 1990). The price linkage between futures market and spot market would be investigated using cointegration (Johansen, 1991) analysis which offers several advantages. First, cointegration analysis measures the extent to which two markets have achieved a long run equilibrium. Another distinct advantage of the cointegration technique is that it explicitly allows for divergence from equilibrium in the short run. The cointegrating vectors define the long run equilibrium while error correction dynamics characterize the price discovery process, whereby markets attempt to find equilibrium (Schreiber and Schwartz, 1986).

To examine the cointegration and error correction dynamics, this study used four futures indices and corresponding underlying spot indices of Multi-Commodity Exchange (MCX), Mumbai. The four indices are MCXCOMDEX, MCXAGRI, ACXENERGY, and MCXMETAL. The period of study is from June 2005 to July 2007 having 624 observations after adjusting for dates and missing observations. The justification behind
considering MCX for our study is shown below in terms of market shares figure\textsuperscript{6}. The Indian commodity exchange market share in terms of turnover is shown below.

![Commodity Exchange Market Share]


Cointegration methodology considers non stationarity and allows for both short term and long run adjustment. Economic forces such as arbitrage prevent futures and spot price from drifting too far apart over time. Cointegration acts as evidence of this long run equilibrium in which deviation is due to short run shocks. The link between cointegration and causality stems from the fact that if futures and spot price are cointegrated; causality must exist in at least one direction. The possibility that one variable in a system of cointegrated series is exogenous (independent) within the error correction process motivates the use of error correction models in evaluating price discovery. The cointegrating vectors define the long run equilibrium while error correction dynamics characterize the price discovery process, whereby markets attempt to find equilibrium. An appropriately specified error correction model allows the long run component of variables to obey equilibrium constraints, while the short term component has a flexible dynamic specification which may diverge from the long run trend. The model indicates not only the proportion of disequilibrium from one period that is corrected in the next, but also the relative magnitude of adjustment in both markets towards equilibrium. This also reveals the nature of causal relationship.

\textsuperscript{6} The detailed picture of index construction in MCX is given in appendix.
Cointegration analysis represents an attempt to determine whether two markets (such as futures and spot) are pricing information similarly by investigating the price difference between the two markets. A major advantage of cointegration analysis is that it allows for the possibility that price for identical commodities in two separate markets may respond differently to information in the short run, but would return to a long run equilibrium if both are efficient. There are several reasons for an asymmetric response from different markets in the short run. One is that the markets have different access times to the information being delivered. Another is that the information is interpreted differently. However, because the markets are for the same commodity, arbitrage opportunity between the markets eventually results in a multi-market consensus concerning the value of information.

Evidence of price change in one market (futures or spot) generating price change in the other market (spot or futures) so as to bring about a long run equilibrium relation is

\[ F_t - \alpha - \beta S_t = \hat{u}_t \]  \hspace{1cm} (1)

where \( F_t \) and \( S_t \) are futures and spot price at time \( t \). Cointegration implies that each series can be represented by an error correction model which includes last period’s equilibrium error as well as lagged values of first difference of each variable. Hence, temporal causality can be assessed by examining the statistical significance and relative magnitude of the error correction coefficient and coefficient on lagged variables. The error correction model is

\[ \Delta F_t = \delta_f + \alpha_f \hat{u}_{t-1} + \beta_f \Delta S_{t-1} + \gamma_f \Delta F_{t-1} + e_{f,t} \]  \hspace{1cm} (2)

\[ \Delta S_t = \delta_s + \alpha_s \hat{u}_{t-1} + \beta_s \Delta F_{t-1} + \gamma_s \Delta S_{t-1} + e_{s,t} \]  \hspace{1cm} (3)

Each of the two equations above is interpreted as having two parts. The first part \((\hat{u}_{t-1})\) is the equilibrium error. This measures how the left hand side variable adjusts to the previous period’s deviation from long run equilibrium. The remaining portion of the equation is lagged first difference which represents the short run effect of previous period’s change in price on current period’s deviation. The coefficient of the equilibrium error, \( \alpha_f \) and \( \alpha_s \), are the speed of adjustment coefficient and have important implication in an error correction model. At least one speed of adjustment coefficient must be non zero for the model to be an ECM. The coefficient serves the role of identifying the direction of causal relation and shows the speed at which departure from equilibrium is corrected.
\( \alpha_f \) is statistically insignificant, the current period’s change in futures price does not respond to last period’s deviation from long run equilibrium. If both \( \alpha_f \) and \( \beta_f \) are statistically insignificant; the spot price does not Granger cause futures price. The primary purpose of estimating the ECM is to implement price leadership test between futures and spot price.

Tests of causality between cointegrated variables are conducted in an error correction framework because standard tests of causality overlook the reversion to equilibrium channel of causality represented by \( \hat{u}_{t-1} \). Causality test in the ECM framework involves testing exclusion restriction on the coefficients \( \alpha_f, \beta_f \) (Equation 2) and \( \alpha_s, \beta_s \) (Equation 3). If the coefficients are jointly insignificant, there is no Granger causality. If futures and spot price are cointegrated, there is causality in at least one direction. The dynamics of price discovery are studied using the maximum likelihood approach of Johansen.

VI. Empirical Analysis

To establish the order of integration of futures and spot prices we performed the Augmented Dickey Fuller (ADF) unit root test. (Dickey and Fuller; 1979, 1981). A constant and a time trend are included in the equation. Lag length four found to be sufficient in removing autocorrelation in all cases. The results are shown in table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>On Levels</th>
<th></th>
<th>On First Difference</th>
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<td></td>
<td>Unit Root</td>
<td>Probabilities</td>
<td>Unit Root</td>
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<td></td>
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<tr>
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<tr>
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<td>0.47</td>
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<td>0.88</td>
<td>-28.86</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: The critical values are -3.97, 3.42, and 3.13 at 1%, 5%, and 10% level of significance respectively.
From the table 1, we observe that the null hypothesis of no unit root cannot be rejected in all cases. Hence, we conclude that all the futures and spot prices are non-stationary of order (1). Next, first difference of all the series are found to be stationary, indicating all are $I(1)$. The cointegration results using Johansen technique are reported in table 2. In case of cointegration $r$ denotes the number of cointegrating vectors. In this case, the number of cointegrating vectors can be at most one as there are only two series in each group. In table 3 all the trace statistics show that the null hypothesis of futures and spot prices are not cointegrated ($r=0$) against the alternative of one or more cointegrating vectors ($r>0$) is rejected. Next, the null hypothesis of $r\leq1$ against the alternative of two or more cointegrating vectors cannot be rejected at 5% significance level for all the cases. The presence of single cointegrating vector in all cases shows that there exists long run relationship between futures and spot prices. Hence we conclude that futures and spot markets are cointegrated in India.

### Table 2: Cointegration Test Results

<table>
<thead>
<tr>
<th>$H_0$</th>
<th>$H_1$</th>
<th>$\lambda$ Trace values</th>
</tr>
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<tr>
<td>$\lambda$ Trace tests</td>
<td>$\lambda$ Trace tests</td>
<td>Comdex_spot &amp; Comdex_futures</td>
</tr>
<tr>
<td>$r = 0$</td>
<td>$r &gt; 0$</td>
<td>50.41</td>
</tr>
<tr>
<td>$r \leq 1$</td>
<td>$r &gt; 1$</td>
<td>4.42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\lambda$ Max tests</th>
<th>$\lambda$ Max tests</th>
<th>$\lambda$ Max values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r = 0$</td>
<td>$r = 1$</td>
<td>45.99</td>
</tr>
<tr>
<td>$r = 1$</td>
<td>$r = 2$</td>
<td>4.42</td>
</tr>
</tbody>
</table>

Note: $r$ refers to number of cointegrating vectors.
The results for error correction models for all four indices are reported in table 3. For ECM, we have used one lag as it was found to be sufficient in removing autocorrelation problem. The ECM results for all four indices are consistent with and support the findings for cointegration. At least one error correction coefficient ($\alpha_f$ or $\alpha_s$) is significant in all cases where the cointegration result indicates the presence of a cointegrating vector. In our study, we find $\alpha_s$ is significant in all the cases. The causality and price discovery can be discussed using the coefficients $\beta_s$ and $\beta_f$. The coefficient $\beta_s$ is always significant indicating that causality exists from futures markets to spot markets for almost all indices. In other words price discovery occurs in futures market as indicated by all indices in
MCX. Price discovery also occurs additionally in the spot market for metals as indicated by a significant $\beta_f$. If we look at the magnitudes, we find magnitude of $\beta_s$ is higher than that of $\beta_f$ indicating a stronger feedback from futures markets to spot markets in India. Hence we conclude that price discovery occurs almost in all the futures markets and in case of metals price discovery occurs both in futures and spot markets.

VII. Conclusion

The objective of this study was to empirically examine whether futures markets help in discovering the right price for commodities in India. The futures and spot markets in Multi-Commodity Exchange are cointegrated and sharing a long run relationship. There is a causality flow from futures markets towards spot markets indicating information flow from futures to spot markets. At the same time, there is also a reverse information flow happening in case of metals signifying price discovery in both futures and spot markets.

This finding to a large extent answers to the apprehensions of the politicians about the destabilizing impact of commodity futures markets in India. To examine further the destabilizing impact of commodity futures markets, future research may use effect of futures volatility on spot market volatility.
Reference


Appendix: MCX Index Construction and Methodology

MCX COMDEX is designed & developed by the Research Department of Multi Commodity Exchange of India Ltd. (MCX) in association of the Indian Statistical Institute (ISI), Kolkata. This is the maiden Composite Commodity Index in India based on commodity futures prices of an exchange. The MCX COMDEX is composed of futures contracts of 10 different exchange traded physical commodities.

- Agri – Wheat, Urad, Soy oil, Rubber, Guarseed, Kapas khalli
- Metals – Gold, Silver, Copper
- Energy – Crude Oil

For the purpose of Index computation, only the near month active contract prices are taken for the index computation. The Index base period has been kept as average price of 2001 it being a normal year.

Key Features of the MCX index construction

Diversified Exposure – No related group of commodities (eg. Agri, metals, energy) may constitute more than 33% of the Index. No single commodity may constitute less than 2% of the Index

Computational Methodology - The Index is computed based on Geometric Mean, which is better than Arithmetic Mean. The impact from equal, successive percentage changes in one element is constant for geometric averages, but increases with rising prices and decreases with falling prices for arithmetic averages.

Weightings - By relying on factors that are both endogenous to the futures market (liquidity) and exogenous to the futures market (physical market). The MCX COMDEX provides a unique measure of the relative significance of its component commodities. Physical market size data alone, while significant, may tend to overstate the relative importance of the commodities. The inclusion of liquidity as an additional weighting factor reduces this type of distortion.

Rebalancing - The target weights of the MCX COMDEX are determined annually or as required by the Index Committee by announcing to the market with a notice period of three months or as deemed suitable.

The other sector specific indices are also constructed in fashion similar to the COMDEX. However no smooth roll over methodology explicitly mentioned by the MCX.