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ABSTRACT

Gold is considered as a safe and secure avenue of investment in India. While the country does not have an active electronically traded spot market and prices are based on polled information, the gold futures market has been in existence for over a decade. This paper looks at the relationship of domestic and international polled spot prices with the gold futures market in India to determine the direction of information flow between these markets. It also examines the relationship between the domestic and global spot prices. A detailed analysis of the market microstructure and the impact of various policy changes on India's gold market is done. A VECM model is used to test for price discovery and market efficiency in the short and long run. The optimal hedge ratio is computed to test the hedging effectiveness in the Indian gold futures market.

The results indicate no strong evidence of cointegration between the domestic and international spot prices. The series of tax and policy measures introduced during 2013 to 2015 temporarily weakened this relationship. With respect to the futures market, a long run cointegration relationship does exist with the domestic spot market prices. However a strong relationship between the futures market and the international spot market is not seen. The daily price discovery process in the gold market ideally takes place in the futures market and not the spot market. The domestic spot market prices make either a greater adjustment to the long run equilibrium level or follow the lead of the futures market prices in entirety. The results also indicate that the futures market does not serve as an efficient hedging instrument for the domestic spot price movements, but plays a better role in hedging the variation of the international gold spot returns. The results of the study highlight the need for an organized spot market that would facilitate better price discovery.

JEL Classification: E44, G13, G14, G17

Keywords: Gold futures, market efficiency, price discovery, vector error correction model, Gonzalo Granger statistic, optimal hedge ratio

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1. INTRODUCTION

India has a special affinity to gold as an item of cultural relevance used in jewelry and also traditionally as one of the safe and secure avenues of financial investment. As per the Niti Aayog (2018) report, globally as of the second quarter of 2018, India is the second largest consumer of gold (800-900 tonnes p.a. of domestic demand on average) and accounts for around 25% of world's gold demand. Less than 1% of India's gold requirements are met through domestic mining, with around 10% being obtained through recycling. India's gold import primarily caters to the demand for jewelry manufacturing, investment as coins and bullion, industrial / medicinal input, and underlying for financial products ETFs.

1.1. Gold as an Investment Product

India's affinity for gold arises from various cultural, religious, economic and social reasons (RBI Report, 2013). Gold has since centuries provide the common man with a hedge against difficult times, with pawn brokers and money lenders providing gold loans. The gold loan business in India has witnessed a transformation with the shift to the organized sector like banks and specialized non-bank financial institutions providing loans against gold jewellery as collateral. An investment product to track the movement of gold without actually physically holding it is the Gold Exchange Traded Funds (ETFs), which are passive investment instruments based on gold prices, which invest in gold bullion and have a lower expense compared to physical gold investments. Since 2015, various measures have been adopted to promote the monetization of the large gold reserves held with the Indian public. The Gold Monetization Scheme introduced in October 2015 aimed to mobilize the gold held by households and institutions across the country and offered the scheme for short-term, medium-term and long term for interest rates varying between 2.25% to 2.50%. A Gold Bond Scheme was also launched in November 2015 with the objective of reducing the demand for physical gold and shifting a part of the domestic savings, used for purchase of gold, into financial savings.

1.2. Gold Imports

The enormous gold demand in India is primarily satisfied through imports as India has very little supply of gold. Gold imports are permitted into the country only through authorized dealer banks nominated by RBI or designated agencies or entities *(Metal and Minerals Trading Corporation of India (MMTC), Premier Trading Houses, Star Trading Houses, State Trading Corporation (STC) etc.*) notified by the Department of Commerce. The major gold supplying countries to India are Switzerland (71%), United Arab Emirates (15%), South Africa (7%) etc. (Thomson Reuters, 2018). It is the fifth largest commodity imported in value terms (as of 2017-18) and as stated by the KUB Rao Committee (RBI Report,2013), the domestic demand for gold is not amenable to reduction through policy intervention and is also price inelastic. This combination of high demand leading to higher imports has had an adverse impact on the current account deficit (CAD) and gold as a commodity has been first in the line to face any measure to control the country's CAD. The series of increases in import duty on gold between 2012 and 2013 led to cheaper import of gold through the unofficial channels leading to an arbitrage in prices between the gold imported through banking channels and unofficial channels. Thus the increase in customs duty during this period led to higher imports from countries like South Korea and Malaysia, with whom India had signed Free Trade Agreements (FTAs), leading to price arbitrage between the gold imported from the official banking channels.

Historically gold had an average share of around 8% in the total imports of the country, which rose to 12% in 2011-12 *(Table 1).*

The high levels of gold imports combined with the high gold prices were one of the major factors contributing to the ballooning of the CAD in the first quarter of 2013-14 to 4.9% of GDP. This led to a series of measures to control the import of gold into the country and in turn control this deficit.

The summary of policy changes from 2012 to 2015 are highlighted below:

1. **Taxation:** Increase in the Basic Customs Duty from Rs. 300/10 gms in 2011 to 2% in January 2012. It was further increased gradually to 4% in March 2013 and further to 6% in January 2013, 8% in June 2013 and finally to 10% in August 2013. In September 2013, the import duty tax on gold jewellery was increased to 15% from 10%. Following the implementation of the uniform tax regime i.e. the Goods and Services Tax (GST) in India from July 2017 onwards, a GST of 3% was imposed on gold.

2. **Policy Restrictions on Gold Imports**: During the first half of 2013-14 India witnessed a flight of capital along with other emerging market economies triggered by the US Fed Chairman's comment on the tapering of the pace of Quantitative Easing (QE). One of measures adopted by the Government during this turbulent period between May 2013 to September 2013 was to restrict the inbound shipments of gold into the country.

With this intention, in May and June 2013, gold imports of banks and other agencies was restricted only to meet the requirement of gold exporters and there was a restriction on imports to meet domestic demand under the 20:80 rule. The banks had to ensure that atleast one-fifth i.e. 20% of the gold imported into the country by them was exclusively made available for the purpose of exports and the balance for domestic use. Further the gold could be made available for domestic use only for entities engaged in the jewellery business only on full up-front payment. Further, Premier and Star trading warehouses based in SEZs and EOUs could import gold only for the sole purpose of exporting it again.

In August 2013, RBI also banned the import of gold in the form of coins and medallions. These measures while helping to reduce the gold imports had a debilitating impact on the jewellery industry. Gold imports instantly plunged from 6% of the total imports in July 2013 to 2% by August 2013 and witnessed a 70% month-to-month drop in August 2013. With the easing of the CAD crisis, there was a relaxation in the 20:80 rule in May 2014 and finally in November 2014 the government withdrew this rule and eased all restrictions placed on the import of gold. *Annexure 1* highlights the key RBI circulars related to the policy measures on the gold market issued during this period.

Subsequent to the enforcement of controls in the import and use of gold domestically, the share of gold in the total imports has come down as of 2017-18 below its historical average. Concurrently there has been a decline in the gold consumption pattern also.

1.3. Indian Gold Spot Market

India is the second largest importer of gold in global markets. In terms of gold importation points, the cities of Delhi, Mumbai, Ahmedabad, Bangalore, Chennai, Jaipur, Kolkata, and Hyderabad are India's most important gold centers.

Despite being the second largest consumer of gold globally, India remains a price taker from the price set in international markets like the OTC markets in London and the COMEX in US. Due to lack of a spot market, the domestic spot price for gold varies across all these centers and is adjusted to the international price of gold along with the cost of transportation and the relevant taxes. Generally the price fixation in the spot market was at either Mumbai or Ahmedabad due to the lower tax structure there. However, the imposition of GST of 3% on gold from July 2017 onwards has facilitated some measure of tax homogeneity in this sector, as the bias in taking delivery in a particular location like say Ahmedabad or Mumbai no longer exists due to the uniformity in taxation structure under GST.

The Union Budget (2018-19) had proposed establishing a system of consumer friendly and trade efficient system of regulated gold exchanges in the country. Factors like lack of quality assurance, weak price transparency, fragmented liquidity and regulatory challenges are inhibiting the development of a vibrant gold trading market in India (World Gold Council, 2017).

1.4. Indian Gold Futures Market

In India, the future trading in gold started from 2003 and is primarily concentrated in the Multi Commodity Exchange of India (MCX), which accounts for more than 95% of the trading in gold futures in India (Soundarajan and Goswami, 2017) . MCX currently lists four deliverable Indian Rupee gold futures contracts based on the contract sizes: Gold, Gold

Mini, Gold Guinea and Gold Petal. The spot price on the MCX for the gold contracts is arrived at from polling a panel of representatives from value chain of the physical market, with the polling conducted twice in a day (12.15 pm to 12.45 pm and 4.00 pm to 4.30 pm). The price is ex-Ahmedabad and excludes GST and any other additional tax, cess or surcharge. *Annexure 2* depicts the contract specification of MCX Gold Futures. Trading volumes in the MCX gold futures market have declined over the years, especially after 2013, due to a combination of factors like the policy restrictions in the purchase of gold, increase in taxes and specifically with relevance to the futures market, the imposition of commodity transaction tax (CTT) of 0.01% in the 2013-14 Union Budget. *Table 2* shows the trends in the trading in the MCX gold futures.

1.5. International Gold Market

The global gold market comprises of a diverse range of participants ranging from physical players like producers, refiners, fabricators, financial intermediaries like banks who provide financing, and other services like selling of gold bars on consignment and other wholesale market players like official institutions and Central banks. While global gold trading is intrinsically linked there are distinctions across geographies especially in terms of prices, due to trade restrictions, taxes and bar standards. The important global gold trading centers are London OTC market, US futures market and the Shanghai Gold Exchange (SHE).

London is the biggest market place for over the counter gold transactions and most of the bullion transactions are cleared through London. In addition to this, the London market maintains the global standard for quality of gold bars and also offers vaulting services. Historically, the gold fix set at London has served as a benchmark for pricing the gold widely used by producers, consumers, investors and Central banks. The London Gold Fixing was initiated in 1919, with the market making members setting a single trading price. Initially conducted at N M Rothschild & Sons, it shifted to a telephonic fixing on an annual rotation system in 2004, set by 5 major banks – Barclay's, Deutsche Bank, Bank of Nova Scotia, HSBC Holdings and Societe Generale. The benchmark price had 2 fixings - one at 10.30 am and 3.00 pm (GMT). The detection of a manipulation of the gold fixing process in 2012 by an employee of Barclays in order to avoid a payout to the client led to a major upheaval in this process of fixing of the spot gold price.

In order to overcome the shortcomings of member driven fixing, the LBMA Gold Price auction was launched on the ICE Benchmark Administration (IBA) platform on March 20, 2015. IBA an independent specialist benchmark administrator provides the price platform, methodology as well as the overall administration and governance for the LBMA Gold Price. The auctions are conducted in US dollars, through an electronic physically settled auction mechanism, with real-time on-line dissemination of the anonymous bids. The auctions are run at 10:30 am and 3:00 pm London time and published as LBMA Gold Price AM and LBMA Gold Price PM in US dollars and converted into the benchmarks in other currencies using foreign exchange rates from when the final round ends. There are currently 13 institutions accredited as participants in the LBMA Gold Price fixing. From April 1, 2015, the LBMA Gold Price became a 'Regulated Benchmark' of the UK's Financial Conduct Authority (FCA) along with LIBOR and six other systemically important pricing benchmarks (i.e *the LBMA Silver Price, ISDAFix, ICE Brent, WM/Reuters fx, SONIA, and RONIA*). Some of the large gold futures exchanges are the COMEX of CME Group and Tokyo Commodity Exchange (TOCOM)

1.6 Objective of the Study

The objective of this study is to empirically examine if Indian gold futures market is efficient and determine the direction of information flow between the spot and futures markets. Given the unique nature of gold as an imported commodity, with the prices being influenced by global prices with an add-on tax (import duty), a pass through of the same is assumed thus keeping a long run relation. An attempt is made to understand the market micro-structure and the extent of pass through of the prices from international to domestic spot markets. Given that there is a vibrant gold futures market in India, this paper attempts to look at the long run and short run price discovery / efficiency between the global spot prices, the domestic market spot prices and the futures market. In addition to price discovery, a key role of a futures market is to serve as an effective hedging instrument for the underlying spot market. Hence, it is also examined if the gold futures market acts as an effective hedge for the domestic as well as international spot prices.

The paper is organized as follows: Section 2 presents a review of previous studies that have examined the efficiency of gold futures market in India and in global markets. Section 3 describes the data and methodology adopted in the study. Section 4 presents the empirical results and the concluding remarks are provided in Section 5.

2. LITERATURE REVIEW

Pavabutr and Chaihetphon (2008) analyzed the price discovery process of the gold futures contracts traded on MCX over the period 2003 to 2007, by employing a VECM model. Their results indicated that futures prices of both standard and mini contracts lead the spot price. They further found that mini contracts contributed to over 30% of price discovery in gold futures trade even though they account for only 2% of trading value on the MCX. Shihabudheen and Padhi (2010) examined the dynamics of price discovery between the Indian spot and futures market of six commodities including gold, for the period of 2004-2008. Using a VECM model, the authors found that futures market plays a crucial role in the price discovery and that futures market leads the spot market.

Iyer and Pillai (2010) analyzed the rate of convergence of information from one market to another to infer the efficiency of futures as an effective hedging tool, by using a two regime threshold vector autoregression model (TVAR) and a two regime threshold autoregression model for six commodities. The authors found evidence for price discovery process happening in the futures market in five out of six commodities. However, the rate of convergence of information was slow, particularly in the non-expiration weeks. For copper, gold and silver, the rate of convergence was found to be almost instantaneous during the expiration week of the futures contract affirming the utility of futures contracts as an effective hedging tool. In case of chickpeas, nickel and rubber the convergence worsens during the expiration week indicating the non-usability of futures contract for hedging.

Fuangkasem et al (2012) looked at the international information transmission among three major gold futures markets namely COMEX, MCX, and TOCOM. They considered the 5 minute intra-day price data of the most liquid gold futures standard contract in the 3 exchanges from April 2011 to August 2011, with the unit of gold measurement and the trading times of the exchanges synchronized with COMEX. The evidences indicated that the three gold futures prices are cointegrated and driven by one common factor. Based on synchronous data, both VECM and Hasbrouck approach indicate that COMEX play a dominant role in global gold futures trading and therefore the US gold futures market is the most efficient in processing information. Although COMEX appears to mostly contribute in price discovery, information transmission across three gold futures markets is extremely rapid.

Palamalai and Ibrahim (2012) examined the price discovery process and volatility spillovers in the Indian gold futures and spot markets by employing a VECM and the Bivariate ECM-EGARCH model. Analyzing data from 2009 to 2011, the authors found that the spot market of gold plays a dominant role and serves as effective price discovery vehicle. They also found spillovers of certain information taking place from spot market to futures market.

Aggarwal et al. (2014) examined price discovery and hedging effectiveness of commodity futures market in India. Using daily price data on both the spot and the futures prices for six agricultural and two non-agricultural commodities (crude oil and gold) for the period of 2003 to 2014, the authors concluded that, on average, futures prices do discover information relatively efficiently, but helps to manage risk less efficiently. Nath and Dalvi (2014) test for price efficiency in commodities future market by examining the MCX gold futures market with the underlying spot price using VAR and VECM models analyzing data from 2005 to 2014. A comparative analysis was made with the CME gold futures and London spot prices. They find that the Indian spot and futures markets are not well integrated, but find a very strong long term relationship between the London spot and CME futures market.

In the study on the efficiency of the futures market using metal and energy futures, Chinmaya Behera (2015), use a co-integration and error correction mechanism on daily futures and spot closing price from 1st September, 2005 to 30th December 30, 2011 for gold, silver, copper, and crude oil, and from 1st November, 2006 to 30th December, 2011 for natural gas. The study found fair price discovery in the futures market and its transgression to the spot market from the futures market. Using ratio of standard deviation, to check market efficiency, it was found that gold market is not efficient as it fails to incorporate all the information available in the market.

Chinmaya Behera (2016) also analyzed the price discovery and spill-over impact in the Indian futures market (metal and energy futures) using the daily futures and spot closing price 2005 to 2016 for gold, silver and copper. Using cointegration and error correction mechanism, the study finds that daily spot and futures are cointegrated, with a fair price discovery in the futures market which is then transgressed to the spot market. Bi-directional shock transmission were observed across the commodities like gold, silver and copper which means shocks in the futures market have an impact on spot market volatility for gold, silver and copper.

Kumar et al (2018) have examined the process of price discovery between Spot Gold and Gold derivative contracts traded at MCX from 2011 to 2016. Analysis of daily prices of two different contracts Gold, and Gold Guinea showed that cointegration exists in spot and future market with reference to contract of Gold and Gold Guinea. The Granger Causality test reported a bilateral relationship between Gold spot and Gold derivative, while no causal relationship was found in case of Gold Guinea future.

Inani (2018) looked at the price discovery process and relative efficiency of ten most liquid agricultural commodities' futures contracts, traded on NCDEX. Three different common factor methodologies were used namely, Gonzalo and Granger component share method, Hasbrouck information share method and the modified information share method. The sample consists of daily data for the period from 2009 to 2015. Stationarity and Cointegration test results revealed that spot and futures prices are integrated and cointegrated for all commodities. The price discovery results indicated that the futures market leads the spot market in case of six commodities, i.e., castor seed, coriander, cottonseed oilcake, soy oil, sugar and turmeric. Whereas, in the case of four commodities (chana (chickpea), guar seed, jeera, and mustard seed), price discovery takes place in the spot market.

3. DATA AND METHODOLOGY

For the analysis, the three most liquid gold futures contracts i.e. 1 month, 2 months and 3 months traded on MCX have been considered. The time series for the gold futures contracts is obtained from the Thomson Reuters Eikon platform (RICs- MAUc1, MAUc2 and MAUc3). It is a continuation series of the closing price taking into account the rollover of the contracts on the 5th day of the contract expiry month. Closing price of the contracts is considered for analysis as it incorporates all the information during the course of the trading day.

Three spot prices were considered for the analysis- MCX spot, Reuters spot and World Gold Council (WGC) spot prices. The MCX spot prices are the ex-Ahmedabad polled spot prices that are published on MCX website. The Reuters spot prices, obtained from Thomson Reuters Eikon platform, are polled contributions from merchants in Ahmedabad (RIC - XAU-TT-INA). In case of MCX spot and Reuters spot, there are two polling sessions. The 1st and 2nd polling sessions are conducted at around 13:00 PM and 17:00 PM respectively. The price of the second session is considered as it would capture the entire day's movement in the prices.

The global spot price considered is the LBMA Gold Price, which is the global benchmark price for unallocated gold delivered in London published by IBA. For this study, the prices of the second auction conducted by IBA, known as the LBMA Gold Price PM were considered. The LBMA prices were obtained from World Gold Council (WGC) website in Indian Rupee terms adjusted appropriately for the unit conversion (*Global prices are quoted for per troy ounce and in India the price is per gram*). The MCX spot and Reuters spot prices are considered to be a representative of the domestic spot prices, while the WGC price is considered to be a representation of the global spot prices. The natural logarithm of all the variables was considered for the purpose of the analysis. Data for the period from January 2008 to March 2018 has been used.

A comparison of the domestic spot gold prices with the international prices brings forth the disruption in the ratio of Indian gold prices relative to the international gold prices, following the policy measures implemented between 2013 and 2015. The ratio indicates that, after May 2013 there is a prominent divergence in the levels of the domestic and international spot prices, with the domestic prices moving upwards, as the gold supply was controlled in the domestic markets. Due to the gradual easing of import restrictions, initiated in May 2014, and with the eventual withdrawal of the import restrictions, this ratio between the domestic and international spot prices began to stabilize. However, in the recent period, the ratio has settled at a higher level, and the extent of difference is attributable to the existence of the 10% tax on gold imports.

Table 3 indicates that between May 2013 and May 2015 the relation between global gold prices and the domestic gold prices has been volatile and clearly there is no pass through of the tax (duty) impact. Given this divergence in the prices, the sample was divided into 3 sub-periods: (1) January 2008 – May 2013, (2) June 2013 – May 2015, (3) June 2015 – March 2018.

Table 4 presents the descriptive statistics of the variables used in the study for the period from January 2008 to March 2018. The behavior of the different series for the full period and also for the sub-periods in terms of mean and median are similar. The second moment (standard deviation) is also similar across the different spot rates. However, the third (skewness) and fourth (kurtosis) moment, are different between the three spot rates. The methodology for calculation of the spot rates at the MCX and that from Reuters indicates that these are polled rates. No further details are provided. This lack of clarity on the calculation of the spot rate prevents us from providing any further insights into the cause of difference between the higher order moments of the two domestic spot price series. The difference is high as compared to the global prices. This could be due to price difference between global and domestic price due to import duty and other additional charges (including *CIF (Cost, Insurance and Freight), Landed Cost, Bank Cost etc.*).

The Pearson's correlation analysis (*Table 5*) for the full period indicated a statistically significant correlation between the domestic spot and international spot prices. A high correlation also exists between the futures and various spot prices. During the second period however, the correlation between the domestic and international spot prices weakened. A similar scenario was observed when the futures prices were compared to the underlying spot prices during this period. This supplements the observation that there is a period between 2013 and 2015 when the correlation between the global price and the domestic price of gold had declined.

In the rest of this section, the major econometric methods that are used to test for the efficiency of gold prices are explained.

3.1. Stationarity and Cointegration Testing

We considered the Phillips Perron (PP) test for detecting the presence of unit root in the gold spot and futures market prices. Further, the Johansen's cointegration rank test was used to determine if there gold spot and futures markets were cointegrated. In case the gold spot and futures series are found to be I (0) process, we can simply run the VAR model at their levels. If however, the two time series are integrated to the first order but fail to exhibit a cointegrating relationship, a VAR model of the differenced series can be implemented to examine the relationship between gold futures and spot market.

3.2. Vector Error Correction Model (VECM)

If the gold spot and futures prices tend to exhibit cointegration, the inferences of the VAR model can misleading, as we fail to factor in the long run relationship that exists between the two markets. In such instances, the VAR model has to be modified by adding an error correction term to the model. In such a case, the relationship needs to be modelled using a vector error correction model as expressed in equation *(1 and 2).*

$$\Delta F_t = \lambda_F + \sum_{i=1}^{k} \eta_{F,i} \Delta F_{t-i} + \sum_{i=1}^{k} \theta_{F,i} \Delta S_{t-i} + \alpha_F \beta' \binom{F_{t-1}}{S_{t-1}} + \varepsilon_{F,t} \qquad ...(1)$$

$$\Delta S_t = \lambda_S + \sum_{i=1}^{k} \eta_{S,i} \Delta S_{t-i} + \sum_{i=1}^{k} \theta_{S,i} \Delta F_{t-i} + \alpha_S \beta' \binom{F_{t-1}}{S_{t-1}} + \varepsilon_{S,t} \qquad ...(2)$$

In the above equations, ΔF_t and ΔS_t stand for the change in the natural logarithm of gold futures and spot rates respectively. λ_F and ζ_S are the intercept terms. The coefficients $\eta_{F,i}$ and $\eta_{S,i}$ explain the autoregressive nature of the gold futures and spot market respectively. $\theta_{F,i}$ detects the presence of the dependence of the returns in the futures market on the lagged spot market returns (at lag of $t - i$). $\theta_{S,i}$ examines whether the lagged returns in the futures market impacts the spot market returns. The optimal lag length of the model can be estimated using the AIC information criteria.

To examine the presence of a short-run relationship between the gold futures and spot market, we perform a Granger Causality Wald test. Two separate tests of granger causality were conducted i.e. one testing granger causality from gold spot market to futures market and the second testing granger causality from the gold futures market to the underlying spot market. The null hypothesis is that the spot (futures) market returns are influenced only by itself, and not by the returns in the futures (spot) market. A rejection of the null hypothesis would suggest that the spot (futures) market returns are influenced not only by its past returns but also by the past returns in the futures (spot) market. A failure to reject the null hypothesis would imply that $\sum_{i=1}^{k} \theta_{F,i}$ and $\sum_{i=1}^{k} \theta_{S,i_{t-i}}$ parameters are not significantly different from 0.

The fourth term on the right hand side of equation *(1) and (2)* is the error correction term introduced in the model. β' = $[\beta_F , \beta_S]$, wherein coefficient β_F and β_S are the parameters of the common stochastic trend that exists between the gold futures and spot markets returns. We normalize β_F by restricting it to 1, such that the long run cointegrating relationship can now be expressed as $F_{t-1} = \nu + \beta_S S_{t-1}$, where ν and β_S are the intercept and the slope of the common stochastic trend. The terms α_F and α_S are the coefficients that explain the speed of adjustment of the futures prices and the spot prices to the long run cointegrating levels. The larger the values of α_F and α_S, faster is the adjustment to the common stochastic trend.

In case α_F is statistically insignificant while α_S is positive and statistically significant, we can infer that the adjustment process to the long run relationship level is determined by the changes to the spot market price in response to the change of the price in the futures market i.e. the spot market prices would follow the lead of the futures market prices. In other words, the futures market would play a dominant role in the price discovery process as compared to the spot market. Likewise, if α_F is negative and statistically significant, while α_S is insignificant, the futures market follows the lead of the spot market in the adjustment process.

When α_F and α_S are both statistically significant with opposing signs the contribution of each of the variables in the adjustment process (to the long run equilibrium level) can be estimated using the Gonzalo-Granger common factor model. The Gonzalo Granger common factor model stipulates that the speed of adjustment parameters determine the role that two cointegrated markets play in price discovery process and in establishing the common long run equilibrium trend between them. The contribution (weights) of the spot and futures market to the adjustment process can be defined as:

$$GG_{spot} = \frac{\alpha_S}{(\alpha_S - \alpha_F)} \quad ...(3)$$

$$GG_{Futures} \ \frac{-\alpha_F}{(-\alpha_F - \alpha_S)} = 1 - GG_{spot} \quad ...(4)$$

The market in which prices adjusts the most (least) would be assigned a higher (lower) weight in the adjustment process and a lower (higher) weight in the price discovery process. This is because the market which does not rapidly adjust its prices to converge to the long run equilibrium level would more likely be the market in which prices are determined i.e. a price setter, while the market which adjusts its prices rapidly would be a price taker. If the adjustment process can be interpreted as the price taker reacting to new information, it would imply that price setter would be source of this new information.

A significant speed of adjustment parameter would also allow us to compute the half-life of the price deviation i.e. the number of days a variable would take to make up for (recover from) from half of its deviation from the long run equilibrium level. Accordingly, the speed of adjustment (in days) for a variable can be calculated as two times the half-life of that variable (*Kroeger and Sarkar, 2017*). The half-life (H) and speed of adjustment (SA) is computed as follows:

$$H_{Spot} = \left|\frac{\log(2)}{\alpha_S}\right|, \qquad SA_{Spot} = 2 \times \left|\frac{\log(2)}{\alpha_S}\right| \quad ...(5)$$

$$H_{Futures} = \left|\frac{\log(2)}{-\alpha_F}\right|, \qquad SA_{Futures} = 2 \times \left|\frac{\log(2)}{-\alpha_F}\right| \quad ...(6)$$

It is pertinent to note that the GG weight and SA would follow an inverse relationship. The higher the contribution (weight) to the adjustment process lesser would be the time taken for the variable to revert back to the long run equilibrium level and hence smaller would be the SA.

Additionally, we examine the impact of how a shock in one market would affect the other market using the impulse response function. A forecast error variance decomposition analysis was also conducted to indicate the proportion of the variation in the spot (futures) market returns that is accounted for by the innovation of the futures (spot) market and by its own innovation.

3.3. Optimal Hedge Ratio

In addition to understanding the short run and long run dynamic relationship between the gold spot and futures market, the level of market efficiency can also be examined by testing if the gold futures market serves as an effective hedging instrument for the underlying spot market. To test for the hedging effectiveness of the gold futures market we construct an unhedged and a hedged portfolio. The returns of the unhedged and hedged portfolio from time t to $t+1$ can be expressed as:

$$R_{unhedged} = S_{t+1} - S_t \qquad ...(7)$$

$$R_{hedged} = (S_{t+1} - S_t) - h(F_{t+1} - F_t) \qquad ...(8)$$

where h is the hedge ratio and represents the number of units of the gold futures contracts that need to be purchased for hedging the exposure to a single unit of gold in the spot market.

Specifically, we define the optimal hedge ratio as the number of gold futures contracts per unit of the gold in the spot market that will minimize the variance of our hedged portfolio returns. We compute the constant optimal hedge ratio from the variance-covariance matrix of ε_F and ε_S , derived from the VECM model specified in Equation *(1)/(2)* above. The variance-covariance matrix of the error terms can be expressed as $\sum_{\varepsilon,t} = \begin{bmatrix} \sigma^2{}_F & \sigma_{FS} \\ \sigma_{FS} & \sigma^2{}_S \end{bmatrix}$, where, $\sigma^2{}_F$ is the variance of $\varepsilon_{F,t}$, $\sigma^2{}_S$ is the variance of $\varepsilon_{S,t}$ and σ_{FS} is the covariance of both the error terms. The optimal hedge ratio can be computed as:

$$h^* = \frac{\sigma_{FS}}{\sigma^2{}_F} \qquad ...(9)$$

3.4. Hedging Effectiveness

The hedging effectiveness of the futures market can be examined by testing the extent to which the position in the futures market has helped in reducing the variance of the hedged portfolio. To do so, we first compute the variance of the unhedged portfolio (Var_U) and hedged portfolio (Var_H) as:

$$Var_U = var_S \qquad ...(10)$$

$$Var_H = var_S + h^{*2}\, var_F - 2h^* cov_{FS} \qquad ...(11)$$

where, var_S and var_F are the variance of the spot and futures price returns respectively, with their covariance expressed as cov_{FS}.

We then compute the variance reduction (%) as $\left(1 - \frac{Var_H}{Var_U}\right) \times 100$. The variance reduction indicates the percentage by which hedgers can reduce their risk to the variation in the gold spot prices by entering into a gold futures contract.

4. EMPIRICAL ANALYSIS AND FINDING

4.1. Results of Stationarity and Cointegration

The stationarity of the spot prices (MCX Spot, Reuters spot and WGC spot) and futures prices (1 month, 2 month and 3 month) are tested using the Phillips Perron unit root test. The results are presented in *Table 6*. The level (natural logarithm) and first difference of each price series were tested under scenario (a), (b) and (c). For the period as a whole as well as the sub-periods, the tau statistic was found to be statistically insignificant in case of the level series, but significant at 1% after first differencing. This was evident under each of the scenarios. Since the prices were found to be non-stationary at level but stationary after differencing, the return series (differenced series) are used for further analysis.

The cointegration test was run for the combinations of the spot prices (both domestic and international) and the futures prices, for the entire period and as well as the 3 sub periods. For the null hypothesis [$H_0: r = 0$], the trace statistics was found to be highly significant at 1% (*Table 7.1*) for the domestic spot prices. The null hypothesis is rejected and it is concluded that there is a cointegration relationship between the domestic spot market prices and the futures prices when the full period was considered. There is a however a weak long run relationship between the futures market and the international spot market, due to which the null hypothesis is rejected at only a 5% significance level. The results were consistent in case of domestic markets for the sub-periods as well, although trace statistic numbers were found to be significant at a lower significance level of 5% during the second sub period.

The results for the cointegration, in case of the domestic MCX and Reuters spot prices with the international WGC spot prices, independently revealed a significant cointegrating relationship in the first and third period, but not in case of the second period (as indicated by the insignificant trace statistic for the null hypothesis of $r = 0$ in *Table 7.2*). For the period as a whole, no strong evidence of cointegration between the domestic and international spot prices was found. The regulatory changes during the second period had further weakened the long run relationship between domestic and international spot prices.

4.2. Application of the VAR and VECM models

Based on the results of the Johansen's cointegration, a VECM model was estimated to explain the relationship between the gold futures market and underlying spot market[1]. The model was estimated for the 1 month, 2 month and 3 month gold futures returns with each of the underlying spot rates, i.e. the MCX spot returns, the Reuters spot returns and the WGC spot returns. The results are summarized in Exhibit 1. The Exhibit illustrates the relationship between their prices (long run) and the changes in their prices (short run).

Exhibit 1: Direction of Pass Through between Spot and Futures Market Returns.

Spot Price	Long Run			Short Run		
	1M	2M	3M	1M	2M	3M
Full Period						
MCX Spot	$F \leftrightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$
Reuters Spot	$F \leftrightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$
WGC Spot	$F \nleftrightarrow S$	$F \nleftrightarrow S$	$F \nleftrightarrow S$	$F \leftrightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$
Period 1						
MCX Spot	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$
Reuters Spot	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$
WGC Spot	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$
Period 2						
MCX Spot	$F \leftarrow S$	-@	$F \leftarrow S$	$F \leftrightarrow S$	$F \leftrightarrow S$	$F \leftrightarrow S$
Reuters Spot	$F \leftrightarrow S$	$F \leftarrow S$	$F \leftarrow S$	$F \leftrightarrow S$	$F \leftrightarrow S$	$F \leftrightarrow S$
WGC Spot	$F \nleftrightarrow S$	$F \nleftrightarrow S$	$F \leftarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$
Period 3						
MCX Spot	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$
Reuters Spot	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \rightarrow S$
WGC Spot	$F \rightarrow S$	$F \rightarrow S$	$F \leftarrow S$	$F \rightarrow S$	$F \rightarrow S$	$F \leftrightarrow S$

Notes:

1. $\rightarrow$ indicates unidirectional pass-through, $\leftrightarrow$ indicates bi-directional pass-through and $\nleftrightarrow$ indicates absence of pass-through. For example, $F \rightarrow S$ suggests a unidirectional pass-through from futures to spot returns.

2. @ indicates that a VAR model was estimated for MCX spot and 2M Futures returns during period 2. Hence there is no long run parameter. No cointegrating relation exists for any further analysis

3. The direction in the long run was based on parameters of the VECM model while that in the short run was based Granger causality results.

4. Coefficients significant upto 5% were considered.

[1] A VECM model is estimated in case the trace statistic for the model satisfied the 5% level of significance threshold at the minimum. In other cases, a VAR model was estimated.

The results for the full period are presented in Panel *A* of *Table 8* through *Table 10*. The following results are highlighted below:

1. The parameters α_F and α_S, which indicate the speed of adjustment to the long run equilibrium level, were found to statistically significant when modelling the relationship of 1 month gold futures returns with the MCX Spot (*Table 8.1.)* as well as with the Reuters spot returns (*Table 9.1*). This confirmed the presence of a long run relationship between the near month futures returns and the domestic spot market returns. In both the cases, the coefficients of α_S were found to be higher than α_F, which indicated that the domestic spot prices made a faster adjustment to the common stochastic trend as compared to the futures prices.

   The individual contributions of the spot and futures prices in the adjustment process to this long run equilibrium level were then estimated using the Gonzalo Granger statistic. In case of the MCX spot, the Gonzalo Granger statistic was found to be 0.6137[2], which suggested that the MCX spot price accounted for around 61% of the total contribution in the adjustment process to the long run equilibrium level, while that of the 1 month futures prices stood at 39% (*Panel A of Table 11*). Additionally, it was found that the MCX spot price took only 12 days[3] to make up for its deviation from the long run equilibrium level, while that for the 1 month futures prices was estimated to be around 19 days (*Panel B of Table 11)*. The lower weight of the 1 month futures prices (in comparison to the underlying MCX spot price) indicates that the futures market played a greater role in the price discovery process as compared to the spot. The Gonzalo Granger statistics for the Reuters spot (1 month futures) price was found to be approximately 80% (20%) and took around 7 days (28 days) to recover from its deviation.

2. When modelling the relationship of the 2 month and 3 month gold futures with the domestic spot prices (MCX spot and Reuters spot), only α_S was found to be statistically significant while α_F was insignificant, which indicates that the adjustment process to the long run equilibrium level was primarily made by the changes to the spot market prices (with a weight of 100%) in response to the change of the prices in the futures market. In other words, the spot market prices were found to follow the lead of the futures prices. The results are presented in *Tables 8.2, 8.3, 9.2* and *9.3* respectively. It took a longer time to re-establish the equilibrium in case of the 2 months and 3 months contracts vis-à-vis the near term contracts.

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[2] $GG_{MCX\ Spot} = \left(\frac{0.1189}{0.1189-(-0.07485)}\right) = 0.6137 \sim 61\%$

[3] $SA_{MCX\ Spot} = 2 \times \left(\frac{\ln(3)}{0.1189}\right) = 12\ days$

3. When modelling the relationship between the WGC spot and each of the tenors of the futures market (*Table 10.1. – Table 10.3.*) , the α_F and α_S parameters were found to be insignificant. This confirms earlier cointegration results that the domestic futures market prices do not exhibit any long run relationship with the international spot market prices.

4. In case of the domestic spot prices, the β parameter, which is an indicator of the slope of the long run relationship, ranged between 0.9989 to 1.0039, while that for the WGC spot was found to lie between 1.1113 to 1.1164. A β of close to 1, like in the case of the domestic spot prices, indicates the existence of a greater degree of alignment between the futures market prices and the domestic spot prices vis-à-vis the international spot market prices in the long run.

5. An analysis of the short run parameters of the VECM models revealed that the lagged domestic futures market returns (in some cases upto even 3 days prior), significantly impacted the current returns in the underlying spot market, both domestically and internationally. This was evident as the parameter $\theta_{S,i}$ was statistically significant at a 1% level of significance for all the cases examined. To reconfirm the short run impact of the futures market returns on that of the spot, a Granger-Causality Wald Test was (*Table 12*) conducted. The null hypothesis that the spot market returns were only influenced by its own returns and not the returns in the futures market is rejected, since the chi square statistic was significant at 1% in all cases. This implies that the futures market returns granger cause the spot market returns in the domestic and international markets (Panel B of Table *12*).

6. To examine if the past spot market returns impacted the current futures market returns, the significance of the parameters $\theta_{F,i}$ are tested. No consistent evidence of a pass through was found from the past spot market returns to the futures market returns in the short run. The Reuters spot price lagged returns did not show any signs of significantly impacting the traded gold futures returns, for any of the tenors. Certain instances of a pass through from the MCX spot and WGC spot returns to the 1 month and 3 month futures market returns was found, albeit with weaker significance levels. These results were supported by the Granger causality test.

Thus, the results suggests that there also seems to be a disconnect between the domestic gold futures market and the international gold spot market returns in the long run when the full period was considered. Although there is a long run relationship between the domestic spot and futures prices, it can be inferred that the daily price discovery process in the gold market ideally takes place in the futures market but not the spot market, since in almost all instances the domestic spot market prices were found to be making either a greater adjustment to the long run equilibrium level or following the lead of the futures market prices in entirety. A strong unidirectional causality in the short run, from the futures market to the underlying spot market was also found but not always the other way around. A reason as to why the futures market plays a dominant role in the price discovery process could be because the gold futures market is an actively traded market with price information made available on a real-time basis. The prices in domestic spot market on the other hand, being a polled price from only a select group of market participants, do not seem to capture the dynamics of the price discovery process.

To examine if the relationship between the gold spot and futures market was impacted by the change in the regulatory and taxation regime, the sample period was divided into three sub periods as described earlier. The following observations were made:

i. The results of the 1st period and the 3rd period (Panel B and Panel D of *Tables 8* through *Tables 10*) were largely consistent with the results obtained for the entire period. For example, in almost all the cases, the speed of adjustment parameter of only the spot price (α_s) was largely positive and significant, suggesting that the domestic spot prices (with a weight of 100%) were generally following the lead of the futures prices in the long run. The SA of the domestic spot prices was found to be on an average 5 to 12 days during these periods. The slope parameter β using the domestic spot prices was also found to be close to 1 during these two sub samples. β ranged from 1.0051 to 1.0652 in Period 1 and 0.9452 to 0.9964 in Period 3. The granger causality results also largely indicated unidirectional causality from the futures prices to the underlying spot prices.

ii. In the second period however, α_F was mostly statistically significant in many instances when the domestic spot price was considered (Panel C of *Tables 8* through *Tables 10*). A significant α_F implies that futures market followed the lead of the spot market prices during the second period. The futures prices, which largely contributed to 100% of the adjustment process, took around 15 days to recover from its disequilibrium. A reason as to why the α_F turned significant in the 2nd period but not in case of the 1st or 3rd period, could be because participants in the futures market had to dynamically adjusted their prices, to factor in the changes in the domestic spot price on account of the restrictions imposed on the domestic supply of gold during this period. Further in the second period, the β parameter ranged from 0.5925 to 1.1392, which suggests that the introduction of these changes brought about a transitory disruption to the long run equilibrium level between the domestic spot and the futures market. A bi-directional granger causality was largely found between futures market returns and the underlying spot market returns for the 2nd sub period, indicating short run adjustments as well.

iii. For the full period, it was observed that there is no long run relationship between the domestic futures market and the international spot prices. A period wise break actually reveals that there was a significant pass-through from the futures to the international spot returns in the first and third period. The long run relationship essentially dissipated during the second period.

4.3. Analysis of the Impulse Response Function (IRF)

The IRF for the futures and spot market was estimated so as to find out the impact of the futures market returns (spot market returns) to a shock in its own lagged errors terms and the lagged error terms of the spot market returns (futures market returns*). Annexure 3* depicts the IRF function (within the +/- 2 standard error band) for the MCX spot, Reuters Spot and WGC spot with each of the futures tenors. The results were estimated upto 10 lags.

The IRF analysis reconfirmed the results of the VECM model. It was observed that a unit shock to the futures market returns, led to a positive response in the spot market returns in the range of +0.50 to +0.75. The response of the futures market returns stood between +0.00 to +0.25, when unit shock to the spot market returns was introduced in the system. The results thus indicate that the impact of a shock to the futures market returns on the underlying spot market returns was markedly higher than an impact on returns in the futures market on account of a shock to the spot market returns. The results were consistent for the 1 month, 2 month and 3 month tenors when tested against the MCX spot price, Reuters spot price and the WGC spot price.

It was also worth noting that in a standard VAR model, the response to a unit shock would eventually fade to 0. In this case however, the spot and futures markets are cointegrated. Hence, after introducing a unit shock to the spot market (futures market) returns, over a sufficient number of lags, the response in the futures market (spot market) returns would not diminish to 0 but would stabilize at a steady state value.

The immediate response in the futures market returns to a shock in its own lagged errors was found to be closer to +1.00, indicating a very strong initial effect. The effect gradually weakened to around +0.75. In case of spot market returns, the response to a shock in its own lagged error terms was found to lie at and around +0.65.

4.4. Forecast Error Variance Decomposition (FEVD) Analysis:

A FEVD analysis was also conducted to estimate the proportion of the variance in spot (futures) market returns that could be explained by its own innovation and by the innovation in the futures (spot) market returns (Tables *13.1. to 13.3.*). The results suggest that the variation in the returns of the domestic spot markets were largely explained by the movement in the futures market. For example in case of the pair of the 1 month futures contract and the MCX spot, it was found that 74% of the variation in the MCX spot returns was explained by movement in the futures market returns, at a 2-step ahead forecast (Panel *A* of the Tables *13.1 to 13.3*). This number increases to 83% at a 5-step ahead forecast and further to 86% at a 10-step ahead forecast. Only a small proportion of the variation in the MCX spot market returns was accounted for by its own innovation. Similar inferences were drawn for the combination of MCX spot with the 2M and 3M futures tenors. The variation in the innovation of the futures market returns also seemed to play a dominant role in explaining the variance of the Reuters spot returns as well. A look at the FEVD for WGC spot also indicated that the variation in the futures market return accounted for a sizable share in the variation of the WGC spot. This could be on account of the fact that India's is one of the largest consumers of gold worldwide. Any variation in domestic demand would impact prices globally.

When the variation of the returns in the 1 month futures market on account of the movement in MCX spot prices forecast was studied (Panel *B* of the Tables *13.1 to 13.3*), it was found that around 50% of its variation was explained by the fluctuations in the spot returns (the balance 50% was accounted for by its own innovation) at a 10-step ahead forecast. This number dropped to around 32% in when Reuters spot price was considered. However, it was found that around 64% of variation in the futures was accounted for by the WGC spot. This suggests that the unlike the domestic spot prices the variation in the international spot prices have a larger role to play in explaining the variation in the domestic futures market.

4.5. Optimal Hedge Ratio and Hedging Effectiveness

Until now, the causal relationship between the returns of the domestic spot prices and futures prices was tested. To determine if the gold futures contract serve as an effective hedging instrument to the underlying spot market, the optimal hedge ratio and hedging effectiveness for the full period and sub periods was computed. The domestic spot and international spot prices were used for comparison.

The optimal hedge ratios (*Table 14*) are first computed for 1M, 2M and 3M from the variance-covariance matrix of the residuals obtained from the VECM model. The results indicated that the optimal hedge ratio ranged between 0.42-0.55 in case of the MCX Spot rate and between 0.45-0.55 in case of the Reuters Spot rate. For the WGC spot rate this ratio was found to lie between 0.75-0.90. The optimal hedge ratios suggest that there might be a greater possibility to utilize the relationship of futures prices with the international rather than the domestic spot prices to minimize the hedged portfolio variance.

The variance of the unhedged and hedged portfolio is then computed. The variance of the unhedged portfolio is simply the variance of (a long position in) the spot price, while the variance of the unhedged portfolio is the variance of a long position in the spot and short The variance of the hedged portfolio was found to be lower than the variance of the unhedged portfolio. However, the variance reduction in case of the domestic spot prices was found to be less than 30% for the period as a whole, while that for the international spot price was around 48%. This means that if a spot trader were to buy gold at the domestic spot market price, he would need to bear 70% of the risk for his holding in the spot market, despite hedging in the gold futures market. If he were to use the international gold spot price as a reference at the time of entering into a long position in the spot market, the hedge position would help him in reducing about half of his risk.

The hedging effectiveness of gold futures traded on the Indian commodity exchanges (MCX) with that traded on international platforms is also compared. Gold futures contracts traded on CME Globex during the same sample period was considered. It was found that the CME Gold futures were able to reduce the risk in the underlying spot price by around 57%. This was nearly 33% higher than the hedging ability of domestic futures market.

The results highlight that the domestic gold futures market does not seem to be an effective hedge for the domestic gold spot market. Further, if market participants decide to use gold futures for hedging, they would be slightly better off by using the international spot price as a reference rather than the domestic spot prices. The hedging effectiveness of the gold futures worsened in the second period when both the domestic and international spot prices were considered, as compared to other sub-periods.

5. CONCLUSION

The objective of this study was to analyze the market microstructure and policy changes in India's gold market. The study empirically tests for the gold futures market efficiency and determine the direction of information flow between the spot and futures markets under various policy regimes. Given that India imports gold to support the domestic demand, the impact of global gold prices on the domestic spot and futures market had to be explicitly captured.

The principle of market efficiency was tested using domestic and global spot reference prices. A VECM model was estimated to determine the presence of long and short run relationship between the markets.–A Granger Causality Wald test was used to establish a short run causal relationship. An impulse response and variance decomposition analysis was conducted to examine the extent to which the variance of one market impacts the other.

For the full period , no strong evidence of cointegration was found between the domestic and international spot prices. A long run cointegration relationship was found between futures prices and domestic spot market prices. A strong long run relationship between the futures market and the international spot market was not detected.-It was also established that the futures market returns granger cause the spot market returns in the domestic and international markets in the short run.

The daily spot prices made either a greater adjustment to the long run equilibrium level or followed the lead of the futures market prices in entirety. It could be because the gold futures market is an actively traded market. The prices in domestic spot market on the other hand, being a polled price from only a select group of market participants, do not seem to capture the dynamics of the price discovery process.

The futures market provided greater hedge effectiveness against variation in international spot prices. The impulse response analysis indicates that variation in the international spot prices has a larger role in explaining the variation in the domestic futures market.

To summarize, the study indicates that domestic spot prices for gold have no active role in price discovery. Currently the rates are polled due to the lack of an organized spot market. Based on the analysis, a regulatory suggestion would be to create a single organized platform for domestic spot gold market that would aggregate all participants in both physical gold and financial gold market and help set in place a transparent domestic spot gold price setting mechanism leading to an efficient price discovery process linkage between domestic spot and futures market.

Table 1: Trends in Gold Imports and Consumption - India				
Year	Gold Imports (US$ bn.)	Gold Consumption (Tonnes)	Gold Imports as % of GDP	% Share in Total Imports
2010-11	41	1145	2.4	11
2011-12	57	788	3.0	12
2012-13	54	1067	2.9	11
2013-14	29	772	1.5	6
2014-15	34	813	1.7	8
2015-16	32	737	1.5	8
2016-17	27	800	1.2	7
2017-18	34	739	1.3	7
Source: Department of Commerce, World Gold Council, Reserve Bank of India				

Table 2: Trading in MCX Gold Futures			
Year	Traded Contract(Lots)	Total Value (Rs. Cr.)	Average Daily Turnover (Rs. Cr.)
2008	14024217	1714741.92	5585.48
2009	12144967	1849971.91	6065.48
2010	12052225	2198747.84	7162.05
2011	12655760	3147133.54	10184.90
2012	10287609	3056724.43	9956.76
2013	8944603	2563856.15	8324.21
2014	3971634	1106665.19	4129.35
2015	3947175	1040399.90	4032.56
2016	4093572	1210836.82	4675.05
2017	2296957	664689.55	2606.63
2018	1461537	445468.59	2531.07
Source: MCX			

Table 3: Year-Wise MCX/WGC Ratio	
Year	**MCX/WGC**
2008	1.0058
2009	1.0062
2010	1.0147
2011	1.0110
2012	1.0323
2013	1.1059
2014	1.1328
2015	1.1009
2016	1.0906
2017	1.1008
2018	1.0984

Table 4: Descriptive Statistics of MCX Gold Futures, MCX Spot, Reuters Spot and WGC Spot Prices

	Full Period						Period 1 (Jan'08 - May'13)					
Price Series												
Variable	**1M**	**2M**	**3M**	**MCXSPOT**	**REUTERS**	**WSPOT**	**1M**	**2M**	**3M**	**MCXSPOT**	**REUTERS**	**WSPOT**
Mean	24236.41	24352.30	24492.07	24243.73	24240.54	22706.90	20574.49	20761.43	20937.50	20528.00	20528.95	20107.27
Median	26988.00	27151.00	27314.00	26932.00	26950.00	24597.63	19109.50	19237.50	19341.50	19120.00	19087.50	18826.72
StdDev	6346.83	6377.32	6428.36	6361.08	6360.96	5455.21	6684.02	6828.45	6959.22	6640.94	6638.91	6275.90
Kurtosis	-0.92	-0.90	-0.90	-0.93	-0.94	-0.76	-1.38	-1.39	-1.40	-1.38	-1.38	-1.40
Skewness	-0.76	-0.76	-0.76	-0.75	-0.75	-0.73	0.27	0.28	0.28	0.27	0.27	0.24
Range	23567.00	23537.00	22994.00	22037.00	23315.00	20562.76	21487.00	21803.00	22112.00	21554.00	21465.00	20562.76
Minimum	10872.00	10940.00	10985.00	10906.00	10935.00	10813.96	10872.00	10940.00	10985.00	10906.00	10935.00	10813.96
Maximum	34439.00	34477.00	33979.00	32943.00	34250.00	31376.72	32359.00	32743.00	33097.00	32460.00	32400.00	31376.72
Count	2522	2522	2522	2522	2522	2522	1340	1340	1340	1340	1340	1340
Difference Series												
Variable	**d 1M**	**d 2M**	**d 3M**	**d MCX**	**d REUTERS**	**d WSPOT**	**d 1M**	**d 2M**	**d 3M**	**d MCX**	**d REUTERS**	**d WSPOT**
Mean	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0007	0.0007	0.0007	0.0007	0.0007	0.0006
Median	0.0004	0.0003	0.0000	0.0000	0.0000	0.0002	0.0008	0.0007	0.0008	0.0005	0.0000	0.0008
Standard Deviation	0.0111	0.0107	0.0103	0.0102	0.0129	0.0119	0.0119	0.0118	0.0115	0.0119	0.0142	0.0136
Kurtosis	8.7426	7.6457	8.4356	10.3919	14.0021	5.7438	7.6542	7.8206	8.7409	9.7028	10.3006	5.3364
Skewness	-0.3427	-0.0442	-0.41	-0.0715	0.0299	-0.2342	-0.3707	-0.3184	-0.7281	-0.2029	-0.0798	-0.4146
Range	0.1759	0.1738	0.1489	0.1911	0.2297	0.1662	0.1759	0.1738	0.1489	0.1911	0.2022	0.1662
Minimum	-0.0947	-0.0927	-0.0925	-0.0866	-0.1121	-0.095	-0.0947	-0.0927	-0.0925	-0.0866	-0.0897	-0.095
Maximum	0.0812	0.0811	0.0564	0.1045	0.1176	0.0713	0.0812	0.0811	0.0564	0.1045	0.1125	0.0713
Count	2521	2521	2521	2521	2521	2521	1339	1339	1339	1339	1339	1339

Table 4: Descriptive Statistics of MCX Gold Futures, MCX Spot , Reuters Spot and WGC Spot Prices (cont.)

	Period 2 (Jun'13 - May'15)						Period 3 (Jun'15 - Mar'18)					
	Price Series											
Variable	**1M**	**2M**	**3M**	**MCXSPOT**	**REUTERS**	**WSPOT**	**1M**	**2M**	**3M**	**MCXSPOT**	**REUTERS**	**WSPOT**
Mean	28066.41	27947.91	27989.49	28254.84	28246.59	25041.55	28609.13	28750.41	28888.30	28594.78	28587.12	26075.74
Median	27764.00	27765.00	27894.00	27872.50	27862.50	24847.81	28953.50	29059.50	29190.50	29010.50	28937.50	26395.21
Standard Deviation	1567.47	1376.60	1297.49	1679.64	1730.02	1202.89	1743.47	1747.05	1759.24	1729.31	1744.83	1674.90
Kurtosis	0.70	2.77	3.67	-0.82	-0.50	4.43	-0.54	-0.54	-0.54	-0.57	-0.60	-0.51
Skewness	0.83	1.22	1.37	0.47	0.49	1.57	-0.51	-0.44	-0.35	-0.60	-0.56	-0.44
Range	9064.00	8975.00	8377.00	7757.00	10980.00	8542.56	7356.00	7667.00	7697.00	6967.00	7025.00	7156.53
Minimum	25375.00	25502.00	25602.00	25186.00	23270.00	22560.92	24597.00	24691.00	24900.00	24562.00	24500.00	22241.54
Maximum	34439.00	34477.00	33979.00	32943.00	34250.00	31103.48	31953.00	32358.00	32597.00	31529.00	31525.00	29398.07
Count	482	482	482	482	482	482	700	700	700	700	700	700
	Difference Series											
Variable	**d 1M**	**d 2M**	**d 3M**	**d MCX**	**d REUTERS**	**d WSPOT**	**d 1M**	**d 2M**	**d 3M**	**d MCX**	**d REUTERS**	**d WSPOT**
Mean	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Median	0.0003	-0.0001	0.0000	-0.0004	-0.0005	0.0000	0.0000	-0.0002	0.0000	0.0000	0.0000	-0.0001
Standard Deviation	0.0128	0.0110	0.0105	0.0111	0.0092	0.0136	0.0078	0.0079	0.0074	0.0068	0.0094	0.0088
Kurtosis	8.3441	4.0417	4.0327	3.1822	1.6465	21.7902	4.7154	5.6100	3.3739	3.5841	9.9356	4.0368
Skewness	-0.5944	0.3668	0.2916	0.0566	0.2692	0.2308	0.6825	0.8121	0.4739	0.4051	0.2290	0.5376
Range	0.1468	0.1073	0.0945	0.1002	0.0701	0.2297	0.0769	0.0779	0.0714	0.0733	0.1349	0.0870
Minimum	-0.0907	-0.0519	-0.0426	-0.0477	-0.0304	-0.1121	-0.0261	-0.0268	-0.0264	-0.0293	-0.0679	-0.0365
Maximum	0.0561	0.0554	0.0518	0.0526	0.0397	0.1176	0.0507	0.0512	0.0450	0.0440	0.0670	0.0504
Count	482	482	482	482	482	482	700	700	700	700	700	700

Table 5: Results of Pearson Correlation Coefficients

Pearson Correlation Coefficients with Prob. > |r| under H0: Rho=0, N = 2522

Panel A: Full Period

	1M	2M	3M	MCXSPOT	REUTERS	WSPOT
1M	1	0.9993 <.0001	0.9980 <.0001	0.9989 <.0001	0.9987 <.0001	0.9885 <.0001
2M	0.9993 <.0001	1	0.9995 <.0001	0.9974 <.0001	0.9973 <.0001	0.9918 <.0001
3M	0.9980 <.0001	0.9995 <.0001	1	0.9960 <.0001	0.9959 <.0001	0.9930 <.0001
MCX Spot	0.9989 <.0001	0.9974 <.0001	0.9960 <.0001	1	0.9997 <.0001	0.9854 <.0001
Reuters Spot	0.9987 <.0001	0.9973 <.0001	0.9959 <.0001	0.9997 <.0001	1	0.9853 <.0001
WGC Spot	0.9885 <.0001	0.9918 <.0001	0.9930 <.0001	0.9854 <.0001	0.9853 <.0001	1

Panel B: Period 1

	1M	2M	3M	MCXSPOT	REUTERS	WSPOT
1M	1	0.9999 <.0001	0.9998 <.0001	0.9996 <.0001	0.9995 <.0001	0.9987 <.0001
2M	0.9999 <.0001	1	0.9999 <.0001	0.9995 <.0001	0.9994 <.0001	0.9985 <.0001
3M	0.9998 <.0001	0.9999 <.0001	1	0.9994 <.0001	0.9993 <.0001	0.9983 <.0001
MCX Spot	0.9996 <.0001	0.9995 <.0001	0.9994 <.0001	1	0.9998 <.0001	0.9986 <.0001
Reuters Spot	0.9995 <.0001	0.9994 <.0001	0.9993 <.0001	0.9998 <.0001	1	0.9986 <.0001
WGC Spot	0.9987 <.0001	0.9985 <.0001	0.9983 <.0001	0.9986 <.0001	0.9986 <.0001	1

Panel C: Period 2

	1M	2M	3M	MCXSPOT	REUTERS	WSPOT
1M	1	0.97514 <.0001	0.91917 <.0001	0.95856 <.0001	0.95842 <.0001	0.85931 <.0001
2M	0.97514 <.0001	1	0.96351 <.0001	0.91202 <.0001	0.91515 <.0001	0.91877 <.0001
3M	0.91917 <.0001	0.96351 <.0001	1	0.85984 <.0001	0.86531 <.0001	0.90465 <.0001
MCX Spot	0.95856 <.0001	0.91202 <.0001	0.85984 <.0001	1	0.99199 <.0001	0.77966 <.0001
Reuters Spot	0.95842 <.0001	0.91515 <.0001	0.86531 <.0001	0.99199 <.0001	1	0.78508 <.0001
WGC Spot	0.85931 <.0001	0.91877 <.0001	0.90465 <.0001	0.77966 <.0001	0.78508 <.0001	1

Panel D: Period 3

	1M	2M	3M	MCXSPOT	REUTERS	WSPOT
1M	1	0.99785 <.0001	0.9923 <.0001	0.98908 <.0001	0.98752 <.0001	0.99471 <.0001
2M	0.99785 <.0001	1	0.99634 <.0001	0.98264 <.0001	0.98099 <.0001	0.99384 <.0001
3M	0.9923 <.0001	0.99634 <.0001	1	0.97843 <.0001	0.97697 <.0001	0.99115 <.0001
MCX Spot	0.98908 <.0001	0.98264 <.0001	0.97843 <.0001	1	0.99512 <.0001	0.98753 <.0001
Reuters Spot	0.98752 <.0001	0.98099 <.0001	0.97697 <.0001	0.99512 <.0001	1	0.98487 <.0001
WGC Spot	0.99471 <.0001	0.99384 <.0001	0.99115 <.0001	0.98753 <.0001	0.98487 <.0001	1

Table 6: Results of Phillips Perron Unit Root Test

	Panel A:Full Period								Panel B: Period 1							
	Level				First Difference				Level				First Difference			
Type	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau
	1M								1M							
Zero	0.0977	0.706	1.7867	0.9827	-2565.4864	<.0001	-50.8963	<.0001	0.0888	0.7038	2.0711	0.9913	-1232.3591	<.0001	-35.3087	<.0001
Single	-4.1545	0.5226	-2.3346	0.1611	-2554.8817	0.0019	-50.959	<.0001	-1.8739	0.7936	-1.466	0.5513	-1226.0754	0.0019	-35.4144	<.0001
Trend	-6.2891	0.7217	-1.9534	0.6267	-2548.037	0.0008	-50.9982	<.0001	-14.2394	0.212	-2.223	0.476	-1224.3618	0.0008	-35.431	<.0001
	2M								2M							
Zero	0.0975	0.7059	1.7948	0.983	-2472.4506	<.0001	-49.017	<.0001	0.0888	0.7037	2.0942	0.9918	-1191.9493	<.0001	-34.6574	<.0001
Single	-4.1219	0.5262	-2.3328	0.1617	-2462.1829	0.0019	-49.0696	<.0001	-1.8228	0.7996	-1.4593	0.5547	-1185.768	0.0019	-34.7621	<.0001
Trend	-6.1149	0.7357	-1.9292	0.6397	-2455.6183	0.0008	-49.1024	<.0001	-13.2867	0.2517	-2.098	0.5465	-1184.0662	0.0008	-34.7792	<.0001
	3M								3M							
Zero	0.098	0.706	1.8147	0.9838	-2391.6588	<.0001	-47.4869	<.0001	0.0889	0.7038	2.0905	0.9917	-1181.8955	<.0001	-34.0028	<.0001
Single	-4.131	0.5252	-2.3585	0.1539	-2381.7439	0.0019	-47.5324	<.0001	-1.8024	0.8019	-1.4528	0.558	-1175.9667	0.0019	-34.0993	<.0001
Trend	-5.9783	0.7465	-1.9208	0.6441	-2375.3105	0.0008	-47.5609	<.0001	-12.8923	0.2698	-2.0387	0.5797	-1174.285	0.0008	-34.1149	<.0001
	MCX Spot								MCX Spot							
Zero	0.0979	0.706	1.851	0.9851	-2579.813	<.0001	-49.7131	<.0001	0.0902	0.7041	2.1126	0.9921	-1302.0499	<.0001	-36.472	<.0001
Single	-4.0044	0.5392	-2.3322	0.1619	-2568.4798	0.0019	-49.7685	<.0001	-1.8407	0.7975	-1.4392	0.5648	-1295.1279	0.0019	-36.5894	<.0001
Trend	-5.9253	0.7507	-1.9029	0.6535	-2561.0918	0.0008	-49.8024	<.0001	-15.2694	0.1753	-2.3677	0.3964	-1293.426	0.0008	-36.6044	<.0001
	WGC Spot								WGC Spot							
Zero	0.0904	0.7042	1.5494	0.9708	-2525.0951	<.0001	-50.8365	<.0001	0.0838	0.7026	1.7709	0.982	-1291.7865	<.0001	-36.9141	<.0001
Single	-5.004	0.4353	-2.3866	0.1457	-2517.3596	0.0019	-50.8836	<.0001	-2.2856	0.7444	-1.5619	0.5022	-1286.8798	0.0019	-36.9992	<.0001
Trend	-7.3205	0.6386	-2.1378	0.5243	-2511.8772	0.0008	-50.9155	<.0001	-15.1838	0.1781	-2.338	0.4124	-1285.0269	0.0008	-37.0204	<.0001
	Reuters Spot								Reuters Spot							
Zero	0.0976	0.7059	1.7369	0.9806	-2969.6904	<.0001	-58.9406	<.0001	0.0893	0.7039	1.95	0.9882	-1467.7327	<.0001	-41.409	<.0001
Single	-4.1722	0.5207	-2.2814	0.178	-2958.3745	0.0019	-59.0478	<.0001	-1.9719	0.7821	-1.4346	0.5671	-1460.6863	0.0019	-41.554	<.0001
Trend	-6.59	0.6975	-1.9815	0.6114	-2951.1354	0.0008	-59.1133	<.0001	-18.5397	0.0931	-2.6766	0.2466	-1458.9333	0.0008	-41.5757	<.0001

Table 6: Results of Phillips Perron Unit Root Test (cont.)

	Panel C: Period 2								Panel D: Period 3							
	Level				First Difference				Level				First Difference			
Type	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau
	1M								1M							
Zero	-0.0015	0.6824	-0.0587	0.6634	-566.159	<.0001	-25.5213	<.0001	0.0128	0.6859	0.6186	0.8497	-678.9781	<.0001	-25.5562	<.0001
Single	-11.325	0.0967	-2.3774	0.1487	-566.1549	0.0017	-25.4953	<.0001	-6.0084	0.3461	-1.7363	0.4123	-678.7125	0.0018	-25.5519	<.0001
Trend	-19.4779	0.0749	-3.3101	0.066	-566.1143	0.0007	-25.4842	<.0001	-9.2513	0.4878	-2.1526	0.5153	-678.7125	0.0008	-25.5334	<.0001
	2M								2M							
Zero	-0.0011	0.6825	-0.0443	0.6683	-541.7431	<.0001	-23.3174	<.0001	0.012	0.6857	0.5729	0.8398	-692.0764	<.0001	-25.8018	<.0001
Single	-13.3014	0.0594	-2.5814	0.0979	-541.7386	0.0017	-23.2944	<.0001	-6.0963	0.3392	-1.7334	0.4138	-691.8267	0.0018	-25.7956	<.0001
Trend	-20.2159	0.0643	-3.3025	0.0672	-541.8199	0.0007	-23.2778	<.0001	-9.1004	0.4989	-2.134	0.5258	-691.8257	0.0008	-25.7772	<.0001
	3M								3M							
Zero	-0.0011	0.6825	-0.0456	0.6678	-494.6086	<.0001	-22.0045	<.0001	0.0117	0.6856	0.5682	0.8388	-664.6264	<.0001	-24.5613	<.0001
Single	-14.2216	0.0472	-2.6708	0.0804	-494.6045	0.0017	-21.9821	<.0001	-5.8385	0.3599	-1.6883	0.4368	-664.4597	0.0018	-24.5549	<.0001
Trend	-20.1855	0.0648	-3.2699	0.0728	-494.6745	0.0007	-21.9633	<.0001	-8.4565	0.5474	-2.0554	0.5699	-664.4607	0.0008	-24.5376	<.0001
	MCX Spot								MCX Spot							
Zero	-0.0007	0.6826	-0.0347	0.6714	-494.0039	<.0001	-21.4099	<.0001	0.013	0.6859	0.716	0.8694	-673.0825	<.0001	-25.3468	<.0001
Single	-6.898	0.2806	-1.849	0.3563	-494.0042	0.0017	-21.3888	<.0001	-4.4616	0.4889	-1.4743	0.5468	-672.8044	0.0018	-25.347	<.0001
Trend	-13.4818	0.2399	-2.8904	0.1666	-494.077	0.0007	-21.3926	<.0001	-7.5564	0.6181	-1.9441	0.6309	-672.8047	0.0008	-25.3289	<.0001
	WGC Spot								WGC Spot							
Zero	-0.0048	0.6816	-0.2007	0.6141	-476.8315	<.0001	-21.826	<.0001	0.0124	0.6858	0.5701	0.8392	-726.8838	<.0001	-27.7735	<.0001
Single	-14.3778	0.0454	-2.6958	0.076	-476.8191	0.0017	-21.8047	<.0001	-5.666	0.3743	-1.6538	0.4545	-726.5531	0.0018	-27.7679	<.0001
Trend	-20.3559	0.0625	-3.2091	0.084	-476.8175	0.0007	-21.7815	<.0001	-8.6964	0.5291	-2.0876	0.5519	-726.5542	0.0008	-27.7482	<.0001
	Reuters Spot								Reuters Spot							
Zero	-0.0006	0.6826	-0.027	0.674	-600.6776	<.0001	-27.8991	<.0001	0.0132	0.6859	0.6758	0.8615	-850.8324	<.0001	-33.5955	<.0001
Single	-8.8373	0.1767	-2.1082	0.2412	-600.6775	0.0017	-27.8703	<.0001	-5.2655	0.4098	-1.6041	0.4802	-850.3082	0.0018	-33.6024	<.0001
Trend	-15.9725	0.1506	-3.0908	0.1098	-600.4293	0.0007	-27.8732	<.0001	-9.1242	0.4971	-2.1432	0.5206	-850.3071	0.0008	-33.5784	<.0001

Table 7.1: Johansen's Cointegration Rank between Futures Prices and Spot Prices

Results reported for H0:Rank 0 against H1: Rank 1									
	Eigenvalue	Trace	Pr > Trace	Eigenvalue	Trace	Pr > Trace	Eigenvalue	Trace	Pr > Trace
Futures	MCX Spot			REUTERS Spot			WGC Spot		
Panel A: Full Period									
1M	0.0507	136.905	<.0001	0.0525	141.24	<.0001	0.0049	17.941	0.0208
2M	0.0167	48.3187	<.0001	0.0179	50.7968	<.0001	0.0058	19.977	0.0093
3M	0.0123	37.0469	<.0001	0.0123	36.4206	<.0001	0.0083	26.532	0.0006
Panel B: Period 1									
1M	0.2235	340.607	<.0001	0.262	408.616	<.0001	0.0344	48.931	<.0001
2M	0.0857	121.977	<.0001	0.066	93.1322	<.0001	0.0225	32.468	0.0002
3M	0.052	78.2495	<.0001	0.0481	67.9034	<.0001	0.0215	31.18	0.0002
Panel C: Period 2									
1M	0.0655	35.7639	0.0001	0.0933	50.765	<.0001	0.0281	19.376	0.0119
2M	0.022	12.6908	0.1263	0.0264	16.239	0.0381	0.0306	21.207	0.0059
3M	0.0281	16.7698	0.0315	0.03	18.8742	0.0146	0.0646	38.237	<.0001
Panel D: Period 3									
1M	0.089	67.646	<.0001	0.1452	112.385	<.0001	0.0944	71.969	<.0001
2M	0.0512	39.1902	<.0001	0.0526	40.2566	<.0001	0.0628	48.017	<.0001
3M	0.0357	27.8712	0.0004	0.0333	26.1655	0.0007	0.0662	50.533	<.0001

Table 7.2: Johansen's Cointegration Rank between Domestic and International Spot Prices

Results reported for H0:Rank 0 against H1: Rank			
	Eigenvalue	**Trace**	**Pr > Trace**
WGC Spot			
	Panel A: Full Period		
MCX Spot	0.0052	18.529	0.0167
Reuters Spot	0.0038	14.825	0.0627
	Panel B: Period 1		
MCX Spot	0.0215	31	0.0002
Reuters Spot	0.0219	31.859	0.0002
	Panel C: Period 2		
MCX Spot	0.0214	13.11	0.1104
Reuters Spot	0.0243	15.945	0.0424
	Panel D : Period 3		
MCX Spot	0.0779	59.358	<.0001
Reuters Spot	0.1221	93.617	<.0001

Table 8.1. : VECM Results of 1M Futures and MCX Spot Price Returns

Variable	VECM (MCX Spot with 1M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value
Cosnt.	0.0012	0.0003*	-0.0010	0.0003*	-0.0032	0.0027	0.0263	0.0019*	0.2250	0.0453*	0.0089	0.0306	0.0010	0.0015	-0.0062	0.0011*
Long Run																
α	-0.0749	0.0243*	0.1189	0.0174*	-0.0798	0.0546	0.5286	0.0377*	-0.2014	0.0405*	-0.0079	0.0274	-0.0206	0.0380	0.1683	0.0278*
$\alpha\beta$	0.0748	0.0243*	-0.1188	0.0174*	0.0802	0.0549	-0.5313	0.0379*	0.1793	0.0361*	0.0071	0.0244	0.0205	0.0378	-0.1677	0.0277*
β	1.0000	-	-0.9989	-	1.0000	-	-1.0051		1.0000	-	-0.8903	-	1.0000	-	-0.9964	-
Short Run																
$\Delta 1M_{t-1}$	0.0146	0.0307	0.6047	0.0220*	0.1016	0.0486**	0.3994	0.0335*	-0.0924	0.0524***	0.3415	0.0354*	0.0725	0.0514	0.4103	0.0376*
$\Delta Spot_{t-1}$	0.0175	0.0361	-0.4061	0.0259*	-0.0590	0.0353***	-0.1836	0.0243*	0.0789	0.0683	-0.1681	0.0462*	-0.0582	0.0531	-0.2497	0.0388*
$\Delta 1M_{t-2}$	-0.0480	0.0319	0.1963	0.0228*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta Spot_{t-2}$	0.0229	0.0266	-0.1149	0.0191*	-	-	-	-	-	-	-	-	-	-	-	-

Notes: (i) $\mathbf{a_F} = -0.0749$ and $\mathbf{a_S} = 0.1189$ in Equation (1)/(2).

(ii) For a 1-day lag, $\boldsymbol{\eta}_{\mathbf{F_{t-1}}} = 0.0146$, $\boldsymbol{\theta}_{\mathbf{F_{t-1}}} = 0.0175$, $\boldsymbol{\eta}_{\mathbf{S_{t-1}}} = -0.4061$ and $\boldsymbol{\theta}_{\mathbf{S_{t-1}}} = 0.6047$ in Equation (1)/(2)

(ii) * , ** and *** indicates significance at 1%, 5% and 10% respectively.

Table 8.2. : VECM Results of 2M Futures and MCX Spot Price Returns

Variable	VECM (MCX Spot with 2M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot	
	Coef.	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**	**Coef.**	**t Value**
Const	0.0003	0.0002	0.0006	0.0002*	-0.0047	0.0078	0.0451	0.0054*	0.0000	0.000	0.0000	0.0004	0.0026	0.0045	-0.0145	0.0033*
Long Run																
α	-0.0139	0.0140	0.0458	0.0102*	-0.0326	0.0473	0.2725	0.0329*	-	-	-	-	-0.0158	0.0292	0.0947	0.0213*
$\alpha\beta$	0.0139	0.0140	-0.0458	0.0102*	0.0332	0.0481	-0.2773	0.0335*	-	-	-	-	0.0155	0.0288	-0.0934	0.0210*
β	1.0000	-	-1.0013	-	1.0000	-	-1.0175	-	-	-	-	-	1.0000	-	-0.9855	-
Short Run																
$\Delta 2M_{t-1}$	0.0261	0.0270	0.7232	0.0196*	0.0927	0.0511***	0.6587	0.0356*	-0.1753	0.0566*	0.5183	0.0418*	0.0558	0.0487	0.4556	0.0356*
$\Delta Spot_{t-1}$	0.0096	0.0339	-0.4913	0.0247*	-0.0548	0.0543	-0.4285	0.0378*	0.2420	0.0760*	-0.3580	0.0561*	-0.0518	0.0530	-0.2656	0.0386*
$\Delta 2M_{t-2}$	-0.0463	0.0320	0.2437	0.0233*	-0.0179	0.0501	0.2078	0.0349*	-0.1279	0.0639**	0.1887	0.0472*	-	-	-	- -
$\Delta Spot_{t-2}$	0.0195	0.0260	-0.1378	0.0189*	-0.0195	0.0355	-0.1092	0.0247*	0.1710	0.0652*	-0.1083	0.0481**	-	-	-	-
*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*																

Table 8.3. : VECM Results of 3M Futures and MCX Spot Price Returns

Variable	VECM (MCX Spot with 3M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot	
	Coef.	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Const.	0.0000	0.0004	0.0012	0.0003*	-0.0060	0.0092	0.0440	0.0075*	0.3123	0.0853*	0.0922	0.0737	0.0044	0.0039	-0.0099	0.0034*
Long Run																
α	-0.0140	0.0104	0.0299	0.0089*	-0.0254	0.0350	0.1652	0.0283*	-0.0749	0.0205*	-0.0221	0.0177	-0.0252	0.0232	0.0598	0.0204*
$\alpha\beta$	0.0140	0.0105	-0.0300	0.0089*	0.0261	0.0359	-0.1699	0.0291*	0.0444	0.0121*	0.0131	0.0105	0.0248	0.0228	-0.0589	0.0201*
β	1.0000	-	-1.0039	-	1.0000	-	-1.0284	-	1.0000	-	-0.5925	-	1.0000	-	-0.9847	-
Short Run																
$\Delta 3M_{t-1}$	0.0101	0.0263	0.6192	0.0224*	0.0782	0.0447***	0.7020	0.0362*	-0.0494	0.0509	0.2836	0.0440*	0.0213	0.0507	0.3102	0.0446*
$\Delta Spot_{t-1}$	0.0977	0.0297*	-0.4004	0.0254*	0.0041	0.0479	-0.4744	0.0388*	0.1896	0.0573*	-0.1224	0.0495**	0.1052	0.0538	-0.1763	0.0473*
$\Delta 3M_{t-2}$	-0.0836	0.0291*	0.1754	0.0248*	-0.0209	0.0459	0.2355	0.0372*	-	-	-	- -	-	-	-	-
$\Delta Spot_{t-2}$	0.0239	0.0259	-0.1586	0.0221*	-0.0403	0.0365	-0.1827	0.0295*	-	-	-	- -	-	-	-	-
*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*																

Table 9.1: VECM Results of 1M Futures and Reuters Price Returns

Variable	VECM (REUTERS Spot with 1M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value
Cosnt.	0.0006	0.0002**	-0.0004	0.0002**	-0.0014	0.0027	0.0406	0.0023*	0.1924	0.0454*	-0.1346	0.0430*	0.0007	0.0016	-0.0141	0.0016*
Long Run																
α	-0.0495	0.0244**	0.1955	0.0219*	-0.0353	0.0448	0.6785	0.0379*	-0.1764	0.0416*	0.1235	0.0394*	-0.0134	0.0372	0.3446	0.0368*
$\alpha\beta$	0.0495	0.0244**	-0.1955	0.0219*	0.0355	0.0450	-0.6827	0.0382*	0.1576	0.0372*	-0.1103	0.0352*	0.0134	0.0371	-0.3433	0.0367*
β	1.0000	-	-0.9996	-	1.0000	-	-1.0061	-	1.0000	-	-0.8930	-	1.0000	-	-0.9960	-
Short Run																
$\Delta 1M_{t-1}$	0.0089	0.0306	0.6281	0.0275*	0.0681	0.0438	0.2975	0.0371*	-0.0714	0.0516	0.3890	0.0488*	0.0354	0.0488	0.3181	0.0483*
$\Delta Spot_{t-1}$	0.0027	0.0302	-0.4954	0.0271*	-0.0380	0.0303	-0.1251	0.0257*	-0.0108	0.0464	-0.3132	0.0440*	0.0112	0.0372	-0.2842	0.0368*
$\Delta 1M_{t-2}$	-0.0330	0.0324	0.3312	0.0291*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta Spot_{t-2}$	0.0036	0.0295	-0.2859	0.0264*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta 1M_{t-3}$	0.0104	0.0291	0.1696	0.0261*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta Spot_{t-3}$	0.0134	0.0217	-0.0742	0.0195*	-	-	-	-	-	-	-	-	-	-	-	-
*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively*																

Table 9.2: VECM Results of 2M Futures and Reuters Price Returns

Variable	VECM (REUTERS Spot with 2M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value
Const.	0.0003	0.0003	0.0010	0.0002*	-0.0007	0.0074	0.0709	0.0064*	0.2542	0.0891*	-0.0543	0.0933	0.0012	0.0051	-0.0264	0.0050*
Long Run																
α	-0.0075	0.0139	0.0722	0.0129*	-0.0081	0.0424	0.4041	0.0366*	-0.0773	0.0271*	0.0165	0.0284	-0.0059	0.0300	0.1577	0.0294*
$\alpha\beta$	0.0075	0.0140	-0.0723	0.0129*	0.0083	0.0432	-0.4116	0.0372*	0.0524	0.0184*	-0.0112	0.0192	0.0058	0.0295	-0.1552	0.0290*
β	1.0000	-	-1.0015	-	1.0000	-	-1.0186	-	1.0000	-	-0.6780	-	1.0000	-	-0.9842	-
Short Run																
$\Delta 2M_{t-1}$	0.0253	0.0257	0.7837	0.0238*	0.0675	0.0466	0.5622	0.0402*	-0.0501	0.0532	0.6732	0.0557*	0.0143	0.0484	0.5041	0.0475*
$\Delta Spot_{t-1}$	0.0056	0.0260	-0.6064	0.0241*	-0.0265	0.0425	-0.3620	0.0367*	0.0565	0.0487	-0.5384	0.0509*	0.0301	0.0441	-0.4848	0.0432*
$\Delta 2M_{t-2}$	-0.0367	0.0306	0.4139	0.0284*	-0.0376	0.0434	0.2203	0.0375*	-0.0162	0.057	0.2527	0.0599*	-0.0420	0.0487	0.2354	0.0478*
$\Delta Spot_{t-2}$	0.0023	0.0275	-0.3558	0.0255*	-0.0101	0.0297	-0.1365	0.0256*	0.0720	0.0436***	-0.2053	0.0456*	-0.0148	0.0390	-0.2261	0.0382*
$\Delta 2M_{t-3}$	0.0136	0.0288	0.2237	0.0267*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta Spot_{t-3}$	0.0136	0.0209	-0.1021	0.0194*	-	-	-	-	-	-	-	-	-	-	-	-
*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*																

Table 9.3.: VECM Results of 3M Futures and Reuters Price Returns

Variable	VECM (REUTERS Spot with 3M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t Value	Coef.	t Value
Const	0.0001	0.0004	0.0016	0.0004*	-0.0015	0.0094	0.0586	0.0090*	0.2567	0.0789*	-0.0377	0.0944	0.0028	0.0043	-0.0178	0.0049*
Long Run																
α	-0.0092	0.0104	0.0451	0.0109*	-0.0077	0.0342	0.2133	0.0329*	-0.0699	0.0215*	0.0103	0.0257	-0.0146	0.0238	0.0992	0.0269*
$\alpha\beta$	0.0092	0.0104	-0.0452	0.0110*	0.0079	0.0352	-0.2196	0.0339*	0.0448	0.0138*	-0.0066	0.0165	0.0143	0.0234	-0.0975	0.0265*
β	1.0000	-	-1.0038	-	1.0000	-	-1.0293	-	1.0000	-	-0.6409	-	1.0000	-	-0.9834	-
Short Run																
$\Delta 3M_{t-1}$	0.0437	0.0251***	0.7261	0.0264*	0.0741	0.0440***	0.7264	0.0423*	0.0051	0.0497	0.4487	0.0594*	0.0654	0.0474	0.4403	0.0536*
$\Delta Spot_{t-1}$	0.0304	0.0235	-0.5721	0.0247*	0.0010	0.0423	-0.5415	0.0407*	0.0389	0.0382	-0.3678	0.0457*	0.0235	0.0400	-0.4719	0.0451*
$\Delta 3M_{t-2}$	-0.0484	0.0287***	0.3619	0.0301*	-0.0239	0.0468	0.3970	0.0450*	-	-	-	-	-0.0340	0.0471	0.2920	0.0532*
$\Delta Spot_{t-2}$	0.0031	0.0252	-0.3468	0.0265*	-0.0308	0.0412	-0.3654	0.0396*	-	-	-	-	0.0316	0.0377	-0.2507	0.0426*
$\Delta 3M_{t-3}$	0.0193	0.0272	0.1998	0.0286*	-0.0020	0.0419	0.2305	0.0403*	-	-	-	-	-	-	-	-
$\Delta Spot_{t-3}$	0.0126	0.0208	-0.1084	0.0219*	0.0225	0.0308	-0.0991	0.0296*	-	-	-	-	-	-	-	-

*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*

Table 10.1: VECM Results of 1M Futures and WGC Spot Prices

Variable	VECM (WGC Spot with 1M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot		Δ1M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value
Cosnt.	-0.0064	0.0066	0.0098	0.0066	-0.0110	0.0099	0.0348	0.0101*	-0.0816	0.0699	0.1133	0.0598***	0.0494	0.0323	-0.1187	0.0348*
Long Run																
α	-0.0065	0.0063	0.0090	0.0063	-0.0312	0.0264	0.0917	0.0270*	-0.0203	0.0174	0.0282	0.0149***	-0.0814	0.0534	0.1966	0.0575*
$\alpha\beta$	0.0072	0.0070	-0.0100	0.0070	0.0324	0.0275	-0.0953	0.0280*	0.0286	0.0245	-0.0397	0.0209***	0.0773	0.0507	-0.1867	0.0546*
β	1.0000	-	-1.1113	-	1.0000	-	-1.0399	-	1.0000	-	-1.4087	-	1.0000	-	-0.9496	-
Short Run																
$\Delta 1M_{t-1}$	-0.0688	0.0302**	0.5875	0.0302*	0.0439	0.0442	0.6690	0.0451*	-0.2017	0.0562*	0.2100	0.0480*	0.0660	0.0668	0.3994	0.0720*
$\Delta Spot_{t-1}$	0.0713	0.0303**	-0.4561	0.0303*	-0.0083	0.0423	-0.4852	0.0432*	0.0988	0.0656	-0.1271	0.0561**	-0.0254	0.0590	-0.3075	0.0636*
$\Delta 1M_{t-2}$	-0.0918	0.0344*	0.3112	0.0344*	-0.0551	0.0448	0.3369	0.0456*	-	-	-	- -	-	-	-	-
$\Delta Spot_{t-2}$	0.0556	0.0321***	-0.2847	0.0321*	0.0111	0.0375	-0.2597	0.0382*	-	-	-	-	-	-	-	-
$\Delta 1M_{t-3}$	-0.0545	0.0321***	0.1282	0.0320*	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta Spot_{t-3}$	0.0751	0.0281*	-0.0818	0.0281*	-	-	-	-	-	-	-	-	-	-	-	-

*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*

Table 10.2: VECM Results of 2M Futures and WGC Spot Prices

Variable	VECM (WGC Spot with 2M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot		Δ2M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value
Const	-0.0044	0.0077	0.0147	0.0078**	-0.0059	0.0120	0.0372	0.0122*	-0.0321	0.0310	0.0508	0.0302***	0.0397	0.0314	-0.0845	0.0335**
Long Run																
α	-0.0044	0.0070	0.0131	0.0071***	-0.0129	0.0235	0.0725	0.0241*	-0.0247	0.023	0.0392	0.0232***	-0.0602	0.0479	0.1293	0.0512**
$\alpha\beta$	0.0049	0.0078	-0.0147	0.0079***	0.0136	0.0248	-0.0764	0.0254*	0.0281	0.027	-0.0446	0.0264***	0.0569	0.0453	-0.1222	0.0484**
β	1.0000	-	-1.1164	-	1.0000	-	-1.0542	-	1.0000	-	-1.1392	-	1.0000	-	-0.9452	-
Short Run																
$\Delta 2M_{t-1}$	0.0172	0.0319	0.7219	0.0325*	0.0413	0.0462	0.7601	0.0473*	-0.1000	0.0642	0.3597	0.0624*	0.0575	0.0685	0.4639	0.0731*
$\Delta Spot_{t-1}$	0.0086	0.0313	-0.5666	0.0318*	0.0144	0.0453	-0.5657	0.0463*	0.0581	0.0640	-0.2338	0.0622*	-0.0303	0.0610	-0.3728	0.0651*
$\Delta 2M_{t-2}$	-0.0532	0.0369	0.3993	0.0376*	-0.1195	0.0518**	0.4036	0.0531*	-	-	-	-	-	-	-	-
$\Delta Spot_{t-2}$	0.0224	0.0336	-0.3586	0.0342*	0.0747	0.0468	-0.3298	0.0479*	-	-	-	-	-	-	-	-
$\Delta 2M_{t-3}$	-0.0231	0.0344	0.1869	0.0350*	-0.1090	0.0482**	0.1093	0.0493**	-	-	-	-	-	-	-	-
$\Delta Spot_{t-3}$	0.0463	0.0290	-0.1240	0.0295*	0.0929	0.0390**	-0.0630	0.0399	-	- -	-	-	-	-	-	-

*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*

Table 10.3: VECM Results of 3M Futures and WGC Spot Prices

Variable	VECM (WGC Spot with 3M)															
	Panel A: Full Period				Panel B: Period 1				Panel C: Period 2				Panel D: Period 3			
	Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot		Δ3M		ΔSpot	
	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	t Value	Coef.	T-Stat		Coef.
Const.	-0.0121	0.0077	0.0140	0.0087	-0.0138	0.0126	0.0324	0.0140**	0.0124	0.0038*	-0.0026	0.0041	0.0704	0.0225*	-0.0449	0.0278
Long Run																
α	-0.0115	0.0072	0.0127	0.0080	-0.0237	0.0206	0.0525	0.0229**	-0.0769	0.0234*	0.0153	0.0249	-0.1109	0.0355*	0.0712	0.0439
$\alpha\beta$	0.0129	0.0080	-0.0142		0.0252	0.0220	-0.0560	0.0244**	0.0765	0.0233*	-0.0152	0.0248	0.1051	0.0337*	-0.0675	0.0416
β	1.0000	-	-1.1148	-	1.0000	-	-1.0652	-	1.0000	-	-0.9951	-	1.0000	-	-0.9478	-
Short Run																
$\Delta 3M_{t-1}$	-0.0844	0.0304*	0.4835	0.0341*	-0.0295	0.0462	0.6127	0.0512*	-0.0661	0.0563	0.1929	0.0598*	-0.1204	0.0531**	0.1505	0.0657**
$\Delta Spot_{t-1}$	0.1652	0.0273*	-0.3438	0.0306*	0.1129	0.0424*	-0.4398	0.0471*	0.1099	0.0543**	-0.0973	0.0577***	0.2277	0.0463*	-0.1184	0.0573**
$\Delta 3M_{t-2}$	-0.1370	0.0323*	0.2595	0.0362*	-0.1328	0.0492*	0.3534	0.0546*	-	-	-	- -	-	-	-	-
$\Delta Spot_{t-2}$	0.0905	0.0287*	-0.2744	0.0322*	0.0797	0.0436***	-0.3358	0.0484*	-	- -	-	- -	-	- -	-	- -
$\Delta 3M_{t-3}$	-0.0416	0.0306	0.1322	0.0343*	-0.0818	0.0460***	0.1241	0.0511**	-	- -	-	- -	-	- -	-	- -
$\Delta Spot_{t-3}$	0.0636	0.0266**	-0.1024	0.0298*	0.0698	0.0389***	-0.1002	0.0432**	-	- -	-	- -	-	- -	-	- -

*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*

Table 11: Gonzalo Granger Statistic (%) and Speed of Adjustment (in days)

Variable	Panel A: Speed of adjustment Weights (%)				Panel B: Speed of Adjustment in days			
	Full Period	Period 1	Period 2	Period 3	Full Period	Period 1	Period 2	Period 3
MCX Spot								
1M	39%	0%	100%	0%	19	-	7	-
Spot	61%	100%	0%	100%	12	3	-	8
2M	0%	0%	N.A.	0%	-	-	N.A.	-
Spot	100%	100%	N.A.	100%	30	5	N.A.	15
3M	0%	0%	100%	0%	-	-	18	-
Spot	100%	100%	0%	`100%	46	8	-	23
Reuters Spot								
1M	20%	0%	59%	0%	28	-	8	-
Spot	80%	100%	41%	100%	7	2	11	4
2M	0%	0%	100%	0%	-	-	18	-
Spot	100%	100%	0%	100%	19	3	-	9
3M	0%	0%	0%	0%	-	-	20	-
Spot	100%	100%	100%	100%	31	6	-	14
WGC Spot								
1M	0%	0%	0%	0%	-	-	-	-
Spot	0%	100%	0%	100%	-	15	-	7
2M	0%	0%	0%	0%	-	-	-	-
Spot	0%	100%	0%	100%	-	19	-	11
3M	0%	0%	100%	100%	-	-	18	13
Spot	0%	100%	0%	0%	-	26	-	-

Notes: (a) The Gonzalo Granger statistic is computed in case α_F and α_S are both significant. An insignificant α parameter is assigned a weight of 0%.
(b) The speed of adjustment in days is computed only if the α parameter is significant
(c) N.A: A VAR model was estimated for MCX spot and 2M Futures returns during period 2. Hence there is no long run parameter. No cointegrating relation exists for any further analysis.

Table 12: χ^2 Statistics of the Granger-Causality Test

Tenor	MCX Spot		Reuters Spot		WGC Spot	
	S --> F	F --> S	S --> F	F --> S	S --> F	F --> S
	Panel A	*Panel B*	*Panel A*	*Panel B*	*Panel A*	*Panel B*
Full Period						
1M	13.2600*	1657.6100*	6.7800	1587.5900*	11.8900**	396.3300*
2M	1.7400	1841.6200*	0.9600	1649.4000*	3.0500	520.4600*
3M	15.1200*	908.3300*	4.2100	973.5300*	44.9300*	219.0600*
Period 1						
1M	3.3400	1490.4700*	1.5800	1281.2300*	1.8400	328.1100*
2M	1.0600	1513.3300*	0.4700	1248.2700*	7.3500	366.9000*
3M	2.5500	879.1200*	3.0400	850.1400*	13.1800**	188.8600*
Period 2						
1M	25.4900*	108.7700*	17.1400*	119.3900*	4.7000***	22.5800*
2M	12.8300*	155.6800*	8.4900**	171.6600*	2.5500	38.7600*
3M	20.6900*	41.2500*	7.6300**	61.9200*	16.4000*	12.3700*
Period 3						
1M	1.0000	278.6800*	0.3300	275.1700*	2.1500	70.1600*
2M	0.7800	263.9900*	1.3200	270.6100*	1.3900	67.3000*
3M	5.4800***	72.4200*	1.4200	144.8600*	53.6500*	10.5000*

*Notes: * , ** and *** indicates significance at 1%,5% and 10% respectively.*

Table 13.1: FEVD for MCX Spot and Futures Price Returns

FEVD Input Variables	Panel	Proportion of Variation in	Explained by	Lead								
				2	3	4	5	6	7	8	9	10
MCX Spot and 1 Month	*Panel A*	MCX Spot	1 Month	0.7363	0.7893	0.8078	0.8252	0.8362	0.8446	0.8515	0.8572	0.8620
			MCX Spot	0.2637	0.2108	0.1922	0.1748	0.1638	0.1554	0.1485	0.1428	0.1380
	Panel B	1 Month	MCX Spot	0.4130	0.4299	0.4415	0.4524	0.4623	0.4713	0.4796	0.4874	0.4946
			1 Month	0.5870	0.5701	0.5585	0.5476	0.5377	0.5287	0.5204	0.5126	0.5054
MCX Spot and 2 Months	*Panel A*	MCX Spot	2 Month	0.7424	0.7953	0.8126	0.8289	0.8390	0.8466	0.8529	0.8581	0.8626
			MCX Spot	0.2576	0.2047	0.1874	0.1711	0.1610	0.1534	0.1471	0.1419	0.1374
	Panel B	2 Months	MCX Spot	0.3848	0.3908	0.3936	0.3962	0.3987	0.4009	0.4031	0.4051	0.4071
			2 Month	0.6152	0.6092	0.6065	0.6038	0.6013	0.5991	0.5969	0.5949	0.5929
MCX Spot and 3 Months	*Panel A*	MCX Spot	3 Month	0.6759	0.7302	0.7446	0.7603	0.7700	0.7772	0.7833	0.7884	0.7927
			MCX Spot	0.3241	0.2698	0.2554	0.2397	0.2300	0.2228	0.2167	0.2116	0.2073
	Panel B	3M Months	MCX Spot	0.4369	0.4461	0.4499	0.4540	0.4572	0.4600	0.4627	0.4651	0.4675
			3 Month	0.5632	0.5539	0.5501	0.5460	0.5428	0.5400	0.5373	0.5349	0.5325

Table 13.2: FEVD for Reuters Spot and Futures Price Returns

FEVD Input Variables	Panel	Proportion of Variation in	Explained by	Lead								
				2	3	4	5	6	7	8	9	10
Reuters Spot and 1 Month	*Panel A*	Reuters Spot	1 Month	0.6278	0.7161	0.7483	0.7818	0.8046	0.8222	0.8370	0.8492	0.8596
			Reuters Spot	0.3723	0.2840	0.2517	0.2182	0.1954	0.1778	0.1630	0.1508	0.1404
	Panel B	1 Month	Reuters Spot	0.2785	0.2890	0.2965	0.3037	0.3100	0.3156	0.3207	0.3253	0.3295
			1 Month	0.7215	0.7110	0.7035	0.6963	0.6900	0.6844	0.6793	0.6747	0.6705
Reuters Spot and 2 Months	*Panel A*	Reuters Spot	2 Month	0.6308	0.7252	0.7632	0.7848	0.8053	0.8193	0.8300	0.8390	0.8467
			Reuters Spot	0.3692	0.2748	0.2369	0.2152	0.1947	0.1807	0.1700	0.1610	0.1533
	Panel B	2 Months	Reuters Spot	0.2514	0.2531	0.2565	0.2579	0.2592	0.2605	0.2617	0.2627	0.2638
			2 Month	0.7487	0.7469	0.7435	0.7421	0.7408	0.7395	0.7383	0.7373	0.7362
Reuters Spot and 3 Months	*Panel A*	Reuters Spot	3 Month	0.5989	0.6899	0.7282	0.7484	0.7679	0.7813	0.7913	0.7996	0.8068
			Reuters Spot	0.4011	0.3101	0.2718	0.2516	0.2321	0.2187	0.2087	0.2004	0.1932
	Panel B	3 Months	Reuters Spot	0.3185	0.3207	0.3243	0.3264	0.3284	0.3302	0.3320	0.3336	0.3351
			3 Month	0.6815	0.6793	0.6758	0.6736	0.6716	0.6698	0.6681	0.6664	0.6649

Table 13.3: FEVD for WGC Spot and Futures Price Returns

FEVD Input Variables	Panel	Proportion of Variation in	Explained by	Lead								
				2	3	4	5	6	7	8	9	10
WGC Spot and 1 Month	*Panel A*	WGC Spot	1 Month	0.7396	0.7920	0.8081	0.8140	0.8228	0.8289	0.8328	0.8357	0.8384
			WGC Spot	0.2604	0.2080	0.1920	0.1860	0.1772	0.1711	0.1672	0.1643	0.1616
	Panel B	1 Month	WGC Spot	0.5951	0.6081	0.6214	0.6247	0.6277	0.6307	0.6333	0.6352	0.6369
			1 Month	0.4049	0.3919	0.3786	0.3753	0.3723	0.3693	0.3667	0.3649	0.3631
WGC Spot and 2 Months	*Panel A*	WGC Spot	2 Month	0.7912	0.8437	0.8612	0.8680	0.8772	0.8836	0.8877	0.8908	0.8937
			WGC Spot	0.2088	0.1564	0.1388	0.1320	0.1228	0.1164	0.1123	0.1092	0.1063
	Panel B	2 Months	WGC Spot	0.6184	0.6237	0.6316	0.6332	0.6345	0.6361	0.6375	0.6386	0.6395
			2 Month	0.3816	0.3763	0.3684	0.3668	0.3655	0.3639	0.3625	0.3614	0.3605
WGC Spot and 3 Months	*Panel A*	WGC Spot	3 Month	0.7058	0.7555	0.7731	0.7787	0.7865	0.7926	0.7965	0.7994	0.8020
			WGC Spot	0.2942	0.2445	0.2269	0.2213	0.2135	0.2074	0.2035	0.2007	0.1980
	Panel B	3 Months	WGC Spot	0.6377	0.6622	0.6738	0.6775	0.6821	0.6862	0.6893	0.6918	0.6942
			3 Month	0.3623	0.3378	0.3263	0.3225	0.3179	0.3138	0.3107	0.3082	0.3058

Table 14: Results of the Optimal hedge Ratio

Period	Spot Price	Optimal Hedge Ratio			Variance of the unhedged Portfolio	Variance of the hedged Portfolio			Variance Reduction (%)		
		1M	2M	3M		1M	2M	3M	1M	2M	3M
Indian Gold Market											
Full Period	MCX SPOT	0.4167	0.4545	0.5455	1.0461	0.8277	0.8086	0.7396	20.8820	22.6990	29.3006
	REUTERS SPOT	0.5000	0.4545	0.5455	1.6700	1.4455	1.4191	1.3132	13.4470	15.0255	21.3654
	WGC SPOT	0.7500	0.8182	0.9000	1.4266	0.7658	0.6981	0.7444	46.3180	51.0672	47.8209
Period 1	MCX SPOT	0.4286	0.4286	0.5385	1.4247	1.1260	1.1169	1.0003	20.9649	21.6065	29.7861
	REUTERS SPOT	0.4286	0.4286	0.5385	2.0243	1.7032	1.6945	1.5512	15.8615	16.2887	23.3682
	WGC SPOT	0.7857	0.7857	0.8462	1.8367	0.9554	0.9351	0.8758	47.9805	49.0902	52.3172
Period 2	MCX SPOT	0.4000	0.4167	0.5000	0.8489	0.7286	0.6647	0.6865	14.1707	21.7073	19.1363
	REUTERS SPOT	0.4667	0.5000	0.5455	1.8361	1.7439	1.6519	1.5870	5.0196	10.0283	13.5647
	WGC SPOT	0.5625	0.7500	0.6364	1.2298	0.8057	0.6400	0.7984	34.4849	47.9635	35.0849
Period 3	MCX SPOT	0.5000	0.5000	0.6000	0.4569	0.3183	0.3224	0.2713	30.3500	29.4377	40.6238
	REUTERS SPOT	0.5000	0.5000	0.6000	0.8795	0.7424	0.7496	0.6735	15.5795	14.7641	23.4219
	WGC SPOT	0.8333	1.0000	1.0000	0.7780	0.3054	0.2840	0.4099	60.7379	63.4950	47.3114
International Gold Market											
Full Period	CME Spot	0.7333	0.7333	0.7333	1.4631	0.6270	0.6272	0.6408	57.1428	57.1339	56.1988

Annexure 1

RBI Circulars on the Gold Market

Sl. No.	RBI Circular	Key Points of the Circular
1	AP Circular No. 79 dated Feb 18, 2015 Ref: AP Circular 42 dated Nov 28, 2014	Banks as well as Start and Premier Trading Houses permitted to import gold on consignment basis. All sale of gold domestically will be against upfront payments. Banks are free to grant gold metal loans. Import of gold coins and medallions no longer prohibited. Banks restricted from selling gold coins and medallions
2	AP Circular No. 42 dated Nov 28, 2014 Ref: AP Circular 25 dated August 14, 2013 and AP Circular 133 dated May 21, 2014	With draw the 20:80 scheme and restrictions. Instructions since AP. Circular 25 dated August 14, 2013 stand withdrawn with immediate effect.
3	AP Circular No. 133 dated May 21, 2014 Ref : AP circular No. 25 dated August 14 ,2013	Star trading houses / Premier trading houses allowed to import gold under 20:80 scheme. Permit banks to provide GML to domestic jewellery manufacturers from the 80% quota
4	AP Circular No. 25 dated August 14, 2013 Ref: AP Circular no. 15 dated July 22, 2013	Import of gold in the form of coins and medallions is now prohibited 20% of all import of gold is exclusively made available for the purpose of exports and the balance for domestic use. Same applies for gold dore. Banks to ensure no front loading of imports.
5	AP Circular No. 15, dated July 22,2013 Ref: AP Circulars 103, 107 and 122 dated May 13, Jun 04, and Jun 27 2013 respectively.	Ensure (20%) i.e. one-fifth of the imports are meant for exports. The balance 80% shall be made available for domestic use to entities engaged in jewellery business / bullion dealers supplying gold to jewelers.
6	AP. Circular 122, June 27,2013 Ref: AP. Circular 103, 107 dated 13 May 2013 and 04 June 2013	Restrict the import of Gold to meet needs of the exporters of gold jewellery.
7	AP Circular 107, June 4, 2013 Ref: AP Circular 103, May 13, 2013	Extending the restricting on import of gold to all nominated agencies / premier / star trading houses. Imports allowed only to meet the needs of exporters of gold jewellery.
8	AP Circular No. 103, May 13, 2013 Ref: Paragraph 97, of the Monetary Policy statement 2013-14 dated May 3,2013 regarding import of gold. AP. Circular 7, dated March 6, 1998 permitting nominated banks / agencies to import gold on loan basis.	To moderate the demand for gold for domestic use, it has been decided to restrict the import of gold on consignment basis by banks only to meet the genuine needs of exporters of gold jewellery.

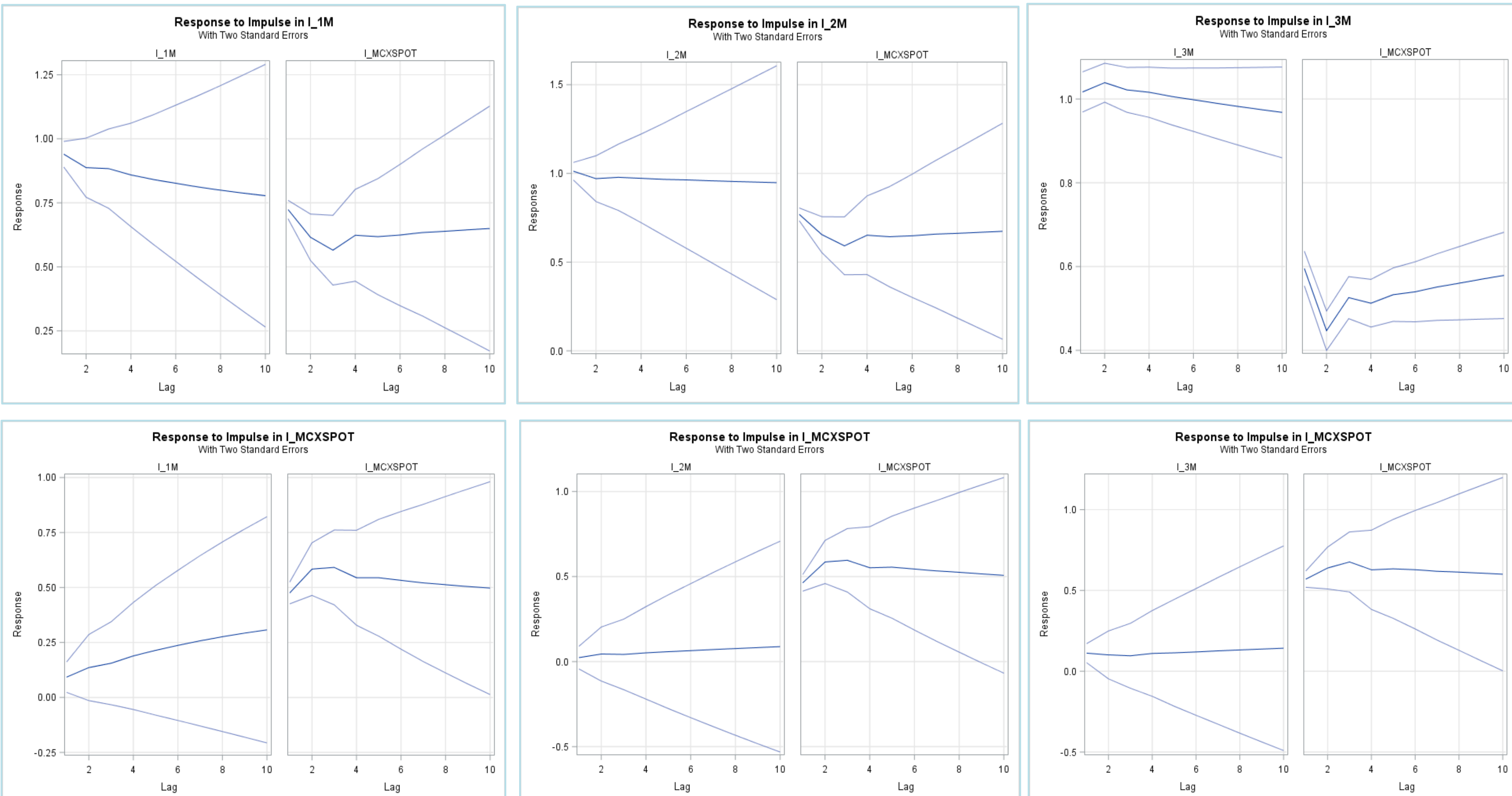
Annexure 2

Product Description of MCX Standard Gold Futures Contracts

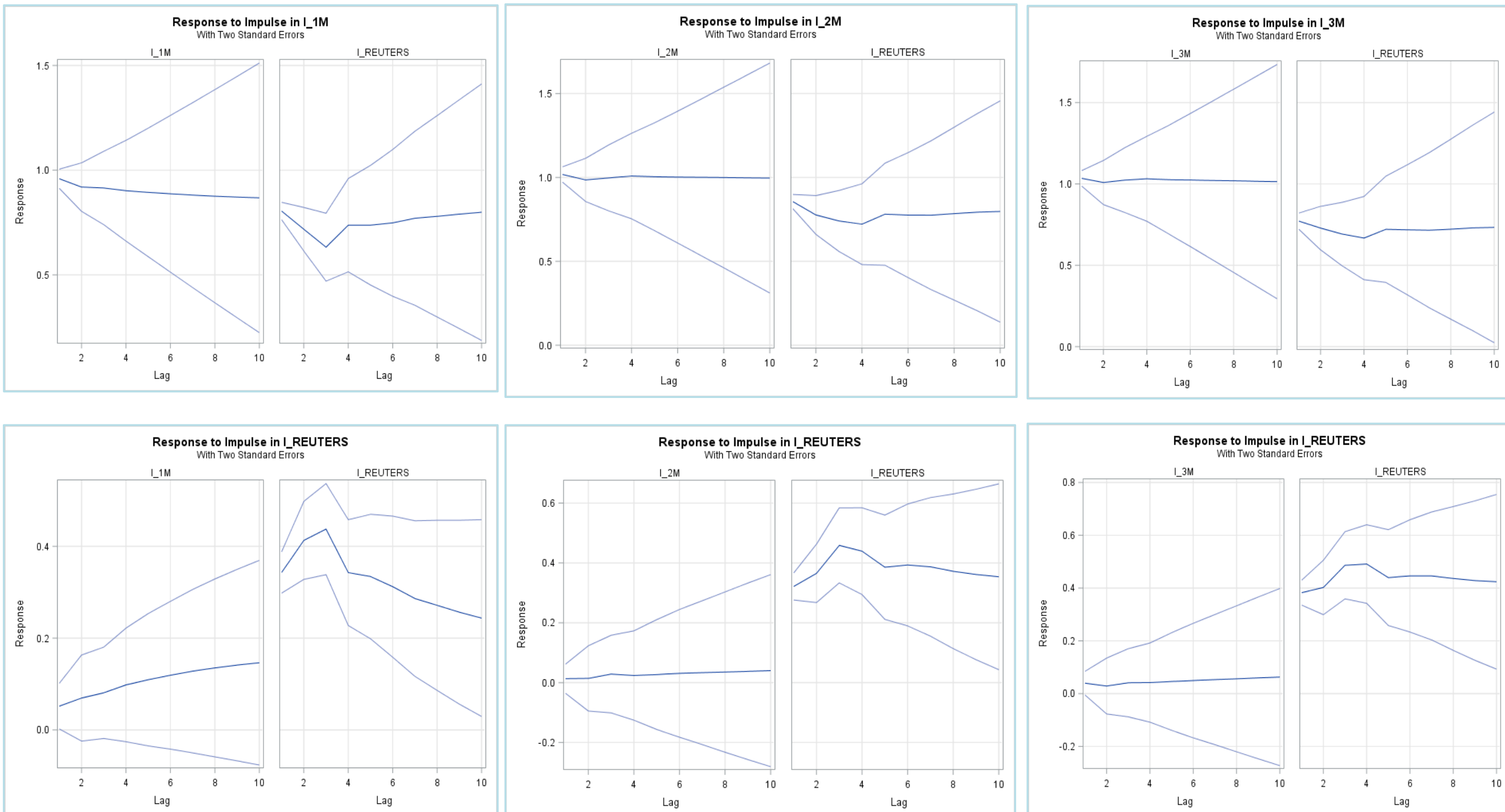
Contract Start Day	16th day of contract launch month. If 16th day is a holiday then the following working day.
Last Trading Day	5th day of contract expiry month. If 5th day is a holiday then preceding working day.
Trading Details	
Trading Session	Monday to Friday: 10.00 a.m. to 11.30 / 11.55 p.m.
Trading Unit	1 kg
Quotation/ Base Value	10 grams
Price Quote	Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge as may be applicable)
Maximum Order Size	10 kg
Tick Size	Re. 1 per 10 grams
Daily Price Limit	The base price limit will be 3%, with a relaxation to 6% and 9% of a breach.
Initial Margin (IM) and Extreme Loss Margin (ELM)	IM is the minimum of 4% or based on SPAN whichever is higher. ELM is 1%.
Maximum Allowable Open Position	For individual client: 5 MT for all Gold contracts combined together or 5% of the market wide open position whichever is higher, for all Gold contracts combined together. For a member collectively for all clients: 50 MT or 20% of the market wide open position whichever is higher, for all Gold contracts combined together.
Delivery Details	
Delivery Unit	1 kg
Delivery Centre(s)	Designated clearinghouse facilities at Ahmedabad. Additional Delivery Centre(s) are Mumbai and New Delhi.
Quality Specifications	995 purity. It should be serially numbered Gold bars supplied by LBMA approved suppliers or other suppliers as may be approved by MCX to be submitted along with supplier's quality certificate.
If the Seller offers delivery of 999 purity	Seller will get a proportionate premium and sale proceeds will be calculated in the manner of Rate of delivery 999/ 995. If the quality is less than 995, it is rejected.
Due Date Rate (Final Settlement Price)	For contracts where Final Settlement Price (FSP) is determined by polling, unless specifically approved otherwise, the FSP shall be arrived at by taking the simple average of the last polled spot prices of the last three trading days viz.,E0 (expiry day), E-1 and E-2. In the event the spot price for any one or both of E-1 and E-2 is not available, the simple average of the last polled spot price of E0,E-1, E-2 and E-3, whichever available, shall be taken as FSP.
Source: MCX website	

Annexure 3

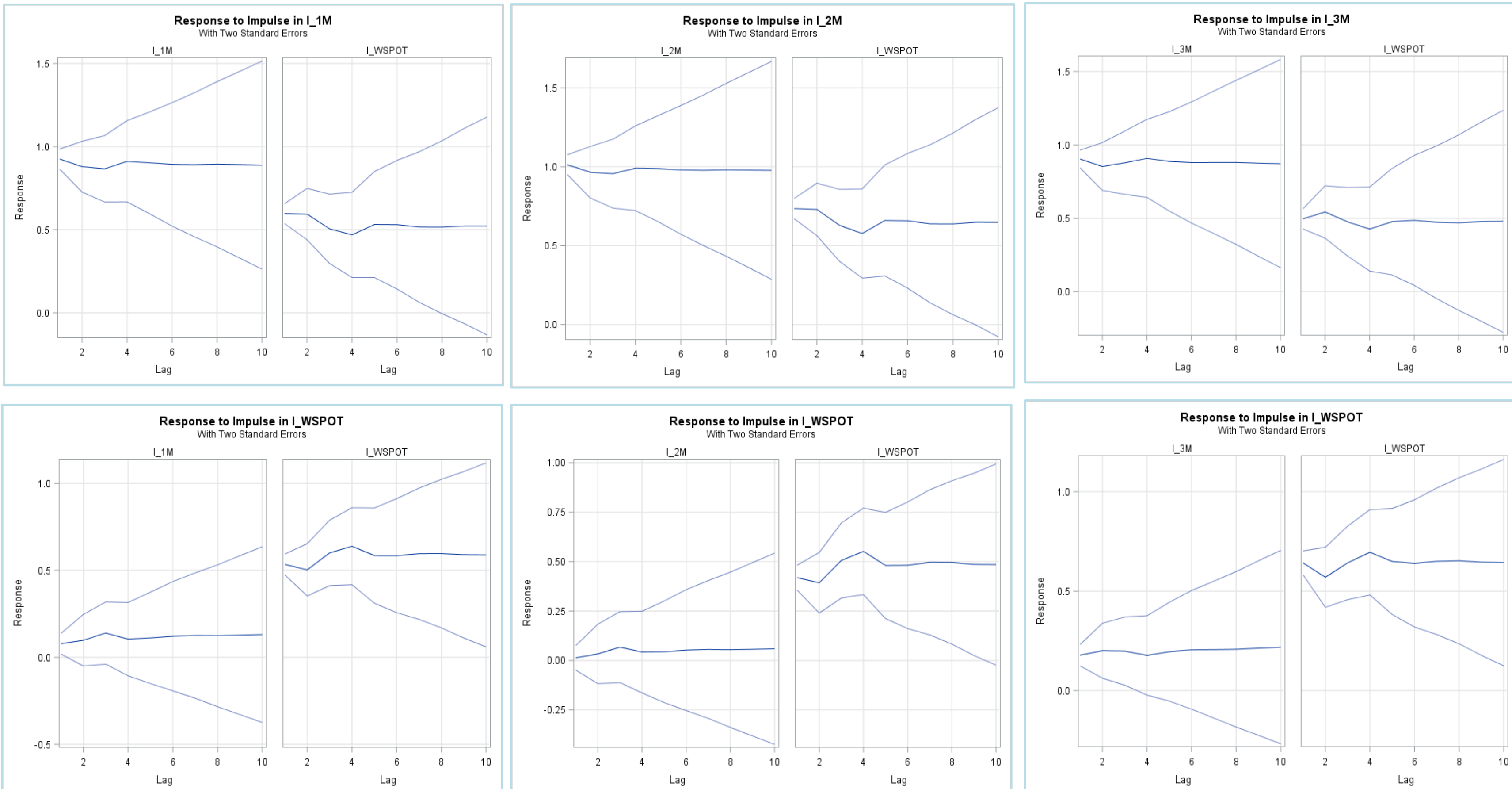
Panel A: Impulse response function of MCX Spot and Futures



Panel B: Impulse response function of Reuters Spot and Futures



Panel C: Impulse response function of WGC Spot and Futures



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