Essay on "*Information asymmetry, market efficiency and likelihood of arbitrage*" in bullion and energy sectors commodity market in India

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Abstract

The evolution and growth of bullion and energy precinct commodities market in India has shown an impressive record of performance in the past decade. Hedging under these categories is becoming a thriving phenomenon itself compared to the other sector commodities traded in India because of its volatility spillovers. Exploration of the fact underlying such a structural breakdown can bring sometime a presence of information asymmetry in the markets under study and that may cause a severe arbitrage. The purpose of this paper is to identify the efficiency of bullion and energy sector commodity markets by assessing the relationships between futures prices and spot market prices. Consisting with the hypothesis that Indian commodity future market of bullion and energy sectors is efficient and symmetry of information is being maintained among all the stake holders who are having the active participation in both the markets. The entire work has been categorized into two sections comprising chapter one, detailing bullion market and chapter two elucidates energy sector commodity derivatives. The sample has been encompassed 7bullions and 3 energy sector commodities from 2016 to 2019.

Design /methodology/Approach

The efficiency of the futures market for 10 bullion and energy commodities, traded at one of the largest commodity exchanges of India, i.e.**Multi Commodity Exchange of India Ltd (MCX**) has been explored by using the Johansen's co-integration test, Engle ganger co-integration and Granger causality tests. Before these entire tests, Unit root test were applied both parametric Augmented Dickey-Fuller (ADF) and non-parametric Phillips-Perron were initially to examine whether future price and spot price are stationary or not.

The proposition, that futures prices are impartial predictors of spot prices has been tested using econometric software package.

Findings

The results show that there is a co-integration that exists significantly between the futures and spot prices for all the selected commodities. Hence this implies that there is a long-term association between the future price and spot price for most of the bullion commodities like gold, gold petal, gold mini, silver etc.

The Granger causality test further distinguishes and categorizes the commodities based on direction of relationship linking the future and spot prices. The analysis of Long-term relationship by causality test indicates that futures markets have stronger ability to predict subsequent spot prices for Crude oil, Gold petal, Gold mini ,Gold guinea ,Silver mini ,Silver, Gold ,silver micro and natural gas.

Practical implication- a huge number of investors invest in bullions and energy hence the result from our study will help all the stakeholders who are related to the bullions and energy market. The regulators and policymakers can take steps to maintain transparency in the market which will lead to market efficiency.

Original value- the study is based on the very recent data i.e. from 2016-2019 to examine the market efficiency in the bullion and energy market in India.

Keywords– *market efficiency, spot price, future price, bullion, energy, stationary, co-integration, causality*

Paper type-Research paper

1. INTRODUCTION

A commodity market is a market place for buying, selling, and trading raw or primary products like- wheat, rice, gold etc.There are different types tradable commodities fall into the following four categories: Metals for example (gold, silver, platinum, and copper),Energy such as (crude oil, heating oil, natural gas, and gasoline),livestock and Meat such as (lean hogs, pork bellies, live cattle, and feeder cattle)and agricultural commodity such as (corn, soybeans, wheat, rice, cocoa, coffee, cotton, and sugar)There are six national level major commodity trading exchanges in India as-

- Multi Commodity Exchange (MCX)
- National Commodity and Derivatives Exchange (NCDEX)
- National Multi Commodity Exchange(NMCE)
- Indian Commodity Exchange(ICEX)
- Ace Derivatives Exchange(ACE)
- The Universal Commodity Exchange (UCX)

2. Review of literature

These commodity market survives because of the information exists in a market. Information acts as "oxygen" of every market. The term market is efficient has some ambiguity in many definition*(Beaver H.William, market efficiency, The Accounting Review, Vol. 56, No. 1 (Jan., 1981), pp. 23-37).*There are some researchers who have assumptions for market efficiency as investors are rational and information in symmetric in the market {Hellwig (1980), Allen (1981)}.Whereas some researchers have some evolutionary approach of natural selection for market efficiency which states that traders with more information earn more profit at an less expenses, hence information symmetric will lead to market efficiency in long run *(Luo Ying Guo,The Review of Financial Studies, Vol. 11, No. 3 (Autumn, 1998), pp. 647-674).* If the spot price can fully predict the future price we can say the market is efficient. In this study we have considered the two most volatile commodities i.e. metal and energy trading in MCX (multi commodity exchange) in which is India's largest commodity derivatives exchange market to check for which commodity market is efficient.

3. Sample description and research methodology

3.1 Data

The data for our study has been collected from MCX (Multi Commodity Exchange) which is India's largest commodity derivative market. The commodities selected for our study are broadly classified under bullion and energy. The commodities under bullions are gold, gold mini, gold petal, gold guinea, silver, silver micro, silver mini and the commodities under energy are crude oil, crude oil mini and natural gas. The daily closing price and the spot price of the above mentioned commodities are collected for the last four years (2016-2019)

3.2 Econometric models used

The literature provides the increasing use of co-integration tests for testing the efficiency of futures markets *(Chowdhury, 1991; Lai, K.S. and Lai, 1991; Crowder and Hamed, 1993; Beck, 1994; Kellard et al., 1999; Yang et al., 2001; McKenzie et al., 2002; Kellard, 2002; Liu, 2004; Wang and Ke,2005).*(*Wang and Ke,2005)* elaborated the use of co-integration for examining the efficiency in futures commodity market as it provides predictive ability on price convergence. The co-integration between the spot price and futures price is an important condition for market efficiency. It ensures that there exists a long-run equilibrium relationship between the two series. After exploring the existence of co-integration between futures and spot prices, it is essential to test the causality to identify the direction of relation existing*(Malliaris and Urrutia, 1998; Silvapulle and Moosa, 1999; Bryant et al., 2006).*As precondition of co-integration and causality, a unit root test is performed using an autoregressive mode.lt is done to check whether a time-series variable isnonstationaryornot.Aseriesisstationaryifthemeanandautocovariancesoftheseriesdonotdepend on time. Unit root tests based on Augmented Dickey-Fuller (ADF) test and Phillips Perron test for checking the Stationarity in spot and future prices have been examined by using the following regression model.

$$\Delta X_t = b_0 X_{t-1} + \sum_{i=1}^{T} b_i \Delta X_{t-1} + \varepsilon_t \qquad (1)$$

Xt implies the first difference of the variables. The null hypothesis of non-stationarity is b0=0. If the null hypothesis is accepted at the level of the series but rejected at the first difference of the series, then the series is

considered to be stationary at the first difference level, and it is indicated by I (1). The test has been done with constant intercept assumption and lag length criteria has been chosen as per Schwarz information criterion.

In order to ascertain long run relationship among spot and future price, Johansen co-integration test is being applied *(Johansen and Juselius; 1990).*

$$\Delta xt = \mu + \sum \Gamma i \, \Delta xt\text{-}I + \prod i \, xt\text{-}k + \varepsilon t \quad (2)$$

where Xt is an n*1 vector of the I(1) variables representing spot (St) and futures (Ft-n) prices, respectively, □ is a deterministic component which may include a linear trend term, an intercept term, or both, Δrepresent the first difference operator, $\prod_i$ is an n*r matrix of parameters indicating α and β , c is a vector of constants, k is lag length based on the Hannan-Quinn criterion, and 1t is a random error term, which indicates how many linear combinations of Xt are stationary.

To reconfirm the result of Johansen's co-integration, as a robustness check we had embedded Engle-Granger co-integration. This method first constructs residuals (errors) based on static regression. The residuals are tested for the existence of unit roots using ADF or a similar test. If the time series are co-integrated, then the residuals will be practically stationary Engle, R. F., and C. W. J. Granger. 1987

Finally, the Granger causality test has been used to analyze the direction and causal relations between futures and spot prices *Ali Jabir &Gupta Bardhankriti., (2011).* The Granger (1969) approach predicts how much of the current value of one variable can be explained by past values of other variables and then tries to see whether adding lagged values of the prior variable can improve the explanation. For instance, Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged X is statistically significant. Xt is causing Xt if some coefficient, ai, is non-zero in the following equation:

$$Xt = c0 + \sum_{i=1}^{p} ai \, Yt\text{-}1 + \sum_{j=1}^{p} bjXt\text{-}j + \dot{\varepsilon}t$$

A time series, Yt, causes another time series, Xt, if the current value of Xt can be predicted better by using past values of Yt than by not doing so:

$$Yt = \gamma 0 + \sum_{i=1}^{p} \alpha iXt\text{-}1 + \sum_{j=1}^{p} \beta j \, Yt\text{-}j + \dot{\varepsilon}t$$

Where p is the number of lags used for the variable. The causality test is based on an F-statistics, which tests whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X and vice versa. The test diagnosis the statistical significance of aforesaid model using F statistics. If both of the models are statistically significant then there exists a bi-directional causality, if anyone of the model is significant then the causality is unidirectional.

3.3 Empirical result

Table No- 3.3.1 Data visualisation (Descriptive statistics)

Commodity	Mean	Minimum	Maximum	SD
Crude oil				
Spot price	3792.684	2952.000	5550.000	534.804
Future price	3881.935	3108.000	5699.000	470.544
Crude mini				
Spot price	3817.138	0.000	5580.000	501.929
Future price	3900.130	3136.000	5690.000	441.892
Natural gas				
Spot price	202.4206	154.6000	265.9000	22.6161
Future price	200.9565	155.7000	247.8000	20.3116

Gold				
Spot price	30820.8000	0.0000	39011.0000	2965.8880
Future price	31251.0000	25458.0000	40362.0000	2892.7470
Gold petal				
Spot price	3213.5400	0.0000	3920.0000	404.6537
Future price	3232.0590	2751.0000	4021.0000	376.9367
Gold mini				
Spot price	32146.0400	0.0000	38703.0000	4019.6300
Future price	32305.1800	28062.0000	39153.0000	3530.7870
Gold guinea				
Spot price	25711.400	0.000	31386.000	3248.905
Future price	25819.200	21937.000	32063.000	2923.103
Silver				
Spot price	40093.150	0.000	49846.000	3242.264
Future price	41690.550	36025.000	52486.000	3138.692
Silver micro				
Spot price	40449.670	0.000	49846.000	3427.960
Future price	41838.980	36667.000	49846.000	3427.967
Silver mini				
Spot price	40086.270	0.000	49846.000	3256.171
Future price	41806.000	36658.000	52486.000	3236.559

Unit root test

The ADF and PP unit root tests are used to examine the stationarity of spot and future prices and to check whether the two prices are in same order or not. These two methods have been adopted to assess the unit root test by using both the Parametric and non-parametric approaches.

TABLE No-3.3.2

COMMODITIES	**AUGMENTED DICKEY-FULLER(ADF)**		**PHILIPS-PERRON(PP)**	
	Level	**1st Difference**	**Level**	**1st Difference**
CRUDE OIL				
SPOT PRICE	-2.22	-22.50***	-3.86***	-38.69***
FUTURE PRICE	-1.81	-21.33***	-2.22	-21.61***
CRUDE OIL MINI				
SPOT PRICE	-2.44	-18.20***	-4.25***	-41.01***
FUTURE PRICE	-2.07	-22.47***	-2.43	-22.63***
NATURAL GAS				
SPOT PRICE	-1.788037	-12.86488***	-1.43	-15.30***
FUTURE PRICE	-1.114237	-14.77121***	1.102	14.77***
GOLD				
SPOT PRICE	-2.099367	-20.04051***	-7.24***	-135.18***
FUTURE PRICE	-1.922641	-33.79709***	-1.867	33.796***

GOLD PETAL				
SPOT PRICE	-2.227069	-1431420***	-5.594***	-78.882***
FUTURE PRICE	-1.836263	-1587114***	-1.898	15.7944***
GOLD MINI				
SPOT PRICE	-2.413381	-12.503***	-5.6466***	-66.05***
FUTURE PRICE	-1828174	-16.72568***	-1.805	16.726***
GOLD GUINEA				
SPOT PRICE	-2.215414	-14.33088***	-5.576***	-72.04***
FUTURE PRICE	-1.964536	-17.31047***	1.898	-17.297***
SILVER				
SPOT PRICE	-3.102213**	-20.49968***	-12.264***	-95.888***
FUTURE PRICE	-2.321330	-29.47184***	-2.493	29.53***
SILVER MICRO				
SPOT PRICE	-2.848271**	-17.56245***	-11.85***	-93.22***
FUTURE PRICE	-1.173983	-24.54243***	-1.446	-24.576***
SILVER MINI				
SPOT PRICE	-3.156240**	-20.49393***	-12.25***	-98.05***
FUTURE PRICE	-2.357389	29.79***	-2.474	-29.799***

Note: *Significance level: p< 0.01=****

*Significance level: p<0.05=***

*Significance level: p<0.1=**

Discussion of the result 1:

Table 3.3.2 represents the result of unit root tests for major bullion and energy commodities by both the approaches. The ADF and PP unit root tests are used to examine the stationarity of the series. Both ADF and PP confesses with the fact that the spot and futures prices of all the commodities getting stationary at 1st order of integration or first difference, except for "silver, silver mini and silver macro". ADF itself along with PP suggests that the spot prices of these commodities are stationary at the level itself while future prices are not. But when we are integrating it at order one, both the series namely "future and spot" coming to stationarity where spot remains stationary and the level of significance coming it to the equal magnitude as like the future price series. Thus it is being considered that the series is of the same order. And as in case all other commodities excluding " natural gas", the spot prices are stationary at a level while future prices are having a unit root at the level as per PP while ADF is contradicting with the result because as per ADF these commodities both "spot" and "future" prices are stationary only at 1st difference. So to get better clarity of the result, we integrated the series at 1st order of integration under PP and tried to see the impact. It is being notified that the "spot and future" prices of the commodities are at stationary as per PP at 1st difference, where the spot prices remain stationary as like level but the significance level coming to equalize with the level of significance of the "future prices". So even PP is opposing slightly the ADF at the level for the above commodities, at 1st order both PP and ADF confirm the same result thus we finally concluded that the series i.e. spot, and future prices of all the commodities are of the same order of integration.

Johansen co-integration-

Both trace and max Eigen value statistics confirms the rejection of the hypothesized null that holds the co-integrated equations are nil and signifies there is one co-integrated equation in all the pairs of base metal commodities consisting spot and future prices. The presence of co-integration implies there is a long run association ship between the spot and future price of bullions and energy commodities in India's derivative commodity market, that clearly states that the first pre-condition for market efficiency *Ali Jabir &Gupta Bardhankriti.,2011.*. Less-developed futures commodity exchanges, market manipulation by large traders and government regulation may account for the inefficiency or no co-integration in futures and spot markets *(Yang et al., 2001; Wang and Ke, 2005; Bhar and Hamori, 2006*

Table no-3.3.3 Johnson co integration test result

Commodity	Trace statistics	p- value	Max-Eigen statistics	p- value
Crude oil				
H0: r=0	43.109370***	0.000000	15.494710***	0.000000
H0: r<=1	4.867032**	0.027400	3.841466**	0.027400
Crude oil mini				
H0: r=0	49.525520***	0.000000	44.298470***	0.000000
H0: r<=1	5.227047**	0.022200	5.227047**	0.022200
Natural gas				
H0: r=0	11.052610	0.208300	7.226575	0.462700
H0: r<=1	3.826031**	0.050500	3.826031**	0.050500
Gold				
H0: r=0	111.129000***	0.000000	107.665400***	0.000000
H0: r<=1	3.463600*	0.062700	3.463600*	0.062700
Gold petal				
H0: r=0	62.052510***	0.000000	58.933800***	0.000000
H0: r<=1	3.118703*	0.077400	3.118703*	0.077400
Gold mini				
H0: r=0	48.383370***	0.000000	45.130120***	0.000000
H0: r<=1	3.253246*	0.071300	3.253246*	0.071300
Gold guinea				
H0: r=0	63.029280***	0.000000	59.786900***	0.000000
H0: r<=1	3.242371*	0.071800	3.242371*	0.071800
Silver				
H0: r=0	73.312070***	0.000000	67.007860***	0.000000
H0: r<=1	6.304205***	0.012000	6.304205***	0.012000
Silver micro				
H0: r=0	73.931218***	0.000000	71.185060***	0.000000
H0: r<=1	2.727112*	0.098700	2.727112*	0.098700
Silver mini				
H0: r=0	64.024170***	0.000000	57.495210***	0.000000
H0: r<=1	6.528953***	0.010600	6.528953***	0.010600

*Notes: Significance level: p< 0.01=****

*Significance level: p<0.05=***

*Significance level: p<0.1=**

Discussion of result 2

Table 3.3.3 represents the results from the application of the Johansen co-integration method of reduced rank. The Johansen trace (trace statistics) and max (maximal Eigen value), statistic indicates that the null hypothesis of non-co integration (r =0) is rejected at 0.01 level of significance for all the commodities except natural gas. Thus natural gas excluded from the causality test since there is no co-integration. The null hypothesis of reduced rank, r <=1, is being rejected by both the trace and max Eigen value statistics for all of the commodities for which null of r =0is rejected. The rejection of reduced rank implies that the data series for these commodities are stationary, despite the earlier conclusion drawn from the unit root tests (Kellard et al., 1999, Ali Jabir &Gupta Bardhan kriti., 2011). This implies that with an increase in the lag length, price series

of these commodities become stationary. In this case, these commodities could be excluded from further analysis. However, as indicated by Kellard et al. (1999), Ali Jabir &Gupta Bardhankriti, (2011) the co-integration results may be sensitive to the lag length chosen by the model, hence, these commodities were not dropped while performing causality tests. The test proves that there is a co-integration between the two prices hence a long term association between the spot price and future price which will ultimately satisfy the precondition of the market being efficient. Even though as per Johansen's co-integration, we finally conclude that the series may be co-integrated, to conform it further, we embedded, Engle-Granger co-integration as robustness.

Engle granger –

Some critics of Johansen co-integration say that Johansen is not suited for a two-variable set. For more evidence in our study we did another co-integration test that doesn't have any criticism or perfectly suited for the two-variable set to check the robustness and for further confirmation of the result. The Engle Granger test is a test for co-integration.

Table no: 3.3.4 Engle Granger test result

Commodity	**tau statistics**	**p- value**	**Z statistics**	**p- value**
Crude oil				
Spot price	-9.088295***	0.0000	-200.9929***	0.0000
Future price	-8.177761***	0.0000	-155.8690***	0.0000
Gold guinea				
Spot price	-18.15756***	0.0000	-334.3066***	0.0000
Future price	-10.20056***	0.0000	-208.5955***	0.0000
Gold mini				
Spot price	-15.74143***	0.0000	-251.8551***	0.0000
Future price	-8.245918***	0.0000	-136.3144***	0.0000
Silver mini				
Spot price	-6.727882***	0.0000	-113.1819***	0.0000
Future price	-5.056640***	0.0000	-59.17432***	0.0000
Natural gas				
Spot price	-2.750205***	0.0000	-17.60568*	0.0832
Future price	-2.624271***	0.0000	-14.01822***	0.0000
Silver				
Spot price	-8.100135***	0.0000	-167.8968***	0.0000
Future price	-5.473202***	0.0000	-69.42207***	0.0000
Silver micro				
Spot price	-5.595658***	0.0000	-77.39617***	0.0000
Future price	-14.58035***	0.0000	-426.2518***	0.0000
Crude oil mini				
Spot price	-9.088295***	0.0000	-200.9929***	0.0000
Future price	-8.177761***	0.0000	-155.8690***	0.0000
Gold petal				
Spot price	-10.03947***	0.0000	-202.5263***	0.0000
Future price	-17.95305***	0.0000	-330.4526***	0.0000
Gold				
Spot price	-14.14444***	0.0000	-506.5037***	0.0000
Future price	-8.503433***	0.0000	-187.9034***	0.0000

*NOTE: Significance level: p <0.01=****

*Significance level: p<0.05=***

*Significance level: p<0.1=**

Discussion of the result 3:

Table no. 3.3.4 shows the test result of Engle granger co-integration test. The result states that all the commodities are significant at p<0.01 except for natural gas in Z statistics but still it is significant at p<0.1, hence we can reject the null hypothesis. Thus the test proves that there is a co-integration between the spot price and the future price and vice-versa for all the commodities including natural gas. Even as per Johansen's co-integration, we decided to ignore "natural gas" from further causality diagnosis, since Engle-Granger co-integration test suggests that there exist a co-integration, we decided to include it in causality test

Causality (long run)

The co-integration test will tell the long term association between the two prices but the check market efficiency we have to understand the direction of relationship between the spot and future prices. If the direction of relationship is from future to spot price it can be said that the market is efficient. The Granger causality test will tell us the direction of relationship between the two price series. The below table shows different direction of relationship among future price and spot price of the commodities-

Table no. 3.3.4

Commodity	Hypothesis	F-statistics "S to F"	F-statistics "F to S"	Direction	Relationship
Crude oil mini	H0:F does not cause S H0: S does not cause F	0.09040	72.2806***	Uni-directional	F → S
Natural Gas	H0:F does not cause S H0: S does not cause F	0.87005	4.62605***	Uni-directional	F → S
Gold	H0: F does not cause S H0: S does not cause F	7.50426**	133.568***	Bi-directional	F ↔ S
Gold petal	H0: F does not cause S H0: S does not cause F	0.17076	67.0368***	Uni-directional	F → S
Gold mini	H0: F does not cause S H0: S does not cause F	0.50999	45.9404***	Uni-directional	F → S
Gold guinea	H0: F does not cause S H0: S does not cause F	0.66559	65.5882***	Uni-directional	F → S
Silver	H0: F does not cause S H0: S does not cause F	12.1115***	73.4025***	Bi-directional	F ↔ S
Silver micro	H0: F does not cause S H0: S does not cause F	7.41113***	79.6926***	Bi-directional	F ↔ S
Silver mini	H0: F does not cause S H0: S does not cause F	11.8513***	65.0995***	Bi-directional	F ↔ S
Crude oil	H0: F does not cause S H0: S does not cause F	0.10	64.3942***	Uni-directional	F → S

Notes: S – spot prices; F – futures prices; → shows direction of relationship

*NOTE: Significance level: p <0.01=****

*Significance level: p<0.05=***

*Significance level: p<0.1=**

Discussion of result 4:

Commodities like crude oil mini, natural gas, crude oil, gold petal, gold guinea, and gold mini have unidirectional causality where future prices lead to spot prices which mean spot market prices are influenced by the future market prices. It can be said that for these commodities future market have ability to predict the spot price. On the other hand commodities like silver, silver micro, silver mini and gold shows a bi-directional relationship between the spot market prices and future market prices. Thus the test result confirms that the future prices of the aforesaid commodities are the unbiased predictor of the spot prices.

Conclusion and implication

The sustainability of bullion and energy commodity futures markets depends on the transparency and efficiency in the market. It can be maintained in various ways like in terms of price discovery, price risk management, flexible contact specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support, etc. This study empirically examines the efficiency of futures markets for 10 major commodities widely traded in the commodity exchanges, using co-integration and causality approaches. Empirical results suggest the existence of long-run equilibrium relationships between futures and spot prices of bullion and energy commodities under study.

The study aims at evaluating the market efficiency and likely hood of arbitrage in bullion and energy sector commodity future market in India. It is being believed that in an efficient commodity market, future prices will be an unbiased predictor of spot prices *(Kellard et al., 1999; Haigh, 2000)*. That is an indication that points out there is no information asymmetry in favor of any stakeholders who are dealing in the market as participation. The study has been provided noble evidence that the spot and futures prices of all the commodities selected understudy having long-run association ship and the futures markets have enough ability to predict subsequent spot prices, i.e. to discover prices in spot market for these commodities *Ali Jabir &Gupta Bardhan kriti., 2011and* all of them ensuring the concept of market efficiency in the long run as well as in the short run. Thus, it can be noted that futures prices are unbiased predictors of spot prices with no arbitrage opportunity and ensures that a risk premium is not present *(Haigh, 2000).*

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APPENDIX-

ITEM	**FREQUENCY**	**TIME**
Crude oil	Daily	20-09-2016 to 26-12-2019
Crude oil mini	Daily	20-09-2016 to 18-12-2019
Natural gas	Daily	28-12-2016 to26-12-2019
Silver	daily	16-03-2016 to 20-12-2019
Silver mini	Daily	16-05-2019 to 20-12-2019
Silver micro	Daily	01-08-2016 to 20-12-2019
Gold	Daily	16-12-201 to 05-12-2019
Gold guinea	daily	01-09-2016 to 31-12-2019
Gold petal	Daily	01-09-2016 to 31-12-2019
Gold mini	Daily	06-09-2016 to 05-12-2019