INTEGRATION OF INDIAN COMMODITY MARKET AND US COMMODITY MARKET (WITH SPECIAL REFERENCE TO CAUSALITY, VOLATILITY SPILLOVER AND PRICE TRANSMISSION)

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DECLARATION

I, Swaty , hereby declare that the thesis "Integration of the Indian Commodity Market and the US Commodity Market (With special reference to Causality, Volatility Spillover and Price Transmission)" submitted for the award of a Degree of Doctor of Philosophy in Commerce to lovely professional university is an original research work that I did at Mittal School of Business at lovely professional university under supervision of Dr. Babli Dhiman (Professor), Mittal School of Business, Lovely Professional University. Any extract to this research in part or as a whole has not been included, incorporated or added to any other work or similar title by any scholar in any other university.

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Abstract

The globalization of commodity has prompted the developing pertinence of rising commodity markets. India is one of the countries with a developing commodities market that is dynamically pulling funds from different countries that increase co-integration. Integration is a procedure by which markets become open and bound together so members in a single market have unhindered access to another market. Commodity market integration means without authoritative and instructive obstructions, hazard balanced profits for a commodity of a similar residency in each fragment of the market ought to be similar to each other.

Commodity market integration refers to a status where investors of one nation can purchase and sell products (unbounded) that are issued in another nation and subsequently, indistinguishable protections are issued and exchanged at a similar cost crosswise over business sectors after adjustment of foreign exchange rates. Commodity market integration plays the main job in the development of the commodity market just as the economy of the nation. The commodity market integration influences the macroeconomic approaches and market viability, so it is significant for academicians and strategy creators and financial specialists, and investors (UNCATD 2010).

The commodity markets are viewed as co-integrated where long term relationship found or the co developments with one another which demonstrate the nearness of co mix among the business sectors. After globalization and advancement, the investigation of the commodity market turns out to be progressively significant for policymakers as well as for worldwide investors.

Word 'market integration' has been differently utilized for various terms of research. Integration of market is characterized by the level of value transmission among two, it can be vertical or spatial. Market mix means one price law - indistinguishable item is sold or similar cost crosswise over various markets. The same commodity adheres to one value law (Monke and Petzel, 1984). An integrated market is defined as one in which the LOOP exists for a commodity across all markets. In the local economy, if LOOP holds, at that point there is existence of integration of domestic market

(Bradford and Lawrence, 2004). At the time of globalization, the commodity market around the globe has been incorporated inside just as crosswise over limits. Simultaneously, deregulation in the market has prompted the expulsion of exchange limitations that is essentials for market integration. A commodity is presently progressively versatile crosswise over national limits with the advancement of innovations and correspondence frameworks.

From the financial crises, the 2007-08 commodities market becomes a worldwide issue. Uncertain changes in commodity prices over time are known as volatility. Therefore, as a result of these uncertain movements in commodity prices, commodity market performance is reduced that affects the income of producers and traders (world market, 1997). The term "volatility spillover" represents the impact of a market's low return and unpredictability on the unpredictability of other markets. The worldwide monetary development cycle is commodity concentrated. The expanded interest in commodities because of expanding industrialization in rising economies like India prompted a flood of the commodities cost. In this manner, the interesting side stuns are most conspicuous that draw the commodity costs up.

Recently, in non-agriculture commodities, SEBI has approved option contracts. This has resulted that investor's participation in the commodities market has been increased as well as the daily turnover of gold has been from sixty-four crore in December 2017 to seven hundred crores in July 2018 due to the gold options contract introduction. Presently option contracts are available for soft metals, crude oil, copper, and zinc. These commodities are used by investors as a hedging tool against fluctuation in the real economy (Rukhaiyar, 2018).

Current research explores the co-integration between the Indian commodity market and the United States Commodity Market to provide clearer insights into the hedging efficacy of commodities against unpredictable volatility, provided the evidence of recent developments and reforms in commodity trading to increase investor interest and participation. This study will be informative for investors as well as policymakers for increasing the participation of investors in commodity markets and investor can use it to hedge their risk effectively. This study is also beneficial for SEBI as well as brokers, traders, commodity exchanges, and finance ministry.

Research Gap

After going through the literature on integration, price transmission, volatility spillover, causality it has been found that the trend of domestic and international market integration is increasing. But only a few studies are available related to the integration of commodity markets across countries. Most of the studies are restricted to a limited period and limited numbers of commodities and integration of domestic market. In summary, the majority of the research on international commodity markets integration across future market proposed there is a strong international market connection among highly tradable commodities as compare to least tradable commodities. Price discovery process is highly influenced by developed markets. The United States is a developed country and its commodity market is in the world's topmost five commodities market. As well as it is the oldest largest and highly traded market. Due to limited research on the international linkage of an Indian commodity market, this research is an effort to investigate integration and price transmission, volatility spillover, and causality of Indian commodity market with United States commodity market with fourteen homogenous commodities in both the market.

Objectives of the Study

1. To examine the causal relationship between the Indian commodity market and United States commodity markets
2. To identify volatility and price transmission among Indian commodity market and United states commodity markets.
3. To study the long run and short run co-integration between Indian commodity market and United States commodity markets.

Research Design and Methodology

Total fourteen common commodities in Indian and US commodity markets which includes aluminum, copper, cotton, crude oil, gold, lead, maize, natural gas, nickel, silver, sugar, Tin, wheat and Zink are taken as sample size for the study. Monthly spot prices data is collected for Indian commodity as well as United States commodity market since 2005. The international commodity prices are compiled from the

International Monetary Fund's official data sources and US commodity markets. Indian commodities prices are collected from the Reserve Bank of India (RBI) and official website of MCX. The econometric models used in the present study

Major Findings and Conclusion

- The overall findings related to causality between the Indian commodity market and the market of the United States suggest that in case of Aluminum, copper, crude oil, gold, maize, wheat, tin, and zinc unidirectional causal relationship among Indian commodity market and united states commodity markets. In case of cotton, lead; sugar no causality among Indian commodity prices and United States commodity prices. Natural gas, nickel, silver had bi-directional causal relation among Indian commodity market and United States commodity prices.
- Result of eleven commodities (aluminum, copper, crude oil, gold, natural gas, nickel, silver, tin, zinc) out of fourteen homogeneous commodities among India's commodities market and United States' commodities market indicates that previous day volatility and information both effects today's volatility. It means Indian commodity market's volatility is influenced by ARCH and GARCH factors means by own shocks or own volatility as well as United States also transmits volatility.
- The overall result related to long-run co-integration among India's commodities market and United States' commodities market reveals that in relation to all commodities theses two markets are not connected. It means no existence of long-term connection among these two markets. Both markets are having a long run association with few commodities.
- The overall result related to short-run co-integration among India's commodities market and United States' commodities market reveals that in relation to all commodities these two markets are not co-integrated in short run. But in relation to few commodities Indian commodity market and United States commodity markets are co-integrated.

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LIST OF ABBREVIATIONS

ACDEX	Ace Derivative and Commodity Exchange
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criteria
ARCH	Autoregressive Conditional Heteroskedasticity
ARDL	Auto Regressive Distributed Lag
CBOT	Chicago Board of Trade
CME	Chicago Mercantile Exchange
DCC	Dynamic Conditional Correlation
ECM	Error Correction Model
EMH	Efficient Market Hypothesis
FMC	Forward Market Commission
FY	Financial Year
GARCH	Generalized Autoregressive

	Conditional Heteroskedasticity
GDP	Gross Domestic Product
ICE	Intercontinental Exchange
ICEX	Indian commodity Exchange Limited
KCBT	Kansas City Board of Trade
LM	Lagrange Multiplier
LOOP	Law of One Price
MCX	Multi Commodity Exchange
MGE	Minneapolis Grain Exchange
NCDEX	National Commodity Derivative Exchange
NMCE	National Multi Commodity Exchange
NYBOT	New York Board of Trade
NYMEX	New York Mercantile Exchange
SEBI	Security and Exchange Board of India
TY	Toda Yamamoto
UCEX	Universal Commodity Exchange
US	United States
UK	United Kingdom
UNCATD	United Nations Conference on Trade and Development
USID	Universities Scientometrics Information Database
VAR	Vector Autoregressive
VECM	Vector Error Correction Model
WFO	World Financial Organization

CHAPTER -1

INTRODUCTION

The globalization of commodity has prompted the developing pertinence of rising commodity markets. India is one of the countries with a developing commodities market that is dynamically pulling funds from different countries that increase co-integration. Integration is a procedure by which markets become open and bound together so members in a single market have unhindered access to another market. Commodity market integration means without authoritative and instructive obstructions, risk adjusted returns for a commodity of the same tenure in each segment of the market should be comparable to one another.

Commodity market integration refers to a status where investors of one nation can purchase and sell products (unbounded) that are issued in another nation and subsequently, indistinguishable protections are issued and exchanged at a similar cost crosswise over business sectors after adjustment of foreign exchange rates. Commodity market integration plays the main job in the development of the commodity market just as the economy of the nation. The commodity market integration influences the macroeconomic approaches and market viability, so it is significant for academicians and strategy creators and financial specialists, and investors (UNCATD 2010).

The commodity markets are viewed as co-integrated where long term relationship found or the co developments with one another which demonstrate the market co-integration. After globalization and advancement, the investigation of the commodity market turns out to be progressively significant for policymakers as well as for worldwide investors.

Word 'market integration' has been differently utilized for various terms of research. The degree of value transmission between two markets is referred to as market integration; it can be vertical or spatial. Market mix means one price law - indistinguishable item is sold or similar cost crosswise over various markets. The same commodity adheres to one value law (Monke and Petzel, 1984). An integrated

market is defined as one in which the LOOP holds for a commodity across all markets. If LOOP holds in the domestic economy, then domestic business integration occurs (Bradford and Lawrence, 2004). Commodity markets across the world have been integrated both inside and across borders throughout the globalization era. Simultaneously, deregulation in the market has prompted the expulsion of exchange limitations that is essentials for market integration. A commodity is presently progressively versatile crosswise over national limits with the advancement of innovations and correspondence frameworks.

1.1 Commodity

The article should be mobile of significant worth, something that can be purchased or sold as well as that is produced or used for trade, deal, or as the subject. In conclusion, researcher can say commodities incorporate a large range of Goods. Forward Contracts Regulation Act, 1952 featured "Goods" as "each sort of mobile property other than an actionable claim, cash as well as security.

1.2 Commodities Market

It is a market that exchanges in the primary economic sector, not in any processed goods. Investor access around fifty significant commodities market globally in which goods are delivered. For commodities investment, there is one old way that is Future contracts. Physical assets are used to secure futures contracts. The commodity market incorporates physical exchanging along with derivatives trading utilizing spot, forward, future as well as an option on the future. For price risk management farmers uses derivative trading in the commodities market.

1.3 Need for Commodity Market and Exchanges in India: -In addition to being a large consumer of bullion and energy products, India ranks among the top five producers of most commodities. Agriculture accounts for over 21% of the Indian economy's GDP. The agriculture sector plays a vital role to generating GDP growth. All of this suggests that India may be marketed as a significant commodity trading center. There should be a common platform for the growth of commodity trading interest in which demand along with supply may do together for drawing out the lower cost of the commodity. The major economic motive behind commodity trades

as a commercial center to empower commodity's producers as well as manufacturers to ensure them against conceivable cost succumb to their wares and permit customers, brokers, and processors to purchase ahead of time to secure against conceivable cost increment. Purchase ahead of time to ensure against conceivable cost increment. In such a manner they can „hedge" their value hazard, by booking the value, which they will get, and which they will pay separately.

1.4 Overview of Indian Commodity Market

The commodity market of India is the foundation of the Indian economy. Commodity markets assume a significant job in the Indian economy where the commitment of farming generation to GDP is Mammoth. India is one of the world's greatest producers of agricultural products, with farmers facing both yield and price risk. Farmers require insurance to protect their crops from price risk. From the time of sowing through the time of harvest, farmers are under constant threat. By freezing asset prices and using a simple derivative product, they can move their price risk (commission 2014).

- **Spot Market**

Spot exchange brings about prompt conveyance of an item for a specific thought among buyer and seller. A marketplace that encourages Spot exchange is referred to as the Spot market and transaction cost is generally referred to as the Spot cost. Here the buyer and seller meet up close and personal and arrangements are frozen. These are conventional markets. The case of a spot market is a Grain Markets in India where nourishment grain is sold to mass. Farmers would carry their items to these markets and traders would promptly buy the items as well as fix the arrangement on Spot and take or give delivery right away.

- **Forwards and Futures Market**

In the forwards and futures markets, contracts are typically established to obtain commodities at a later date for a predetermined price under agreed-upon terms and conditions. The principle contrast among these two contracts is how they are arranged. Forward contracts all terms like amount, quality, conveyance date, and cost

are talked about face to face between the purchaser and the merchant. Each agreement is in this way novel and not institutionalized since it considers the necessities of a specific dealer and a specific purchaser as it were. Then again, future contracts are institutionalized. Prospects contracts are regularly referred to as an improved variation of forward contracts.

1.5 Legal Framework in India for Regulating Commodity Market

Commodity trades are done in the direction of govt. under the rules made by Forward Contracts Regulations Act, 1952. Ministry of Consumer Affairs Food and Public Distribution is the supreme authority.

Forward Market Commission was incorporated in 1953 under Forward Contracts Regulation Act, 1952 which is a statutory organization. The central government can appoint 2 and 4 members for the commission. There is one selected administrator. Every trade is done under and large control of Forward Market Commission. When FMC merge with SEBI, on 28 September 2015, SEBI take over commodity market regulation. The merger of two Regulators is a unique and rare event across the world. It was also a heartening moment for SEBI as an organization that the Government had reposed faith in its regulatory capacity while entrusting regulation of a new sector.

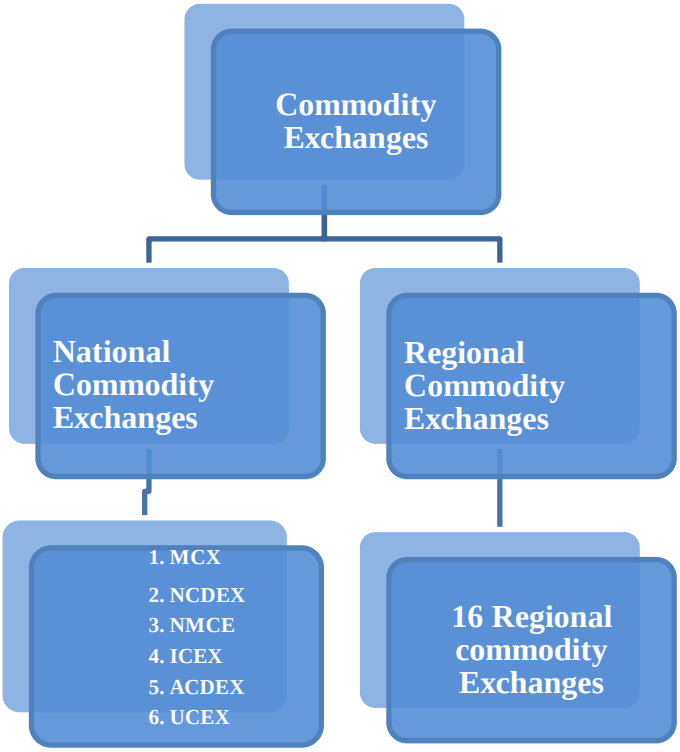
1.6 Types of Commodity Exchanges in India

Large portions of commodity exchange, which survive presently, have their inception in the late nineteenth as well as prior twentieth century. The primary exchange was built up in 1848 in Chicago. Development of derivatives market like efficient risk management tool in the nineteen seventies as well as nineteen eighties has brought about fast making and extension of the new commodities exchange. Presently there are significant commodities exchanges throughout the globe for managing various kinds of commodities.

A commodities exchange is characterized like focuses where future trading is composed in a more extensive manner; which incorporates any organized marketplace where an exchange is steered via one mechanism, permitting compelling challenge among purchasers and dealers. It would incorporate auction type exchanges, yet not

wholesale markets, there trade is limited, however, viably happens through numerous non-related individual transactions between various stages of purchasers and dealers.

Figure1.1: Types of Commodity Exchanges in India



Source: Retrieved from http://www.fmc.gov.in/reports/

- **National Commodity and Derivatives Exchanges Limited:** It is public limited organizations which was set up under the Companies Act, 1956 on April 23, 2003, and begin dealing with December 15, 2003. It is situated in Mumbai and advanced through ICICI Bank Limited, Life Insurance Corporation, National Bank for Agriculture and Rural Development, and National Stock Exchange of India Limited. Especially agricultural commodities trading are done on it (NCDEX, 2014).

- **Multi Commodity Exchange of India Limited (MCX):-** It's Head office is in Mumbai. The Government of India has permanently recognized MCX as an independent as well as de-materialized exchange. It started operations in November 2003. It is the global biggest exchange for silver, 2nd biggest for

gold, copper as well as natural gas, and 3rd biggest for crude oil futures. However, as a whole, exchange-traded commodities account for only a 5th of the total volume of commodities traded in India (MCX 2014). There is evidence of an increase in the volume of trading in India. MCX has the largest market share in India that is close to 70%. NCDEX is having around 25% market share.

- **National Multi Commodity Exchange of India (NMCE):-** It began operations on November 26, 2002. Its head office is in Ahemadabad. Various agro and non-agro commodities are traded on NMCE.
- **Indian Commodity Exchange (ICEX):-** It started operation in 27 November 2009. It offers only future trading.
- **ACE Derivative and Commodity Exchange (ACDEX):-** It was established on 26 October 2010.
- **Universal Commodity Exchange (UCEX):-** It was 6th national level commodity exchange. It started operation in 2013, but in 2014 it was shut down.
- **Regional Commodity Exchange:-** There are 16 regional commodity exchanges named as Bikaner Commodity Exchange, Bombay Commodity Exchange, Chamber of Commerce, Hapur, Central Indian Commerce Exchange Gwalior, Cotton Association of India Mumbai, East India jute and Hussian Exchange Kolkata, kochi is the first Commodity Exchange of India, Haryana Commodities Exchange Sirsa, Indian Pepper and Spices Trade Association, kochin, Meerut Agro Commodity Exchange, National Trade of Board Indore, Rajkot Commodity Exchange, Rajdhani oil and oilseed Exchange, Surendranagar Cotton oil and Cotton Seeds Association, Spices and Oilseed Exchange Sangli, Vijay Beopar Chamber Muzaffarnagar (Sharma and Dhiman, 2019).

1.7 Functioning of Commodity Exchanges

An investor can freeze their trade order on phone/broker software/online portals through a broker. Subsequent to getting affirmation, the traders place the request in exchange trading platform. Toward the start of trading, value is fixed and initial

margin money from an investor is submitted. Toward the finish of the trading session, a settlement cost is dictated by the Exchange. On the occasion, that market moved in the help or in restriction investors' incentive for finance is either being exhausted from or added to the client's record. Total is the differentiation in the trading cost and the settlement cost. On the next trading session, the settlement cost is used as the base expense. As the spot market costs changes every day, another settlement cost is settled at the completion of reliably. On daily basis, before exchanging sessions the record will be adjusted by the differentiation in the new settlement cost and the past session's value according to the selected method.

India is one of the world's leading producers of a wide range of commodities. Commodity derivatives market has seen up and down yet seems to have at enduring shown up now. The market has increased immense development as far as innovation, straightforwardness, and trading action. Surprisingly, this occurred only after government security for a variety of goods was withdrawn, allowing market forces to take over (Market, 2014).

1.8 Overview of United States Commodity Market

United States commodity market is the world's oldest commodity market. In 1864, it was started with few commodities like wheat, corn, cattle and pigs. Time by time in 1930 and 1940 more commodities like milk feeds, rice, butter, egg, Irish potatoes, soya bean, etc were added to this commodity exchange. For a successful market, there should be a variety of products. The leading commodity exchanges of the United States are situated in New York and Chicago and some others are in other parts of the country. Some commodity exchanges are merged in CME in 2008 and now they are known as the CME group. A successful commodity market requires large variation in commodities. In the 19^{th} century, there was a lot of improvement in commodity exchange like innovation, improvement in transportation, warehousing, and financing. Nowadays so many commodities are traded in the United States commodity market. United States commodity exchanges are:-

- **Chicago Board of Trade**

The main exchange of goods was founded in 1848 on the site that is now known as the Chicago Board of Trade by a group of Chicago shippers who were swift to develop a trading center. CBOT is amongst the world's largest markets for the trading of futures and options. CBOT is now offering more than 50 futures and options agreements through open opposition as well as electronically. CBOT at first managed uniquely in Agricultural and non-agricultural commodities.

- **Chicago Mercantile Exchange**

Chicago Mercantile Exchange is the biggest exchange of US as well as the biggest future clearinghouse on the planet for fates and choices exchanging. Framed in 1898 essentially to exchange Agricultural items, the CME presented the globes' 1st budgetary prospects over 30 years prior. Today it exchanges vigorously in financing costs prospects, stock files, and outside trade fates. Its items also fill in as a benchmark related to money and experience the greatest open enthusiasm for CME's prospects profile consisting of poultry, dairy and backwood products and encouraging small family homes to cope with their value hazards. Exchanging CME should be possible either through pit exchanging or electronically.

1.9 Commodity Exchanges in United States

The fundamental commodities exchange of the United States is arranged in Chicago and New York; others are arranged in the rest of the place of the nation. The table given below shows the leading commodity exchange in the United States, alongside a portion of commodity exchanged every one.

Table 1: Commodities Traded in Various Exchanges in United States

Sr. No.	Name of Exchanges	Traded Commodities
1.	Chicago Board of Trade	Corn, Ethanol, Gold, Oats, Rice, Silver, Soybeans, Wheat
2.	Chicago Mercantile Exchange	Butter, Milk, Feeder Cattle, Frozen Pork Bellies, Lean Hogs, Live Cattle, Lumber

3.	Intercontinental Exchange	Crude oil, Electricity, Natural gas
4.	Kansas City Board of Trade	Wheat, Natural gas
5.	Minneapolis Grain Exchange	Corn, Soybeans, Wheat
6.	New York Board of Trade	Cocoa, Coffee, Concentrated Orange Juice, Cotton, Ethanol, Frozen, Sugar
7.	New York Mercantile Exchange	Aluminum, Copper, Crude Oil, Electricity, Gasoline, Gold, Heating Oil, Natural Gas, Palladium, Platinum, Propane, Silver

Source: researcher's creation

In 2007 all exchanges were merged in CME. Now they are known as CME group.

1.10 Legal Framework for Regulating US Commodity Market

US commodity future trading commission regulates the US commodity market which was established in 1974. It is an independent agency of government that works under the commodity exchange act. From time to time many amendments were made under this act. The CFTC was established primarily to address the need for effective and open commodity markets, with a focus on consumer protection. As a result, one must only trade with exchanges and brokers that have been licensed by the commission. In the event of a commodity trading misdeed, it would be simple to file a lawsuit and recover your funds.

1.11 Commodity Market Participants

An effective market for product fates requires countless market members with differing hazard profiles. Responsibility for a basic item is not required for exchanging commodity futures. The market members need to store adequate cash with business firms to cover the edge prerequisites. Market members can be comprehensively isolated into hedgers, theorists, and arbitrageurs.

- **Hedgers**

Hedgers are commonly the business makers and buyers of the exchanged products. They participate in the market to deal with their spot advertise value hazard. Commodity costs are unstable and participating in the futures market allows

businesses to hedge or protect themselves against the risk of losses from shifting prices. For example, a copper smelter will hedge by selling copper futures since it is vulnerable to dropping copper prices.

- **Speculators**

  Speculators are traders who make bets on the direction of futures prices in the hopes of profiting. Trading in commodities futures is thus an investment opportunity for speculators. Most speculators would rather liquidate their positions before the contract's expiration date than make or accept genuine commodity deliveries.

- **Arbitrageurs**

Arbitrageurs are brokers who exchange between various markets to make cash on value differentials. Exchange includes ongoing deals and the acquisition of similar items in various markets. Exchange keeps the costs in various markets following one another. Normally such exchanges are without a chance.

Commodity price volatility is both a danger and a potential profit opportunity. By forsaking the corresponding profit opportunity, hedgers can move this risk. Speculators make educated guesses about this risk in the hopes of profiting from price swings. The arbitrageurs help to organize the price discovery process.

1.12 Co-integration

Integration is the procedure of a relationship between two markets with the goal that the investors can get the advantage of the same. Commodity market integration is significant because of a few reasons. On the off chance that two markets are integrated, at that point, it is increasingly gainful for makers to sell in the more costly region. The trend will continue until prices in all regions are equal.

Geologically, isolated markets are integrated spatially if the products and knowledge streams between them unreservedly as well as subsequently the impacts of value changes in a single market are transferred to other market costs.

When modeling time series data, which has many applications in financial markets, co-integration is a key factor to consider. Co-integration and correlation are concepts that are sometimes used interchangeably. These phrases are connected, yet they have different meanings. If two assets have a high correlation, it does not necessarily imply that they have a high co-integration. The correlation describes the return's co-movement, yet the prices are instable over time. It's a phenomenon known as the short run. Co-integration between two assets, on the other hand, signified a long-term relationship. Hedging techniques purely based on correlation cannot ensure long-term success. To account for long-term price trends, both risk and return must be taken into consideration.

1.13 Volatility and Volatility Spillover

It denotes risk and uncertainty and is regarded as a negative sentiment in the market. A high volatile market is featured with quick price fluctuations and lowers the stakeholder's confidence and participation in the market. Commodity prices are unstable and volatile. Reason can be natural calamities; domestic and global policies, industry structural change, sudden rise, and fall in import and export, exchange rate.

- **Volatility spillover**

From the financial crises, the 2007-08 commodities market becomes a worldwide issue. Uncertain changes in commodity prices over time are known as volatility.

Therefore, as a result of these uncertain movements in commodity prices, commodity market performance is reduced that affects the income of producers and traders (world market, 1997). The term "volatility spillover" refers to the effects of a market's low return and unpredictability on the unpredictability of other markets. The worldwide monetary development cycle is commodity concentrated. The expanded interest in commodities because of expanding industrialization in rising economies like India and China prompted a flood of the commodities cost. In this manner, the interesting side stuns are most conspicuous that draw the commodity costs up. The supply-side components are for the most part noticeable in the agricultural commodities which happen because of unfavorable climate conditions. The expanded changeability in the

cost of products influences the financial development of a nation (Devlin et al., 2012). Fluctuation in the commodity costs are caused by speculative practices. The speculation involves moving hazard from least hazard-bearing investors to investors with more prominent desire and ability to hold on to high hazard. Speculators say workers in the commodity industry are destabilizing (Devlin et al., 2012; Brunetti et al., 2016). Because of the increment in speculative exercises, the agricultural commodities costs turned out to be progressively inclined to the large scale monetary stuns (Tang and Xiong, 2012). Further, the expanded changeability in the costs of commodities builds the speculative exercises in the commodities market, which in turn influences the future exchanging on the commodity markets (Ramadas et al., 2014). Nonattendance of exchange openings in the commodities market raises the costs of the assets because of the expanding stream of data, which leads to building unpredictability (Mahalik et al., 2009). In the short-run volatility in commodities prices was found high. Price volatility is moved across various products which aggravate the issue (Brown et al., 2008). High volatility in crude oil prices, according to Mishra (2018), affects the entire commodity market as well as other financial markets through development and mining, affecting the global economy and the country's economic growth. Increasing instability in the cost of the commodity has long haul sway on the economy. As time goes on, the essential commodities costs begin diminishing compared with the cost of manufacturing goods. This has made it expensive to spend on innovation and on purchasing different commodities (Brown et al., 2008). Traders and, more importantly, commodity-importing developing countries face difficulties as commodity prices fluctuate. They can confront issues identified with a balance of payment as a result of the increasing expense of import of these commodities. At the point, when the rising cost of commodities all around moved to the local nations, it will disintegrate the obtaining intensity of family unit and purchaser of different commodities (Mugera, 2015).

High fluctuation in the costs of the commodities prompts increment exchanging volume of a commodity by expanding the exchanging open doors for investors (Ram, 2012). Agreeing to the basic view, the rising costs of commodities are significant for monetary development yet now and then these are negative to the financial development according to the monetarist's (Ramadas et al., 2014). Commodity price

volatility makes it difficult for commodity-dependent economies to plan their finances (Brown et al., 2008). Unexpected price swings in commodities raise the chances of manufacturers, traders, and market participants losing money.

1.14 Causality

If we want to know one-time series is helpful for the prediction of the future of another series, we can know about this by econometrics tool causality dependent on the standard Chi square-test structure. For instance: if one time series is helpful to predict current change, but not vice versa that is called unidirectional causality. But on the other side, they both can each other which is called bi-directional causality (Chris Brooks, 2010).

1.15 Price Transmission

Extensively, the commodity market is classified in 3 measurements –nationally, regionally, and globally. From an elective point of view, commodity market integration happens horizontally and vertically. Connection happens among domestic commodity market sections is called horizontal while vertical combination happens among local markets and universal commodity market. Domestic market integration includes a horizontal connection (USID, 1998). Meyer and Cramon-Taubadel (2004) reviewed the economic literature on price transmission and found that it has a long history. Simply put, price transmission occurs as one price changes, causing another price to adjust. It's usually expressed in terms of transmission elasticity, which is interpreted as the percentage change in one market's price in response to one percent change in another market's price.

1.16 Justification of the Study

Since the financial crisis 2007-08, co-integration becomes a more attractive topic worldwide (Baldi et al., 2016; Tang and Xiong, 2010). Research has shown that there is an increase in co-integration in the past few years. The logic behind it is the increasing number of financial investors in the commodities market which is known as financialization. These investors consider commodities as other financial assets such as stocks and bonds. As with financial markets, for several reasons, the

integration of commodity markets is of vital importance. If two regions are integrated, then selling in the region where goods are more expensive is more profitable for producers. The movement will continue until prices across regions equate

Some researchers have given contradictory definitions related to co-integration. The increases in the price of commodities are taken like higher inflation as well as interest rate in the economy that affects negatively. If there is unexpected fluctuation in one commodity market hedge can be done by a long position in another commodities market (Conover et al., 2010).

Further ongoing improvement in the Indian commodities market by security SEBI has expanded the presence of a commodity to a singular investor. Recently SEBI has done a tremendous job of strengthening integration.

Recently, in non-agriculture commodities, SEBI has approved option contracts. This has resulted that investor's participation in the commodities market has been increased as well as the daily turnover of gold has been from sixty-four crore in December 2017 to seven hundred crores in July 2018 due to the gold options contract introduction. Presently option contracts are available for soft metals, crude oil, copper, and zinc. These commodities are used by investors as a hedging tool against fluctuation in the real economy (Rukhaiyar, 2018).

Nowadays investors are taking more interest in the commodity market for investment purposes. Since the introduction of commodity exchanges in India, the commodities market has grown tremendously (Sinha and Mathur, 2013). According to the WFO report, certain rising economies, such as India, have experienced faster growth than predicted. NCDEX report reveals that the commodity market's investors are increased by 23% (Singh, 2011). In NCDEX number of investors has been increased, even in the form of volume, we can say trade increased from 194255 thousand tonnes for the financial year 2015-2016 to 217736 thousand tonnes for the financial year 2016-17. The volume traded in MCX has been increased from 89331thousand tones for the year 2015-16 to 93078 thousand tones for the financial year 2016-17. There are 21 lakhs investors in the commodity future market (SEBI's Annual report 2016-17). The volume in terms of commodity future contracts traded on the exchange increased by

20% in FY 2019, to 246 million lots, as compared to 205 million lots traded in FY 2018. In the financial year, 2020 the trade volume of MCX is increased by 20%.

Therefore this study is an attempt to explore the integration issue in the commodities market which is considered as the first aspect in commodity trading. Volatility is the second aspect in which the present study seeks to explore. Volatility denotes risk and uncertainty and is regarded as negative sentiment in the market. A highly volatile market is featured with quick price fluctuations and lowers the stakeholders' confidence and participation in the market. It determines the economic growth and prompts the government to intervene in the market. Commodity prices are unstable and volatile. Reasons can be numerous such as unpredictable natural calamities, domestic and global policies, industry structural changes, upturn or slump in the equity market, sudden rise or fall in export, import, exchange rates, etc. Therefore, the empirical modeling of commodities market volatility and its spillover to the other markets is very important because it creates ambiguity and risk to the parties concerned such as the producers, consumers, and others. Causality is another aspect of the present study seeks to explore.

So, the present study is focusing on the issues of co-integration, price transmission, causality as well as volatility spillover in the context of fourteen common commodities that are traded in India and the United States commodity market. This study will be helpful to the policymakers for increasing investor's participation in the commodity market as well as policy makers. An investor will be better prepared for anticipation and unexpected fluctuations in a commodity market. This research will enhance the prospects of the spot commodity markets in India as a whole as it can improve the capabilities and competitive advantage of commodity exchanges and beneficial for the Indian economy. Development in systematized commodity markets accrued to India's economy like business generation, growth of the farmers, and employment opportunities.

1.17 Chapter plan

The thesis contains seven chapters

Chapter 1: Introduction chapter in the thesis describes introduction of Indian and United States commodity market, its need and types, legal Framework, market Participants and variables related with the study. This chapter also include about commodity market, how it works, who regulates Indian as well as United States commodity market. Further it explains total number of exchanges in Indian and United States commodities market. A detail description about variables of the study includes integration, volatility spillover, price transmission and causality. It also include brief summary of the chapter plan given the thesis.

Chapter 2: Review of literature chapter reviews the literature related with Integration of commodity market, volatility spillover and causality. By reviewing literature this chapter helps to find out gap for study. Till the date what type of studies is done and what types of tools have been applied for various studied as well as variables used for study.

Chapter 3: Research Methodology chapter explains research methodology related with the study, research problem, significance and scope of study, objectives. This chapter identifies the research problem and suitable tools to identify these problems. After identified gap it described homogeneous commodities among Indian and United States commodity market. It also gives introduction about the tools used in the study.

Chapter 4: Causal relationship between the Indian commodity market and United States commodity market chapter examines the causal relation among Indian as well as United States commodity market. It describes cause and effect relationship among India's commodity market and United States' commodity market. It further explains unidirectional and bi-directional causality among Indian commodity market and United States commodity.

Chapter 5: Volatility and Price Transmission among Indian commodity market and United States commodity markets chapter analyzed how volatility affects Indian commodity and United States Commodity market via using GARCH model. It also

describes national as well as international shocks among both markets. Further it explains which market is information provider and up to which level both the markets control each other.

Chapter 6: Long run and short run co-integration between Indian commodity market and United States commodity markets chapter examines in long run and short run Indian commodity market and United States commodities market can move together by using various tests like Johensen Co-integration test, ARDL and Wald test.

Chapter 7: Findings, Conclusion and Suggestions chapter concludes the study with findings, implications, suggestions, social impact and future scope of study. It shows how these findings are helpful to SEBI, policy makers as well as investors. It also describes how future researchers can be helpful with this study and they can find out gap for future research.

References

CHAPTER 2

LITERATURE REVIEW

Integration between domestic and world market has become one of the most attractive and interesting topics in the world. The present study analyzes the integration and price transmission among India's commodities market as well as the United States' commodities market by taking into account volatility spillover and causality. Therefore a review of literature has been described on related topics like market integration, price transmission, volatility spillover and causality in both the commodity markets.

2.1 Integration of Commodity Market and Price Transmission

There has been significant integration of the commodity market in the nineteenth century as well as in the late twentieth century. It was periodical hindered by shocks, for example, war, world depression, and political reactions to globalization. For ongoing period markets are progressively lively as well as transpicuous in connection with one another. In the course of the most recent period, it was found that production costs were expanded and remained highly volatile in global as well as in India. It was discovered that aside from the agriculture prices, the adjustment in domestic commodity prices was because of progress in worldwide commodity prices. From 1850 to 1913 there was generous proof of a very much integrated commodity market. The level of integration was not widespread crosswise over the market but rather shifts after some time. After liberalization, there was a huge change in the commodity market. A commodity market is additionally an elective choice for an investor who isn't content with the equity market. The dynamic development in the commodity market has seen an amazing change in the previous decade. Reason behind integration is incorporate advancement of transportation framework, changes in obstructions to exchange, and momentary stuns, like conflicts (Findlay and Rourke, 2003; Federico, 2021; Klovland, 2005; Jena, 2016).

The vast majority of the investigations on value transmission are analyzed inside the setting of the LOOP (Baffes, 1991). Over the long haul, transmissions of value were

impeccable as well as stockpile, interest stuns were completely transmitted to all costs in the framework. For small period, examinations proposed a higher level of flat focus between retailers enabled them to have market control (Kaabia et al. 2002). On the opposite side, the effect of LOOP in the Chinese discount horticulture markets was broke down and found that the LOOP didn't win in the greater part of these business sectors even with skimmed milk powder law of one cost doesn't hold between the USA, EU and Oceania (Esfahani, 2006; Fousekis and Trachanas, 2016).

There are a few examinations on spatial market integration particularly with the worldwide market (Badiane and Shively, 2003). Rice market in Bangladesh was flawlessly integrated and discovered a long-term connection among chickpeas and green gram and furthermore revealed solid integration and price transmission in wheat market too long-run connection (Dawson and Dev, 2002; Ghosh, 2003; Choi et al. 2008). Markets were consummately incorporated with one another in long run. The purpose for these incorporated markets was better transportation, closeness in socio-economic culture, and proper flow of information among market and infrastructure (Asche et al. 2003; Zahid et al. 2007; Verala et al. 2013; Silva et al. 2018).

The job of rising economies in the overall value development in the Brazilian and US coffee market was analyzed by utilizing the multivariate GARCH model and discovered bi-directional informational transmission regarding overflow impacts between these two markets. U S assumes a significant job in worldwide price formation. Flow of information among local and universal markets assumes a significant job in market effectiveness (Bohl, 2016; Swati, 2017). The link between India and the world market was analyzed, and the result showed a high degree of market integration before the recession. It was also suggested that emerging markets such as India should empower their development of residential agriculture and the farthest point of dependence on global markets to create an atmosphere of economic growth (Saji, 2018).

Co-integration among the Asian rice market indicates Japan, Thailand, Bangladesh, and the Philippines influence other countries' prices. Long term elasticity was low but short term elasticity was quite significant between India and Thailand, between

Bangladesh and Pakistan. It was proposed that adjustment on the world rice price influenced domestic rice price. Furthermore, independence across the rice market contributed to a clear spillover of price shocks from one country to the next within the region (Reddy, 2006; Acharya et al. 2012; Lee et al. 2016). Sadiq et al., (2021) suggested that integration can be increased by developing infrastructure, e-trade, e-commerce etc. (Nareswari & Wibowo, 2020) examined global future price can affect the local spot prices by applying the bi- variate VAR/VECM model. Study found cointegration among these prices as well as bi-directional causality.

Johansen co-integration test, VECM, and Granger causality test were utilized to examine China along world future market related to copper, aluminum, soybean, and wheat. The investigation shows that Shanghai Futures Exchange prices are co-integrated for the future price of copper and aluminum with (LME) copper and aluminum. Examination likewise locates that co-integration connection is among CBOT and Dalian Commodity Exchange soybean future price but for the wheat future price no connection between Zhengzhou Commodity Exchange and CBOT (Hua and Chen, 2007). In the case of cereals strong market integration but in case of beef strong market integration which is not so well connected with the international market (Fossati et al., 2007). The connection among South African as well as world maize price demonstrates non-linearity exists in transmission of price in all three systems which were activated by the price spread in the past period (Abidoye and Labuschagne, 2012). International linkage in coal was inspected by utilizing a co-integration test and discovered co-integration. For robustness Philips-sul test and Kalmman Filter test was applied (Li et al. 2010). Price transmission shocks among Bamako and Kayes market was examined via TAR model and found international price changes affect domestic prices (Sossou & Diallo, 2019). Indonesian coffee and other coffee exporting countries' comparison was done through the ECM and cointegration model and integrated relationship between all these countries (Hadi et al., 2019). (Izaati, Anindita, & Sujarwo, 2020) found no transmission among Indonesian and global market but long-term integration is there. Such a result was found by applying Johansen co-integration, VECM as well as GARCH. On the other side Fatima and Shamim (2020) analysed integration among BRICS counteries Via

ARDL model and found long term relation as well as two way causality among these countries.

Ciner (2020) analyzed the relationship among the global non-ferrous metal market for a period of twenty-two years by applying various models and found a high degree of return and volatility spillover among these markets. It was also found that the behavior of non-ferrous metal just like bounds and equaity.

Multivariate time series was applied to look into the link among the global sugar markets and found a close relationship among these markets. On the other side Price, bubbles, and global sugar market was examined from the year 2006-2017 via ADF. It was found that price bubbles impact market integration (Rumankova et al., 2019; Huang & Xiong, 2020). Kumar and Bozward (2021) examine connection among indian sugar market , US and UK sugar markets through VECM and found connection among these counteries.

From a global prospect, Khandagiri (2020) examined the long-term connection among crude oil and agricultural commodities from the year 2000-2018 by using the co-integration test, VECM, ADF, and Wald test. It was found oil price affects agricultural commodities directly in terms of the increased cost of production and transportation. Lond term unidirectional connection was also found among all these. Vu et al., (2020) also found the same result. Nigatu and Adjemian (2020) analyzed the connection among international and US prices for corn, soybean, and cotton from the year 2011 to 2018 via ECM and Wavelet coherence. It was found that China is the largest importer of US agricultural products but there is no connection among these two.

A large portion of the investigations on internal linkage is done with a study on gold as a commodity. The gold future in developing markets increased more significance side by side in expansion in the quantity of gold exchanging. The examination demonstrates the presence of extended cost demesnes along with modified distress diversification utility in the related nations. Outcomes farther mean that China along with Russia is the major confined nations included in the developing market test and gold spot along with future markets are connected with both sub-time frames in the two India and US. Result demonstrates that gold futures assume a significant job in

cost discovery in two Indian as well as US markets. All of them have utilized different methods for their study (Lin et al. 2008; Pavabutr and Chaihetphon, 2010; Aruga and Manage, 2011; Baklaci et al. 2016 and Singh and Singh, 2018). Oil shocks significantly affected gold's return as well as exchange growth rates, while the GDP development rate influenced oil prices. The outcomes propose the nearness of a long-run connection just as short-run elements among variables and oil price for a greater part of the GCC nations. Outcomes recommend the requirement for approaches that went for further diminishing reliance on oil since the impact of oil shock is as yet huge in these economies (Albaity and Mustafa, 2018). Worldwide advancement in cash, yield, and expansion can be identified with improvements in the gold price in the long-term was inspected by utilizing the Multivariate integration model. It was proposed that a noteworthy impact of abundance worldwide liquidity on genuine gold costs and a co-development of genuine gold costs and worldwide inflation (Murach, 2019).

Co-integration among crude oil prices along with worldwide financial action was tried by utilizing the error correction model. The Kilian economic model was utilized as a pointer of worldwide financial action. In light of an inventory request system and the co-integration hypothesis, the investigation discovered that genuine future crude oil prices are co-integrated with the Kilian economic index and a trade-weighted US dollar record, and that variations in the Kilian economic index have a fundamental effect on crude oil prices (He et al. 2010). The linkage among the worldwide oil market and china's commodity market was examined by utilizing the DCC-GJR-GARCH model and the result uncovered a solid linkage between these two. It was likewise discovered that broadened portfolios can enable us to decrease risk, and the exhibitions of portfolio diversification strategy change crosswise over the various timeframe (Jiang et al. 2019). Bhanja et al., (2021) found connection among international gold market via using Sparse Bayesian time-varying covariance estimation. Price transmission between the beef market of Australia, China, Indonesia as well as Vietnam was analyzed, and discovered enormous nation impacts on the transmission of price of meat were demonstrated to exist between four nations (Dong et al. 2018). Price integration and volatility among Brazil and United state market was

examined by utilizing VAR and VECM model. No integration no causal relationship was found between these two (Felipe, 2017). Price transmission of US soybean future into Italian spot market was analyzed by utilizing ADF ECM and found the presence of a noteworthy association between two markets, supporting the hypotheses that a compelling hedging strategy for Italian could be applied working on the CBOT future market (Penone and Trestini, 2018). The relationship among international prices of energy, food, agriculture, and metal was examined via using wavelet coherency and found integration among them. Results also indicated that other markets affected the agriculture sector most (Tiwari et al. 2020). On the other side, Tian et al. (2020) investigated risk spillover effects of the oil market and other commodity markets via applying beta-skew-t-EGARCH and found two-way positive risk spillover between domestic and international commodity markets. (Stavroyiannis, 2020) investigated connection among Dubai crude oil and US natural gas prices via ARDL and Toda-Yamamoto. The study indicates unidirectional causality and long term connection.

Studies related to vertical integration include gas, agricultural food commodities, metal, and energy (Bakucs et al. 2013). Asche (2000) found price transmission holds in the European gas market and the German gas market. One of the contentions against horticultural progression is that the business areas are not sufficiently coordinated Price transmission in the agriculture commodity market between sixteen countries was examined and found lower degree price transmission. Main reason behind it was a low level of information. It was recommended that the market can play an efficient job whenever enhanced with progressively open policy initiatives (Abdulai, 2002; Sekhar, 2012; Barreto and Ramesh, 2018). Most of the commodities market shows the sign of price convergence even prior nineteenth century and international commodity market integration during the twentieth century (Findlay and Rourke,2003; Ronnback,2009).

The latest work recommends that the performance of the agricultural future market in India may have improved essentially from that point forward. Research on the long term integration of future and spot market in India proposes that they are co-integrated for most agricultural commodities, aside from rice and wheat when

compared to maize, black lentil, and pepper, where bidirectional relations occur in the short run but no convergence in the long run, future markets for chickpea, castor seed, soybean, and sugar have a more grounded capacity to predict subsequent spot prices (Ali and Gupta, 2011; Mukherjee, 2011; Kharin, 2017).

Market integration and price in agriculture crops, for example; onion assumes a significant job in deciding the creation choice of the farmers and diversifying to high-value crops. Price transmission and integration in the onion market were investigated by utilizing Johnson co-integration, Granger causality test, and onion markets were discovered to be co-integrated and interdependent which confines the administration intercession. The study affirms the law of one price (Ramadas, 2014; Ahmed and single, 2017).

Price discovery in spot and future market was investigated with FCVAR model and discovered more proof of price discovery in the spot market. There was likewise discovered linkage among future and spot market (Dolatabadi, 2015; Nirmala and Deepthy, 2016; Lakshmi, 2017). The connection amongst future as well as spot price of crude oil was examined via means of Johnson co-integration test. It was recommended that investor should prefer crude oil future to the crude oil spot, investor instead of low risk would able to earn high. Commodity future market plays important role in risk management (Narasimhulu and Stayanarayana, 2016; Radha et al. 2017; Minimol, 2018). Price discovery and efficiency of chili future market were analyzed by utilizing Johansen's co-integration, vector error correction model, Wald test. The outcomes demonstrated that two of the markets are co-integrated and error correction is occurring in both the markets. The Granger causality test outcome additionally affirms this. Be that as it may, Wald test outcomes uncover short-term causality spilling out of future to spot price for chili. The examination watches long haul co-movement among spot and future price which demonstrates future agreements can fill in as a valuable hedging instrument (Sharma and Sharma, 2018). Inter linkage between various records of MCX India was examined by utilizing Johnson co-integration and discovered none of the variables was co-integrated aside from MCX Agri which was affecting MCX metal. Toda and Yamamoto causality test outcome show unidirectional causality from MCX Agri to MCX metal (Shahani et al. 2019).

Co-integration and price transmission in major spices were analyzed through co-integration, VECM model, and causality test. Study revealed that both spot and future markets assumed a major role in the price discovery process and information well organized in responding to one another (Xu, 2018; Sahu et al. 2019). Partial co-integration among future and spot markets in Europe depicted that price discovery is when all is said in done ruled by the future market. During times of higher price uncertainty, however, the spot market takes on greater importance for the pricing process. We also discovered evidence that the availability of high-quality wheat on the spot market influences the long-run relations between spot and future markets as measured by partial co-integration methods (Vollmer and Taubadel, 2018).

2.2 Volatility Spillover and Causality

Displaying volatility of asset price has stayed one of the profoundly sought after zones for over two decades. At the appointed time, we found that sufficient research works directed at the domain of instability and its overflow impacts got incredible suggestions for market microstructure. Market microstructure typifies an innovation carried systematized agreement plans that incorporate edge call system, open intrigue, settlement designs, value step/tick size, volume, assurance for (offer inquire) rollout. Otherwise, different targets for fluctuation are to give great gauges of it which would then be able to be utilized for an assortment of purposes.

A significant translation of volatility is that a proportion up to which degree the present price of an asset goes astray by their normal old price. On an increasingly essential position, unpredictability demonstrates for quality either judgment for a value move. Naturally, one may place for estimation matter of instability can likewise be valuable to comprehend the markets joining, their development as well as overflow impacts. Best measurement for instability can be acquired by displaying time fluctuating contingent differences likewise, on a methodological basis, time varying fluctuation makes recommendations for the productivity of the parameters depicting the basic procedure's elements (Krishnan, 2009).

Even though volatility isn't legitimately discernible, it has some adapted actualities that are ordinarily found in, state asset returns. Hardly any important inquiries can be elevated and may be replied via legitimate. Forecasting of the volatility of commodity

future as well as their basic spot markets and therefore, the coinciding of approach will prompt closefisted structure of the models for comprehension. We can further respond to a couple of relevant inquiries. Fluctuation in the different markets is due to one market leader? Does shocks in one market increment the instability in other markets? Is the symptom and dimension of shocks relevant? Does the correlation among assets change after some period?

Volatility: - It donates risk and uncertainty and is regarded as negative sentiment in the market.

Volatility spillover donates the effects of lagged return and volatility of one market to other markets. Commodity market volatility is global and one of the attractive from the financial crisis of 2007-2008 (Aboura and Chevallies, 2015; Baldi et al, 2016; Tang and Xiong, 2010). Uncertain movement over the period in the cost of a commodity is known as volatility. Volatility is high in poor countries in comparison to rich countries and it intercepts their development. Least developed nations are more affected by shocks in comparison to developed nations. We found fluctuation in commodity prices is the main cause for these shocks. There was no increase in price volatility over time. globalization seems healthy for the progress of poor nations at least by reducing price volatility. India is among the rapidly developing future markets of the globe. Such as other arising markets Indian commodity market may respond to the global market on the other side it may influence the global market. Indian commodity future market act like a satellite market as well as acclimatize data through the global market (Jacks et al. 2009; Kumar and Panday, 2011; Xiarchos and Burnett, 2018). Unexpressed volatility indicator was obtained via option price that describes it as a healthy symbol of market uncertainty. Implied volatility carries past volatility data as well as investor's anticipations future market situations. Volatility transmission is more similar at the time when trades are largely related to domestic requirements. Inflation is also responsible for volatility (Ceballos et al. 2015; Dutta et al. 2018; Hesary et al. 2018). During the financial crises of Asia as well as globe, researchers looked into the trends of uncertainty in the agricultural commodity market. Volatility for agriculture commodities market as well as the oil market

throughout the time related to calamity was tested by using the T-GARCH model. Results indicated that instability in the commodity market was enhanced during the 2008 global financial crises and that had a stronger and persistent impact during the Asian Financial Crises. It was also suggested that commodity market uncertainty is due to speculative practice and this will have a major impact on oncoming years. During the financial crisis of 2008, global commodity prices changed dramatically (Morales, 2017; Zhang and Broadstock, 2018; Algieri et al. 2019). Because of relatively low agriculture costs and the IMF's implementation of basic programs, many developing countries received market progression approaches from the 1980s to the mid-2000s. With the onset of the 2008 food crisis, however, a shift in viewpoint occurred, leading food shortage legislative bodies to adopt protectionist systems that promote greater food independence. Wheat price volatility was examined via the GARCH model and found international markets always affect local markets. On the other side, volatility spillover was examined among crude oil and agricultural commodities since the 2008-09 financial crises by the Appling HAR model. In two ways short-run spillover was found. It was suggested that there was less integration after the 2008-09 financial crises (Guo and Tanaka, 2019; Lu et al., 2019).

Siami-Namini (2019) analyzed volatility transmission between oil, exchange rate as well as agricultural commodities by using the EGARCH model. The result indicated in post crises period crude oil affects agricultural commodities and the US dollar.

There is high proof that oil prices affect agricultural commodities prices. The positive effect of a powerless dollar on agriculture costs is additionally affirmed. Domestic markets are always affected by international markets. It is due to shocks (Nazlioglu and Soytas, 2011; Mittal et al., 2018). (Guhathakurta, Dash, & Maitra, 2020) suggests that oil prices not only affect agricultural prices but also metal prices. Crude oil is not only an important source of fuel and energy but also a raw material for several items. Fluctuations in crude oil will directly affect commodity groups (Khin et al., 2017).

Gold market and crude oil market is the major representative for large commodity and Crude oil spillovers for each ethanol and corn market. Ethanol and corn price variability is a direct indicator of volatility. In crude oil, it was found 10% to 20% but due to the financial crisis, it goes up 45%. Instability transmission is likewise found

from the corn to the ethanol market, yet not vice-versa. Results reveal that there is a volatility connection between the agriculture market, energy market, and corn-based ethanol market (Barrera et al., 2012). Macroeconomic determinants like the business cycle, fiscal condition, and monetary market assessments, and a monthly cost for gold, silver, platinum, and palladium of these volatilities described that gold volatility was due to monetary variables but not correct for silver. On the whole, there was limited proof that gold silver, etc metals were influenced by similar macroeconomic but volatility feedback was found between these metals (Batten et al. 2010). (Immanuvel & Lazar, 2020) examined how information affects the international gold market by using EGARCH and found positive news affects more in comparison to negative news. It was also suggested whoever invest in the market should keep watch information received from Indian and US market especially positive news.

Month to month volatility of four valuable metals (gold, silver, platinum, and palladium costs) and determinants of macroeconomic (business cycle, fiscal condition, and money related market assumption) of these volatilities clarified that Gold instability was clarified by financial factors, yet it was not valid for silver. While there was proof of unpredictability input between the valuable metals, there was limited proof that equal macroeconomic factors jointly influence the uncertainty procedures of the four valuable metal value arrangements. These outcomes were predictable with the view that valuable metals are too particular to ever be viewed as a solitary resource class, or spoke to by a solitary file (Lucey et al. 2009). As ascend in crude oil is relied upon to expand expansion in the economy while gold is utilized to support against inflation. Gold costs return has Granger cause on oil costs return in since quite a while ago run. The crude oil market assumes a significant job in clarifying changes in the costs and related instability of products (Singh and Singh, 2017; Ahmad et al. 2018; Vo et al. 2019). Oil price shocks and gold return were examined via the VAR model. It was found observing oil price fluctuation could be helpful in the prediction of gold price movement (Le and Chang 2012). Market integration and volatility in edible oil were studied by using the GARCH model. Results indicated linkage between different markets transmits unpredictability starting with one market then onto the next. It was suggested that understanding the cost dynamic is essential for effective policy otherwise extreme volatility in the global

agriculture market can threaten world food security (Mensi et al., 2013; Sundaramoorthy, 2014). The connection between major rural items' costs, for example, characteristic elastic value (NRP) and palm oil value (POP); and mining wares' costs, for example, petroleum gas value (NGP) and gold value (GP) and unrefined petroleum value (COP) changes on the planet showcase inspected by different test. Results from Johansen co-reconciliation investigation with vector error correction technique (VECM), there was a long haul connection between NRP, POP, and COP and a momentary connection among NGP and slacked estimation of COP with factually critical in the COP model. Along these lines, unrefined petroleum value instability would not influence just the interest in the oil business, some significant organizations, and a few nations, yet additionally, it will discover tough occasions in boosting the economy (King and Fong, 2017). Analysis of unpredictability overflows between S & P, Crude Oil and Gold described bi-directional volatility spillover. Oil plays an essential role in the transmission of information (Balcilar, 2018). The effect of vulnerability stuns on the instability of commodity prices was examined by applying the VAR model and found positive shock increase volatility and individual commodity price (Bakas and Triantafyllou, 2018).

Volatility overflows linkage and price discovery in India's commodities market was studied with thirteen commodities. To study volatility spillover bivariate EGARCH was used. Block exogeneity test was applied for causality analysis. The result indicates that the market does not seem to be aggressive. Only in three commodities volatility spillover was found not in others. It means the Indian commodity market needs a proficient hazard move framework for a large portion of the commodities (Sehgal et al., 2013). Volatility spillover among Indian spot and the gold futures market was examined by using VECM as well as ECM E GARCH (1, 1) model. It indicated that the gold spot market ensures an effective price discovery system and dominant position and overflows of information take place via spot market to future market (Srinivasan and Ibrahim, 2012).

The worldwide commodities market has inhabited an extremely dominant place in economic development as well as the advancement of countries. In the past period, the cost of crude oil and gold are the twin primary indicator related to a huge commodities market, which was influenced by the market supply and demand. All of

the evidence suggests that the two markets, Gold and Crude Oil, have a close relationship and follow similar patterns (Zhang & Wei, 2010). Gold along with crude oil are amongst highly exchanged commodities everywhere throughout the world. An Indian commodity market is a developing country commodity market. US commodity market is the oldest, largest, and high trading commodity market and also a developed country market.

The idea of exchanging commodities isn't new to India, as exchanging items was very much in presence notwithstanding during antiquated occasions. It is very much recorded as one of the most proficient types of markets until the mid-1970s. Be that as it may, because of the various confinements on exchanging, the development of commodity markets stayed immature. As of late a few of these devastating confinements have been discarded, and this has prompted novel improvements and energetic development of the Indian commodity markets. The market assumes a vital job in the monetary advancement of our nation. In 1991 after the progression of the Indian economy, progressions of measures were taken to open-up the commodity subsidiaries market.

Causal concern between crude oil, ethanol, as well as sugar costs in a setting of Brazil was researched by utilizing ARDL bound test. The outcome demonstrates that co-integration exist just when ethanol is utilized as an independent variable. Findings recommend in the long term sugar and oil cost will give direction to ethanol costs in long term. Besides, the consequence of the nonlinear causality test additionally demonstrates the presence of a small-run one-way causality sugar to ethanol market (Dutta, 2018). Price discovery and volatility spillover among non-agriculture commodity market was examined through the GARCH model. The outcomes demonstrated that there are bidirectional overflow impacts and Indian is playing its role in improving price efficiency and also influence the volatility (Kaura et al., 2018). The volatility spillover before and after the global financial crisis in Malaysians rubber market was examined by using the ARCH model and found the existence of volatility for both the period. The global financial crisis of 2008 leads to disruption and uncertainties in future demand and supply for natural rubber and paramount to greater natural rubber cost uncertainty (Gohl et al., 2016). Guo and Tanaka, 2020 examined the relationship among US and Global prices for agricultural

goods like wheat soybean, and corn by applying VECM-GARCH-BEKK. It was found that there is a long-term connection among these two. It was also suggested that global prices play a leading role in the US market.

(Tanaka & Guo, 2020) examined international food price volatility by applying GJR-GARCH along with DCC and found a BI-directional causal relationship among global as well as domestic market. It was also found substitutes goods also elevates volatility from the international market

Volatility spillover between capital, commodities as well as the currency market in India was examined by using the AR (1)-GARCH (1, 1) model. The results show that there is an instability overflow from the goods and money markets to the capital markets. In addition, there was an overflow from the stock market to the money market, but not from the commodity market to the currency market (Palakkod, 2012).

Lovcha & Perez-Laborda (2020) analyzed dynamic volatility and stuns among oil and natural Gas from the period 1994-2018 by using the VAR model. It was found that volatility varies from time to time and it has long-lasting effects. Even after Katrina, volatility was faster with short-run stuns.

Chen et al. (2020) examined correlation and volatility spillover among international as well as Chinese market concerning crude oil, energy, and earth market via BEKK-GARCH model for the period 2012-2018. It was found volatility transfers among these markets indirectly and these markets are highly correlated. It was suggested that development in the rare earth market can be used for risk control in the financial market. (Lee & Park, 2020) examined volatility spillover among London metal exchange and Chinese exchange via using a multivariate GARCH model and found no significant impact.

The causality between costs of corn, raw petroleum, and Ethanol was inspected by utilizing the VAR model. Results acquired uncovered conditions among costs of energy sources as well as the edibles costs changes during period (Papiez, 2014). The causal connection between world oil and agricultural commodities costs was inspected with the Toda-Yamamoto Linear Granger Causality test. Results demonstrate that oil cost and agribusiness don't impact one another. In the short run, bi-directional causality was found in every agricultural commodity (Nazlioglu, 2011).

Causality between spot and the future market was investigated with the VECM model

and found the existence of causal connection among both markets. Results also indicted for long run one-way causality going on the spot to futures market (Shrinivasm, 2009). A causal relationship was analyzed between India and china markets by using multivariate non-linear causality test and found the existence of nonlinear bidirectional causality relationships and causal relationship in live cattle market (Chow et al. 2017; Amarante et al. 2018). Price transmission and causality were examined by using the VAR model and found price transmission and causal relationship (Silva et al. 2018). Nareswari and Wibowo, 2020 investigated whether global prices can be a source of prediction of local prices. VAR/VECM was used for results and found markets are co-integrated and there is two-way causality.

Gold has been one of the most significant valuable metals for a long time on the globe, and it assumes a significant job like a source for significant value particularly in times with political and financial vulnerabilities (Aggarwal et al., 2007). In correlation among different metals with huge commodities markets, gold recognizes as an obvious preferred position as well as an overwhelming place around the world. In ongoing years, on account of the great benefit making circumstance and noteworthy hazard evasion highlight, the gold market demonstrates a functioning picture. It is likewise noticed that examination on raw petroleum cost is a hotly discussed issue and countless creations exist now (Zhang et al., 2008).

There is solid proof of the effect of the oil costs on the agriculture commodities. The favorable effects of a powerless dollar on agriculture commodities are additionally affirmed. Local markets are constantly influenced by worldwide markets. It is because of shocks (Nazlioglu and Soytas, 2012; Paramati et al. 2018). Causal concern between crude oil, ethanol, as well as sugar costs in a setting of Brazil was researched by utilizing ARDL bound test. The outcome demonstrates that co-integration exists just when ethanol is utilized as an independent variable. Findings recommend in the long term sugar and oil cost will give direction to ethanol costs in long term. Besides, the consequence of the nonlinear causality test additionally demonstrates the presence of a small-run one-way causality sugar to ethanol market (Dutta, 2018). The causality between costs of corn, raw petroleum, and Ethanol was inspected by utilizing the VAR model. Results acquired uncovered conditions among costs of energy sources as

well as the edibles costs changes during period (Papiez, 2014). A causal connection between world oil and agricultural commodities costs was inspected with the Toda-Yamamoto Linear Granger Causality test. Results demonstrate that oil cost and agribusiness don't impact one another. In the short run, bi-directional causality was found in every agricultural commodity (Nazlioglu, 2011; Ali and Gupta, 2016). Causality among spot and future markets was explored with the VECM model and discovered the presence of causal connection among each market. Results additionally arraigned one-way relationships among spot and future markets in the long-term (Shrinivasm, 2009). A causal relationship was broken down among India and china markets by utilizing multivariate non-linear causality test and found the presence of nonlinear bidirectional causality connections and causal relationship in live dairy cattle market (Chow et al., 2017; Amarante et al., 2018). Price transmission and causality were analyzed by utilizing a Granger Causality test. The outcomes demonstrate on MCX, India, and NYMEX, US gold act like price risk management during pre as well as Post-Crisis era (Singh and Singh 2018). Co-integration and price transmission in major spices were analyzed through co-integration, VECM model, and causality test. The study revealed each future, as well as spot markets, assumed driving jobs for the value transmission process and instructive proficiency for responding to one another. There is a strong causal relationship between these two (Xu, 2018; Sahu et al. 2019). Before the crisis period unidirectional causality was found from spot to future yet during the crisis period bidirectional causality was found and during the post-crisis era, there was one-way causality among spot as well as future returns (Chhatwal and Puri, 2013). There are numerous explanations behind inverse relation like inflation, exchange rate; repo rate and so forth the price for Gold as well as Crude oil were exceptionally associated however volatility of these couple impacts each other (Sindhu, 2013; Yuwei and Wang, 2013). Positive relation among crude oil and gold was found it is because of the worth in the US exchange rate in each of the markets. Crude oil influences exchange rates and direct co-relationship amongst Gold as well as crude oil (Subhashini and Poornima, 2014; Nirmala and Deepthy, 2015). Co-integration and causality were inspected by utilizing Granger causality and Johansen co-integration test. Cause and effect relationship was found between Gold as well as crude oil spot costs. All things considered, gold costs assume

control over the crude oil expenses and bear long haul causality and changes in gold expenses are controlled by gold not by some different factors. Aftereffects of the result uncover a powerless big haul connection between these factors (Sujit and Kumar, 2011; Narang and Singh, 2012; Singh and Sharma, 2017). Granger causality test found that it is consistently observed causality is there and cost of gold influences crude oil and bi-directional causality was found with other spices (Ahmed et. al, 2018; Gayathri and Deshmukh, 2018; silva et. al 2018).

He (2020) analyzed non-linear causality among China's investor's sentiment as well as crude oil by using Hiemstra and Jones, the Diks and Panchenko test, and VAR. It was found that there is a non-linear causal connection but the effect of oil price is negative in most of the cases from global financial crises.

2.3 Research Gap

After going through the literature on integration, price transmission, volatility spillover, causality it has been found that the trend of domestic and international market integration is increasing. But only a few studies are available related to the integration of commodity markets across countries. Most of the studies are restricted to a limited period and limited numbers of commodities and integration of domestic market. In summary, the majority of the research on international commodity markets integration across future market proposed there is a strong international market connection among highly tradable commodities as compare to least tradable commodities. Price discovery process is highly influenced by developed markets. United States is a developed country and its commodity market is in the world's topmost five commodities market. As well as it is the oldest largest and highly traded market. Due to limited research on the international linkage of an Indian commodity market, this research aims to look at price transmission and integration, volatility spillover, and causality of Indian commodity market with United States commodity market with fourteen homogenous commodities in both the market.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter describes the study's needs and research objectives. Main emphasis of this chapter is to highlight the data collection sources. This is followed by discussing the econometrics tools used to analyze the data.

3.1 Need for the Study

Indian is the seventh-largest country is the largest producer of commodities of mass consumption like jute, pulses, milk, and 2nd largest producer of vegetables, fruits, wheat, rice, sugarcane, groundnut, and cotton. As per FAO United States' data, India alone produces 25% of world production of pulses, consumes 27% of world consumption, and imports 14% of total imports of pulses in the world. It is lesser-known fact that India has the second-largest producer of cattle also.

Indian is the largest consumer and producer of agriculture as well as net importer of metal and energy. World's 20% to 25% gold consumption is in India. India's Silver consumption is 10% to 15% of total world's consumption. After US India is the largest consumer of crude oil. Indian is the largest consumer as well as producer of Aluminum, copper and Zinc.

For the last five years, the active participation of investors in the commodity has been increased. Nowadays investors are taking interest in investing in the commodities market. NCDEX data reveals that commodities market investors are increased by 23% (Singh, 2011). NCDEX retail investors are also increased even in volume trade that is increased to 217736 thousand tonnes in the financial year 2016-17 from 194255 thousand tonnes in the financial year 2015-2016 to. The volume traded in MCX has been increased from 89331thousand tones in the year 2015-16 to 93078 thousand tonnes in the financial year 2016-17 (SEBI's Annual report 2016-17). The volume in terms of commodity futures contracts traded on the exchange increased by 20% in FY 2019, to 246 million lots, as compared to 205 million lots traded in FY 2018. Investors manage their risks by investing in commodities because there is low volatility in the commodity market in comparison with the stock market. In the

financial year, 2020 the trade volume of MCX is increased by 20%. As per MCX and NCDEX annual report numbers of clients in June 2021 are 10 millions. On MCX 6572729 clients and on NCDEX total numbers of clients are 2.910 million.

Present study examines the co-integration and price transmission as well as volatility spillover and causality of the Indian commodity market and the United States commodity market. It will build up the confidence of the investor. This study will be informative for investors as well as policymakers for increasing the participation of investors in commodity markets and investor can use it to hedge their risk effectively. This study is also beneficial for SEBI as well as brokers, traders, commodity exchanges, and finance ministry.

3.2 Objectives of the Study

1. To examine the causal relationship between the Indian commodity market and United States commodity markets
2. To identify volatility and price transmission among Indian commodity market and United states commodity markets.
3. To study the long run and short run co-integration between Indian commodity market and United States commodity markets.

3.3 Research Design and Methodology

Research design is a framework which provides direction to conduct the investigation effectively and efficiently. It includes the below mentioned points:

3.3.1 Data Collection

The current research is focused on secondary data. Data has been collected from the official websites of Indian commodity market and United States commodity market.

3.3.2 Sample Size

Total fourteen common commodities in Indian and US commodity markets which includes Aluminum, Copper, Cotton, Crude Oil, Gold, Lead, Maize, Natural Gas, Nickel, Silver, Sugar, Tin, Wheat, and Zink are taken as the sample size for the

study. Combination of total commodities includes two precious metals (Gold and Silver), six metals (Aluminum, Copper, Nickel, Lead, Tin and Zinc), two from energy (Crude oil and Natural Gas) and four from agriculture (Cotton, Maize, Sugar and Wheat). Reason for selecting these commodities is homogeneity, tradability and availability of data. Precious metal, industrial metal and energy commodities that are heavily traded (and have lower tariff barriers/transportation costs) as well as agricultural commodities that are more controlled and less traded. Trade volumes of all the selected commodities are not same. Some of them are having high trade volume and some are low trade volume. Monthly spot prices data is collected for Indian commodities as well as United States commodity market since 2005. The international commodities prices are collected from the official data resources of international monetary fund and US commodity markets. The domestic commodities price sub-indices are collected from the Reserve Bank of India (RBI) and the official websites of MCX and NCDEX. Total homogeneous commodities and their period of availability are given in table no. 3.1. The total number of commodities trade in the Indian commodities market and United States commodities market is different. The main reason for considering fourteen commodities is the homogeneity and availability of the data and highly tradable.

Table 3.1 Homogenous Commodities

Sr. no	Commodities	Time Period
1	Aluminum	Oct 2005 to Dec 2019
2	Copper	April 2005 to Dec 2019
3	Cotton	April 2005 to Dec 2019
4	Crude oil	April 2005 to Dec 2019
5	Gold	April 2005 to Dec 2019
6	Lead	March 2006 to Dec 2019
7	Maize	May 2005 to Dec 2019

8	**Natural gas**	**July 2006 to Dec 2019**
9	**Nickel**	**April 2005 to Dec 2019**
10	**Silver**	**April 2005 to Dec 2019**
11	**Sugar**	**April 2005 to Dec 2019**
12	**Tin**	**April 2005 to Dec 2019**
13	**Wheat**	**April 2005 to Dec 2019**
14	**Zinc**	**March 2006 to Dec 2019**

Source: official website of MCX and NCDEX market

3.3.3 The study's time frame

The thesis spans the years 2005 to 2019.

3.3.4 Data Analysis Tools and Technique

To examine the volatility spillover Generalized autoregressive conditional heteroskedasticity model GARCH (1, 1) model is applied. The market integration and price transmission are analyzed via Johnson Co Integration Test, Vector Error Correction Model (VECM), and Granger Causality Test.

Unit Root Test

The unit root test is used to determine the time series property of each variable, which is the first step in any estimation. In order to create a time series model, you must first determine if obtained probabilistic (stochastic) mechanism changes over time. The series differences were calculated, and an Augmented Dickey Fuller (ADF) unit root test was performed.

The following is an example of a simple regressive process:

$Yt = \mu 0 + \mu 1t + \alpha Yt\text{-}1 + \varepsilon t.$

In this equation, Yt is known as a stochastic process, and μ0, μ1, and α all these are parameters. t is the time period and εt is a random error term. Various tools are developed for testing non-stationarity. These tools are augmented Dickey-fuller (ADF) and Phillips perron (PP), KPSS. In most of the studies, ADF is applied. The importance of these tests increased with non-stationary time series.

Augmented Dickey-Fuller Test

The first-order difference equation has a unit root, according to this examination.

Phillips Perron Test

One of the DF test's fundamental assumptions is that the error terms are uncorrelated, homoscedastic, indistinguishable, as well as autonomous. It appears that the PP test adopted the similar basic values of the DF test; nevertheless, it has a more influential ability to reject the invalid unit root theory.

Johansen Co-integration Test

For analyzing the long run connection between Indian commodity markets with US commodity markets Johansen co-integration test is applied. At least two markets move mutually over the long haul in any case the business sectors separately floated, and afterward, the contrast between them is consistent, known as co-integration and it is additionally named as since quite a while ago run harmony affiliation (Hall and Henry, 1989). On the off chance that there is the nonappearance of co-integration between these factors, it implies they floated away from each other (Dickey et al., 1994). For understanding with co-integration variables equation is as

$$\mathbf{Y_t = A_1 y_{t-1} + \ldots \ldots + A_P y_{t-p} + B x_t + \varepsilon_t}$$

$$\mathbf{\Delta Y_t = \Pi Y_{t-k} + \Gamma_1 \Delta Y t_{-1} + \Gamma_2 \Delta Y t_{-2} + \ldots \ldots \ldots \ldots . + \Gamma_{k-1} \Delta Y_{t-(k-1)} + ц_t}$$

Rank Γ will not be significantly different from zero if the variables are not co-integrated. If Γ=0, there will be no co integration; but if Γ=1 there will be co integration.

Granger Causality Test

To study causal relations among two markets granger causality test is applied. If there is one-way causal relation among two markets it is called bi-directional causality and if two-way causal relations are there it is called unidirectional causality.

1st, if variables are incorporated, the following VAR estimation equations are evaluated in the first differences. Equation is as under

$$\Delta Y_t = \Sigma^n_{j-1} b_j \Delta x_{t-j} + \Sigma^n_{j-1} c_j \Delta x_{t-j} + u_{t-1}$$

$$\Delta X_t = \Sigma^n_{j-1} b_j \Delta x_{t-j} + \Sigma^n_{j-1} c_j \Delta x_{t-j} + u_{t-1}$$

2nd, the following vector error correction models (VECM) are checked if the variables are co-integrated. The explanation for the use of VECM is that variables co-integrated on the 1st difference could lead to error in the misspecification.

Vector Error Correction Model (VECM)

VECM permits the short-run dynamic change of factors to the since quite a while ago run conduct of the endogenous factors. The co coordination term is known as the mistake redress term since the deviation from since quite a while ago run balance is amended progressively through a progression of halfway short-run changes. Equation is given below

$$\Delta £_{1,t} = a_1(£_{2,t-1} - b£_{1,t-1}) + \varepsilon_{1,t}$$

$$\Delta £_{2,t} = a_2(£_{2,t-1} - b£_{1,t-1}) + \varepsilon_{2,t}$$

Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH)

GARCH model is applied to measure volatility spillover. In present study, GARCH model is applied to identify volatility among the Indian commodity market and United States commodity markets.

ARCH is required before estimating GARCH. Equation is given below.

$$K^2_t = c + \sum^4_{i=1} b_1 K^2_{t-1} + a_t$$

Where a_t is an error term. ARCH effect is absent from error term. Confirmation of ARCH effect present in error term is when coefficients are statistically significant.

Concept of volatility was introduced by Engle in 1982 with the introduction of ARCH model. The conditional variance in the GARCH model is modified to have a linear relationship with both the lagged squared residual value from the mean equation and the lagged conditional variance. As a result, the conditional variance in the GARCH model will shift as a function of both past errors and past conditional variances. As a

result of these factors, it has grown in importance and popularity as an econometric time series model for forecasting volatility.

The equation of GARCH model is as under:

$$£_t = c + \varepsilon_t$$

Variance equation

$$R_t = \mu + À\varepsilon^2_{t-1} + ÈR^2_{t-1}$$

In this equation t is the time εt is the error term, c constant term, and À, as well as È, are representative of ARCH and GARCH. High volatility is represented by high GARCH. Insensitivity of variance to surprise reaction of the market is represented by ARCH. Addition of À and È should be near to one.

Toda and Yamamoto Granger Causality Test

Toda & Yamamoto causality test (1995) has been applied to research the causal connection among India's commodities market as well as United States' commodities market. This procedure is more effective than other conventional approaches for investigating the causal relationship. To begin with, the validity of this procedure is unaffected by the order in which the variables under investigation are integrated. This approach can be used on any integration order. Second, determining the co-integrating relationship between the variables is not necessary before determining the causal relationship between them. Finally, this approach has reduced the bias associated with the unit root test and the co-integrating properties of the variables. Toda and Yamamoto's approach is based on the concept of using a Vector Autoregressive Model at the level (p= k+dmax) with the right VAR order k and d extra lag, where d represents the highest order of time series integration. Finally, wald statistics were used to investigate the causality between the variables under investigation. The application of Granger Causality's Toda and Yamamoto approach connects all the variables under analysis as follows.

$$£_t = a_0 + a_1£_{t-1} + a_2£_{t-2} \ldots\ldots\ldots + a_k£_{t-k} + \varepsilon_t$$

The augmented level VAR (k+dmax) is used to detect causal relationships between variables and is represented by the following equation.

$$£_t = b + a_1£_{t-1} + £_{t-k} + a_{k+1}£_{t-k+1} + a_p£_{t-p} + \varepsilon_t$$

Hedge Ratios and Hedge Efficiencies

If an investor holds commodities in the Indian commodity market and wants to protect his position against unanticipated volatility in the US commodity market, he can do so by hedging his position in the US commodity market and vice versa. As a result, the primary goal of an investor is to reduce risk while maintaining the projected return.

The most basic and extensively used method for determining efficiency is regression using the Ordinary Least Squares method. The minimal variance hedge ratio is determined by the co-efficient of the dependent variable. The hedging efficiency is represented by the R square values of the regression equation.

The regression equation is as under.

$$\Delta IND_t = C + h^* \Delta US_t + \varepsilon_t$$

Here ε is the error term and ΔIND_t as well as ΔUS_t are the representative of Indian and US prices. The slope of the equation is the minimal hedge ratio h*. The efficiency of hedging is indicated by the R2 of this model.

C h and ε are the parameters. C is the intercept co-efficient (constant). h* is the slope efficient (hedge ratio). E is the error term.

CHAPTER 4
CAUSAL RELATIONSHIP BETWEEN THE INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

4.1 Causal Relationship

The concept of the lead-lag relationship between two markets is a very important criterion in the study of the relationship between two markets. This is about the effects of two economies that are forcing one another to adjust. The Granger causality test has become famous for determining the causality between two markets.

The presence of a relationship between variables does not imply causation or bearing effects. In time series results, however, the situation may be to some degree different. Time's not running in reverse. That is, if event x occurs before event y, it is likely that A will activate B at that stage. Nonetheless, the fact that y triggers is x is absurd. As a result, events from the past will manifest themselves in the present. This is usually the thought behind the causalities of the Granger test (Peter, 2015).

The Granger causality test tests whether the time series 'one-period lagging value increases the predictability of other time-series' current and future value (Ciner, 2001). The first part of the study is based on the VAR model to assess if one variable's lag helps to explain another variable's current values (Granger, 1969). For two variables {At, Bt) strictly following the stationary bivariate process, the variable {Bt} is a granger caused by {At}, if the past variable value {At} contains information about the future variable value {Bt} not contained only in the previous variable value {Bt}. The principle of predictability is taken into account in the Granger causality test when estimating the direction of influence among the variables. The lead and lagging relation between the variables are defined in this test (Elen, 2013; Kang et al., 2013; Lehecka, 2014). In order to analyze the lead-lag relationship between the Indian commodity market and the US commodity market, the Granger causality test was also used.

To examine the causal relationship between the Indian commodity market and United States commodity markets Granger Causality test was applied. At a level, both series

should be non-stationary. To identify integration order, ADF test was applied. Table 4.1 shows the stationarity result. For robustness check, Phillips Perron test was applied. Phillips Perron test results shown in table 4.2. The null hypothesis for the ADF and PP test is that the sequence has a unit root. It is confirmed that all series are non-stationary at a stage as a preliminary condition of the causality test. Then, unit root test was applied again and all series are found stationary at 1st difference. It has been found all series are non-stationary on level except Copper, Crude oil, Lead, and Wheat. This is the validation for causality test preliminary condition. Then, unit root properties tested again on 1st difference. Now all series are stationary on the first difference. Phillips Perron test shows the same result but there is a contradiction in the case of Crude oil. It shows crude oil non-stationary on level. On 1st difference, it was found stationary. All results are similar to ADF test. Means all series are found non-stationary on level except copper, Lead, Wheat. Then, unit root properties tested again on 1st difference. On the first distinction, both series are now stationary. On I (1) both are integrated. These findings satisfy the pre-condition for the causality Test application.

Table 4.1 Result of Augmented Dickey-Fuller Test for Indian commodities and U.S. Commodities

Variables	Level		First difference	
	Statistic	P-Value	Statistic	P-Value
Aluminum	8.49369	0.0751	150.073	0.0000
Copper	14.7691	0.0052	143.206	0.0000
Cotton	11.2078	0.0243	113.8090	0.0000
Crude oil	12.0163	0.0172	111.540	0.0000
Gold	4.24901	0.3734	159.600	0.0000
Lead	18.3958	0.0010	147.113	0.0000
Maize	9.33004	0.0534	131.581	0.0000
Natural gas	5.74653	0.2189	170.536	0.0000

Nickel	5.74653	0.2189	170.536	0.0000
Silver	5.80178	0.2144	146.000	0.0000
Sugar	4.20058	0.3795	138.541	0.0000
Tin	11.3602	0.0228	112.569	0.0000
Wheat	14.5414	0.0058	150.743	0.0000
Zinc	9.40297	0.0518	133.148	0.0000

Source: Author's calculation

Table 4.2 Result of Phillips Perron Test for Indian Commodities and U.S. Commodities

Variables	**Level**		**First difference**	
	Statistic	**P-Value**	**Statistic**	**P-Value**
Aluminum	9.45020	0.0508	151.866	0.0000
Copper	14.0550	0.0071	142.730	0.0000
Cotton	6.35960	0.1739	109.964	0.0000
Crude oil	8.91148	0.0634	112.755	0.0000
Gold	4.01724	0.4037	158.986	0.0000
Lead	16.8068	0.0021	147.706	0.0000
Maize	6.43687	0.1688	147.272	0.0000
Natural gas	5.36196	0.2521	170.535	0.0000
Nickel	5.36196	0.2521	170.535	0.0000
Silver	4.75054	0.3139	146.359	0.0000
Sugar	3.57365	0.4668	140.154	0.0000
Tin	8.03441	0.0903	157.318	0.0000
Wheat	12.4355	0.0144	147.227	0.0000
Zinc	5.60248	0.2309	129.721	0.0000

Source: Author's calculation

Before applying Granger Causality Lag selection is required. Lag – One variable respond to another variable with lapse of time. That lapse of time is called lag. Proper lag selection is very much required because it can cause serial correlation in error

term and misspecification in error term. It means it will increase the error term. What is the ideal lag? What number of lag ought to be utilized for a specific model? There are numerous measures to pick optimal lag. They are successive LR test statistic, Final prediction error, Akaike information criterion (AIC), Schwarz criterion, and Hannan-Quinn information criterion. Here for lag selection Akaike information criterion has been applied. The results presented in table 4.3, indicates k=3 lag for aluminum, k=2 lag for copper, k=2 lag for cotton, k=4 lag for crude oil, k=2 lag for gold, k=2 lag for lead, k=3 lag for maize, k=6 lag for natural gas, k=6 lag for nickel, k=3 lag for silver, k= 2 lag for sugar, k=4 lag for tin, k=2 lag for wheat, k=2 lag for zinc. Table 4.1 shows a lag length.

Table 4.3 Optimal Lag Length

Variables	Optimal Lag Length
Aluminum	**3**
Copper	**2**
Cotton	**2**
Crude oil	**4**
Gold	**2**
Lead	**2**
Maize	**3**
Natural gas	**6**
Nickel	**6**
Silver	**3**
Sugar	**2**
Tin	**4**
Wheat	**2**
Zinc	**2**

Source: Author's calculation

Lag selection is done by running VAR model. Before running any model it is very important to select a suitable lag. After lag selection, granger causality test can be easily applied. Granger Causality analysis starts with VAR estimation by using

monthly spot prices of India's commodity market as well as United States' commodity market individual commodities. Here null hypothesis for this test is no granger causality exists among tested variables. It also describes cause and effect relationship. If null hypothesis is rejected, therefore it implies the possible presence of causality of granger between the tested variables. Table 4.4 shows the result of Granger Causality test. It is also used for robustness check. Both the models are showing same results. The result suggests that if the null hypothesis rejected is at 5% level of significance, it implies United States, Aluminum does not granger cause India's Aluminum but on other side if null hypothesis is not rejected at 5% level of significance it implies India's Aluminum does not granger cause United States Aluminum. It means United States Aluminum prices granger cause Indian Aluminum market but Indian Aluminum prices do not granger cause United States aluminum market. It means unidirectional causality or one-way causality is there. In case of copper, results suggest that null hypothesis is not rejected. It means United States copper market does not granger cause Indian copper market, as well as Indian copper market, does granger cause United States copper market. It means uni-directional causality is there. In case of cotton null hypothesis is not rejected. Means neither United States' nor Indian cotton prices influence each other. The result suggests no causality among cotton prices. In case of crude oil United States, crude oil prices influence Indian crude oil prices buy Indian crude oil prices does not influence the United States crude oil prices. It means unidirectional causality among crude oil prices. In case of gold result suggests untied states gold prices influence India's gold prices but India's gold prices does not influence United States gold. It means one-way causality among Gold prices of both markets. In case of lead result suggests no causality among lead prices of United States and India. It means neither United States nor India's lead prices influence each other. In case of maize unidirectional causality among Maize prices of these two countries. It means only United States Maize prices influence India's Maize prices. In case of natural gas bi-directional causality is there. Means both the market prices influences each other. Same in case of Nickel result suggest bi-directional causality among these two markets. It means both the markets influence each other. In case of silver bi-directional causality among these two markets. It means both markets influence each other. On the other side in case of

sugar no causality is there. It means none of the market influences each other. In case of wheat, tin and zinc unidirectional causality among these markets. It means result suggests in case of tin Indian market influences United States market. In case of wheat and zinc only United States market influences Indian market prices.

Table 4.4 Results of Granger Causality Test

	F-stat	**P-value**
United States Aluminum doesn't granger cause India's Aluminum	6.17967	0.0005
India's Aluminum doesn't granger cause United States Aluminum	0.90954	0.4378
United States copper doesn't granger cause India's copper	16.6573	2.E-07
India's copper doesn't granger cause United States copper	3.14968	0.0454
United States cotton doesn't granger cause India's cotton	1.79213	0.1697
India's cotton doesn't granger cause United States cotton	1.51557	0.2226
United States crude oil doesn't granger cause India's crude oil	2.69058	0.0330
India's crude oil doesn't granger cause United States crude oil	1.31818	0.2654
United States gold doesn't granger cause India's gold	4.07020	0.0188
India's gold doesn't granger cause United States gold	0.75427	0.4719
United States lead doesn't granger cause India's lead	23.9437	8.E-10

India's lead doesn't granger cause United States lead	1.18024	0.3099
United States maize doesn't granger cause India's maize	4.43983	0.0052
India's maize doesn't granger cause United States maize	1.72810	0.1640
United States natural gas doesn't granger cause India's natural gas	4.68590	0.0002
India's natural gas doesn't granger cause United States natural gas	3.34535	0.0041
United States nickel doesn't granger cause India's nickel	4.59627	0.0003
India's nickel doesn't granger cause United States nickel	2.21106	0.0447
United States silver doesn't granger cause India's silver	4.49701	0.0046
India's silver doesn't granger cause United States silver	3.35681	0.0203
United States sugar doesn't granger cause India's sugar	1.16687	0.3138
India's sugar doesn't granger cause United States sugar	0.55611	0.5745
United States tin doesn't granger cause India's tin	7.41443	2.E-05
India's tin doesn't granger cause United States tin	3.36268	0.0112
United States wheat doesn't granger cause India's wheat	6.08544	0.0028
India's wheat doesn't granger cause United States wheat	0.77474	0.4625
United States zinc doesn't granger	5.79178	0.0037

cause India's zinc India's zinc doesn't granger cause United States zinc	0.98783	0.3747

Source: Author's calculation

Consistency of above mentioned results lied with Kumar and Pandey (2011) and Jena (2016). The above mentioned outcome concludes that in most of the commodities is having only uni-directional causality or no causality among the prices of Indian commodity prices and United States commodity prices except natural gas, nickel and silver prices. Because in case of natural gas, nickel and silver bi-directional causality exists among the prices of these two countries. But the same issue could have different consequences for emerging markets like India, owing to certain specific features, such as greater volatility and speculative activity in Indian commodity markets, which vary from those in developed nations.

In this research, Toda Yamamoto's Granger Causality Test method, developed by Toda and Yamamoto (1995), was used to establish the causal relationship between the variables. For some factors, Toda and Yamamoto approach for granger non-causality is favored over conventional approaches. First, regardless of the order of integration and the presence of co-integration in any arbitrary order, this approach is valid. Secondly, the preconceptions associated with co-integration and unit root test are reduced since this approach does not require co-integration properties to be pre-tested. The TY approach is recommended over general VAR modelling, where long-term data is often sacrificed due to the obligatory first differentiation and pre-whitening process. To fix these issues, TY suggested VAR modelling of an increased degree (Toda and Yamamoto, 1995).

The Granger Non-causality Test method Toda and Yamamoto (1995) has been used to find out the causal connection between Indian commodities and US commodities. Before performing any further experiments, it is necessary to examine the order of integration for each variable used in this research. For this purpose ADF and PP test has been applied. Table 4.1 and 4.2 shows the results of ADF and PP test. Results

suggest that order of integration is I (1) for maximum commodities. The Toda and Yamamoto Granger Non-Causality Test study starts with the Vector Autoregressive (VAR) model estimation using monthly prices of Indian commodities and commodities from the United States. To pick the lag length, the Akaike Information Criterion (AIC) is used. In Table 4.3, the results are already presented. An augmented VAR of the order p= K (lag length) +dmax (maximum order of variable integration) is chosen in the next step. The null hypothesis for this test is that there is no granger causality. Any rejection of the null hypothesis therefore implies the possible presence between the tested variables of granger causality. The T Y test results are listed in the table 4.5. For aluminum, copper, crude oil, gold, lead, corn, natural gas, nickel, silver, tin, wheat, and zinc, the null hypothesis of no granger causality from Indian commodity markets to United States commodity markets has been rejected at a 5% level of significance. The null hypothesis of no granger causality has been recognized in the case of the remaining commodities. In summary it can be said that no causal relationship found in case of cotton, sugar.

Table 4.5 Result of Toda and Yamamoto Granger Causality Test

Independent variable	Dependent variable	Chi-square	Df	P value
U S Aluminum	Indian Aluminum	12.42173	3	0.0061
Indian Aluminum	U S Aluminum	2.297871	3	0.5129
U S Copper	Indian Copper	27.38264	2	0.0000
Indian Copper	U S Copper	4.729788	2	0.0940
U S Cotton	Indian Cotton	0.352389	2	0.8385
Indian Cotton	U S Cotton	1.367046	2	0.5048
U S Crude oil	Indian Crude oil	11.87742	4	0.0183
Indian Crude oil	U S Crude oil	5.512392	4	0.2386
U S Gold	Indian Gold	7.853271	2	0.0197
Indian Gold	U S Gold	1.445742	2	0.4854
U S Lead	Indian Lead	47.76567	2	0.0000
Indian Lead	U S Lead	1.838702	2	0.3988

U S Maize	Indian Maize	12.66509	3	0.0054
Indian Maize	U S Maize	4.901657	3	0.1791
U S Natural Gas	Indian Natural Gas	24.50500	6	0.0004
Indian Natural Gas	U S Natural Gas	33.22156	6	0.0000
U S Nickel	Indian Nickel	26.94162	6	0.0001
Indian Nickel	U S Nickel	13.06132	6	0.0421
U S Silver	Indian Silver	13.14082	3	0.0043
Indian Silver	U S Silver	9.806950	3	0.0203
U S Sugar	Indian Sugar	2.267445	2	0.3218
Indian Sugar	U S Sugar	1.100692	2	0.5768
U S Tin	Indian Tin	29.72193	4	0.0000
Indian Tin	U S Tin	13.78397	4	0.0080
U S Wheat	Indian Wheat	11.26909	2	0.0036
Indian Wheat	U S Wheat	1.126679	2	0.5693
U S Zinc	Indian Zinc	10.98982	2	0.0041
Indian Zinc	U S Zinc	2.090771	2	0.3516

Source: Author's calculation

The above mentioned outcome concludes that most of the commodities found only uni-directional causality or no causality among the prices of Indian commodity prices and United States commodity prices except natural gas, nickel, tin and silver prices. Because in case of natural gas, nickel, tin and silver bi-directional causality exists among the prices of these two countries. It can be summarized that out of two precious metals (Gold and Silver) only in case of silver found bi-directional causality and gold found unidirectional causality, out of six metals (Aluminum, Copper, Nickel, Lead, Tin and Zinc) only Nickel and Tin found bi-directional causality, rest four metal commodities (Aluminum, Copper, Lead, Zinc) found unidirectional causal relationship, out of two energy (Crude oil and Natural Gas) only Natural Gas found bi-directional causal relation and Crude Oil found unidirectional causal relation and out of four from agriculture (Cotton, Maize, Sugar and Wheat) two (Cotton and Sugar) found no causal relationship found and rest two (Maize and Wheat) found one way relationship. Study suggests that in case of sugar and cotton no lead leg

relationship it means no one is cause and no one is effect. It means neither Indian market nor US market is helpful in the prediction of future of each other. Overall it can be concluded that in maximum number of commodities only one-way causality is there. It means Indian market is highly influenced by US market. It means US market have stronger impact on Indian commodities prices. Only in few commodities both impact each other prices. It may be because of difference in transportation cost, tariff barriers, and subsidies as well excessive control of govt.

CHAPTER 5

VOLATILITY AND PRICE TRANSMISSION AMONG INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

5.1 Volatility Spillover

The flow of information between two financial markets is referred to as spillover (Maitra and Dawar, 2018). It defines the impact of changes in one market's return or volatility on other markets (Bouri, 2015). A variety of hypothesis has been proposed to explain the transmission of uncertainty or spillover in previous studies. The first source of spillover is the idea that changes in commodity prices have a negative impact on the profits of businesses that use these goods as a raw material because businesses do not want to pass on increased costs to their consumers, and therefore profits decline (Broadstock et al., 2012). Commodities are known as financial assets much like because of the growth in the number of financial investors in the commodity market and commodities are taken as a safe haven for investment.

5.1.1. Volatility Spillover between Indian Commodity Market and US Commodity Market

- To identify volatility among Indian commodity market and United States commodity markets GARCH (1, 1) test was applied. When using a GARCH (1, 1) specification, a single lagged square error (the ARCH term) and a single lag on the lagged conditional variance are included (the GARCH term). Periods of high volatility tend to be followed by period of high volatility and periods of low volatility tend to be followed by periods of low volatility. This suggests that residual or error term is conditionally hetroscedastic and it can be represented by GARCH (1, 1) model. R square value was more than 90%. In case of maximum variables it was 98% and 99%. Higher the R square value best fit the model. Durbin-Watson was near about 2. Table 5.1 shows the result of GARCH (1, 1) model. It has a two-equation means equation and variance equation

Table 5.1 Result of GARCH (1, 1)

Variables Aluminum		**Coefficient**	**Z-Statistic**	**P value**
Mean equation	Indian	0.995400	650.0710	0.0000
	United states	1.004195	583.9992	0.0000
Variance equation	RESID(-1)^2 ind	7.088805	8.700010	0.0000
	GARCH(-1) ind	0.336949	21.74667	0.0000
	RESID(-1)^2 us	6.898393	8.302252	0.0000
	GARCH(-1) us	0.339819	21.49537	0.0000
Variables Copper		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.993196	47.24410	0.0000
	United states	1.009711	14383.94	0.0000
Variance equation	RESID(-1)^2 ind	-0.010216	-1.683336	0.0923
	GARCH(-1) ind	0.579606	1.075410	0.2822
	RESID(-1)^2 us	-0.016872	-6.402144	0.0000
	GARCH(-1) us	1.046612	104.3287	0.0000
Variables Cotton		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.074924	6.454449	0.0000
	United states	0.117169	1.880796	0.0000
Variance equation	RESID(-1)^2 ind	1.135595	3.525514	0.0004
	GARCH(-1)	-0.055144	-0.617131	0.5371

	ind			
	RESID(-1)^2 us	0.199211	4.079297	0.0000
	GARCH(-1) us	0.520745	2.723720	0.0065
Variables Crude Oil		Coefficient	Z-Statistic	P value
Mean equation	Indian	1.067246	144.1265	0.0000
	United states	0.928315	163.3362	0.0000
Variance equation	RESID(-1)^2 ind	0.729718	3.092513	0.0020
	GARCH(-1) ind	0.368489	3.793113	0.0001
	RESID(-1)^2 us	0.725248	3.179570	0.0015
	GARCH(-1) us	0.371805	4.259283	0.0000
Variables Gold		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.849857	237.2982	0.0000
	United states	1.141240	427.7466	0.0000
Variance equation	RESID(-1)^2 ind	0.412187	3.122980	0.0018
	GARCH(-1) ind	0.607575	13.80145	0.0000
	RESID(-1)^2 us	0.418872	2.693101	0.0071
	GARCH(-1) us	0.631329	12.56129	0.0000
Variables Lead		Coefficient	Z-Statistic	P value

Mean equation	Indian	0.972934	70.96050	0.0000
	United states	0.973829	36.75886	0.0000
Variance equation	RESID(-1)^2 ind	0.482101	1.588080	0.1123
	GARCH(-1) ind	-0.000759	-0.006986	0.9944
	RESID(-1)^2 us	11.01438	16.33520	0.0000
	GARCH(-1) us	0.001808	0.309129	0.7572
Variables Maize		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.887494	20.91932	0.0000
	United states	0.472250	22.06659	0.0000
Variance equation	RESID(-1)^2 ind	0.874192	2.322661	0.0202
	GARCH(-1) ind	0.114751	0.548593	0.5833
	RESID(-1)^2 us	0.928487	2.944479	0.0032
	GARCH(-1) us	0.007824	0.080854	0.9356
Variables Natural Gas		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.987143	2450.684	0.0000
	United states	1.009633	137.1171	0.0000
Variance equation	RESID(-1)^2 ind	-0.028142	-15.26050	0.0000
	GARCH(-1) ind	1.005248	446.0653	0.0000
	RESID(-1)^2	1.714560	5.668698	0.0000

	us			
	GARCH(-1) us	-0.010323	-3.178425	0.0015
Variables Nickel		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.998495	851.4536	0.0000
	United states	0.999124	560.7387	0.0000
Variance equation	RESID(-1)^2 ind	0.395191	4.009127	0.0001
	GARCH(-1) ind	0.722496	14.47049	0.0000
	RESID(-1)^2 us	0.401859	3.836911	0.0001
	GARCH(-1) us	0.709194	14.37040	0.0000
Variables Silver		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.906175	157.2269	0.0000
	United states	1.024723	212.6870	0.0000
Variance equation	RESID(-1)^2 ind	0.765611	3.467556	0.0005
	GARCH(-1) ind	0.318163	2.994891	0.0027
	RESID(-1)^2 us	0.620514	2.274824	0.0229
	GARCH(-1) us	0.418978	2.215682	0.0267
Variables Sugar		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.006697	29.72187	0.0000
	United states	16.11505	7.069889	0.0000

Variance equation	RESID(-1)^2 ind	0.896215	4.103298	0.0000
	GARCH(-1) ind	0.105867	1.396870	0.1625
	RESID(-1)^2 us	0.925671	2.136958	0.0326
	GARCH(-1) us	0.047260	0.306587	0.7592
Variables Tin		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.999896	555.2019	0.0000
	United states	0.997904	193.0504	0.0000
Variance equation	RESID(-1)^2 ind	-0.009301	-10.05261	0.0000
	GARCH(-1) ind	0.966591	70.14493	0.0000
	RESID(-1)^2 us	-0.007923	-2.997244	0.0027
	GARCH(-1) us	0.885627	12.98748	0.0000
Variables Wheat		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.622787	13.04087	0.0000
	United states	0.190065	14.41794	0.0000
Variance equation	RESID(-1)^2 ind	1.008030	3.777823	0.0002
	GARCH(-1) ind	-0.058507	-0.450042	0.6527
	RESID(-1)^2 us	0.937229	3.409032	0.0007
	GARCH(-1)	-0.117800	-0.979082	0.3275

	us			
Variables Zinc		Coefficient	Z-Statistic	P value
Mean equation	Indian	0.988118	660.1768	0.0000
	United states	1.010912	668.9788	0.0000
Variance equation	RESID(-1)^2 ind	1.869132	7.927148	0.0000
	GARCH(-1) ind	0.445691	6.605582	0.0000
	RESID(-1)^2 us	1.878499	7.419628	0.0000
	GARCH(-1) us	0.438389	6.077571	0.0000

Source: Author's calculation

Here Indian commodity market is considered as dependent variable. In case of aluminum all are significant. Means ARCH term is significant, GARCH term is significant and another variable also significant. All it shows, there is internal shocks as well as international and United State is an international shock. It means United State commodity market's volatility transmits in to Indian commodity market. There are also internal shocks. In case of gold all are significant. It means there are internal shocks as well as international shocks.

In case of natural gas where India is dependent variable Arch term and GARCH term both are significant and c is also significant. It means previous trading day return affects next day return. Volatility affect is there. Means volatility transmission is there. Both are internal shocks and United State is an international shock which affect Indian Natural gas. In case of Tin ARCH and GARCH both are significant. C is also significant. In case of Copper all are significant. In case of Crude oil all are significant. In Zinc all are significant. In silver all are significant. In case of Nickel all are significant. All it shows that there is internal shocks as well as international shocks. It also shows previous day trading return also influence today's return.

In case of cotton ARCH and GARCH is significant but C is not significant. Means previous day volatility and information both affects today's volatility. It means both ARCH and GARCH factors influences the Indian cotton volatility means affected by own shocks or own volatility.

On the other side where United State is a dependent variable where as in case of aluminum all are significant means there is an internal shock as well as international shock. In case of crude oil all are significant. In gold all are significant. In case of natural gas, nickel, silver, Tin and Zinc all are significant. It means internal shock, as well as Indian commodity market, also transmits volatility to United States commodity market.

In case of cotton, ARCH is significant but GARCH is not. In Maize, GARCH is not significant. In wheat, GARCH is not significant. In case of sugar, GARCH is not significant. All it describes that information from the previous day influences today's volatility, but that previous day return volatility is unaffected by its own shocks.

In case of copper both ARCH and GARCH are not significant. In case of lead not significant. No transmission of volatility from Indian commodity market as well volatility not affected by its own shock. In case of lead, ARCH is significant but GARCH is not significant. In sugar all are significant but GARCH is not significant. In wheat, GARCH is not significant. In case of Maize GARCH is not significant. It means there is no effect of previous day's volatility on today's return.

Results of study are similar to Bohl et al., (2018) and Khalifa et al., (2011). Overall conclusion of the study is that volatility in Indian commodity market is largely dependent on its own shocks, ARCH and GARCH and also influenced by United States commodity market but in case of United States, volatility is not much affected by its own shocks as well as shocks from Indian commodity market. It implies Indian commodity market can not much contribute in the volatility of United States.

Result of above study indicates high volatility spillover among India's commodities market and United States' commodities market. Even it can be said that both the markets are also affected by own past shocks as well as volatility. Current volatility

forecasting is very much important. If the prices are increasing it is a sign of economic growth. Commodity market volatility is global issue and one of the most attractive topic from the financial crisis of 2007-2008 (Aboura and Chevallies, 2015; Baldi et al, 2016; Tang and Xiong, 2010). Volatility is high in poor countries in comparison to rich countries and it intercepts their development. Least developed nations are more affected by shocks in comparison to developed nations. We found fluctuation in commodity prices is the main cause for these shocks. The results show that the United States market plays an important role in the transmission of information to the Indian commodity market. Overall, Indian commodities markets are found to be co-integrated with the markets of the United States and to act as a satellite market. They have the ability to absorb data from United States markets by spillovers of return and volatility.

5.2 Price Transmission

Meyer and Cramon-Taubadel (2004) reviewed the economic literature on price transmission and found that it has a long history. Simply, price transmission occurs as one price changes, causing another price to adjust. It's usually expressed in terms of transmission elasticity, which is interpreted as the percentage change in one market's price in response to a 1 percent change in another market's price. Because of numerous factors such as a weak dollar, domestic infrastructure, and market stability policies, the pass-through of rising global prices does not translate into an immediate and proportionate increase in domestic price levels, according to the International Bank (2008). FAO (2008), on the other side, claims that the massive increase in agriculture and fuel prices pose a threat to macroeconomic stability and overall development, especially in importing countries with low net incomes. However, this ensures that government policies have been designed to avoid severe domestic price shocks. The transition from domestic prices to foreign market prices continues to be constrained by the weakness of the US dollar against many currencies.

Table 5.2 shows the result of Johansen test.

Table 5.2 Result of Johansen Co-integration Test

Variables		**Trace statistic**	**Maximum Eigen value**

	No. of CEs	Trace stat	P-Value	Eigen stat	P-value
Aluminum	**None**	20.57908	0.0078	12.11495	0.1064
	At most 1	8.464127	0.0036	8.464127	0.0036
Copper	**None**	47.95454	0.0000	35.47632	0.0000
	At most 1	12.47822	0.0004	12.47822	0.0004
Cotton	**None**	17.96793	0.0208	13.67778	0.0617
	At most 1	4.290158	0.0383	4.290158	0.0383
Crude oil	**None**	14.50996	0.0700	11.08755	0.1499
	At most 1	3.422408	0.0643	3.422408	0.0643
Gold	**None**	8.396961	0.4240	4.886165	0.7562
	At most 1	3.510796	0.0610	3.510796	0.0610
Lead	**None**	40.75505	0.0000	29.41340	0.0001
	At most 1	11.34164	0.0008	11.34164	0.0008
Maize	**None**	11.05331	0.2082	5.966333	0.6175
	At most 1	5.086973	0.0241	5.086973	0.0241
Natural gas	**None**	38.18016	0.0000	32.27312	0.0000
	At most 1	5.907040	0.0151	5.907040	0.0151
Nickel	**None**	38.18016	0.0000	32.27312	0.0000
	At most 1	5.907040	0.0151	5.907040	0.0151
Silver	**None**	7.948585	0.4709	4.449343	0.8091
	At most 1	3.499242	0.0614	3.499242	0.0614

Sugar	**None**	5.824151	0.7162	1.873338	0.8645
	At most 1	1.873338	0.1711	1.873338	0.1711
Tin	**None**	39.01018	0.0000	30.78835	0.0001
	At most 1	8.221829	0.0041	8.221829	0.0041
Wheat	**None**	17.73106	0.0227	11.61178	0.1261
	At most 1	6.119277	0.0134	6.119277	0.0134
Zinc	**None**	9.814492	0.2953	7.097389	0.4777
	At most 1	2.717103	0.0993	2.717103	0.0993

Source: Author's calculation

Price transmissions were measured via applying Johansen co-integration test. Results indicate that a long-run equilibrium relationship exist in some common commodities among Indian and United States commodities prices. In case of Aluminum market long-run equilibrium exist among Indian and United States commodity prices. In case of cotton prices, copper prices and lead price long-run equilibrium found among Indian and United States. Natural Gas prices, long-run equilibrium among Indian nickel and United States Nickel prices, long-run equilibrium exists among Indian and United States tin prices and wheat prices, no equilibrium found among Indian and United States crude oil prices and gold prices, no equilibrium among Indian maize prices and United States maize prices. No equilibrium exists among Indian and United States silver as well as sugar prices; no equilibrium exists among Indian and United States zinc prices.

Analysis of volatility spillover reveals precious metal (Gold and Silver) found bi-directional informational spillover. In case of five metals (Aluminum, Lead, Nickel, Tin, and Zinc) two ways volatility spillover. In case of one metal (Copper) only US transmits volatility to Indian market. In case of energy (Crude oil and Natural Gas) two way informational flows. In case of agricultural commodities (Maize, sugar and Wheat) no informational flow among these markets only in case of cotton US

transmits volatility to India. Investor can make hedging strategies by knowing about volatility. Flow of information is very much important for hedging strategy. It is found that volatility is taking place from United States commodity market to Indian commodity market. Indian market can internalize information from US markets via return and volatility spillovers. Higher volatility leads to higher prices that will increase input cost reduce demand and reduce investment.

CHAPTER 6

LONG RUN AND SHORT-RUN CO-INTEGRATION BETWEEN INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

6.1 Co-integration Test

If two or more series are individually non-stationary, their linear combination is stationary in the same integration order. It is then said that both series are co-integrated (Ahmed et al., 2017). While certain stochastic patterns are independently followed by all time series used in the co-integration model, they may share a similar stochastic pattern in the long run (Pan et al., 2007; Lehecka, 2014). By definition, a non-stationary series appears to drift very far apart, but it is the property of a linear mixture of non-stationary series to hold them together. Under these conditions, it can be said that the two variables are co-integrated (Maghyereh and Kandari, 2007). Whether both markets are not co-integrated in the same order or if causality is not found in both directions it implies both markets are independent of one another, and if causality runs from one market to another it means the second market is information efficient. If causality runs both ways and the markets are co-integrated, it would be advantageous for policy makers to respond quickly to a market shock because it quickly reflects in the other market due to the general stochastic pattern that both markets adopt (Reddy and Sebastin, 2009). Investors can shield their portfolio from risk by diversifying if all markets are not co-integrated (Reddy and Sebastin, 2009; Yamori, 2010; Dutta, 2017).

6.1.1 Co-integration between Indian Commodity and US Commodity Market

To study the long run and short run co-integration between Indian commodity market and United States commodity market Johansen co-integration test and ARDL model was applied. At a level, both series should be non-stationary. To identify integration order, ADF test was applied. Table 6.1 shows the Unit Root Test result. For robustness check, Phillips Perron test was applied. Table 6.2 shows the result of Phillips Perron test. The null hypothesis for the ADF and PP tests is that the sequence has a unit root. It is verified that all series are non-stationary at level for the preliminary condition of Johansen co-integration. Then, unit root test has been applied

again and all series are found stationary at 1st difference. It has been found all series are non-stationary on level except Copper, Crude oil, Lead, and Wheat. This is the validation for co-integration preliminary condition. Then, unit root properties tested again on 1st difference. Now all series are stationary on the first difference. Phillips Perron test shows the same result but there is a contradiction in case of Crude oil. It shows crude oil data was non-stationary on level. On 1st difference, it was found stationary. All results are similar to Augmented Dickey-Fuller test. Means all series are found non-stationary on level except copper, Lead, Wheat. Then, unit root properties tested again on 1st difference. Now all series are stationary on first difference. On I (1) all series are integrated. These findings satisfy the pre-condition for the Johansen Co-integration Test application.

Table 6.1 Result of Augmented Dickey-Fuller Test for Indian Commodities and U.S. Commodities

Variables	Level		First difference	
	Statistic	P-Value	Statistic	P-Value
Aluminum	8.49369	0.0751	150.073	0.0000
Copper	14.7691	0.0052	143.206	0.0000
Cotton	11.2078	0.0243	113.8090	0.0000
Crude oil	12.0163	0.0172	111.540	0.0000
Gold	4.24901	0.3734	159.600	0.0000
Lead	18.3958	0.0010	147.113	0.0000
Maize	9.33004	0.0534	131.581	0.0000
Natural gas	5.74653	0.2189	170.536	0.0000
Nickel	5.74653	0.2189	170.536	0.0000
Silver	5.80178	0.2144	146.000	0.0000
Sugar	4.20058	0.3795	138.541	0.0000
Tin	11.3602	0.0228	112.569	0.0000
Wheat	14.5414	0.0058	150.743	0.0000
Zinc	9.40297	0.0518	133.148	0.0000

Source: Author's calculation

Table 6.2 Result of Phillips Perron Test for Indian Commodities and U.S. Commodities

Variables	Level		First Difference	
	Statistic	P-Value	Statistic	P-Value
Aluminum	9.45020	0.0508	151.866	0.0000
Copper	14.0550	0.0071	142.730	0.0000
Cotton	6.35960	0.1739	109.964	0.0000
Crude oil	8.91148	0.0634	112.755	0.0000
Gold	4.01724	0.4037	158.986	0.0000
Lead	16.8068	0.0021	147.706	0.0000
Maize	6.43687	0.1688	147.272	0.0000
Natural gas	5.36196	0.2521	170.535	0.0000
Nickel	5.36196	0.2521	170.535	0.0000
Silver	4.75054	0.3139	146.359	0.0000
Sugar	3.57365	0.4668	140.154	0.0000
Tin	8.03441	0.0903	157.318	0.0000
Wheat	12.4355	0.0144	147.227	0.0000
Zinc	5.60248	0.2309	129.721	0.0000

Source: Author's calculation

Before moving Johansen test lag length selection of variables is required. Under this study lag order has been selected by using vector Auto-Regressive (VAR) model. Table 6.3 shows the results of Lag length, it captures the most reliable result of co-integration model (Kisswani and Elien, 2017).

After selecting the appropriate lag length for fourteen variables, the appropriate co-integration model has been preceded further. Johansen co-integration test has been applied for all the fourteen variables. But for copper, crude oil, lead, and wheat, ARDL Bound test has been applied due to non-similarity of integration order.

6.2 Optimal Lag Length

Granger causality test as well as Johansen Co-integration test both utilizes optimal lag. Lag – One variable respond to another variable with lapse of time. That lapse of time is called lag. Proper lag selection is very much required because it can cause serial correlation in error term and misspecification in error term. What is the ideal lag? What number of lag ought to be utilized for a specific model? There are numerous measures to pick optimal lag. Here for lag selection Akaike information criterion has been applied. The results presented in table 6.3, indicates k=3 lag for aluminum, k=2 lag for copper, k=2 lag for cotton, k=4 lag for crude oil, k=2 lag for gold, k=2 lag for lead, k=3 lag for maize, k=6 lag for natural gas, k=6 lag for nickel, k=3 lag for silver, k= 2 lag for sugar, k=4 lag for tin, k=2 lag for wheat, k=2 lag for zinc.

Table 6.3 Optimal Lag Length

Variables	Optimal Lag Length
Aluminum	**3**
Copper	**2**
Cotton	**2**
Crude oil	**4**
Gold	**2**
Lead	**2**
Maize	**3**
Natural gas	**6**
Nickel	**6**
Silver	**3**
Sugar	**2**
Tin	**4**
Wheat	**2**
Zinc	**2**

Source: Author's calculation

Johansen co-integration test was applied to achieve the objective. Because the variables are unit root at the level, the Johansen Co-integration Test was used to see if the variables in this study followed any common stochastic trend. Table 6.4 shows the results of test. This model consists of two tests maximum Eigen value test as well as trace test. Here null hypothesis is no co-integration among the variables of Indian commodity market and US commodity market. Where p value was less than 5% null hypothesis was rejected and where p value was found more than 5% null hypothesis was accepted. At most one means there is at least one co-integrating equation. It means both the markets have long run association and they can move together. Result shows that long-run co-integration among Indian and United States Aluminum market means null hypothesis can be rejected, long-run co-integration exist among Indian and United States cotton market, long-run co-integration found among Indian Natural gas and United States Natural Gas, long-run co-integration among Indian nickel and United states Nickel market, long-run co-integration exist among Indian and United States tin market, no co-integration found among Indian and United States gold market, no co-integration among Indian maize market and United States maize market, no co-integration exist among Indian and United States sugar market, no co-integration exist among Indian and United States zinc market.

Table 6.4 Result of Johansen Co-integration Test

Variables		**Trace statistic**		**Maximum Eigen value**	
	No. of CEs	**Trace stat**	**P-Value**	**Eigen stat**	**P value**
Aluminum	**None**	20.57908	0.0078	12.11495	0.1064
	At most 1	8.464127	0.0036	8.464127	0.0036
Copper	**None**	47.95454	0.0000	35.47632	0.0000
	At most 1	12.47822	0.0004	12.47822	0.0004
Cotton	**None**	17.96793	0.0208	13.67778	0.0617
	At most 1	4.290158	0.0383	4.290158	0.0383

Crude oil	**None**	14.50996	0.0700	11.08755	0.1499
	At most 1	3.422408	0.0643	3.422408	0.0643
Gold	**None**	8.396961	0.4240	4.886165	0.7562
	At most 1	3.510796	0.0610	3.510796	0.0610
Lead	**None**	40.75505	0.0000	29.41340	0.0001
	At most 1	11.34164	0.0008	11.34164	0.0008
Maize	**None**	11.05331	0.2082	5.966333	0.6175
	At most 1	5.086973	0.0241	5.086973	0.0241
Natural gas	**None**	38.18016	0.0000	32.27312	0.0000
	At most 1	5.907040	0.0151	5.907040	0.0151
Nickel	**None**	38.18016	0.0000	32.27312	0.0000
	At most 1	5.907040	0.0151	5.907040	0.0151
Silver	**None**	7.948585	0.4709	4.449343	0.8091
	At most 1	3.499242	0.0614	3.499242	0.0614
Sugar	**None**	5.824151	0.7162	1.873338	0.8645
	At most 1	1.873338	0.1711	1.873338	0.1711
Tin	**None**	39.01018	0.0000	30.78835	0.0001
	At most 1	8.221829	0.0041	8.221829	0.0041
Wheat	**None**	17.73106	0.0227	11.61178	0.1261
	At most 1	6.119277	0.0134	6.119277	0.0134
Zinc	**None**	9.814492	0.2953	7.097389	0.4777

	At most 1	2.717103	0.0993	2.717103	0.0993

Source: Author's calculation

For copper, cotton, crude oil, lead, tin and wheat ARDL Bound test was applied. Table 6.5 shows the result of ARDL Bound test. Since the F-statistics are less than the lower and upper bound values, the results show that there is no long-run integration between Indian and US cotton, crude oil and wheat. But Johansen co-integration test result shows that copper, cotton, Lead, Tin and Wheat have long run co-integration but in case of crude oil no long rung co-integration among these two commodities market. ARDL model shows cotton, crude oil and wheat have no long run association but copper, lead and Tin can move together in long run. Both the models represented different result. It reflects appropriate model selection is how much important otherwise it will give biased result. In case of copper, cotton, crude oil, Lead, Tin and Wheat data's were stationary at level. In that case Johansen Co-integration test cannot be applied. Only ARDL model can be run.

Table 6.5 Result of ARDL Bound Test for Copper, Crude oil, Lead, Wheat

Variables	F- Statistic	Lower Bound	Upper Bound
Copper	35.03430	4.303	4.16
Cotton	1.834133	4.303	4.16
Crude oil	3.295964	4.303	4.16
Lead	33.77219	4.303	4.16
Tin	1100.853	4.303	4.16
Wheat	3.710029	4.303	4.16

Source: Author's calculation

Result of ARDL Bound test indicates absence of long term co-integration among Indian crude oil and United States crude oil as well as no co-integration found among Indian wheat and United States wheat, because F- statistic is less than upper bound and lower bound. In case of cotton, no co-integration exists. On the other side, result shows that long-term co-integration exists among Indian copper and United States copper, because F-statistic is higher than the lower bound and upper bound. Same for

lead and tin, F-statistic is higher than the upper bound and lower bound. It means there is a long-run relationship among Indian lead, tin as well as United States lead, tin. These results are somewhat similar to Stavroyiannis (2020), who investigated co-integration among Dubai crude oil and US natural gas and the result shows long-term relationship among these variables. These results are somewhat similar to Hua and Chen (2007), examined a similar relationship for china's commodity future market for aluminum, copper, soybean, and wheat but did not found any connection between wheat traded in CBOT and China's market. But results somewhat contradict with Murali et al. (2019) examined integration among Indian sugar market and world sugar market and found integration among these markets.

Johansen Co-integration Test reveals that the prices of Indian commodities and the prices of US commodities have a long-term relationship. In order to support/verify the finding, it is now necessary to confirm whether there is some short-run relationship. Here Vector Error Correction Model has been applied to investigate the short-run relationship among the prices of Indian commodity and United States commodity. Specifications of the VECM allow the correction of long-run equilibrium errors in price in conditional mean equations (Engel and Granger, 1987). The short-term relationship of co-integrated variables was modeled using a similar method (Ghosh et al., 1999; Tomek, 1980). The VECM approach also explores the flow of information among US as well as Indian commodities market. Here VECM and VAR both models have been applied because of different order of integration. Condition for applying VECM is that there should be co-integration among variable. If no co-integration found in that case VAR model has been applied. Table 6.6 shows the result of Vector Error Correction Model.

Table 6.6 Result of VECM

Variables	Coefficient of Indian commodities	P-value	Coefficient of United States commodities	P-value
Aluminum				
Z	-0.437707	0.0019	-0.263102	0.0373

£$_{1, t-1}$	-0.104177	0.5841	-0.015129	0.9299
£$_{1, t-2}$	-0.238940	0.1583	-0.019722	0.8971
£$_{1, t-3}$	0.004839	0.9758	0.044039	0.7600
£$_{2, t-1}$	0.372227	0.0737	0.224034	0.7600
£$_{2, t-2}$	0.253048	0.1830	0.058743	0.7315
£$_{2, t-3}$	0.129289	0.4785	0.095565	0.5619
Constant	-0.001478	0.8733	-0.002863	0.7326
Copper Z	0.224058	0.4304	0.838121	0.0020
£$_{1, t-1}$	-0.879769	0.0009	-0.703173	0.0046
£$_{1, t-2}$	-0.359744	0.0786	-0.289684	0.1315
£$_{2, t-1}$	1.179785	0.0000	1.004162	0.0001
£$_{2, t-2}$	0.346582	0.1133	0.281932	0.1703
Constant	0.016215	0.6265	0.013295	0.6713
Cotton Z	0.005666	0.1253	0.013665	0.0006
£$_{1, t-1}$	0.176626	0.0248	-0.105778	0.2007
£$_{1, t-2}$	-0.027780	0.7243	-0.052485	0.5281
£$_{2, t-1}$	0.040438	0.5669	0.655581	0.0000
£$_{2, t-2}$	-0.028045	0.7004	-0.086685	0.2607
Constant	-0.002624	0.7704	0.000886	0.9256
Maize Z	-0.079434	0.0238	-0.049624	0.2129

£1, t-1	0.174414	0.0493	-0.083478	0.4068
£1, t-2	-0.188236	0.0326	-0.125788	0.2084
£1, t-3	-0.101091	0.2483	-0.056850	0.5687
£2, t-1	0.072818	0.3448	0.157037	0.3205
£2, t-2	0.214729	0.0066	0.088652	0.0754
£2, t-3	0.033611	0.6742	0.129310	0.1577
Constant	0.565808	0.5758	0.414532	0.7193
Natural Gas Z	0.680328	-0.042298	0.680328	0.0000
£1, t-1	-1.134263	0.0001	0.966770	0.0003
£1, t-2	-0.906700	0.0012	-0.762926	0.0029
£1, t-3	-1.013155	0.0001	-0.867450	0.0002
£1, t-4	-0.486334	0.0336	-0.389547	0.0625
£1, t-5	-0.646203	0.0012	-0.734453	0.0001
£1, t-6	-0.159140	0.3434	-0.161691	0.2932
£2, t-1	1.379673	0.0000	1.186936	0.0000
£2, t-2	0.832488	0.0039	0.741477	0.0049
£2, t-3	0.867856	0.0007	0.797913	0.0007
£2, t-4	0.521817	0.0257	0.488400	0.0226
£2, t-5	0.587440	0.0030	0.635697	0.0005
£2, t-6	0.236728	0.1592	0.287429	0.0625
Constant	0.049722	0.2594	-0.042298	0.2944

Nickel Z	-0.639260	0.0156	-0.661655	0.0137
£1, t-1	-1.808229	0.0125	-1.161320	0.1116
£1,t-2	0.115390	0.8937	0.442769	0.6135
£1, t-3	-0.152657	0.8634	0.182021	0.8398
£1, t-4	0.512222	0.5573	0.715358	0.4195
£1, t-5	0.760499	0.3612	0.926458	0.2733
£1, t-6	-0.012528	0.9851	0.256349	0.7063
£2, t-1	2.242976	0.0018	1.578015	0.0289
£2, t-2	0.000131	0.9999	-0.341259	0.6990
£2, t-3	-0.061971	0.9449	-0.377172	0.6786
£2, t-4	-0.482675	0.5853	-0.698196	0.4370
£2, t-5	-0.639779	0.4481	-0.777218	0.3641
£2, t-6	0.009893	0.9886	-0.300671	0.6690
Constant	0.021470	0.8714	0.013572	0.9197
Tin Z	0.675897	0.2750	1.499690	0.0160
£1, t-1	-1.721789	0.0030	-1.631328	0.0048
£1, t-2	-1.081979	0.0398	-1.110182	0.0346
£1, t-3	-0.640534	0.1543	-0.678536	0.1307
£1, t-4	0.247964	0.4475	0.251058	0.4410
£2, t-1	1.883160	0.0010	1.802708	0.0015

£2, t-2	1.262465	0.0165	0.277422	0.0151
£2, t-3	0.657638	0.1495	0.682252	0.1342
£2, t-4	-0.269751	0.4303	-0.258689	0.4485
Constant	0.038145	0.6674	0.039233	0.6579
Wheat Z	-0.068821	0.0013	-0.055341	0.1577
£1, t-1	0.153547	0.0444	0.182056	0.1954
£1, t-2	0.041996	0.5698	0.021043	0.8775
£2, t-1	0.149050	0.0005	0.222611	0.0044
£2, t-2	0.005011	0.9081	-0.131624	0.1020
Constant	0.057589	0.4449	0.038248	0.7835

Source: Author's calculation

Table 6.7 Result of VAR

Variables	Coefficient of Indian Commodities	P- value	Coefficient of U S Commodities	P- value
Crude oil £1, t-1	0.556406	0.0259	-0.393369	0.0979
£1, t-2	0.378383	0.2638	0.452018	0.1624
£1, t-3	0.025570	0.9394	0.164742	0.6082
£1, t-4	-0.196508	0.4209	-0.379586	0.1044
£2, t-1	0.780341	0.0029	1.769211	0.0000
£2, t-2	-0.606689	0.1115	-0.776949	0.0333

£2, t-3	-0.293749	0.4373	0.344026	0.3408
£2 t-4	0.288200	0.2658	0.446698	0.0716
Constant	4.594305	0.0042	4.294147	0.0050
Gold **£1, t-1**	0.600885	0.0040	0.183570	0.3660
£1, t-2	0.311367	0.1290	0.131544	0.5135
£2, t-1	0.569286	0.0077	1.327279	0.0000
£2, t-2	0.488073	0.0225	0.289739	0.1667
Constant	0.650297	0.0936	0.826591	0.0308
Lead **£1, t-1**	0.025487	0.8832	-0.224363	0.1692
£1, t-2	0.185154	0.2951	0.143200	0.3878
£2, t-1	1.278926	0.0000	1.425939	0.0000
£2, t-2	0.535214	0.0085	-0.448363	0.0186
Constant	0.222850	0.0006	0.219098	0.0003
Silver **£1, t-1**	0.157132	0.7415	-0.875742	0.0742
£1, t-2	-0.245512	0.6647	0.421448	0.4681
£1, t-3	1.208283	0.0080	1.149343	0. 0138
£2, t-1	1.372017	0.0036	2.051182	0.0000
£2, t-2	-0.086377	0.8765	0.112437	0.8436
£2, t-3	-1.107929	0.0168	1.037068	0.0288

Constant	0.020729	0.0469	0.021185	0.0475
Sugar $£_{1, t-1}$	1.124864	0.0000	0.001189	0.4577
$£_{1, t-2}$	-0.143651	0.0883	0.001221	0.4452
$£_{2, t-1}$	4.717842	0.2568	1.296589	0.0000
$£_{2, t-2}$	-4.818116	0.2466	0.330309	0.0000
Constant	0.645317	0.2165	0.020425	0.0408
Zinc $£_{1, t-1}$	1.091253	0.0000	100850	0.4562
$£_{1, t-2}$	-0.168419	0.0220	-0.076722	0.5661
$£_{2, t-1}$	0.144055	0.0007	1.161029	0.0000
$£_{2, t-2}$	0.146691	0.0005	-0.236511	0.0022
Constant	2.122795	0.0008	1.087902	0.3405

Source: Author's calculation

To know Short-run relationship among India's commodities market and United States' commodities market Wald test was applied. It can be used to test true values of parameters. Table 6.8 shows the result of Wald test. Short-run causality means Wald Statistic coefficients=0 means no short-run relationship. P value more than 5% means we can accept null hypothesis. It means the coefficients of both the independent variables are zero. There is no short causality in case of aluminum but in case of copper short-run relationship exists among both the market. In case of crude oil short run relationship runs from US to Indian prices but not from India to US prices. In case of gold, Lead, Natural Gas, silver, Tin, Wheat, and Zinc short run among prices of these two markets are confirmed. On the other side in case of maize and sugar short-run relationship is confirmed among the prices India to US but not confirmed US to

India. In case of cotton and nickel short-run relationship exit among the prices of US to Indian markets but not confirmed from India to US.

Table 6.8 Result of Wald Test

Indian commodities			**United States commodities**		
	F-Statistics	**P-Value**		**F-Statistics**	**P- Value**
Aluminum	1.364901	0.2555	**Aluminum**	0.506948	0.6780
Copper	16.65732	0.0000	**Copper**	22.01881	0.0000
Cotton	0.167049	0.8463	**Cotton**	50.13974	0.0000
Crude oil	14.09422	0.0000	**Crude oil**	1.748021	0.1592
Gold	4.046359	0.0192	**Gold**	142.4874	0.0000
Lead	23.94372	0.0000	**Lead**	33.44733	0.0000
Maize	0.955887	0.4156	**Maize**	4.882816	0.0010
Natural Gas	4.805550	0.0002	**Natural Gas**	6.992014	0.0000
Nickel	3.101152	0.0068	**Nickel**	1.858176	0.0913
Silver	4.133947	0.0074	**Silver**	16.62613	0.0000
Sugar	0.676104	0.5100	**Sugar**	1522.350	0.0000
Tin	4.701563	0.0013	**Tin**	4.396535	0.0021
Wheat	6.336015	0.0022	**Wheat**	630.6208	0.0000
Zinc	3.968161	0.0093	**Zinc**	18.04828	0.0000

Source: Author's calculation

The results of above study are somewhat similar to Swati (2017). Over all conclusions is that there is no short-run relationship runs among both the markets except copper, gold, natural gas, silver tin wheat, and Zinc. Over all, it can be said that both the markets are closely related but US market is much efficient in comparison of Indian commodity market. It can also be said that prices of Indian commodities are moving according to US commodity market or they are very much influenced by United States market.

Result of the study concludes that out of 14 commodities which includes two precious metals (Gold and Silver), six metals (Aluminum, Copper, Lead, Nickel, Tin and Zinc), and two from energy (Crude oil, Natural Gas) and four from agriculture (Cotton, Maize, Sugar and Wheat) only in seven Indian commodities long run association exist. It means in long run they can move together with United States Commodity market. These seven commodities include five metals (Aluminum, Copper, Lead, Nickel and Tin), one from energy (Natural Gas) and one from agriculture (Maize). For rest of the seven commodities no existence of long run association among these two markets. These seven commodities includes two from precious metal (Gold and Silver), one from energy (Crude oil), one from metal (Zinc), and three from agriculture (Cotton, Sugar and Wheat). It means in long run these two markets cannot move together. It suggests when there is no link among these markets investors are free to invest any of the market but same cannot be said about those Indian commodities which are linked with United States market. Investor should be careful while investing in these commodities.

CHAPTER 7

FINDINGS, CONCLUSION, AND SUGGESTIONS

Objectives of the Study is to examine the causal relationship, to identify volatility and price transmission as well as to study the long run and short run co-integration between Indian commodity market and United States commodity markets. For achieving the objective of study secondary data is collected from the official websites of both the commodities market. Various econometrics tools such as Generalized Auto-regressive Conditional Heteroskedasticity Test, Johansen Co-integration Test, Toda and Yamamoto Granger Causality Test, and vector error correction model have been used for analyzing the data. Major findings and conclusions based upon interpretations have been described in the present section. Some suggestions for investors, policy makers, brokers are also provided which are results-based.

7.1 Findings of the Study

The major findings of the study are given below:

7.1.1 CAUSAL RELATIONSHIP BETWEEN THE INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

1st objective of the study is to examine the causal relationship between the Indian commodity market and United States commodity market.

- The overall findings related to causality between the Indian commodities market and the market of the United States suggests that in case of Aluminum, copper, crude oil, gold, maize, wheat, and zinc unidirectional causal relationship among Indian commodity market and United States commodity markets.
- In case of cotton, lead and sugar no causality among Indian commodity prices and United States commodity prices.

- In case of natural gas, nickel, silver and Tin bi-directional causal relation among Indian commodity market and United States commodity prices.

7.1.2 VOLATILITY AND PRICE TRANSMISSION AMONG INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

2nd objective of study is to identify volatility and price transmission among Indian commodity market and United States commodity markets.

- Result of eleven commodities (aluminum, copper, crude oil, gold, natural gas, nickel, silver, tin, zinc) out of fourteen homogeneous commodities among India's commodities market and United States' commodities market indicates that previous day volatility and information both affects today's volatility. It means Indian commodity market's volatility is influenced by ARCH and GARCH factors means by own shocks or own volatility as well as United States also transmits volatility.
- In case of cotton, maize, sugar, Indian commodity market is influenced by its own shock. Not much influenced by United States commodity market.
- All it shows there is internal shocks and United State is an international shock. It means United States commodity market's volatility transmits into Indian commodity market also affected by internal shocks.
- It means that in maximum commodities today's behavior is influenced by previous day's volatility or information.
- On the other side, United States commodities (aluminum, crude oil, gold, natural gas, nickel, silver, Tin, and Zinc) are having internal shock, as well as Indian commodity market, also transmits volatility to United States commodity market. A previous day's behavior also affects today's behavior.
- In case of United States copper, lead has no transmission of volatility from Indian commodity market as well volatility not affected by its own shock.
- In case of lead, maize, sugar and wheat, today's return is not affected by previous day's volatility.
- Overall conclusion of the study is that volatility in Indian commodity market is largely dependent on its own shocks and also influenced by United States

commodity market but on the other side United States, commodity market is not much affected by its own shocks as well as Indian commodity market can not much contribute in the volatility of United States.

- Second part of the objective is price transmission among Indian commodity market and United States commodity. The result gives indication of existence of long-run association ship in some common commodities among Indian and United States commodities prices.
- Overall indications from result is that eight (Aluminum, copper, cotton, lead, natural gas, nickel, tin and wheat) out of fourteen homogeneous commodities among Indian commodity and United States commodity have price transmission.
- But on the other side, in case of six (crude oil, gold, maize, silver, sugar and zinc) out of fourteen have no price transmission among Indian commodity prices and United States commodity prices.

7.1.3 LONG RUN AND SHORT-RUN CO-INTEGRATION BETWEEN INDIAN COMMODITY MARKET AND UNITED STATES COMMODITY MARKETS

Objective three of study is to study the long run and short run co-integration between Indian commodity market and United States commodity markets. The key theme behind the co-integration of two markets is basically that the long-term variables shift together regardless of the variables themselves, which in the long run have moved too far apart. It is considered that the divergence between these variables is constant. This is thus described as co-integration (Hall and Henry, 1989; Ahmed et al., 2017). There are many studies which explored only long-run effect but ignore the short run, as well as a long run, affect together.

The overall result related to long-run co-integration among India's commodities market and United States' commodities market reveals that in relation to all commodities theses two markets are not co-integrated. It means there is no long-term relationship among these two markets. In case of few

commodities these markets are having a long run association. Result shows that long term association between Indian as well as United States Aluminum markets, no long term association exist between Indian and United States cotton market, long term association found between Indian Natural gas and United States Natural Gas, long term association between Indian nickel and United states Nickel market, long term association exist between Indian as well as United States tin market, no co-integration found among Indian and United States gold market, no co-integration among Indian maize market and United States maize market, no co-integration exist among Indian and United States sugar market, no co-integration exists among Indian and United States wheat market and no co-integration exist among Indian and United States zinc market.

- The overall result related to short-run co-integration among India's commodities market and United States' commodity market reveals that in relation to all commodities these two markets are not co-integrated in short run. But in relation to few commodities Indian commodity market and United States commodity markets are co-integrated. It means in short run they can move together in respect of these commodities. There is no short-run association in case of aluminum but in case of copper short association exists among both the market. In case of crude oil short run relationship runs from US to Indian prices but not from India to US prices. In case of gold, Lead, Natural Gas, Tin, Wheat, and Zinc short run among prices of these two markets are confirmed. On the other side in case of maize and sugar short-run relationship is confirmed among the prices India to US but not confirmed US to India. In case of nickel short-run relationship exit among the prices of US to Indian markets but not confirmed from India to US.

7.2 Conclusion

After financial crisis of 2007-08, Integration between domestic and world market integration has become one of the most attractive and interesting topics worldwide. In past, there are only a few studies which concentrate on domestic and global market integration with few commodities. Present study firstly

empirically examines co-integration among fourteen homogeneous commodities between India's commodities market and United States' commodities market. The objective wise inference drawn from the results discussed above is set out below:

7.2.1 Causal Relationship between the Indian Commodity Market and United States Commodity Markets

- Result of study confirms, a unidirectional causal relationship in case of eight commodities out of fourteen homogeneous commodities among India's commodities market and United States' commodities market (Aluminum, copper, crude oil, Gold, Lead, Maize, Wheat, and Zinc). Only in case of four homogeneous commodities result confirms, a bidirectional causal relationship (Natural Gas, Nickel, Silver, and Tin). In regards to rest of two commodities absence of causal relationship confirmed by results of study (cotton and Sugar).
- India is largest producer, consumer, and exporter of agricultural commodities which are trade on Indian commodity exchange. Unidirectional causal relationship among eight homogeneous commodities shows that Indian commodity is influenced by United States commodity market. It may be due to a global demand of these commodities.
- Unidirectional relationship means prices in Indian commodities market in regards to eight homogeneous commodities (Aluminum, copper, crude oil, Gold, Lead, Maize, Wheat, and Zinc) are highly influenced by United States commodity market.
- The existence of a uni-directional relationship between one market and another means that there is information productivity in the second market. It means United States commodity market has a strong impact on Indian commodity prices.
- Results confirm a bidirectional causal relationship in four homogeneous commodities (Natural Gas, Nickel, Silver, and Tin) among India's commodities market and United States' commodities market.

- Bidirectional causality means both the markets influence each other. Both markets are informational providers.
- In case of Natural Gas, Nickel, Silver and Tin two ways causality exists among India's commodities market and United States' commodities market. It means both the markets influences prices of each other commodity, but influence of United States commodity market is high as compare to Indian commodity market.
- Results of study indicate absence of causal relationship among India's commodities market and United States' commodities market in regards to two homogeneous commodities (cotton and sugar) out of fourteen commodities.
- If there is no connection among India's commodities market as well as United States commodities market, it means both the markets are independent. They have no impact on the prices of commodities of both the markets.
- If the effect of United States commodities prices is not as stronger, it can be due to higher government regulation (tariff barriers/subsidies) or because of disparities in inventory and transport costs.
- Overall recommendations from the results are in maximum number of homogeneous commodities unidirectional causality exists among India's commodities market and United States' commodities market. Means United States commodity market influences Indian commodity prices in maximum number of commodities. If there is causality in both ways, policymakers may interfere more efficiently in the desired directions within a rational time horizon to take action. Since there is no causal link in any of the directions, it implies that policymakers are expected to make further efforts to strengthen coordination between both markets so that they can effectively intervene in the desired direction to take action within a fair period of uncertainty.
- From investor's point of view, the result recommends that if no causal relationship among both the markets they can diversify their portfolio and gain profits.

- But same thing cannot be said id both the markets are having causal relationship because investor should be careful while including these commodities in their portfolio.
- Consistency of above mentioned results lied with Kumar and Pandey (2011) and Jena (2016).

7.2.2 Volatility and Price Transmission among Indian Commodity Market and United States Commodity Markets

- The overall findings related to volatility spillover among India's commodities market and United States' commodities market shows that own past shocks are much important in the markets, India's commodities market, and United States' commodities market.
- Result of above study indicates high volatility spillover among Indian commodity market and United States commodity market. Even it can be said that own past shocks, as well as volatility, is much important for current volatility forecasting.
- Results of the study recommend Indian commodity market is much affected by volatility spillover as compared to United States commodity market. Indian commodity market is much affected by its own shocks.

- Unlike current investors, those who have come under a new class of investors are investing in different markets, as a result, in normal times; risk-sharing in financial markets is increased. During times of financial market stress, they transfer shocks, crashes, and economic vulnerabilities from one market to the next.
- Moreover, in order to hedge their risk, investors can take a place in both markets. Since the financial crisis, positive ties between the commodity market and the stock market have been established. The explanation behind this is that after the time of volatility, investors became more vigilant and began to respond more to the shock in these markets.
- A symbol of the presence of high risk facing investors is high volatility in every sector. If speculative investors are still involved in the commodity market, it has an influence on the market.

- Result also indicates the absence of volatility spillover in some commodities. The reason behind it may be investors executed effectual hedging strategies to protect themselves from price volatility.
- As compared to the shock spillover effect, the magnitude of the volatility transmission effect is very high, implying that past own shocks and volatilities are more significant in forecasting current volatility.
- The integration among two international commodities markets attracted after the financial crisis of 2008-09, which might be due to the herding behavior of investors.
- In a few commodities, two ways volatility transmission is found. It means Indian commodity market, as well as United States commodity, transmits volatility spillover.
- Overall, it can be concluded that the US market plays a significant role in the transmission of information to the Indian market. Overall, we also find that as a satellite market, the Indian commodity markets are running. They are able to assimilate knowledge from world markets by spillovers of return and uncertainty.
- Overall indications from result is that eight (Aluminum, copper, cotton, lead, natural gas, nickel, tin, and wheat) out of fourteen homogeneous commodities among Indian commodity and United States commodity have price transmission but rest of the six commodities (crude oil, gold, maize, silver, sugar, and zinc) have no price transmission
- It may be due to economic cyclical changes. Because due to recession demand of basic products may be reduced.
- It may also be due to effectiveness of delay in price transmission policies stabilization. That can be shocks in many commodities.
- If there is no integration among two markets then price transmission among these two markets will not be symmetric.
- Due to all these even fluctuations can take place.
- Results of the study are somehow similar with Bohl et al., (2018), Jena (2016) and Khalifa et al., (2011).

- Investor can make hedging strategies by knowing about volatility. Because flow of information is very much important for hedging strategy. it is found that volatility is taking place from United States commodity market to Indian commodity market. Higher volatility leads to higher prices that will increase input cost reduce demand and reduce investment.

7.2.3 Long-run and Short-run Co-integration between Indian Commodity Market and United States Commodity Markets

- Analysis of study indicates long-run co-integration exists among seven homogeneous commodities (Aluminum, copper, Lead, Maize, Natural Gas, Nickel, and Tin) out of fourteen homogenous commodities among Indian and United States commodities market.
    - If long-run co-integration exists among two markets it means in long run they can move together.
    - In case of seven commodities, it can be said that prices of Indian commodities are co-moving with United States commodities.
    - Overall it can be said that Indian commodity market and United States commodity markets are efficient for information incorporation.
    - Hua and Chen (2007) examined same type of relationship and found co-integration with world market.
    - Recommendation of study is that United States commodity market contains appropriate information for the prediction of Indian commodities prices (Aluminum, copper, Lead, Maize, Natural Gas, Nickel and Tin). It means that two markets will run together in the long run if there is no common stochastic distress in any of them.
    - There will be transmission of shocks from United States market to Indian commodity market.
    - In case of rest of seven commodities (Cotton, Crude oil, Gold, Silver, Sugar, Wheat and Zinc) no co-integration exists among Indian and United States commodities market. It means no co-movement among prices of Indian and United States commodities.

- Results of study recommend that United States commodity market is not containing appropriate information for predicting Indian commodities prices (Cotton, Crude oil, Gold, Silver, Sugar, Wheat and Zinc). This means that when a similar stochastic distress occurs in one of the markets, no market move together in the long run.
- Another suggestion of the study is that Indian commodity market is not directly linked with United States commodity market and has no power of return prediction. It implies that two market variables that cannot shift in the same direction have no co-integration.
- In the event of market instability, shocks are not passed from one market to the next.
- Results are somewhat similar to Hua and Chen, (2007); Kumar and Pandey (2011) and Jena (2016).
- Result of study indicates short run relationship exist in all homogeneous commodities (copper, cotton, crude oil, gold, Lead, maize, Natural Gas, Nickel, Silver, Sugar, Tin, Wheat, and Zinc) among India and United States commodity market except Aluminum.
- If short-run co-integration exists it means in short-run they can move together. Study also indicates informational relation among India's commodities market as well as United States' commodities market.
- Trading strategy can be formulated on these bases. Even it can be said that for hedgers there is a profit opportunity.
- In case of aluminum, no short-run relationship among Indian and United States commodity market. It means they cannot move together. None of the market is informational provider.
- On the other side in regards to copper, gold, lead, Natural Gas, silver, Tin, Wheat and Zinc two-way short term relationships is confirmed among Indian and United States commodity market. Both are informational provider to each other.

- In case of crude oil, cotton, maize, Nickel and sugar only one way short run relationship exists. It can be said that only one market is informational provider.
- In case of Maize and Sugar one was short-run relationship. Flow of information is from India to United States.
- On the other side, in case of cotton and nickel there is also one-way short-run relationship, but flow of information is from United States to India.
- Overall recommendation of study is that to devise any trading strategies, this long run as well as short run connection among these two markets is potentially beneficial. And the simulation of trading shows that very few profit prospects exist for hedgers on a regular basis. The United States and Indian commodity markets are both found to be efficient on a regular basis, so there is so little efficiency for profit. But it is found that the United States commodity market is more successful than the Indian commodity market. It may be due to lack of participation of investors in a commodity market. This may be due to a lack of experience and information.
- One of the increasing concerns among policy makers is the creation of an effective strategy to increase integration between the Indian market for commodities and the United States commodities market. The results of this study will enable policy makers to frame their policies and strategies that can create investor trust in the commodity market and thus increase convergence among the India's commodities market and the commodity market of the United States.
- Results of above study are somewhat similar to Swati (2017).
- Because of importance of Indian commodity market in world and due to trade liberalization Indian market should be co-integrated with United States market. US market provides leading role in price discovery process. India has become the fastest growing commodity market in the world. Indian commodity market may respond to US commodity market.

- From review of literature like kaur and Dhiman (2019), Periasanmy (2018) and Rajesh (2014) as well as SEBI's annual report it was found that despite the fact that the Indian commodity market has been expanding in recent years, investor engagement remains low. Less awareness among investors was the main cause behind it.

7.3 Suggestions

For investor it is important issue that there is long run as well as short run co-integration among Indian commodity market and United States commodity market. The fact that investors can reduce their risk by swapping from one market to another is well known. Policy makers should make regulatory changes from a policy point of view to facilitate greater financial integration between these markets.

7.3.1 Suggestions for Investors and Brokers

Investors and brokers will benefit from this analysis. For market professionals and investors such as hedgers, portfolio managers, financial analysts and asset allocators, an understanding of the definition of volatility spillovers across distinct markets is needed. In order to better resist it during the time of financial instability, it is important for investors to adjust their portfolio. If an investor owns an Indian commodity and wants to hedge its position adjacent to the other commodity markets unpredictable fluctuations. The investor's key purpose is to decrease the chances of risk without losing the expected return. This motive can be satisfied by the optimum weights and hedge ratio.

Hedging is at the most basic level, the act of minimizing risks arising from unforeseen potential commodity prices by simultaneously adopting opposite and equivalent positions in the physical and derivatives markets. Commodity derivative exchanges make it easier for investors to take acceptable hedging positions and to disseminate prices of both futures and spot markets to that end. Exchanges have now emerged as one of the most significant Price risk management institutions serve the role of every stakeholder. Although hedging has generally proven to be one of the most common risk management

strategies, it is important to test its effectiveness and quantitatively estimate its effectiveness as a risk management method.

Table 7.1 describes the result of hedge ratio and hedge efficiency. The minimal variance hedge ratio is determined by the co-efficient of the dependent variable. The hedging efficiency is represented by the R square values of the regression equation Hedging efficiency of Indian aluminum and United States aluminum is almost same. It means both can be equally considered. But hedge ratio of United States is high as compare to Indian aluminum. In case of copper hedging efficiency of both the markets are equal but hedge ratio of Indian market for copper is 0.00494 high as compare to United States copper market. For crude oil hedging efficiency of both the market is equal but hedge ratio of United State is 0.142377 high as compare to Indian crude oil market. For gold hedging efficiency of both the market is equal but hedge ratio of Indian market is 0.185449 high as compare to United States gold market. For lead hedging efficiency of United States market is .000186 high but hedge ratio of Indian market is .36486 high as compare to United States market. For maize hedge efficiency of both the markets are equal but hedge ratio of United States market is 0.680263 high as compare to Indian market. In case of natural gas hedge efficiency of both the markets are equal but hedge ratio of Indian market is 0.680263 high as compare to United States commodity market. For nickel hedge efficiency of both the market is equal but hedge ratio of Indian market is 0.020512 high as compare to United State market. For silver hedge efficiency as well as hedge ratio of Indian market is 0.015563 and 0.043781 high as compare to United States market. For sugar hedge efficiency of both the markets are equal but hedge ratio of Indian market is 27.006737 high as compare to United States market. For tin hedge efficiency of both the market is equal but hedge ratio of Indian market is 0.001783 high as compare to United State market. For wheat hedge efficiency of both the market is equal but hedge ratio of United State is 0.559602 high as compare to Indian market. For zinc hedge efficiency of both the market is equal but hedge ratio of Indian market is 0.040503 high as compare to United States market.

Table 7.1 Hedge Ratio and Hedge Efficiency

Variables	Hedge Ratio	Hedge Efficiency	Hedge Ratio	Hedge Efficiency
	Indian Commodity Market		United States Commodity Market	
Aluminum	0.973211	0.960074	0.986502	0.960074
Copper	0.992898	0.985357	0.992404	0.985357
Cotton	0.101030	0.013893	0.137513	0.013893
Crude oil	0.914100	0.965725	1.056477	0.965725
Gold	1.084781	0.975578	0.899332	0.975578
Lead	1.003017	0.969261	0.966531	0.969447
Maize	0.432869	0.481840	1.113132	0.481840
Natural gas	1.020547	0.977321	0.957644	0.977321
Nickel	1.009871	0.999125	0.989359	0.999125
Silver	1.036665	0.992884	0.957644	0.977321
Sugar	27.01430	0.204313	0.007563	0.204313
Tin	0.998886	0.997103	0.998215	0.997103
Wheat	0.258826	0.211830	0.818428	0.211830
Zinc	1.012884	0.984909	0.972381	0.984909

Source: Author's calculation

Overall recommendation of the study is in maximum homogeneous commodities among these two market hedge efficiency is equal but as per as hedge ratio is being concerned that is different in all homogeneous commodities among India's commodities market and United States' commodities market.

The findings show the absence of co-integration among the India's commodities market as well as the United States market in regards to some commodities. Investors can reduce their exposure in both commodity markets by diversifying their portfolio. Investors may use the results of the lack of a causal relationship between the Indian commodities market and the US commodity market to create optimal portfolio and hedging strategies in the presence of various commodities.

7.3.2 Suggestions for Policy Makers

- Only in few commodities there is co-integration among Indian commodity and United States commodity market. Co-integration among these two markets will boost up the confidence of investors as well as more involvement of investors in Indian commodity market. SEBI must devise successful strategies to improve co-integration between these two commodities markets.
- In some of the commodities, there is a risk spillover that may be because of high trading rate in these commodities. In order to increase the relation between the Indian commodity market and the United States Commodity Market, policymakers should take the necessary measures to boost retailers' interest in the commodity market. The size of trade in the commodity market can be increased by providing new commodities to investors. In order to improve trade in the commodity markets, transaction costs should be reduced by the government. In addition, realistic instruction to improve financial literacy needs to be placed in place for financial education programmes.
- It is important to enforce risk-return plans assured through policy makers. Due to absenteeism of such strategies, knowledgeable investors and financial analysts can shift in the opposite direction in order to hedge their risks, as the volatility of both commodity markets increases**.** This study provides the hedge efficiency and hedge ratios that SEBI can provide investors with in order to reduce the financial volatility of commodity prices and to increase the share of investors in the commodity market, thereby raising the co-integration of the two commodity markets.

7.3.3 Social Impact

- This research enhances the prospect of commodity market in India. As a whole, the potential and competitive advantage of exchanges can be strengthened and beneficial for the Indian economy as a whole. Developments in systematized commodity markets and their constituents mean that, in terms of trade generation, farmers' growth and job opportunities, there will be immense advantages and benefits to the Indian economy. With India exporting

masses of commodities, there is potential for the Indian economy as a whole to reduce the price risk of foreign commodities. With rising commodity consumption, especially in developing countries like India, commodity prices are volatile, highlighting the need for structured commodity derivatives exchanges for participants in the commodity markets ecosystem. A thriving, active, and liquid commodity market is also usually regarded as a positive sign of a country's economic growth. It is also commonly assumed that the expansion of a transparent commodity market is a sign of an economy's growth. As a result, it is essential for India to have active commodity markets.

7.4 Limitations and Future Scope

- This study is limited to two international commodities markets India and United State.
- Further study can be done with other countries commodities market.
- This study is limited to spot prices. Further study can be done with future prices.

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