DYNAMIC INTERACTIONS OF THE WORLD GOLD MARKETS

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I, **S. Maria Immanuvel** hereby declare that the thesis entitled "**Dynamic Interactions of the World Gold Markets**" submitted to Pondicherry University for the award of the Degree of **Doctor of Philosophy in Commerce** is my original work and it has not been previously submitted either in part or whole to this or any other University for the award of any degree.

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To

My Guide

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ABBREVIATIONS

ADF	-	Augmented Dickey Fuller
AIC	-	Akaike Information Criterion
ARCH	-	Autoregressive Conditional Hetroskedasticity
ARDL	-	Autoregressive Distributed Lags
ARIMA	-	Autoregressive Integrated Moving Average
ARMA	-	Autoregressive Moving Average
CAPM	-	Capital Asset Pricing Model
CBOT	-	Chicago Board of Trade
CCC Model	-	Constant Conditional Correlation Model
COMEX	-	Commodity Exchange
CPI	-	Consumer Price Index
CRB	-	Commodity Research Bureau
ECM	-	Error Correction Model
EGARCH	-	Exponential Generalised Autoregressive Conditional Hetroskedasticity
FPE	-	Final prediction error
GARCH	-	Generalised Autoregressive Conditional Hetroskedasticity
GCBEW	-	Granger Causality Block Exogenity Wald test
GDP	-	Gross Domestic Product
GFMS	-	Gold Field Mineral Services
HQ	-	Hannan-Quinn information criterion
IBMA	-	Indian Bullion Market Association
IEMH	-	Incrementally Efficient Market Hypothesis
IMF	-	International Monetary Fund

INR	-	Indian Rupees
IRF	-	Impulse Response Function
IU	-	Instantaneously Unpredictable
KSE	-	Karachi Stock Exchange
LBMA	-	London Bullion Market Exchange
LCAP	-	Large Capitalisation
MCAP	-	Mid Capitalisation
MCX	-	Multi Commodity Exchange
NCDEX	-	National Commodity Exchange
NIFTY	-	Nifty Fifty
NYMEX	-	New York Mercantile Exchange
PP	-	Phillips Perron
S&P 500	-	Standard & Poor 500
SC	-	Schwarz information criterion
SCAP	-	Small Capitalisation
SENSEX	-	Sensitivity Index
SGE	-	Shangai Gold Exchange
TOCOM	-	Tockyo Commodity Exchange
VAR	-	Vector Autoregression
VDC	-	Variance Decomposition
VECM	-	Vector Error Correction Model
VIX	-	Volatility Index
WGC	-	World Gold Council
WPI	-	Wholesale Price Index

Chapter

1

Dynamic Interactions of the World Gold Markets

Introduction

CHAPTER – I

INTRODUCTION

1.1 PREAMBLE

"Gold that's put to use more gold begets" – Shakespeare

Gold is an evergreen and noble metal highly valued by mankind since antiquity as an adornment for cultural status and decorative purposes as possessions that symbolise wealth and for coinage. It is also owned as an investment. Gold is a relatively scarce metal in the world and a scarce commodity in India. For centuries, gold has meant wealth, prestige, and power, and its rarity and natural beauty have made it precious to men and women alike. Owing gold has long been a safeguard against disaster. Many times when paper money has failed, men have turned to gold as the one true source of monetary wealth. Today is no difference. Throughout history and across cultures, gold has adorned countless temples and cathedrals. The crowns of kings were made of gold. Top athletes compete in the Olympics for gold medals. In the past, even the money used to buy the things the heart desire was made of gold. Man's attraction to gold is psychological (perhaps even instinctive) and cannot be explained. Humans will continue to be awed by gold and instinctly want to hoard as much gold as possible.

Gold is a comparatively dense, shiny, yellow metall. As an element, gold is quite resistant to corrosion (by oxygen, but also many other chemicals). There are medical (dentistry), chemical and industrial applications of gold. However, aside these rather limited applications (for which, in fact, gold often can be substituted with other materials like copper, ceramics etc.) the metal is more or less useless. Gold is a very dense metal with a density of 19.32 g/cm3 which gives it a very heavy atomic weight of 196.9665 g/atom. In practical terms, this means that a litre carton of gold weighs 19.3 kg, so it's nearly 20 times heavier than water. A one tonne cube of gold would have edges of around 37 centimetres - a bit over a foot. It would store value of well over $12 million in very little space. It is so distinctively heavy that solid gold offers its own immediate qualitative verification in the hand. Gold's heaviness is also

important in that it means large amounts of gold can be stored in relatively small spaces, like bank vaults, in which the same value of gold can be stored in one hundredth of the space which would be required for silver.

Gold is extremely rare. According to all geological experience, it is found only in low concentrations in rocks. Its average concentration in the Earth's crust is 0.005 parts per million. The amount of gold that has been found or dug out in human history is estimated at 120,000 to 140,000 metric tons (1 metric ton = 1000 kilogram). This amount of gold would fit into one massive cube with edges of a length of 19 meters (imagine a cubic 6-storey house made of massive gold). Around 20-25% (30,000 metric tons) of this gold is hoarded by central banks. The rest is privately owned jewellery (70,000-80,000 metric tons) and bullion (20,000 metric tons). In other words, most of the world's gold is in private hands. The amount of gold that is mined per year is comparatively stable at just above 2% of the world's above ground gold (around 2,600 metric tons per year)[1].

The uniqueness of gold is that it has consistently reverted to its historic purchasing power parity and proved to be an effective preserver of wealth. During periods of financial, economic and social turmoil, gold has been a safe refuge when the value of other assets were all but destroyed

1.2 PROPERTIES OF GOLD

1.2.1 Gold weights and measures

The traditional unit of weight for gold is the troy ounce, named, it is thought, after a weight used at the annual fair at Troyes in France in the Middle Ages. Although the metric system is used increasingly in mining and the gold business, the troy ounce remains the basic unit in which the price of 995 gold is quoted. One troy ounce = 31.1034807 grams, 32.15 troy ounces = 1 kilogram, 1 troy ounce = 480 grains, 1 troy ounce = 20 pennyweights (North American jewellery trade), 3.75 troy ounces = 10 tolas (Indian sub-continent), 6.02 troy ounces = 5 taels (Hong Kong), 1 troy ounce = 155.52 metric carats (diamonds/precious stones).

[1] The information is sourced from gold.approximity.com/gold and www.galmarley.com

Table No: 1.1
Fine Gold Contents in Ounces Troy

Gross Weight	Bars of 995.0	Bars of 999.0	Bars of 999.9
1 Kilo	31.99	32.119	32.148
1/2 Kilo	15.995	16.059	16.074
100 Grams	3.199	3.212	3.215
50 Grams	1.6	1.607	1.608
10 Grams	0.321	0.322	0.322
5 Grams	0.161	0.161	0.161
10 Tolas	3.731	3.746	3.75
5Taels	5.987	6.011	6.017

1.2.2 Carat

The purity of gold is described by its 'fineness' (parts per thousand) or by the carat (karat in the United States) scale. The word comes from the Greek karation, the Italian carato and the Arabic qirat, all meaning 'fruit of the carob tree'. The carob seed was formerly used to balance the scales in Oriental bazaars. Since pure gold is soft and liable to wear down, it has always been alloyed with other metals to make it harder. The proportion of gold is defined by the carat scale. Pure gold is 24 carat (or 1,000 fine).

The proportion of gold in jewellery varies considerably from country to country and is preserved not only by custom but often by law. The advantage of lower caratage is that a wider range of colour can be attained, from green to red and white golds, depending on the balance of other metals with which it is alloyed. Strength, hardness and hence wear and scratch resistance tend to increase as caratage is lowered. The validity of the caratage stamped on each piece of jewellery is often guaranteed by an official hallmarking system.

1.2.3 Fineness of Gold

Fineness of gold refers to the gold content in 1,000 parts of a bar or alloy. A normal 'good delivery bar' is 995 parts of pure gold and five parts other metals or impurities. The gold market accepts bars only up to a purity of 999.9 (four nines) but in electronics a bonding wire of 999.99 (five nines) is used. The fineness is usually stamped along with the refiner's or assayer's mark. Fineness is also expressed in

carats, especially in the jewellery trade. All jewellery is required by law to be stamped so that consumers will know the quality of gold used. Jewellery made in North America is typically marked with the karat grade (e.g. 10K, 14K), while jewellery made in other countries may be marked with its fineness (e.g. 417, 583). So jewellery should either have a karat grade stamped on it, or a 3-digit fineness number.

Table No: 1.2
Carat and Fineness of gold

Carat	Parts Gold to Alloy	Percentage	Fineness
8K	8/24	33.33%	333
10K	10/24	41.67%	417
12K	12/24	50.00%	500
14K	14/24	58.33%	583
18K	18/24	75.00%	750
16K	16/24	66.67%	666
20K	20/24	83.33%	833
22K	22/24	91.66%	916
24K	24/24	99.99%	999

Source: http://www.taiba.ae/goldinfo.php

1.2.4 Hallmark

Unless alloyed with a comparatively small proportion of some other metal, both pure gold and pure silver are too soft to withstand wear as an article for use or adornment. This necessity has always demanded some system of control. Frauds on the public are to be prevented, because adulteration of articles manufactured from the precious metals by the introduction of too much of the strengthening alloy is a type of fraud to which the public is extremely vulnerable. It is easy to perpetrate, because with both metals a considerable excess of alloy can be introduced without changing the colour, and is difficult to detect without technical tests.

A mark or number of marks, made on gold, silver or platinum jewellery or plate to confirm that its quality is up to the correct legal standard. In much of Europe that would be 18 carat for gold; in Britain the legal standards are 22, 18, 14 and 9 carat. The concept of the hallmark originated in England in the thirteenth century and systematic hallmarking began in 1300. Shortly thereafter it came under the control of the Worshipful Company of Goldsmiths in London, who still operate one of four

authorised assay offices hallmarking jewellery in Britain. Indeed, strictly speaking, 'hallmark' means the mark of the Goldsmiths' Hall in London, but the term has taken on a broader connotation.

In India, BIS Hallmark for purity and fineness is as given below:

958 – Corresponding to 23 carat	750 - Corresponding to 18 carats
916 –Corresponding to 22 carats	585 - Corresponding to 14 carats
875 - Corresponding to 21 carats	375 - Corresponding to 9 carats

1.2.5 Refining/Refineries

The separating and purifying of gold from other metals is called refining, as distinct from smelting which is the separation of gold from non-metallic impurities. Gold going through refineries may either be recycled scrap being purified and upgraded, or on the final stage of its transformation from ore in the mine to bullion bars. In major refineries two basic processes are used: the Miller Process, employing chlorine as the purifying agent; or electrolysis, a technique originally developed in the 1870s by Dr Emil Wohlwill and since then, much modernised. Using chlorine, gold can be refined up to a fineness of 995 parts per thousand but for fineness up to 999.9, electrolysis is essential. Markets do not recognise bars stamped with a fineness higher than 999.9 although a 999.99 (five nines) gold wire is refined for the electronics industry.

1.3 A BRIEF HISTORY OF GOLD

A child finds a shiny rock in a creek, thousands of years ago, and the human race is introduced to gold for the first time. Gold was first discovered as shining, yellow nuggets. "Gold is where you find it," so the saying goes, and gold was first discovered in its natural state, in streams all over the world. No doubt it was the first metal known to early hominids. Since gold is dispersed widely throughout the geologic world, its discovery occurred to many different groups in many different locales. Nearly everyone who found it was impressed by it, and so was the developing culture in which they lived.

Gold was the first metal widely known to our species. Prospecting for gold was a worldwide effort going back thousands of years, even before the first money in the form of gold coins appeared about 700 B.C. In the quest for gold by the Phoenicians, Egyptians, Indians, Hittites, Chinese, and others, prisoners of war were sent to work in the mines, as were slaves and criminals. And this happened during a time when gold had no value as 'money,' but was just considered a desirable commodity in and of itself. The 'value' of gold was accepted all over the world. When thinking about the historical progress of technology, we consider the development of iron and copper-working as the greatest contributions to our species' economic and cultural progress - but gold came first. The "Gold of Troy" treasure hoard, excavated in Turkey and dating to the era 2450 -2600 B.C., show the range of gold-work from delicate jewelry to a gold gravy boat weighing a full troy pound. Homer,in the "Iliad" and "Odyssey," makes mention of gold as the glory of the immortals and a sign of wealth among ordinary humans. In Genesis 2:10-12, we learn of the river Pison out of Eden, and "the land of Havilah, where there is gold: and the gold of that land is good?" The timeline in the world gold markets are compiled from many sources and presented in Table No: 1.3.

Table No: 1.3

Brief History of Gold

4000 BC	Gold is first known to be used in parts of Central and Eastern Europe.
3000	The Egyptians master the arts of beating gold into leaf and alloying gold with other metals to achieve variations in hardness and color. They also develop the ability to cast gold, using the lost-wax technique still used in today's jewelry industry. The Sumer civilization of southern Iraq uses gold to create a wide range of jewelry, often using sophisticated and varied styles still worn today.
2500	Gold jewelry is buried in the Tomb of Djer, the king of the First Egyptian Dyanisty, at Abydos, Egypt.
1500	The immense, gold-bearing regions of Nubia make Egypt a wealthy nation, as gold becomes the recognized standard medium of exchange for international trade. The Shekel, a coin originally weighing 11.3 grams of gold, is used as a standard unit of measure throughout the Middle East. The coin contained a naturally occurring alloy called electrum, which was approximately two-thirds of gold and one-third silver.
1352	The young Egyptian King Tutankhamun is interred in a pyramid tomb laden with gold, his remains laid in an extravagant gold anthropoid sarcophagus.
1350	The Babylonians begin to use fire assay to test the purity of gold.

1091	Squares of gold are legalized in China as a form of money.
560	The first coins made purely from gold are minted in Lydia, a kingdom of Asia Minor.
58	Julius Caesar seizes enough gold in Gaul (France) to repay Rome's debts.
50	The Romans issue a gold coin called the Aureus.
600-699 AD	The Byzantine Empire resumes gold mining in central Europe and France, an area undeveloped since the fall of the Roman Empire. Artisans of the period produce intricate gold artifacts and icons.
1100	Venice secures its position as the world's leading gold bullion market due to its location astride the trade routes to the east.
1284	Venice introduces the gold Ducat, which soon becomes the most popular coin in the world, and remains so for more than five centuries. Great Britain issues its first major gold coin, the Florin, which is followed by the Noble, the Angel, the Crown, and the Guinea.
1511	King Ferdinand of Spain sends explorers to the Western Hemisphere with the command to "get gold."
1717	Isaac Newton, Master of the London Mint, sets price of gold that lasts for 200 years.
1787	First US gold coin is struck by Ephraim Brasher, a goldsmith.
1792	The Coinage Act places the young United Sates on a bimetallic silver/gold standard, defining the U.S. Dollar as equivalent to 24.75 grains of fine gold, and 371.25 grains of fine silver.
1803	North Carolina site of first US gold rush. The state supplies all the domestic gold coined for currency by the US Mint in Philadelphia until 1828.
1848	The California gold rush begins when James Marshall finds specks of gold in the water at John Sutter's sawmill near the junction of the American and Sacramento Rivers.
1850	Edward Hammong Hargraves, returning from California, predicts he will find gold in Australia within one week. He discovers gold in New South Wales within one week of landing.
1859	The Comstock Lode of gold and silver is discovered in Nevada. As a result, Nevada is made a state five years later.
1886	George Harrison, while digging stones to build a house, discovers gold in South Africa.
1887	Glasgow doctors, Robert and William Forrest, and chemist John S. MacArthur patent the process for extracting gold from ore using cyanide.
1896	Two prospectors discover gold while fishing in the Klondike River in northern Canada, richer finds were rumored farther south in Alaska's Yukon, spawning the Alaska Gold Rush in 1898 -- the last gold rush of the century.
1900	US adopts the gold standard for its currency.
1903	The Engelhard Corporation introduces an organic medium to print gold on surfaces. First used for decoration, the medium becomes the foundation for microcircuit printing technology.
1922	King Tutankhamun's tomb (1352 BC) opened to reveal a 2,448 lb. gold coffin and hundreds of gold and gold-leafed objects (including

	the mask pictured at the beginning of this section).
1927	A Medical study in France proves gold to be valuable in treatment of Rheumatoid arthritis.
1933	President Franklin D. Roosevelt bans the export of gold, halts the convertibility of dollar bills into gold, orders US citizens to hand in all the gold they possess and establishes a daily price for gold.
1934	Roosevelt fixes price of gold at $35 per ounce.
1935	Western Electric Alloy #1 (69% gold, 25% silver and 6% platinum) finds universal use in all switching contacts for AT&T telecommunications equipment.
1944	The Bretton Woods agreement sets an international gold exchange standard and creates two new international organizations, the International Monetary Fund (IMF) and the World Band. The new standard sets par values for currencies in terms of gold and obligates member countries to convert foreign official holdings of their currencies into gold at these par values.
1947	The first transistor, the building block for electronics, is assembled at AT&T Bell Laboratories. The device uses gold contacts pressed into a germanium surface.
1961	Modern-day mining begins in Nevada's Carlin Trend, ultimately making Nevada the nation's largest gold-mining state.
1968	Intel introduces a microchip with 1,024 transistors connected by gold circuits. On March 15, central banks give up fixed price of gold at $35 per troy ounce and let it free float.
1969	Gold coated visors protect the astronauts' eyes from searing sunlight on the moon (Apollo 11 moon landing).
1970	The charged coupled device is invented, using gold to collect electrons generated by light, eventually used in hundreds of military and civilian devices, including video cameras.
1971	The colloidal gold marker system is introduced by Amersham Corporation of Illinois. Tiny spheres of gold are used in health research laboratories worldwide to mark or tag specific proteins to reveal their function in the human body for the treatment of disease.
1971	U.S. President Richard Nixon takes the dollar off the gold standard, which had been in place with minor modifications since the Bretton Woods Agreement of 1944 fixed the conversion rate for one troy ounce of gold at $35.
1972	The United States devalues the dollar to $38 per ounce of gold
1973	The U.S. Dollar is removed from gold standard, and gold prices are allowed to float free. By June, the market for gold in London reaches more than $120 per ounce.
1974	On December 31, US government ends its ban on individual ownership of gold.
1976	The Gold Institute is established in Washington, D.C., to promote the common interests of the gold industry by providing statistical data and other relevant information to its members, the media, government, and the public.

1980	Gold reaches intra-day historic high price of $870 on January 21 in New York.
1986	Gold-coated compact discs are introduced.
1987	Airbags are introduced for cars, using gold contacts for reliability.
1992	Non-Resident Indians (NRIs) on a visit to India were each allowed to bring in up to 5 kilos (160.7 oz) on payment of a small duty of six per cent. This allocation was raised to 10 kilos in 1997.
1994	In India Gold dealers could bid for a Special Import Licence (SIL) which was issued for a variety of luxury imports.
1996	The Mars Global Surveyor is launched with an on-board gold-coated parabolic telescope-mirror that will generate a detailed map of the entire Martian surface over a two-year period.
1997	Congress passes Taxpayers Relief Act, allowing US Individual Retirement Account holders to buy gold bullion coins and bars for their accounts as long as they are of a fineness equal to, or exceeding, 99.5 percent gold. Open General Licence (OGL) was introduced, paving the way for substantial direct imports by local banks from the international market, thus partly eliminating the regional supplies from Dubai, Singapore and Hong Kong.
1999	The Euro, a pan-European currency, is introduced, backed by a new European Central Bank holding 15 percent of its reserves in gold. Gold falls to a low at $251.70 on worries about central banks reducing reserves of gold bullion and mining companies selling gold in forward markets to protect against falling prices.
2000	Astronomers at the Keck Observatory in Hawaii use the giant gold-coated mirrors of the observatory's twin telescopes to produce the most detailed images of Neptune and Uranus ever captured.
2003	Gold reaches a 4- year high on safe-haven buying in the run-up to the invasion of Iraq.
December 2003-January 2004	Gold breaks above $400, reaching levels last traded in 1988. Investors increasingly buy gold as risk insurance for portfolios.
November 2005	Spot gold breaches $500 for the first time since December 1987, when spot hit $502.97.
April 11, 2006	Gold prices surpass $600, the highest point since December 1980, with funds and investors pouring money into commodities on a weak dollar, firm oil prices and geopolitical worries.
May 12, 2006	Gold prices peak at $730 an ounce with funds and investors pouring money into commodities on a weak dollar, firm oil prices and political tensions over Iran's nuclear ambitions.
June 14, 2006	Gold falls 26 percent to $543 from its 26-year peak after investors and speculators sell out of commodity positions.
November 7, 2007	Spot gold hits a 28-year high of $845.40 an ounce.
January 2, 2008	Spot gold breaks above $850.
March 13,	Benchmark gold contract trades over $1,000 for the first time in U.S.

2008	futures market.
March 17, 2008	Spot gold hits an all-time high of $1,030.80 an ounce. U.S. gold futures touch record peak of $1,033.90.
September 17, 2008	Spot gold rises by nearly $90 an ounce, a record one-day gain, as investors seek safety amid turmoil on the equity markets.
Jan-March 2009	Gold-backed exchange-traded funds report record inflows in the first quarter as financial sector insecurity spurs safe-haven buying. Holdings of the largest, the SPDR Gold Trust, rise 45 percent to 1,127.44 tons
April 24, 2009	China announces it has raised its gold reserves by three-quarters since 2003 and now holds 1,054 tons of the precious metal, boosting expectations it may add further to its reserves.
August 7, 2009	European central banks opt to renew their earlier agreement to limit gold sales over a five-year period, setting the sales cap at 400 tons a year.
May 11, 2010	Gold reaches fresh record high above $1,230 an ounce as fears over the contagion of debt issues in the euro zone fuel safe-haven buying.
June 21, 2010	Gold jumps to a new high at $1,264.90 an ounce as underlying fears over financial market stability and sovereign risk combine with dollar weakness to push the metal through resistance at its previous high.
Sept 27, 2010	Spot gold prices touch the $1,300 an ounce mark for the first time.
March 7, 2011	Gold extends record highs to $1,444.40 an ounce as oil prices hit their highest in 2- years after protests are quashed in Saudi Arabia and as violence in Libya rages.
March 24, 2011	The resignation of Portuguese prime minister Jose Socrates pushes the euro zone debt crisis back to center stage, lifting gold prices to a record above $1,447 an ounce.
April 7, 2011	Gold prices extended their record highs toward $1,465 an ounce after the European Central Bank cast doubts over expectations for interest rate rises, while unrest in the Middle East encouraged safe-haven buying.
July 18, 2011	Gold broke above $1,600 for the first time on its eleventh straight day of gains, on persistent worries about a euro zone debt crisis spreading and a growing threat of a U.S. government default.
July 27,2011	Gold set an all-time high of $1,622.89 an ounce, for the sixth time in two weeks, as worries about the deadlock in the U.S. debt ceiling negotiations drove up safe haven buying in bullion.

1.4 GOLD STANDARD

1.4.1 A brief history of gold standard

National money and other forms of money (bank deposits and notes) were freely converted into gold at the fixed price. England adopted a de facto gold standard in 1717 after the master of the mint, Sir Isaac Newton, overvalued the guinea in terms

of silver, and formally adopted the gold standard in 1819. The United States, though formally on a bimetallic (gold and silver) standard, switched to gold de facto in 1834 and de jure in 1900 when Congress passed the Gold Standard Act. In 1834, the United States fixed the price of gold at $20.67 per ounce, where it remained until 1933. Other major countries joined the gold standard in the 1870s. The period from 1880 to 1914 is known as the classical gold standard. During that time, the majority of countries adhered (in varying degrees) to gold. It was also a period of unprecedented economic growth with relatively free trade in goods, labour, and capital.

The gold standard broke down during World War I, as major belligerents resorted to inflationary finance, and was briefly reinstated from 1925 to 1931 as the Gold Exchange Standard. Under this standard, countries could hold gold or dollars or pounds as reserves, except for the United States and the United Kingdom, which held reserves only in gold. This version broke down in 1931 following Britain's departure from gold in the face of massive gold and capital outflows. In 1933, President Franklin D. Roosevelt nationalized gold owned by private citizens and abrogated contracts in which payment was specified in gold. Between 1946 and 1971, countries operated under the Bretton Woods system. Under this further modification of the gold standard, most countries settled their international balances in U.S. dollars, but the U.S. government promised to redeem other central banks' holdings of dollars for gold at a fixed rate of thirty-five dollars per ounce. Persistent U.S. balance-of-payments deficits steadily reduced U.S. gold reserves, however, reducing confidence in the ability of the United States to redeem its currency in gold. Finally, on August 15, 1971, President Richard M. Nixon announced that the United States would no longer redeem currency for gold. This was the final step in abandoning the gold standard.

Widespread dissatisfaction with high inflation in the late 1970s and early 1980s brought renewed interest in the gold standard. Although that interest is not strong today, it seems to strengthen every time inflation moves much above 5 percent. This makes sense: whatever other problems there were with the gold standard, persistent inflation was not one of them. Between 1880 and 1914, the period when the United States was on the "classical gold standard," inflation averaged only 0.1 percent per year.

1.4.2 How the Gold Standard worked

Under the gold standard, a country's money supply was linked to gold. The necessity of being able to convert fiat money into gold on demand strictly limited the amount of fiat money in circulation to a multiple of the central banks' gold reserves, with most countries having legal minimum ratios of gold to notes/currency issued or other similar limits. International balance of payments differences were settled in gold. Countries with a balance of payments surplus would receive gold inflows, while countries in deficit would experience an outflow of gold.

In theory, international settlement in gold meant that the international monetary system based on the gold standard was self correcting. Namely, a country running a balance of payments deficit would experience an outflow of gold, a reduction in money supply, a decline in the domestic price level, a rise in competitiveness and, therefore, a correction in the balance of payments deficit. The reverse would be true for countries with a balance of payments surplus. This was the so called "price-specie flow mechanism" set out by 18th century philosopher and economist David Hume.

Because exchange rates were fixed, the gold standard caused price levels around the world to move together. This co-movement occurred mainly through an automatic balance-of-payments adjustment process called the price-specie-flow mechanism. Here is how the mechanism worked. Suppose that a technological innovation brought about faster real economic growth in the United States. Because the supply of money (gold) essentially was fixed in the short run, U.S. prices fell. Prices of U.S. exports then fell relative to the prices of imports. This caused the British to demand more U.S. exports and Americans to demand fewer imports. A U.S. balance-of-payments surplus was created, causing gold to flow from the United Kingdom to the United States. The gold inflow increased the U.S. money supply, reversing the initial fall in prices. In the United Kingdom, the gold outflow reduced the money supply and, hence, lowered the price level. The net result was balanced prices among countries. The fixed exchange rate also caused both monetary and nonmonetary (real) shocks to be transmitted via flows of gold and capital between countries. Therefore, a shock in one country affected the domestic money supply, expenditure, price level, and real income in another country.

The adjustment process could be accelerated by central bank operations. The main tool was the discount rate (the rate at which the central bank would lend money to commercial banks or financial institutions) which would in turn influence market interest rates. A rise in interest rates would speed up the adjustment process through two channels. First, it would make borrowing more expensive, reducing investment spending and domestic demand, which in turn would put downward pressure on domestic prices, enhancing competitiveness and stimulating exports. Second, higher interest rates would attract money from abroad, improving the capital account of the balance of payments. A fall in interest rates would have the opposite effects. The central bank could also directly affect the amount of money in circulation by buying or selling domestic assets though this required deep financial markets and so was only done to a significant extent in the UK and, later, in Germany. The use of such methods meant that any correction of an economic imbalance would be accelerated and it would not normally be necessary to wait for the point at which substantial quantities of gold needed to be transported from one country to another.

1.5 THE GOLD PRICE

1.5.1 The Gold Fix

A major consequence of the OTC structure of the gold bullion market is the gold "fix". This is an alternate mechanism of price discovery which is designed to allow gold traders to trade at a fair market price. Twice a day the members of the 'fix' in London conduct what amounts to an elegant private auction which establishes the price at which the number of buy orders matches the number of sell orders. The fixers will be acting both on their own behalf and for those customers of theirs who have issued orders for them to trade at the 'fix'. The result is the gold fix price which comes out once in the morning and once in the afternoon. The fix price is published widely in newspapers, on the internet and on teletext services, and is a good guide to the value of gold at that instant. It is the widely used method by which traders establish a fair price for a physical gold transaction. The same price is also available on the LBMA website www.lbma.org.uk and at www.wgc.net.

1.5.2 Various prices for gold

i. **Spot Price**. This is the price for wholesale 400oz bars for immediate delivery usually ex-London as traded in the over the counter (OTC) market. This is the "real" physical price and is the basis on which all the other prices are set.

ii. **Futures Price** (eg COMEX, TOCOM, MCX). This is the price for delivery in the future (ie whenever the next contract is). Americans love to quote this price like it is "the" price of physical gold. It is a future price. It is related to the spot price, with differences reflecting the relative costs of borrowing cash and gold.

iii. **Exchange Traded Fund Price** (eg GLD). This is a proxy for the spot price, because it is based on physical gold in 400oz bar form. Because any significant dealer can deliver physical (or take delivery) in exchange for shares (or deliver shares) its price will never significantly diverge from the Spot Price except to reflect the costs associated with the share creation/redemption process.

iv. **Retail Price.** This price refers to the price for small, non-wholesale amounts of physical gold (Jewellery, coins and bars). It is usually priced based on the spot price plus an additional fee to reflect the cost of turning 400oz bars into smaller sizes. This is a physical price of sorts, but it is not the spot price and can deviate from it if manufacturers don't forecast demand correctly and run out of or get too much inventory. All that is occurring is that the premium to the underlying gold value (based on the spot price) is changing based on shortage or excess of small forms of gold. Until the manufacturers can get metal from the spot market and convert it into small forms, the retail price will continue to move away from its normal price.

1.5.3 Gold price History

The annual average price of gold and the percentage changes since 1968 is given in the Table No: 1.3 and the same is plotted in the Figure No: 1.1. The Bretton Woods system effectively replaced gold with the dollar as underpinning of the world financial system. But when that arrangement began to come apart at the seams in the early 1960s, the US started running up large budget and balance of payment deficit causing international market to loose confidence in the Dollar, and afterwards, capital fled to Gold for lack of alternative bolt hole.

Table No: 1.4
Historical Gold price and the percentage changes

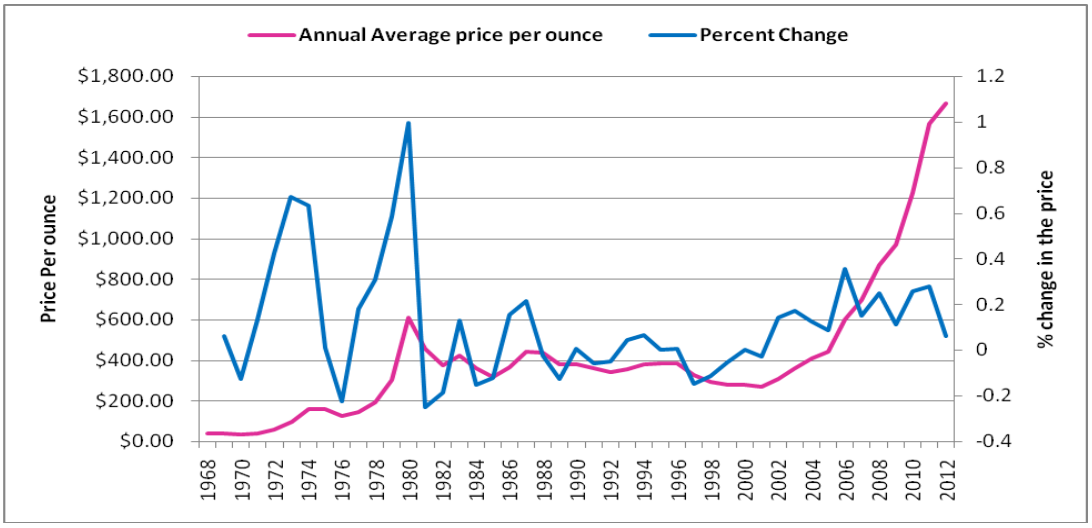
Year	Annual Average World price per ounce	% Change In World Price	Annual Average price per 10 gm in India	Year	Annual Average price per ounce	% Change In World Price	Annual Average price per 10 gm in India
1968	$38.69	-	162	1991	$362.20	-5.50%	3400
1969	$41.09	6.20%	176	1992	$344.20	-5.00%	4300
1970	$35.94	-12.50%	184	1993	$359.77	4.50%	4100
1971	$40.80	13.50%	193	1994	$384.01	6.70%	4500
1972	$58.16	42.50%	202	1995	$384.22	0.10%	4650
1973	$97.33	67.30%	243	1996	$387.70	0.90%	5100
1974	$159.26	63.60%	369	1997	$331.14	-14.60%	4700
1975	$161.06	1.10%	520	1998	$294.16	-11.20%	4000
1976	$124.84	-22.50%	545	1999	$278.80	-5.20%	4200
1977	$147.72	18.30%	486	2000	$279.02	0.10%	4400
1978	$193.23	30.80%	685	2001	$271.02	-2.90%	4300
1979	$306.69	58.70%	890	2002	$310.07	14.40%	5000
1980	$612.56	99.70%	1300	2003	$363.55	17.20%	5700
1981	$460.05	-24.90%	1800	2004	$409.17	12.50%	5800
1982	$375.79	-18.30%	1600	2005	$444.78	8.70%	7000
1983	$424.18	12.90%	1800	2006	$604.39	35.90%	9000
1984	$360.44	-15.00%	1900	2007	$696.73	15.30%	10800
1985	$317.26	-12.00%	2000	2008	$872.49	25.20%	12500
1986	$367.51	15.80%	2100	2009	$972.98	11.50%	14500
1987	$446.47	21.50%	2500	2010	$1,224.74	25.90%	18000
1988	$437.05	-2.10%	3000	2011	$1,568.58	28.10%	25000
1989	$381.43	-12.70%	3100	2012	$1,668.82	6.40%	32000
1990	$383.47	0.50%	3200				

Source: Compiled from The CPM Gold Yearbook 2013

In 1971, far from slipping its dollar, mooring to sink without trace, all cut losses and soared, eventually hitting peak of US$850 per ounce in early 1980's. On January 21, 1980, it reached the peak of $870per ounce. Since then gold entered in bear phase or otherwise in corrective mode, fallen back to the range of $350 to $450

per ounce hitting casually near $500 or $ 300. During first half of 1990s, market was quite stable in the centre of $350-$400 per ounce.

Figure No: 1.1
Gold price per ounce and the percentage change



Since 1997, the price moved in further bear phase breaking the psychological support of $300 per ounce soon after the disclosure of sale of Gold by Reserve Bank of Australia in July '97. The selling pressure of Central Banks jeopardized the price of Gold with advent of interest of sale by Bank of England and Swiss Bank, which were planning to sell 1,300 tonnes. The Gold prices tumble to $252.50 per ounce by July '99. When everyone thought that now the period of Gold is over because of distressed unholding by Central Banks, the Central Banks themselves entered into an agreement known as Washington Agreement to restrict their sales in more disciplined manner. Under that Agreement, 15 Central Banks, including the European Central Bank agreed to limit Gold sales to 400 tonnes a year for five years, not exceeding 2,000 tonnes over the period. The signatories to the Agreement also agreed not to expand their gold leasing and use of Gold futures and options over that period. The Agreement was aimed to remove fear and uncertainty in the market over Central Banks intention toward their Gold reserves.

Gold price in India remained highly volatile since 2008. The spike in the gold prices has affected the demand for gold jewellery in the domestic market during 2008. Besides, uncertainty in the global and domestic markets followed by retrenchment across the sectors, have led to postponement of purchase plans of gold jewellery among the gold customers. Faced with credit crunch and low demand conditions

investors and bullion dealers have imported less gold to India during FY08. According to the World Gold Council, in CY 2008, gold jewellery demand in India, traditionally the world's largest gold market, declined by 15% while gold investment demand fell by 12%. The movement of gold price in India is dependent on the world gold price and the fluctuations in domestic currency against US dollar rupee. A decrease in the world gold price does not mean that the price in India will go down. If the domestic currency depreciates more than the price reduction, then the cost of buying gold in the world gold markets will be increased.

Moreover, the local currency valuation vis-à-vis USD had also great influence on the price of the Gold. When the currency of the producing countries get depreciated, they can sell at lower level as their realization in local currency is unaffected and the buyer country is affected in both times (inflation as well as 24 deflation) as at the time of falling currency valuation, the buyers try to hedge against inflation while at the time of appreciation in the local currency the local prices got themselves in attractive zone.

1.6 GOLD DEMAND

Gold that has been manufactured from the initial cast ingot stage into semi-finished or final products. This involves mechanical shaping or investment casting to shape and to size prior to assembly. It includes jewellery, coin, dental, electronics and other industrial uses and includes gold in alloyed form.

The demand for gold can be classified as below

i. **Industrial applications:** Besides jewelry, gold has many applications in a variety of industries including aerospace, medicine, electronics and dentistry. The electronics industry needs gold for the manufacture of computers, telephones, televisions, and other equipment. Gold's unique properties provide superior electrical conducting qualities and corrosion resistance, which are required in the manufacture of sophisticated electronic circuitry. In dentistry, gold alloys are popular because they are highly resistant to corrosion and tarnish. For this reason gold alloys are used for crowns, bridges, gold inlays, and partial dentures.

ii. **Governments and central banks:** The third source of gold demand is governments and central banks that buy gold to increase their official reserves.

iii. Private investors: Finally, there are private investors. Depending upon market circumstances, the investment component of demand can vary substantially from year to year.

iv. Jewelry fabrication: The largest source of demand is the jewelry industry. These demand goes into making jewellery such as ornaments, chains, rings etc. In recent years, demand from the jewelry industry alone has exceeded Western mine production. Gold's workability, unique beauty, and universal appeal make this rare precious metal the favourite of jewelers all over the world.

Table No: 1.5
Fabrication Demand by Country and Region (Thousand Troy Ounces)

Year	Japan	United States	Europe	India	Total	% of Share	World Total
1985	4,365	7,833	14,674	5,835	32,707	74%	44,127
1986	5,401	7,721	14,291	5,684	33,097	74%	44,495
1987	5,206	7,092	13,995	6,138	32,431	72%	44,972
1988	5,626	7,359	16,473	7,183	36,641	65%	56,560
1989	6,768	7,943	19,326	8,073	42,110	67%	63,077
1990	6,712	7,950	21,211	9,400	45,273	66%	68,628
1991	6,708	7,683	21,534	9,420	45,345	65%	70,161
1992	6,278	8,202	22,660	14,000	51,140	65%	78,174
1993	6,467	8,581	22,647	15,650	53,345	65%	82,674
1994	5,855	8,981	24,195	16,050	55,081	64%	86,575
1995	6,558	9,271	24,307	21,065	61,201	65%	94,169
1996	5,877	9,721	23,319	21,157	60,074	63%	95,548
1997	5,950	10,165	25,677	23,220	65,012	64%	1,00,910
1998	5,147	10,824	28,416	25,700	70,087	67%	1,04,314
1999	4,984	11,135	27,110	24,500	67,729	67%	1,01,798
2000	5,022	11,626	26,262	22,000	64,910	58%	1,10,999
2001	4,964	9,045	25,658	10,866	50,533	52%	98,054
2002	5,406	8,750	23,140	7,343	44,639	50%	88,532
2003	5,064	8,630	19,361	9,540	42,595	50%	85,435
2004	5,022	8,550	18,893	10,000	42,465	48%	88,452
2005	5,362	8,345	17,181	11,600	42,488	46%	91,402
2006	5,781	6,770	12,762	12,024	37,337	42%	89,266
2007	6,317	5,820	12,321	14,082	38,540	41%	93,477
2008	5,900	5,030	10,385	14,900	36,215	41%	88,759
2009	4,895	3,915	8,141	13,100	30,051	40%	76,282
2010	5,056	3,797	7,400	12,500	28,753	39%	76,754
2011	4,100	3,616	7,692	11,932	27,340	40%	69,831

Source: Compiled from The CPM Gold Yearbook 2013

Fabrication is the major element in the demand for gold, absorbing more than all new mine production each year since 1990 (the balance coming from scrap, central bank sales or investors). The World Gold Council also publishes Gold Demand Trends quarterly. An annual report of fabrication demand of each country included in the study is given in Table No: 1.4 from 1985 to 2011. There is constant growth in the world gold demand. It is observed from the table that the world gold demand reached extreme between 19997 and 2001, where the demand reached 110999 troy ounces during 2000. After 2000, the demand started declining. It is because the demand of Europe and USA decreased from 2000. The fabrication demand of Japan is showing constant trend, because the demand did not show any extraordinary changes, instead there is a gradual growth in the trend. The other interesting fact to be noted here is that the Indian gold demand. India's demand is very less in 1985, but the same become number one consumer in the world gold markets.

The demand of India alone is more than all the European countries after 2006. The aggregate demand of all these four countries alone represents more than 50% of the world gold fabrication demand. Hence this study considered only these four countries in the empirical analysis. The percentage and the quantity of the use of gold demand for various uses are given in Table No: 1.5 and 1.6 respectively. Both the tables clearly show that major portion of the gold goes into making jewellery. The data proves that on an average more than 80% of the gold consumption goes to make jewellery.

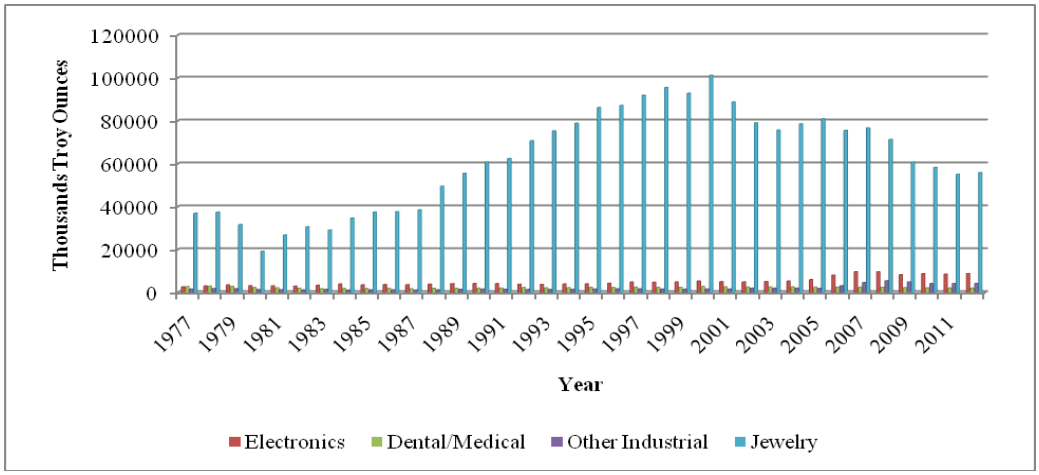
It shows that the primary usage of gold is making jewellery. Only minor portion of gold goes into other usages such as Electronics, Dental/Medical and other industrial usages. This is because, the jewellery is bought by most of the consumers, whereas the demand for other uses are used only by a particular group of people. And hence the demand for jewellery is always higher than the other aspects. As seen in the previous table, the proportion of gold goes into jewellery is extreme during 1992 to 2001. The trend is going down from 2002, and at the same time, the electronics demand is gradually increasing over a period of time.

Table No: 1.6
Percentage of Annual Gold Use

Year	Electronics	Dental/Medical	Other Industrial	Jewelry
1977	5.90%	6.30%	3.70%	84.20%
1978	6.70%	6.50%	4.00%	82.80%
1979	8.80%	7.10%	4.40%	79.60%
1980	12.20%	7.90%	5.30%	74.60%
1981	9.30%	6.50%	3.80%	80.30%
1982	8.10%	5.40%	3.20%	83.40%
1983	9.40%	4.90%	4.00%	81.70%
1984	9.50%	4.40%	2.80%	83.30%
1985	8.10%	4.20%	2.70%	85.00%
1986	8.30%	4.30%	2.80%	84.60%
1987	8.10%	3.70%	2.60%	85.60%
1988	6.80%	3.40%	2.20%	87.60%
1989	6.50%	3.10%	2.40%	88.10%
1990	6.10%	2.90%	2.20%	88.70%
1991	5.90%	2.90%	2.10%	89.00%
1992	4.90%	2.90%	1.80%	90.40%
1993	4.60%	2.60%	1.70%	91.20%
1994	4.50%	2.60%	1.70%	91.20%
1995	4.30%	2.50%	1.60%	91.60%
1996	4.50%	2.50%	1.80%	91.30%
1997	4.80%	2.40%	1.70%	91.10%
1998	4.60%	2.30%	1.50%	91.60%
1999	4.80%	2.40%	1.50%	91.30%
2000	4.80%	2.50%	1.50%	91.20%
2001	5.20%	2.70%	1.60%	90.60%
2002	5.60%	2.90%	2.30%	89.30%
2003	6.00%	3.00%	2.40%	88.70%
2004	6.00%	2.90%	2.30%	88.80%
2005	6.50%	2.70%	2.10%	88.60%
2006	9.10%	2.80%	3.50%	84.70%
2007	10.30%	2.70%	4.90%	82.10%
2008	10.80%	2.70%	6.10%	80.30%
2009	10.90%	3.00%	6.40%	79.80%
2010	11.90%	2.90%	5.70%	79.50%
2011	12.10%	3.00%	6.00%	78.90%
2012	12.40%	2.80%	5.90%	78.90%

Source: Compiled from The CPM Gold Yearbook 2013

Figure No: 1.2
Percentage of Annual Gold Usage



1.7 GOLD SUPPLY

Gold is difficult to find in commercial quantities. It also takes time, typically 5 years, and plenty of money to bring mines into production. In this sense the supply side of the gold equation is relatively constant. One of the features of this is that boom times encourage investment which takes a considerable time to work through to production and eventually too worked out mines. After a boom, when investment decisions may be made on over-inflated expectations of ultimately achievable prices, there is a tendency to subsequent overproduction and poor prices for a considerable period.

The Indian gold demand also shows some seasonality. However the demand in each state seems to be linked to its own marriage, monsoon and the harvest season. The Hindu calendar is marked by a series of religious festivals and auspicious occasions for buying gold which are unique to each individual state. Similarly there are a number specific days that are considered inauspicious for gold purchases. The study made by WGC observed from the historic trends that the most active gold jewellery buying period is during the winter wedding season.

The gold price boom of 1979/80 resulted in steadily increasing production all over the world from a stable base of 1200 tonnes annually to a peak of above 2600 tonnes in 1999. All major producing countries except South Africa substantially increased production in this period. Production then levelled out and started to dip

slightly, as mines were exhausted and poorer mines shut. Also the uninspiring gold market encouraged a decrease in exploration which now means there are a lower number of new mines coming into production than is expected to be required by the market.

Table No: 1.7
Gold Supply (in Thousands troy ounces)

Year	Mine Production	Secondary Supply	Total Supply
1984	46,738	10,397	57135
1985	48,173	8,974	57147
1986	50,842	12,976	63818
1987	52,803	12,768	65571
1988	58,363	11,117	69480
1989	62,842	9,709	72551
1990	64,964	10,747	75711
1991	66,075	11,286	77361
1992	68,705	11,990	80695
1993	70,963	12,569	83532
1994	71,205	13,812	85017
1995	71,606	14,513	86119
1996	72,966	17,009	89975
1997	78,621	15,512	94133
1998	80,947	22,563	103510
1999	82,401	20,000	102401
2000	81,914	22,535	104449
2001	81,976	23,485	105461
2002	80,443	27,536	107979
2003	80,474	30,314	110788
2004	76,944	28,240	105184
2005	78,345	29,371	107716
2006	74,895	27,559	102454
2007	74,652	33,763	108415
2008	73,256	39,767	113023
2009	78,750	41,227	119977
2010	81,232	40,343	121575
2011	82,501	40,626	123127

Source: Compiled from The CPM Gold Yearbook 2013

Gold is still being mined and refined at the rate of almost 2,600 tonnes per year. Thus the world supply of above ground gold is increasing at just over 2% annually. It is considered that lack of exploration expenditure in the 1990s, coupled

with the inherent delays between discovery and production mean than the gold supply will remain inelastic and is likely to reduce slowly over the coming few years.

Historically the production of gold may be divided into two eras; before and after the California gold rush of 1848. Prior to the California discoveries, gold was a rather a rare metal. After the 1848 California gold rush, swiftly followed by that in Australia, production was lifted into another dimension. Output by 1852 was 280 tonnes (9 million oz) and an estimated 10,000 tonnes (321 m oz) was mined in the second half of the nineteenth century. By the end of that century the annual average was 400 tonnes (12.9 m oz). In the twentieth century production rose with price increases; first between 1935 and 1940, following gold's rise to $35 an ounce and then again following the 1980 peak. By then new technology and better mining finance also had a significant influence, pushing output to over 2,500 tonnes (80.4 m oz) by the late 1990s. Total production throughout history will top 123127 thousands troy ounces by the end of 2011.

The statistics of how much of gold is produced through mines and the secondary supply was mined from 1984 to 2011 is given in Table No: 1.7. The total supply of gold is shown in two dimensions such as Mine production and the secondary supply which consists of scrap, sale of major economies and central banks. It is observed that the total supply of gold keeps on growing and the trend is gradually moving up. The production from mines accounts major proportion in the gold supply than the secondary supply. From 2007 onwards the secondary supply of gold accounts fifty percent of the mine production. Gold once produced will not die away, instead it will always be in the circulation. Based on this statistics, it is possible that the there will be more supply from the secondary sources than the primary productions from the mines in the future.

1.8 GOLD AND INDIA

"If India sneezes, the gold industry will catch a cold" Ajay Mitra

India and gold are two words closely linked in the precious metals world. Gold investing is so deeply ingrained in Indian culture that Indian's have over 20 different words for the yellow metal. "India's love for gold is almost a religion. Beyond being a symbol of wealth and status, gold is part of worship and culture – a tradition that goes

back thousands of years. From birth to death, for men and women, among rich and poor – acquiring gold is a goal for the people of India. All of which have made India the world's largest consumer of gold and thus a powerhouse in industry. Just as part of the American dream is to own a home, the dream in India is to own gold. For Indians, gold jewelry is wearable wealth, financial security that's also a fashion statement."

Most Indians have an emotional affinity towards gold – regarded as a symbol of purity, wealth and prosperity – thus driving their desire to possess it. Since the early 1990s, with the repeal of the Gold Control Act and economic prosperity, the demand for gold has increased strongly. A prime reason for an increase in gold purchase is the liquidity factor — the flexibility to sell off gold in return for cash. It is well known that the demand for gold in India is influenced by many social, cultural and economic factors. The rural income distribution, amount of black money, rate of return on alternate financial assets and the general price level all drive gold demand.

The fundamental reasons for buying gold jewelry are rooted in Indian culture especially during weddings. Lot of alteration has happened to our traditions but gold purchase on the occasion of wedding has not changed much. Though the newer generation is not too fond of wearing or flaunting gold jewelry, the demand for gold jewelry has not gone down. We end up demanding 950 tonnes of gold every year

The bullion producers and exporters are targeting India than the other major gold markets in the world. Indian gold market is becoming the cornerstone of the world's physical gold market. Our gold market is important to the gold industry worldwide because it is not only the largest consumer in the world gold markets, but also it is less sensitive to the fluctuations in the gold price. Half of India's annual gold consumption is contributed by demand in just four states: Karnataka, Kerala, Tamil Nadu, and Andhra Pradesh. India's gold market is estimated to have more than 300,000 jewelers – mostly small, family-run businesses. It is estimated that More than 85% of its gold consumption goes into making Jewellery, followed by electronics 6%, medal and coins 2% and other sectors 7%[2].

The domestic demand for gold is mainly met through import. That's because less than 4 tonnes of gold are produced in India every year. This output satisfies only

[2] Indian Minerals year book 2011, Mineral Reviews: 42. Gold, pp 42-13

less than 1% of India's annual gold demand. These low levels of production are no surprise. In the entire country of India, there are known to be only about 2 million ounces of gold resources. So to solve the supply problem, India must import its gold. And with demand in India continuing to rise rapidly, countries that export gold to India will find eager buyers willing to pay premium prices.

1.8.1 Sources of Gold Supply

Where does this much gold come from? The top five producers of gold in the world are China, USA, Australia, South Africa and Russian Federation. India does not produce much of the gold consumed. That means we need to buy gold from these countries. Gold nearly constitutes 12% of the total imports and comes only next to crude and capital good.

The major gold producing countries and their annual gold production given in the Table No: 1.7. The total amount of gold produced by these countries alone represents more than 88% of world's total production. During the year it is only 57% of world's production is accounted by these countries. However their contribution keeps decreasing over the years. This is due to that the other countries also started producing gold from their mines and the increase in the gold demand tends to open up new mines in their own countries. Countries like India whose demand is very high with less production have started to set up new mines and refineries in order to increase their productions. The gold production from China is keeps on increasing over the ten years. Since 2000 the gold production from China contributes a lot to the world gold demand.

Since India is one of the fastest growing countries, in the future as incomes rise, consumption of gold will also go up. Empirical evidence shows that as income increases, there is a propensity to buy more gold. In fact, for every one per cent increase in income, gold consumption increases by 1.554 per cent, showing that gold consumption is highly income elastic.

Table No: 1.8
Major Gold producing countries in Thousands troy ounces

Year	South Africa	United States	Australia	Canada	Indonesia	Peru	Brazil	Papua new Guinea	Chile	Ghana	Total	% of share	Total
1991	19,224	9,452	7,555	5,635	828	121	2,667	1,980	922	845	49229	88	56,047
1992	19,562	10,610	7,591	5,155	1,154	320	2,400	2,289	1,029	1,190	51,300	88	58,601
1993	19,926	10,642	7,739	4,850	1,490	739	2,251	2,003	1,100	1,325	52,065	87	59,942
1994	18,772	10,513	8,029	4,708	1,891	1,125	2,138	1,886	1,250	1,430	51,742	86	60,242
1995	16,795	10,192	8,400	4,888	2,377	1,817	2,026	1,662	1,433	1,650	51,240	85	60,094
1996	15,902	10,481	9,200	5,268	2,571	2,081	1,833	1,658	1,634	1,620	52,248	85	61,529
1997	15,800	11,639	10,005	5,513	2,821	2,468	1,802	1,559	1,522	1,700	54,829	85	64,847
1998	14,931	11,767	9,995	5,298	4,025	3,013	1,708	1,983	1,420	2,360	56,500	84	67,080
1999	14,451	10,963	9,705	5,068	4,450	4,176	1,700	2,110	1,525	2,550	56,698	83	68,432
2000	13,770	11,349	9,560	4,944	4,200	4,240	1,600	2,350	1,720	2,300	56,033	77	72,402
2001	12,652	10,771	9,150	5,059	5,600	4,461	1,425	2,160	1,350	2,175	54,803	76	71,978
2002	12,705	9,581	8,777	4,889	4,650	5,050	1,250	2,030	1,250	2,100	52,282	74	70,677
2003	12,082	8,906	9,100	4,529	4,600	5,550	1,200	2,160	1,250	2,100	51,477	73	70,772
2004	11,019	8,295	8,325	4,203	3,050	5,569	1,350	2,350	1,285	1,700	47,146	70	67,125
2005	9,559	8,359	8,250	3,833	4,525	6,687	1,300	2,200	1,300	2,000	48,013	69	69,088
2006	8,845	7,973	7,950	3,350	2,900	6,521	1,325	1,820	1,325	2,125	44,134	67	65,512
2007	8,188	7,652	7,930	3,270	3,680	5,474	1,475	1,860	1,350	2,275	43,154	66	65,042
2008	7,091	7,491	6,900	3,078	2,100	5,783	1,550	1,980	1,350	2,400	39,723	64	62,348
2009	6,588	7,170	7,170	3,130	3,987	5,916	1,608	2,025	1,318	2,600	41,512	63	66,285
2010	6,250	7,395	8,253	2,893	3,161	5,253	1,650	2,140	1,286	2,650	40,931	61	67,571
2011	6,002	7,684	8,295	3,186	2,476	5,273	1,865	2,151	1,519	2,554	41,005	57	71,872

Source: Compiled from The CPM Gold Yearbook 2013

Since around 40 per cent of the gold is held in bars and coins – even if we are able to convert this gold held in physical assets into financial assets and deploy these for productive purposes – GDP growth of nine to 10 per cent will become a reality. Despite being the largest consumer in the world gold market, India's role is the price taker and not the price maker in the world gold markets. The domestic gold price is determined by the international gold price. Hence a study is required to see impact of Indian demand fluctuation on the world gold price.

The Finance Minister of India P. Chidambaram said that the demand was putting a heavy strain on state finances. "About 80 per cent of India's current-account deficit is due to gold imports, while acknowledging that gold was by far Indians' most preferred avenue of investment. If we have gold [mines] in the country then we will have no current-account problems. But we have to import every ounce of gold," he said. "We want to unfreeze the stockpiles of gold in India and bring it back into circulation. So part of the gold that is lying as idle stock will be unfrozen. Together with the increase of import duty, we hope the import of gold will be moderated."

1.8.2 How does gold come into India?

In November 1997, Government of India / Reserve Bank of India introduced the Open General license scheme authorizing 14 banks and 4 Public Sector Undertakings to import gold for domestic use. As a next step to ease the gold supply constraints in the country, on as on Feb 26, 2009 Ministry of Commerce & Industry added few other new agencies under the list of nominated agencies for the purpose of import of precious metals. The List of the banks and the Nominated Agencies that are authorised to import gold are given in the Table No. 1.8 & 1.9 Respectively. The authorisation of banks is valid up to 31st December, 2013.

The authorised banks and nominated agencies place their order to the international banks who are full members of the London Bullion Market Association (LBMA). The international banks in turn analyses the existing supply and demand conditions in the market and based on this the gold will be delivered. Based on these supply and demand conditions, these members fix the spot gold prices.

Table No: 1.9
Banks Authorised to Import Gold in India

S. No	Name of the Bank	S. No	Name of the Bank
1	Allahabad Bank	19	IndusInd Bank Ltd.
2	Andhra Bank	20	ING Vysya Bank Ltd.
3	Axis Bank Ltd.	21	Karur Vysya Bank Ltd.
4	Bank of Baroda	22	Kotak Mahindra Bank Ltd.
5	Bank of India	23	Oriental Bank of Commerce
6	Bank of Maharashtra	24	Punjab and Sind Bank
7	Bank of Nova Scotia	25	Punjab National Bank
8	Canara Bank	26	South Indian Bank Ltd.
9	Central Bank of India	27	Standard Chartered Bank
10	City Union Bank Ltd.	28	State Bank of Bikaner and Jaipur
11	Corporation Bank	29	State Bank of Hyderabad
12	Dena Bank	30	State Bank of India
13	Dhanlaxmi Bank Ltd.	31	State Bank of Mysore
14	Federal Bank Ltd.	32	State Bank of Patiala
15	HDFC Bank Ltd.	33	State Bank of Travancore
16	ICICI Bank Ltd.	34	Syndicate Bank
17	Indian Bank	35	Union Bank of India
18	Indian Overseas Bank	36	Yes Bank Ltd.

Source: http://www.rbi.org.in/commonman/English/Scripts/Content.aspx?id=336

Table No: 1.10
Nominated Agencies authorised to Import Gold in India

Sl No	Nominated Agencies
1	Metals and Minerals Trading Corporation limited (MMTC)
2	The Handicrafts and Handlooms Export Corporation (HHEC)
3	The Project and Equipment Corporation of India Ltd (PEC)
4	State Trading Corporation Ltd (STC)
5	Metal Scrap Trade Corporation Ltd (MSTC)
6	Diamond India Limited (DIL)
7	EOU and SEZ Gems & Jewellery Export Promotion Council (G&J EPC)
8	A Star Trading Houses
9	Spices Trading Corporation Ltd (STCL)
10	Premier Trading Houses

Source: http://www.eximguru.com/notifications/guidelines-for-import-of-precious-21089.aspx

The gold is imported in the form of large bars. These bars are refined by those who comply with all the London Good Delivery Rules. This ensures purity and quality in world class. The bars are brought into India through reputed professional security institutions like Brinks who also undertakes to store bullion. World over and in India, all ETFs, futures exchanges and banks deliver and store through these institutions.

The Nominated Agency other than SBI or Banks nominated by RBI may be allowed to open private bonded warehouses subject to the observance of the Board's existing instructions on setting up such warehouses, wherein the imported gold would be kept by the nominated agency. In case of SBI or other banks nominated by RBI, they may be allowed to utilise its own vaults in lieu of opening separate private bonded ware house subject to the observance of the Board's existing instruction on setting up such warehouses wherein the imported gold would be kept by the nominated agency. Gold from the said bonded warehouse may be taken to all categories of exporters and the jewellery manufacturers.

The nominated agency can sell it to whomsoever it likes. The jewellery manufacturers and exporters will have to buy the entire raw material from the open market, which, consequently, takes away a part of the price advantage these importers had in procuring gold. The sale of gold through banks may take place in different aspects like outright sale, fixed price sales, back to back basis, bullion loan scheme etc.

The customers will approach the Bank for their requirements specifying the quantity they desire to purchase. Banks will thereafter contact the supplier and fix the price for the quantity desired to be purchased by the customers. The gold will be delivered to the customer on payment of equivalent amount in Indian Rupees at the ongoing rate or agreed rate. The Bank may also sell gold on unfixed price basis on outright to the customers from their consignment stocks. Jewelry Manufacturer Exporters can purchase gold on loan basis from the banks at competitive terms. The sale is subject to the rules and regulations prescribed by Reserve bank of India from time to time.

1.9 SUMMARY

India is the largest consumer of gold especially in the form of jewellery fabrication demand due its culture. But all the demand is met through imports with big strain on the Current Account Deficit. This study attempts to document few important aspects of the world gold markets that are considered to be most important in the world gold markets such as the interrelationships among the markets, to understand the real price maker in the world gold markets etc. This study entitled "**Dynamic Interactions of the World Gold Markets**" is an attempt to empirically examine the Gold price relationship and the information spill over between the Major gold markets in the world. It further estimated the impact of percentage changes in India's Gold demand on the world gold price by incorporating the demand of other three major gold markets in the world. The objectives are framed on the basis of the reviews and in such a way that it fulfils the gap that exist in the world gold markets.

The structure of the study is as follows: the second chapter briefs about the previous studies that are undertaken in the gold markets and provides a thorough knowledge and information about the previous researches. The third chapter elaborates in detail about the data, period of the study and the methodologies that are adopted in the empirical analysis. The fourth chapter deals with the long term and the short term relationship among the major gold markets in the world. The fifth chapter describes the information spillover among the major gold markets. The sixth chapter examines critically to find out the real price maker in the world gold markets. The seventh chapter measures the efficiency of the world gold markets in terms of price and income elasticity and the speed of adjustments to the new information. Finally the eight chapter provides the summary and the conclusion of the study. Finally it makes few suggestions and provides area in which the future research can be conducted.

Chapter

2

Review of Literature

CHAPTER – II

REVIEW OF LITERATURE

2.1 INTRODUCTION

This chapter provides an overview of the research work undertaken previously in the field of gold. It explains how the work of others contributed in the same field and in what way this study differs from others. Reading the previous literatures forms the basis for further research, through which the appropriate gap is identified in the field. Gold is one among the metal commodities that is traded throughout the world, but the research undertaken in the field of gold is very little. Such researches in India are countable. The volume of research in the field of gold does not match the volume of its gold consumption. There are only a few studies available in gold marketing.

The selected articles are critically examined and summarized. The reviews are summarized in the following manner: the title and the period of the study, the model and the methodologies that are adopted in the process of empirical analysis and finally the major findings of the study. The reviewed articles are classified into five major heads for a clear understanding of the relevance of gold in various areas. The classified heads are as follows: Gold price and volatility, Gold with other commodities, Gold with Stock Markets and Exchange Rates, Gold with Macro Economic variables and the demand and supply of gold. Finally the research gaps that are identified from the previous literatures is listed to enable the readers to get an idea of what is going to be covered in the current study.

2.2 GOLD PRICE AND VOLATILITY

Under this head, the studies that have empirically documented the movement of the price of gold and its volatility are briefly explained. The efficiency of the gold markets is also included under this head. This study is intended to examine the long run and the short run relationship among the major gold markets in the world. The study of the gold price movement would help to understand its historical performance and Volatility of gold

Peter. A. Abken (1979) examined the uses of economic theory to explain the changes in the gold price movements and accounted how quickly the market responds to the arrival of new information. Analysis was done with monthly data of gold price and a few Macro Economic variables for the period from 1973 to 1979. The regression results concluded that the current percentage in price changes were independent of the percentage in price changes during preceding months. The market participants responded quickly to new information and no further market price adjustments to the new information occurred in the following months. **Adrian E. Tschoegl (1980)** tested the efficiency of gold with respect to the information contained in sequences of successive price changes. Using CAPM and Markov Transition probabilities matrix models he tested the daily data from 2nd January 1975 to 30th June 1977. It is found that the gold market was as efficient as other international asset market. It also indicated some short term dependencies in successive price changes. The with-in-the day change was independent of the overnight changes. **Adrian E. Tschoegl (1982)** analysed the impact of the launching of option on spot gold price and its daily volatility. He has employed ratio of the variance estimates and regression to test the open, high, low, close and LBMA PM Fix for the period 31st December 1980 to 30th June 1981. It is concluded that the information from option trading reduced the volatility of the underlying asset price and it established a relationship between volatility and transaction cost. Launching of an option trading presumably reduced the cost of trading option which in turn reduced the cost of introducing the information into markets.

Clifford A.Ball et al (1982) investigated the day of the week effect in gold prices of the LBMA AM fix and PM fix data from 2nd January 1975 to 30th June 1979. The Gaussian distribution hypothesis method was used to test the trading time hypothesis and calendar time hypothesis. The study concluded that there is no week end effect on gold prices and supported the trading time hypothesis. It means that the within a day changes were more than the overnight changes. Based on Adrian E. Tschoegl **(1980), Yan-Ki Ho (1985)** also tested the incrementally efficient market hypothesis theory for the London Gold market. Operational causal tests such as the Sims test (1972) and the Hsiao test (1981) were used to test the theory for the daily data from 2nd January 1979 to 30th December 1980. The empirical results supported

the IEMH theory. The changes in the price of US dollar did not influence the gold price changes instead the changes in gold price lead to US dollar price changes. The gold market is incrementally efficient with respect to changes in US$/DM exchange rate changes. **Clifford A.Ball et al (1985)** attempted to study the causes of rounding in transaction prices and documented whether the factors that contribute to the price resolution in the market. The data consisted of the LBMA AM and PM fix prices from 2nd January 1975 to 30th April 1981 and employed regression model and the maximum likelihood. The results concluded that the prices are approximate with the closeness of the approximisation varying frequency.

Adrian E. Tschoegl (1987) examined the seasonal pattern of the rate of return of gold and silver. He used the daily closing prices of gold and silver traded in London for the period from 1974 to June 1986 and employed Kolmogrove Entrophy methods, Sims approach and ARCH model. The empirical results supported the Martingale hypothesis and concluded that the past values could not be used to predict the future values. The correlation dimension estimated suggested that the structures detected in the daily data were not from weekend effect. The short time interval data series possessed the Martingale property of instantaneously unpredictable and the longer the time, the series was more predictable. Like Adrian E. Tschoegl (1980), Yan-Ki Ho (1985), **Rai Aggarwal and Luc A. Soenen (1988)** also tested the efficiency of the gold market but in different dimension, with respect to the possibility of earning extraordinary return from it in a portfolio. His study concluded that gold performed as a defensive security in a portfolio, as excess returns fluctuations of gold are only about one fifth of the fluctuation in the excess return market return. The inefficiency in the gold market could not be used to generate excess return. **Thomas D. Kauffmann and Richard A.Winters (1989)** concentrated on forecasting the gold price based on the US inflation, US exchange rate and world gold production information. The results showed a high correlation between actual price and the predicted price over the past 16 years. The predicted price was only slightly higher than the market price at mid-year.

Risto Laulajaien (1990) analysed the price dependencies between the three important physical gold markets Hong Kong, London and New York, around the globe during a 24 hour period. The study considered the exchange rates and a few

Macro Economic variables along with the gold prices for the period from 1st October 1987 to 30th September 1988. The Multiple Regression analysis concluded that the price movements occurred from east to west following the natural day and night cycle. i.e NewYork market influenced the prices of Hong Kong and London but Hong Kong and London did not influence the COMEX gold price. **Ganesh Mani and Srivyal Voyyuri (2001)** assessed the possible macro economic factors that affect and determine the gold price in India for the period from 1978 to 2000 and adopted the multiple regression models. He concluded that the movement of the gold prices was affected to a large extent by its own lagged prices rather than other macro economic variables, because gold is perceived to be an investment asset. However this study did not consider the international gold price impact on domestic markets.

Graham Smith (2002) using the multiple variance ratio tests, examined whether the LBMA AM fix and PM fix prices follow the random walk hypothesis for the period 3rd January 1990 and ending on 27th September 2001. The results suggested that closing price followed a random walk as there was no correlation in the closing price returns. Hence the arrival of new information changed the closing prices, but news was unpredictable and so were the London closing prices of Gold returns. **Terence C. Mills (2003)** studied the statistical behavior of daily gold price data with special focus on the issues of persistence, Volatility and Multi-Scaling. He has covered vast period from 1st January 1971 to 31st July 2002 comprising of the daily gold prices and used the de-trended fluctuation analysis, Gaussian distribution. He concluded that there was a constant increase in the daily prices of gold and the observations included in the analysis were characterized by short run persistence. The daily returns were highly leptokurtic with multi period return only recovering Gaussian after 235 days. **Colin Lawrence (2003)** by making comparative analysis from January 1975 to December 2001, showed in what way gold is different from the other economic, financial variables and other commodities. Using Pairwise and Pearson correlation coefficient and VAR system and variance decomposition, the empirical results evidenced that the real rate of return of gold was independent of all the macro economic variables, but the other commodities included in the study were all affected by at least one of the macro economic variables. The real rate of return of gold followed the random walk and hence gold is unique and different from other assets. **Xiaoging Eleanor Xu and Hung-Gay Fung (2005)** fulfilled the gap by

extending the study for the remaining period done by Risto Laulajaien (1990). He undertook futures prices of three commodities and documented the information interaction of metal prices between COMEX and TOCOM during trading and non trading hours. The information interaction is tested with the bivariate asymmetric ARMA-GARCH model, the Multivariate GARCH models. The overnight and the daily volatility in the US precious metal futures were lower than those of Japanese. The cross markets effect of the US on Japan was stronger in terms of pricing transmission and for volatility spill over effect both market exhibited similarly strong feedback on each other and the US gold futures volatility had a slightly stronger effect on the Japanese market.

Rogemar S. Mamon et al (2007) evaluated the predictability of the LBMA PM fix price both in long and short run for the period from 1973 to 2006. The results of the Markov-Regime switching model and Hidden Markov suggested that a two-state hidden Markov Model was sufficient to describe the dynamics of the data and the gold price was predictable up to a certain extent in the short run but almost impossible to predict in the long run due to the existence of switching regimes in the volatility series. Like Colin Lawrence (2003), **Edel Tully and Brian M. Lucey (2007)** also took up a study to investigate the impact of Macro Economic announcements on the gold price by using the asymmetric power GARCH model (APGARCH). The monthly data from 1984 to 2003 were analysed and all possible Macro Economic variables were included. US dollar played a dominant role in influencing the gold price specially during the equity crisis period. The volatility of the return on gold is determined endogenously by the dollar. Further to the Xiaoging Eleanor Xu and Hung-Gay Fung (2005), **Hui-Na Lina et al (2008)** undertook a study to examine the international transmission of information and dynamic relationships between the two biggest gold futures markets COMEX and TOCOM. He covered 17 years from January 1990 to July 2006 employed the Bivariate GARCH model to examine the extent of volatility and return transmission. The results evidenced that TOCOM lead the COMEX as it reacted first to the new information. Volatility spillover effect existed in COMEX and TOCOM both before and during the uptrend. The responses to the bullish and bearish news were symmetrical in TOCOM and asymmetric in COMEX before and during the uptrend.

Jonathan Andrew Batten and Brian M. Lucey (2008) used the high frequency and inter day data from January 1999 to December 2005 to investigate the volatility structure of gold future trading contract on the Chicago Board of Trade (CBOT). The empirical results concluded that there was a significant variation in volatility across the trading day and week, although the volatility was only slightly positively correlated with the volume when measured by tick-count. **Piyamas Chaihetphon and Pantisa Pavabutr (2008)** examined the information sharing and the price discovery process between the spot and futures markets traded at MCX for the period from November 2003 December 2007. The Johansen co-integration and VECM model results evidenced that spot and future prices of the standard and mini gold futures contracts and were co-integrated in the long run. The futures contracts of standard and mini strongly influenced the spot prices both in the long run as well as in short run and spot market did not influence the futures market. The spot price is lead by the futures prices indicating that the price discovery occurred in the futures market. **Rozanna Wozniak (2008)** compared the volatility in the gold price with other commodities and equities for the period from 1988 to 2008. It is found that gold showed less volatility than equities and commodities during the study period. This volatility is less even during the credit crisis period and this was consistent over time.

Dirk G Baur (2009) studied the volatility of gold for a 30 year period from 19th November 1979 to 18th November 2009 by using daily, weekly, Monthly and quarterly data of gold spot prices. The GARCH Model results showed that the volatility of gold exhibited volatility clustering and displayed an inverted asymmetric reaction. Positive shocks increased the volatility more than negative shocks did. The volatility and uncertainty were transmitted from the stock market and macroeconomic conditions to the gold market leading to an increased volatility. Previously Thomas D. Kauffmann and Richard A.Winters (1989) undertook a forecasting study and **Z. Ismail et al (2009)** attempted to fill the vast gap that arose in the area of forecasting. They developed a forecasting model based on multiple linear regression (MLR) for predicting the gold prices in the near future. The study considered eight important economic factors that are expected to influence the LBMA PM fix price. The results suggested that while forecasting the next month gold price, the variables such as CRB and Euro/USD with lagged one and INF and M1 with two lags explained around 70% variation in predicting the gold price. Hence the model was considered to be the most

appropriate model as it considered the effect of lags and also it achieved high level of accuracy in predicting the gold price. **Arti Gaur and Monica Bansal (2010)** examined the trend, correlation and the seasonal variations of gold prices in Indian and global markets and studied the effect of changes in the exchange rates. They analysed data for the period between 1991 and 2008 by using Statistical techniques. The gold prices in both the markets did not show any seasonal effect and the seasonality was not associated with the gold price. The gold price in Indian was highly depending on the international gold market price and the exchange rates variation.

Unlike Thomas D. Kauffmann and Richard A.Winters (1989) and Z. Ismail et al (2009), **Shariar Shafiee and Erkan Topal (2010)** developed and employed a new model called mean reverting jump diffusion model and stochastic price forecasting to examine the gold price trends over the past 40 years and to investigate the relationship between the gold price and other key influencing variables such as oil price and the global inflation. His model showed that there were two big jump in the historical gold price data of which the first one occurred in the year 1980 and the next occurred in 2008. There existed a high correlation between gold and oil prices at around 85%. There was no any positive significant relationship between gold price and cumulative inflation. **Steven W. Sumner et al (2010)** studied the existence of interdependent relationship return volatility among the stocks, bonds and gold by using weekly dataset beginning from 9th January 1970 to 24th April 2009. It is evidenced that, since gold had a low and slightly negative correlation with stock and bonds, it acted as a great diversifier in the investment portfolio and reduced the volatility in the portfolio. Most of the spillover was from bond and stocks. The shocks in the volatility of stocks influenced one fourth of the forecast error variance for the bond volatilities.

Taner Akcaci and Tudce Yontem (2010) examined the relationship between the consumer confidence index and gold prices using monthly data for the period from January 2004 to October 2009. The direction of the relationship is tested with Granger Causality and it was concluded that there existed long run relationship between consumer confidence index and gold prices. A strong bidirectional relationship between the consumer confidence index and gold prices is evidenced from the results. **Hakan Gunes et al (2010)** analysed the effect of oil prices, euro

dollar parity and the interest rate (US Treasury bill 3 month) on gold prices. The monthly data for the period from January 2000 to December 2009 analysed with co-integration and pair wise granger causality. They study suggested that there is no long term relationship between gold price and the interest rate and between gold price and euro dollar parity. The gold price was not caused by any of the variables included in the study and gold price also did not cause any of the variables. **Oleksandr Pavlov et al (2011)** made a comparative study to account the hedge ratio and hedging effectiveness in gold futures markets both in India and China. The daily spot and futures prices of gold trading at Shangai Gold Exchange (SGE) and NCDEX were taken for the analysis from 25th February 2009 to 25th February 2011. The minimum variance hedge ratio method (MVHR) introduced by Johnson (1960) was employed to analyse the hedge ratio and hedging effectiveness, Constant Hedge Ratio Model and Dynamic Hedge Ratio Model. It is concluded that the spot and future prices of both the markets were co-integrated in the long run and the Indian gold futures market was more effective than the Chinese gold futures market.

Kang Jangkoo et al (2011) investigated the role of trading volume in the price discovery process and information shares. They considered both US and Japaneese markets and chosen the intraday prices of gold and platinum futures market and the corresponding trading volume. Two methodologies such as Hasbrouck (1995) information share to measure the share in the total variance of efficient price changes and Gonzalo and granger (1995) common factor component weight base from VECM that measure each Market's contribution to the common factor were adopted in the empirical analysis. The empirical results evidenced that the COMEX futures market primarily contributed to price discovery for gold futures market and Japaneese TOCOM market does the same for the platinum futures market. The market was dominated on the basis of whose total market volume is high rather than the specific maturity contracts volume. The price discovery is related to both the total market volumes as well as shortest maturity. **Mohamod Qadan And Joseph yagil (2012)** addressed the causal relationship between gold price and the fear sentiments of the investors. The relationship is tested in two dimension- causality in mean and causality in variance for the period from 3rd January 1995 to 17th May 2010. The results evidenced strong bidirectional causality between mean and variance and concluded that the gold futures return was driven by the market participant's fear (VIX). The

information flow and the emotional fear (VIX) not only affected the mean movements but also their volatility.

It is understood from these literatures that the gold market is efficient and in the short run the movement of the gold prices is largely affected by its own lagged prices than any other variables. The arrival of new information is quickly reflected in its return and the return is comparatively more in the long run than short run. The volatility of gold was highly constant especially during financial crisis periods and volatility clustering behavior is found in the gold price also and further the volatility of gold price is highly influenced by positive shocks than negative shocks. The futures prices of different countries are interlinked with each other and strong feedback relationship exists among the prices. Futures contracts strongly influenced the spot prices both in the long run as well as in the short run and the spot price is lead by the futures prices indicating that the price discovery occurred in the futures market

2.3 GOLD AND OTHER COMMODITIES

The performance of gold with other metal commodities is compared with respect to its volatility, information spillover, performance of gold in a given portfolio that comprised of other metal commodities and so on. All the studies described below have considered gold in their study and the same is compared with the other commodities considered in the study. Most of the studies concluded that performance of gold is much better than other metal commodities and the relationship of gold with other commodities is also much better.

Michael E. Solt and Paul J. Swanson (1981) tested the efficiency of gold and silver markets in the price formation process by analyzing the weekly data from January 1971 to December 1979. The filters rule proposed by Alexander (1964) Fama and Blume (1973) were used to test the dependencies on the price change process. The findings of the study suggested that the gold and silver market was not efficient and there existed price dependencies in the price generating process. The price of the metals did not reflect the information available in the market. **M.W. Luke Chan and C. Mountain (1988)** using Granger's (1969) notion of causality, Sequential technique and Simple random walk model, their study examined the interactive and causal

relationship between gold and silver for the period between March 1980 and February 1983. The results evidenced feedback causal relationship between the price of gold and the price of silver and treasury bill rates were not influenced by the silver and gold prices. **Murray Frank and Thanasis Stengos (1989)** examined the predictability of short and long rates of return on gold and silver. The concept of Martingale property is tested with ARCH Model for the daily, weekly and biweekly closing prices of gold and silver in London. The empirical results tend to accept the Martingale property (instantaneously unpredictable IU) Sims (1984) that the short time interval data series possessed the instantaneously unpredictable and the longer time interval series were allowed to be more predictable.

Ahmed Eris Kocagil (1997) tested empirically whether increased speculation in futures markets stabilised spot price volatility in metals market. Using the daily data between 1980 and 1990, the hypothesis was tested by Monte Carlo methods. The empirical results showed that an increase on the intensity of futures speculations tend to decrease the spot price volatility and thus stabilised spot markets. **Thomas J. Urich (2000)** using principal component analysis and factor analysis, made an attempt to examine the stochastic structure of three metals futures prices namely gold, copper and silver. The daily data were analysed from 3rd January 1990 to the end of 31st December 1996. The results suggested that metal with the different maturities were considered to be excellent substitutes for one another for gold and silver and the fluctuation in copper, gold and silver future prices could be well represented with a small number of futures.

Bahram Adrangi et al (2000) investigated the price discovery process between the gold and silver futures contracts traded on the COMEX. Co-integration, VECM and Bivariate GARCH (1,1) models applied on the fifteen minutes intraday future prices from 27th December 1993 to 30th December 1995. The results revealed that the two markets were co-integrated in the long run and also evidenced a bidirectional causal relationship among these markets. The volatility was initiated by the gold market as the information first arrived in the gold market and the volatility in the silver market was better explained by the movements in the gold silver spread. **Ciner (2001)** using co-integration investigated the long term trend that existed between the prices of gold and silver in the futures contracts traded on the TOCOMO.

He concluded that there was no stable long run relationship between the prices of gold and silver and these two markets should be approached as separate market. The changes in gold to silver ratio should not be used to predict prices in future.

K. Ben Nowman and Helen Wang (2001) applied the nine continuous time models for observing price volatilities of metal commodities such as Gold, Nickel, copper, silver and Tin. The study concluded that the volatility of prices was highly dependent on the level of prices and is larger than usually assumed in these models. The degree of mean reversion varied across models. **Shi-Miin Liu and Chih-Hsien Chou (2003)** examined the co-integration between gold and silver and analysed which market reflected the new information arrival at COMEX. ECM, GPH test, Fractional cointegration pattern and Monte Carlo simulation were employed to test the data between January 1983 and July 1995. The GPH test results discovered a parity relationship between the two metals and their prices were mutually affected with a time-varying risk premium. Bahram Adrangi et al (2000), M.W. Luke Chan and C. Mountain (1988), Michael E. Solt and Paul J. Swanson (1981). The gold prices were influenced by silver prices. The information is centered in the gold market and reflected mainly by the adjustments of gold prices. The futures markets lead the cash markets in terms of information reflection and deviation of futures spreads between gold and silver from the equilibrium seldom happen.

Brian M Lucey and Edel Tully (2004) examined the dynamic relationship between gold and silver traded at COMEX. The data consisted of Friday closing prices from COMEX for cash and futures. The dataset between January 1978 and November 2002 is analysed through dynamic co-integration analysis introduced by Hansen and Johansen (1992) and Johansen and Juselius (1990). It is found that during the study period there was a stable and strong long run relationship existed between gold and silver returns in both cash and futures markets Bahram Adrangi et al (2000), M.W. Luke Chan and C. Mountain (1988), Michael E. Solt and Paul J. Swanson (1981) Shi-Miin Liu and Chih-Hsien Chou (2003). **Jonathasn Phair (2004)** using CAPM regression model, evaluated the performance of gold and silver in an investment portfolio that was primarily composed of equity. The daily and the monthly returns data for period from 1st February 1985 to 28th February 2003 were analysed empirically. The results proved that the beta for gold and silver were clearly

negative and both the assets appreciated when the equity market fell down. Both assets gold and silver could be used to hedge against the market risk, but gold was superior to silver and the gold price is expected to fall when there is increase in CPI and vice versa.

Brian M. Lucey and Edel Tully (2006) using 20 years period data starting from January 1982 to November 2002, tested the existence of seasonal behavior patterns of gold and silver returns traded in COMEX. The models such as GARCH-M models, Leveraged GARCH and ARCH-in-mean were used in the empirical analysis. The results concluded that Monday returns were consistently negative and the lowest for all days of the week. The variance across days of the week was not homogeneous and the standard deviation in both cash and futures gold and future silver was also highest of all days of the week. The leverage term was negative and significant. **Shih-Jen Liao and Jin Ting Chen (2006)** examined the price and volatility relationship between oil and gold and tested whether the changes in these commodities volatility had any significant impact on the 18 individual industrial sub indices considered in the study. GARCH and TGARCH models were employed on the data from 3rd January 1998 to 30th December 2005 to analyse. The results indicated the current period returns of oil and gold was statistically affected by the previous period returns. The volatility of gold price returns did not have any effect on the oil price return. Instead the volatility of oil price returns had spillover effect to the volatility of the gold price returns. Most of the sub-indices of the individual industries showed self spillover effects from their own previous volatilities.

Adrian Douglas (2007) studied the price pattern of gold, copper and silver for the period spanning 1987 to 2007. The regression and Correlation analysis suggested that the price of gold and copper strongly correlated with each other for 12 years period and also there existed a strong correlation among between gold and silver prices. **Jonathan A. Batten et al (2007)** measured the price difference that existed between gold and silver futures contracts traded at COMEX. The study analysed the daily data from January 1999 to December 2005 with ARMA model. The gold and silver returns were highly correlated in the long and the long term dependence in the spread is dominated by the positive dependent relationship. Hence the spread should

tend to get larger or smaller depending upon whether the previous change in price was positive or negative.

Mark C Roberts (2008) examined the existence of the independence in the price movements of selected metals commodities Aluminum, Copper, Lead, Tin, Zinc, Gold and silver. A standard correlation coefficient was used in the study to analyse the monthly data between January 1947 and July 2008. The results revealed that the movements in real metal prices were not independent of each other and their movements were synchronized over time. They had a significant correlation with each other indicating common movements in both amplitude and duration. **Shawkat Hammoudeh and Yuan Yuan (2008)** studied empirically the volatility characteristics of four strategic commodities oil, gold, copper and silver for the period from 2nd January 1990 to 1st May 2006. The data were analysed using the GARCH, CGARCH and EGARCH models. The results suggested that in the presence of oil and interest rate sensitivities, gold and silver showed almost similar type of volatility which was more than copper. Gold and silver was not affected by the bad news (Negative shocks) and could be a better investment alternative especially while anticipating any bad news in the market. The volatility of gold and silver is strongly dominated by past shocks and hence for these it could be used to predict the volatilities in future. **Isabel Figuerola-Ferretti and Jesus Gonzalo (2008)** measured the price discovery in four precious metals commodities such as gold, silver, platinum and palladium by re-examining the Figuerola and Gonzalo (2007) methodology. The COMEX daily prices of spot and forward from January 1986 to December 2006 were analysed with VECM. It is found that the future price played a dominant role for gold and silver in the price discovery and the spot price played a dominant role for palladium in the price discovery. Both spot and future prices were important for platinum in the price discovery.

Ramazan Sari et al (2009) examined the co-movements and the information transmission among the spot prices of four precious metals such as gold, silver, platinum and palladium, oil price and the US dollar / Euro exchange rate. Using VAR VDC and IRF, Co-integration test and ARDL techniques the daily data for the period from 4th January 1999 to 19th October 2007 were analysed. The empirical results evidenced the non-existence of co-integration among the spot prices of precious

metals, oil prices and exchange rate. There exist a relatively strong bi-directional relationship between oil price return and silver. The relationship between oil price and the gold price was very weak. **Paresh Kumar Narayan et al (2010)** using the daily data from 2nd January 1995 to 3rd June 2009, investigated the long run and short run relationship between gold and oil futures prices. The results concluded that the spot and future markets of oil and gold were co-integrated and an increase in the oil price indirectly increased the gold price by moving up the inflation. This implied that the investors used the gold as a hedge against inflation and the oil market could be used to predict the gold market prices.

Yue-Jun-Zhang and Yi-Ming Wei (2010) using Co-integration test, Linear & Non-Linear granger causality models, tested the interactive and causal relationship between gold and crude oil price daily data from 4th January 2000 to 31st March 2008. The results evidenced significant long term equilibrium relationship between the crude oil price and the gold price and both significantly adjusted in the short term from their long term deviation. There existed significant unidirectional linear granger causality from crude oil market to the gold market and the contribution of the crude oil price to the price discovery was greater than that of the gold price. **Wo-Chiang Lee and Hui-na Lin (2010)** analysed the dynamic relationship of return, volatility and information transmission between gold and silver futures traded in TOCOM and COMEX markets. The econometric model AR(1)-GJR-GARCH (1,1) was used to test the daily data between January 1990 and December 2009. It is identified from the empirical results that there existed a volatility transition (spillover) and return transition (contagion) by one lag between the gold and silver futures markets in TOCOM and COMEX. The reaction to the good news and bad news was asymmetrical and there existed low correlation between the two markets COMEX and TOCOM.

Yoichi Tsuchiya (2010) examined the existence of the co movements and the independence among the prices of precious metals commodities gold, palladium, platinum and silver futures contracts traded on TOCOM. The daily data from May 2002 to the end of May 2010 were analysed with cointegration techniques. The results evidenced non existence of long run relationship among the four precious metals futures contracts and their movements were independent on each other's movements.

Ahmed A.A.Khalifa et al (2011) using intraday tick-by-tick futures price data, studied the return distribution and the volatility of gold, silver and copper traded in NYMEX. GARCH model and the integrated volatility using the Fourier transmission (IVFT) were used to test the data from January 1999 to December 2008. The volatility in the gold market was much less than in the silver and in the copper market. The correlation in the daily returns was very low and making prediction from the past history was not possible. The IVFT was considered to be the best estimator of the volatility as it reflected more information regarding the price movements in relation to the other volatility measures.

Thai-Ha Le and Youngho Chang (2011) tested empirically the causal relationship between gold and oil prices. The relationship was tested through inflation channel and their interaction with the US dollar index. The monthly data from January 1986 to April 2011 were analysed with Johansen cointegration test, Pair wise granger causality, VAR VDC and IRF models. Empirical results evidenced the long run relationships between oil price and inflation, between gold price and inflation and oil and gold price Paresh Kumar Narayan et al (2010), Yue-Jun-Zhang and Yi-Ming Wei (2010). In the long run rising oil price generated higher inflation which strengthened the demand for gold and hence pushed up the gold price **Paresh Kumar Narayan et al (2010)**. The variation in gold price was better explained by the fluctuations of US dollar index than that of oil price. Gold price reacted immediately and positively to the innovation in oil price

It is understood from the above given literatures that the volatility of gold price is lesser than that of the other metal commodities. The price of gold and silver are correlated with each other and price dependencies exist between these two commodities. The movement of oil price is highly correlated with gold price and the volatility in the oil prices causes gold price to fluctuate more. To conclude, most of the studies in gold market revealed that the price of gold generally stable.

2.4 GOLD, STOCK MARKETS AND EXCHANGE RATES

Historically it is observed that gold price and stock markets show negative relationship and positive relationship respectively with exchange rates. An upward movement in the stock market, decreases the gold price and vice versa. Gold is known as international commodity and the price of which is also fixed and expressed in international currency usually USD. Any appreciation or depreciation of domestic currency against USD will have its impact on the domestic gold price in the form of either increase or decrease in the price. The following reviews explain the existence of the relationship among gold price, stock markets and exchange rates.

Bertrand Fox (1935) made a descriptive study about the relationship that existed among gold prices, exchange rates and the study was restricted to three countries England, France and United States. The data showed that there was a similarity in the price movements of gold among these three countries and when exchange rates moved the prices of these international commodities, they reacted very quickly to restore international price parities. **Somnath Basu and Maclyn L.Clouse (1993)** conducted a research on how the information in the derivatives market could be used to predict the price of gold. Multiple regression and transfer functional model were used to analyse the data from 1st October 1989 to 30th September 1990. The results indicated that the equity, bond and Yen markets were considered to be an efficient markets as the index prices of these markets were independent of each other. The gold market was inefficient as this was influenced by all the other markets. **Larry A. Sjaastad and Fabio Scacciavielani (1996) and Larry A. Sjaastad (2008)** investigated how the changes in the exchange rates of major currencies affected the price of gold in terms of that currency, which possesses the power of price maker. A model called international pricing model has been developed to study the relationship between the exchange rates and gold price between January 1982 to December 1990. The results from the model pointed out that European currency bloc dominated the entire gold market by having the two third of the market power and any appreciation or depreciation in this currency against USD had a greater impact on the gold price of other currencies, where as the largest producer such as Australia and South Africa had

no in influence over the gold market. The US dollar had only a small influence over the market, even though it is international currency.

Graham Smith (2001) empirically accounted the causal relationship between the gold price and the stock price indices of the US for the period from January 1991 to October 2001 by adopting the Engle and Granger cointegration, ECM and the Granger Causality test. The study found out that there is no long run relationship between the gold prices and the US stock prices indices and there existed a unidirectional causality from US stock returns to the returns on the gold price. **Garry Twite (2002)** analysed how the stocks of the Australian gold mining firms reacted to the fluctuation in the gold prices by using the Regression and Black-Scholes option pricing approach for the period between January 1985 and December 1998. From the results he brought out that the relationship between gold price and stock price is non-linear. The gold mining firms had a substantial gold price exposure and the rate of return on gold stocks was more sensitive to US dollar denominated gold prices than Australian dollar denominated gold prices. **Graham Smith (2002)** empirically examined the long run and short run relationship between gold price and the stock prices indices of Europe and Japan. The study considered 23 stock indices of 18 countries from Europe, Japan and non Europe countries from January 1991 to the end of October 2001. He followed same model as used by **Graham Smith (2001)** and the findings also similar in nature. There is no evidence of cointegration implying that there is no long run equilibrium relationship between the gold price and the stock price indices. Hence these series did not share any common trend throughout the sample period. A weak short run correlation existed between the return on gold and the return on stock price index.

Tomomichi Nakamura and Michael Small (2006) investigated the irregular fluctuations in the financial data are random walk. Other than these ARCH, GARCH and EGARCH models, they used Small- Shuffle Surrogate method and Monte – Carlo hypothesis testing to test the included variables. It is found that there existed some kind of dynamics in irregular fluctuations of price changes, daily gold price, JPY/USD and CHF/USD exchange rates. **Lam Yuk Tak (2007)** using the monthly data from January 1991 through December 2002, tested the causal relationship between USD and Euro with gold price. The models such as Co-integration test,

Granger Causality test and VAR IRF and VDC were used to perform the analysis. The results evidenced the existence of the long run relationship between the exchange rate and the price of gold and there was unidirectional causality from exchange rates to gold price and not in vice versa. **Andrienne Kearney and Raymond Lombra (2008)** investigated the possible impact of derivatives on the gold market for the period from the period from 1973 to January 2006. The research findings suggested that the use of derivatives by gold producers pushed gold prices below what they expected based upon historical relationships. The massive increase in the use of derivatives by the largest producers of gold may well have had the effect of reducing the output of these gold mining firms. **Giam Quang Do et al (2009)** focused on analysing the volatility and return behaviors of the five emerging stock markets in ASEAN incorporating with the effects from the International gold market. The ASEAN countries included in the study were Indonesia, Malaysia, The Philippines, Thailand and Vietnam. Using GARCH-X, GJR-X Model and Granger causality model the study analysed the data from 28th July 2000 to 31st October 2008. The results revealed that three of five stock markets were influenced by the gold markets specifically the Vietnam, Thailand and Indonesia and the stock market returns were found to be significantly affected by the gold returns. The gold and stock market had a bi-directional effect in Vietnam, while some others had unidirectional effect.

Claire G. Gilmore et al (2009) using the weekly data from 5th June 1996 to 31st January 2007, examined the dynamic relationship among gold prices, gold mining stock prices and stock market prices. Johansen-Juselius cointegration test, VECM, Granger causality test and VAR VDC and IRF model used to test the interdependence among the variables. The empirical found the existence of Long term relationship existed between gold mining stock (GOX), gold prices and the stock market prices (LCAP, MCAP, SCAP). The adjustment to the disequilibrium in the long run was more rapid in gold price than S&P 500 index and in the short term gold prices were caused by GOX. The findings are contradictory to the study Graham Smith (2002) and Graham Smith (2001). **Pravit Khaemasunun (2009)** using the daily data from 2nd November 2005 to 25th April 2008, analysed the factors that affect the Thai gold prices and suggested a model to forecast the gold price. The results of Multiple regression and Box-Jenkin's ARIMA (1,1,1) modes revealed that Thai gold prices return is affected negatively by the USD exchange rate and positively by the other

factor such as oil price, AUD, JPY, Canadian dollars and EU pounds. A decrease in the US dollar exchange rate will increase the Thai gold price and the other factors that had positive impact on the Thai gold price could be used as indicator to predict the Thai gold prices as they had an increasing trend.

Mu-Lan Wang et al (2010) examined the impact of fluctuation rates of the US Dollar Vs various currencies on the stock price indices and the gold price of the United States, Germany, Japan, Taiwan and China. Granger Causality test was applied on the daily data from 2nd January 2006 to 27th February 2009. The results concluded that except for the United States, there existed long term stable equilibrium relationship among the national stock index and crude oil prices, Gold and exchange rates **Claire G. Gilmore et al (2009)**. There existed a two way feedback relationship between the crude oil prices of Taiwan group and the Taiwan stock prices/Gold prices. Crude oil prices were leading the exchange rates, Gold price was leading the exchange rates and Gold prices and Taiwan stock prices are mutually independent. **Massimiliano Marzo and Paolo Zagaglia (2010)** accounted the impact of 2007 financial crisis on gold price and investigated the pattern of volatility spillover between gold, silver and US dollar. The daily data set spanned from 13th October 2004 to 5th march 2010 was analysed analysed through Bivariate GARCH and structural BEKK model. The results suggested that gold generated stable co-movements with the Dollar that have indeed persisted during the recent phases of market disruption. The exogenous volatility shocks tend to generate reactions to gold prices that are more stable than those of the U.S. Dollar. **P.K. Mishra et al (2010)** using monthly data for the period 1991 to 2009, made an attempt to study the causal relationship between the domestic gold price and the stock market returns in India. The results of Cointegration test, Granger causality test and VECM model proved that both gold price and stock market had long run equilibrium relationship among them. There existed the two way and feedback causal relationship between gold price and stock market and thereby the information of one could be used to predict the other market. Claire G. Gilmore et al (2009).

Bhagirathi Nayak et al (2011) attempted to forecast the financial market indicators by employing the fuzzy application rules on gold futures, carbon futures traded at NCDEX and CNX Nifty index. The study concluded that the fuzzy system

could be considered as effective methodology for forecasting and predicting the financial parameter. The forecasting values obtained through fuzzy systems were approximately more close to the actual prices of the series. **R. Karthikeyan and M.G. Saravanaraj (2011)** studied the price movement relationship between gold, silver and NIFTY covered the period from 1st January 2011 to 31st May 2011. The estimated Beta Sharp Ration and Treynor Ratio results revealed that Gold and NIFTY always had negative correlation with each other and the risk involved in gold was very low and NIFTY was at highest risk over the period of time. The risk adjusted performance of gold, silver and NIFTY was very low with high risk and there existed a negative performance in all the months. **Hina Shahzadi and Muhammad Naveed Chohan (2011)** using the monthly data from December 2005 to December 2010 examined how the Karachi stock exchange (KSE) was affected by the changes in the gold prices. Through Johansen-Juselius cointegration and Granger Causality test it is found that the gold price and KSE-100 Index were negatively correlated and indicated the non-existence of long term relationship between the gold price and KSE-100 index R. Karthikeyan and M.G. Saravanaraj (2011).

Cuneyt Akar (2011) tested the dynamic relationship between the stock market, gold and foreign exchange in Turkey with the effect of 2001 financial crisis. The dynamic conditional correlation GARCH (DCC-GARCH) model is used to analyse the monthly data from January 1990 to December 2010. The results concluded that the relationship between gold price and LIRA/USD exchange rate was positive throughout the sample period except during the crisis period where the relationship became zero. Before the 2001 crisis, the gold and ISE 100 index had a positive relationship. After the 2001 crisis, the ISE 100 index had a negative relationship with gold and LIRA/USD exchange rate. Hence the 2001 crisis became a turning point for Turkey which altered the nature of relationship between the stock market, gold and the exchange rate. **Kuntara Pukthuanthong and Richard Roll (2011)** using GARCH (1,1) and Granger Causality model, examined the nature of relationship between gold and the exchange rates of the major currency for the period from 2nd January 1971 to 10th December 2009. It is found that a rise in the price of gold is strongly linked with the depreciation of the exchange rate of the same currency and the dollar exchange rate against the DM-Euro granger caused the gold returns expressed in dollar, Yen and pounds. **Subarna K. Samanta and Ali H. M. Zaden**

(2012) examined the daily data from January 1989 through September 2009 to study the interrelationships and the volatility spillover between the commodity and economic variables. The results suggested that there existed a co-integration relationship and volatility spill over between the variables. Unidirectional causality existed from stock price and gold price to oil price and exchange rates. The oil price, exchange rate and Dow Jones index were caused by gold price but gold was influenced by itself and not by other variables. Volatility transmission existed between financial markets and stock markets but with asymmetric relationships. **Ai Han et al (2012)** using cointegration and VECM model investigated the long run and short run relationship between the exchange rate of AUS dollar/USD and the gold price. Monthly, weekly and quarterly data were used for the period from 6th January 2002 to 10th February 2008 were analysed. The estimated results evidenced a positive long run relationship between exchange rate of AUS/USD and the exchange rate is strongly affected by the gold price.

Gold market is positively correlated with the movements of exchange rates and negatively correlated with the stock markets movements. Gold performed as a defensive security in a portfolio and it acted as a better portfolio diversifier than the other securities. Gold price is associated with the currency depreciation, as a rise in the price of gold is strongly linked with the depreciation of the exchange rate of its currency.

2.5 GOLD AND MACRO ECONOMICS

The relationship between gold and the Macro Economic variables are proved empirically. Gold plays a vital role in the formulation of Macro Economic policies. Most of the country's central banks maintain some gold in their reserves. Countries like USA maintain huge amount of gold in their reserves. The uniqueness of gold is that it is used as a hedging instrument at the time of inflation and the price of gold changes accordingly in response to the fluctuation in price level, growth in Gross Domestic Product and Money Supply. Gold also serves a good portfolio diversifier by providing security to the investors. Hence study of the reviews in this area would help

to understand the hidden facts about the relationship between gold and macro economy of a country.

William D. Lastrapes and George Selgin (1996) examined the role played by gold price in formulating the monetary policy. Using VAR VDC and IRF models the monthly data were analysed for the period from December 1982 to November 1995. The analysis concluded that gold played an independent role in formulating the monetary policy and the Fed may rely on other sensitive commodity prices as primary indicator of excess monetary liquidity. **Saeid Mahdavi and Suzhou (1997)** addressed the role of gold and commodity prices in the conduct of monetary policies and investigated the cointegrating relationship between CPI and the price of gold, index of the commodity prices. It employed Johansen cointegration and Granger causality test to test the quarterly data from 1958 to 1994. It is concluded that the gold price and CPI are not cointegrated and the commodity prices (JOCI) and the CPI were cointegrated with each other. The short-term movements in the price of gold were too volatile and the emphasis on the price of gold as to monetary policy may be misplaced. The ability of commodity prices to signal the inflation rate weakened as they accounted only a smaller cost over time.

Rohan Christie-David et al (2000) documented the effect of Macro Economic news release on gold and silver futures prices. The study considered the data of 23 Macro Economic news announcements in US for the period from 3rd January 1992 to 29th December 1995 to analyse their impact. It is concluded that gold is significantly affected by CPI, unemployment rate, Gross domestic product and the PPI, capacity utilization. Silver exhibited a strong response to the release of the unemployment rate and capacity utilisation and had showed higher variance on non announcement days than on announcement days. **Ali M. Kutan and Tansu Aksoy (2004)** empirically examined the impact of inflation and public information on the gold return traded at Istanbul Gold market. The study analysed the daily data for the period from 2nd January 1996 to 14th February 2001 with GARCH (1,1) model. The arrival of inflation information did not have any significant impact on the gold return and hence gold could not be used to hedge against inflation. The information about the balance of trade and GNP had a significant effect on the gold returns indicating

that Gold market movement was driven by the real factors and not the nominal factors.

Robert Faff and David Hillier (2004) extended the work done by Tufano (1998) by investigating the gold price exposure of the gold mining industry portfolio for five different countries such as Australia, Canada, South Africa, US and world gold mining portfolio. Using GARCH (1,1) model and Kalman filtering analysis, the daily data was analysed from 12th June 1993 to the end of 1999. The empirical results was supported by the Tufano(1998) study and it is found that the conditional gold beta was negatively associated with the gold bullion prices, gold bullion volatility and the long term interest. The exposure of the gold mining firms to the gold price varies from one country to the other in such a way that only the gold bullion return volatility had a negative association with the conditional gold beta to Australia and South Africa. **Eric J Levin and Robert E Wright (2006)** empirically examined the factors that determine the price of gold in the short run and long run. Econometric models such as Co-integration, VECM, VAR VDC and IRF were applied for the data from January 1976 to August 2005 to determine the factors. The study found the existence of long term relationship between the price of gold and the US price level (CPI) and the error caused due to the shocks in the long run was corrected in five years. Most of the changes in the gold price were associated with the change in the US price levels followed by the changes in the exchange rate and US inflation volatility.

Andrew C. Worthington and Mosayeb Pahlavani (2006) tested the inflation hedge properties of gold in the long run by using the monthly data from January 1875 to February 2006. The empirical results supported by Eric J Levin and Robert E Wright (2006) study and concluded that the gold prices and the inflation were co-integrated in all the three cases for both the sub period analysis. The investments made in the gold could be used to hedge against inflation in the post war and the post 1970 period. **Natalie Dempster (2006)** using the data from 1996 – 2005, elaborated the role of gold in Indian social, cultural and economic aspects. The study found that there is a huge mismatch between the supply and demand as the demand primarily met through the imports and the increase in the gold price increased the investment demand for gold. It suggested that the factors such as increase in the women

independency, population, cultural values and rapid income growth will make India the world's foremost consumer of gold in the future.

Natalie Dempster (2008) examined the role of gold in enhancing the portfolio performance that contains equity and other financial assets and commodities. The study was conducted between January 1974 and December 2005. The results concluded that the portfolio become more efficient and less volatile when gold was included in the portfolio and gold acted as strategic asset in enhancing the portfolio performance. Hence it suggested that gold could be used as one of the diversifying tool in a portfolio to diversify and to reduce the risk of the portfolio. **Shaun K. Roache and Macro Rossi (2009)** investigated the effect of macroeconomic news on commodity prices and whether gold was just one among the commodities or not. They used twelve commodities daily price from different group from January 1997 to June 2009 and employed the GARCH model to examine the impact. It is found that gold was highly sensitive to the real interest rate and its unique role as a safe haven and store of value typically lead to a counter-cyclical reaction to surprise news. The bad news affected the gold price much more than good news indicating that it was more sensitive to bad news. **Natalie Dempstar (2009)** by using the conservative real return assumption, the relative performance of four assets gold, commodities general, real estate and bonds in a portfolio is assessed for the period from January 1974 to till May 2009. Gold was the best performer and did not produce negative return. Gold consistently delivered a lower average volatility throughout the period and produced maximum reward risk portfolio with minimum variance portfolio. Gold acted as a effective portfolio diversifier against all the other assets taken in the analysis as it had a lowest correlation with all the asset classes over the three sub periods.

Ugur Soytas et al (2009) using the daily data between 2nd May 2003 and 1st March 2007, tested the long run and short run feedback relationship of gold with other Macro Economic variables. The results of Wald test, Granger causality test and IRF concluded that there existed a unidirectional causality from interest rate to the gold and silver prices, exchange rates and from exchange rate to domestic gold price. However in the short run exchange rate did not have any impact on the gold price. **Jonathan A Batten et al (2010)** examined the nature of volatility and the macro economic factors that determine the volatility of the metal commodities. The monthly

data from January 1986 and May 2006 were analysed with Block Exogeneity causality test and VAR conditional standard deviation. It is concluded that gold could be regarded as substitute money and the variables such as inflation, interest rate and growth rate in money supply were likely to be more important for this market. For platinum and palladium on the other hand both monetary and financial variables such the return volatility on S&P 500 and world ex S&P 500 indices were considered to be important as they were more likely to act as a financial market instrument than gold. **Juan Carlos Artigas (2010)** made an attempt to study the impact of broad and narrow money supply of four countries such as US, Europe, India and Turkey on the price of gold for the period between January 1975 and April 2009. It is found that the money supply growth and gold price were correlated positively and the future gold price was affected by the growth in the past money supply. An increase in the money supply today will tend to increase the gold price after six months and hence the growth of money supply is an indicator of the future gold price. These four countries money supply accounted 29% of variation in the gold price.

Fan Fei and Kelechi Adibe (2010) examined the gold price movements with respect to three factors such as safe heaven, negative beta asset and dollar destruction. The empirical analysis is carried with multiple regressions, VAR VDC and IRF from January 1978 to December 2007. There existed a close relationship among the gold price, real exchange rate and exchange rates of USD. The gold price is influenced moderately by the shocks from aggregate demand, monetary demand and gold specific demand. Gold should be considered as another currency because it reflected the value of US dollar and US monetary policy. **Le, Thai-Ha and Chang (2011)** focused on the study of the dynamic relationship among gold price, oil price and macro economic variables such as interest rate, exchange rate and stock price. Using the Bounds testing co-integration and ARDL procedure, the study analysed the monthly data spanning from January 1985 to February 2011. The results concluded that oil price negatively correlated with all the macro economic variables and positively correlated with gold price, where as gold price negatively correlated with stock price and exchange rate. The gold price movements could be observed to predict the interest rate in Japan, and the increase in the gold price had a depreciation impact on the Yen versus major currency.

Jana Simakova (2011) examined the causal relationship between the oil and gold prices for the period between 1970 and 2010 and used the models such as VECM, Granger Causality and Regression. The empirical results concluded that gold and oil were positively correlated with each other and there existed long term relationship between these two commodities. The gold price was caused by oil price in one month period and both gold and oil restored the equilibrium in the long run from the error that caused the disequilibrium. **Cengiz Toraman et al (2011)** examined the macro economic factors that determine the gold price by empirically analyzing the data from January 1992 to March 2002. The relationship was studied through the multivariate GARCH model (MGARCH), which was estimated through the constant conditional correlation model (CCC model). It is found that gold price was highly negatively correlated with the USD exchange rate and positively and significantly correlated with the oil price. Hence it is suggested that the gold market is efficient.

Gold plays a vital role in the process of formulating the monetary policy of a country. Gold price is highly sensitive to the interest rates and it acts as a powerful predictor of the interest rates. Inflation and gold price always moves together in the long run and any investments in gold can be used to hedge against inflation. Increase in the money supply and GDP of a country tends to increase gold demand and this indirectly signals that the gold price will increase in the near future.

2.6 GOLD DEMAND AND SUPPLY

The price of any commodity is directly related with its supply and demand conditions, because the demand for the commodity in the market and the supply from the producer are key factors that determine the price of a commodity. Further price is not the only factor that determines the demand of a product. Instead, the demand of a commodity might be determined by many other factors such as the income of the consumer, price of substitute products, growth of the economy, inflation etc. The following reviews discuss the factors that determine the price of gold and the relationship between the demand, and price of gold and GDP.

G.F. Warren and F.A. Pearson (1933) discussed in detail theoretically and empirically about the relationship between the demand and the supply of gold and its prices. They argued that the price of a particular commodity is a ratio of the two values, and the two values of ratio depends upon the supply of and demand for gold to the supply of and demand for another commodity. It is suggested that the price levels of any commodity cannot be maintained by the proper handling of the credit policy. The extension or suspension of credit will not make a commodity cheaper. Instead a nation can make the gold cheaper by reducing the gold demand in the whole world. It was observed that the gold price rose, when the production was relatively high to the monetary stocks and price fell when the production was relatively low to the monetary stocks. **M.H Govett and G.J.S Govett (1981)** explained the structure of gold supply, demand and the production pattern in different countries for the period between 1965 and 1980. The study concluded that the demand for gold was influenced by many countries holding gold as reserve asset, investments by Government and private, and the jeweler demand. The empirical results also proved that there was a correlation between the trend of rising prices and rising output was relatively good for all the main metals except Gold. Comparing with the other metal prices, gold showed the most spectacular increase particularly from the period 1970 to 1980.

Mohsen Bahmani-Oskooee (1987) assessed the impact of the gold price change on the demand for international reserves of the less developed countries. Using the annual data of 17 developing countries for the period from 1972 – 1983, the study conducted empirical analysis through the two stage least squares method and OLS method. The results concluded that the rising price of gold exerted a significant negative effect on the less developed country's demand for international reserves. As the developed countries exposed to the exchange rate flexibility, the speed of adjustment of reserves was also found to be smaller for the less developed countries than the developed countries. **Roy Batchelor and David Gulley (1995)** using the conventional demand function, tested how the price of gold is affected by its jewelery demand. Six developed countries were included in the study such as USA, Japan, Germany, France, Italy and UK and analysed the annual data for the period from 1973 to 1993. It is found that the dollar denominated gold price had a greater impact on the jewellery demand than the exchange rate and general price level in USA and Japan

and the timings of response of demand to the changes in the dollar gold price varies across all the countries. In France and USA the demand increased in anticipation ahead of the changes in gold price. **Saroja Selvanathan and E.A Selvanathan (1999)** studied the impact of gold price on its production in Western Australia and evaluated the supply elasticity. The empirical analysis of annual data during the period 1948 – 1994 results evidenced that both price and production were not co-integrated in the long run and there existed a unidirectional causality from gold price to gold production. The gold price was determined in the world market and was independent of Australia Production.

A.Vaidyanathan (1999): attempted to study the trends in the gold consumption, to identify the factors that determine the demand. The study included most of the Macro Economic variables annual data ranging from 1970 to 1996 and employed the Multiple Regression model to test. During the pre liberalisation period the factors such as the difference between domestic to foreign gold price, the ratio of gold to share prices were showing positive signal and influence the gold imports and house hold financial savings and real output did not influence the gold import. The co efficient of ISOP and MARG were positive and highly significant implied that when the gold price rise relative to those of ordinary shares and international gold price, the gold import was higher. **I.G.Patel and Anand Chandavarkar (2006)** using the annual data for the period from 1925 to 1942 the study examined the responsiveness of the India's demand for gold to the changes in the price and the real income. Multiple regression results suggested that the demand for gold was highly responsive to the price changes. Increase in the index of relative price of gold showed decreasing trend in the demand for gold in India.

R. Kannan and Sarath Dhal (2008) covered in their research which was not done in I.G.Patel and Anand Chandavarkar (2006) study**.** They focused the study of the relationship between the gold demand and the macroeconomic variables and attempted to identify the factors that determine the gold demand. The annual data of Macro Economic variables for the period 1980 – 2005 has been used in the co-integration and regression analysis. It was found from the results that the gold demand in India was influenced by the real income and the price of gold. The real yield on government bonds had inverse relationship and gold was considered as an alternative

instrument for household savings. The interest on deposit had a significant effect on gold demand and the government capital expenditure relative to aggregate expenditure reduced gold demand for precautionary saving purpose. **Martha Starr and Ky Tran (2008)** by analyzing the annual data of 21 countries from 1992 to 2003, examined the macro economic factors that really influence the physical demand for gold. The results concluded that the credit market had a negative effect with gold demand, and the stock market showed a positive effect implying a strong growth in the price rise in the stock price boosted the physical demand for gold in the sense that gold to be a luxury item. The impact of the per capita income on gold demand was positive and the inflation volatility was associated with the higher gold demand. **Kaspar Allese (2008)** discussed the historical developments in the gold price and attempted to identify the factors that determine the gold prices. The Macro Economic variables for period from 1970 to 2007 were analysed and the result was that there existed a strong relationship between gold and oil price and oil price was one among the major indicators that determine the gold price. Gold price had inverse relationship with the stock prices and gold price showed stable growth in the long run. The increasing inflation, economic and political crisis had strong impact on the gold price where as the supply and demand had very little impact.

Mykhaylo Demkiv (2010) identified the factors that influence the demand and supply of the world gold market by taking the annual data for the period from 1977 – 2009. It is found that the gold price has big influence on the supply and very less impact on the demand. The demand market was highly influenced by the investor's position and the volume of the jewellery market. The supply market was highly sensitive to miner's level of profitability and it was determined by the gold price and the US dollar broad trade weighted index. **Eily Ong et al (2011)** undertook the same kind as done by R. Kannan and Sarath Dhal (2008) tested the macro economic and financial variables that determine the Indian gold demand. The annual data from 1992 to 2010 were analysed through Eangle and Granger Error Correction approach to account the long term and short term components. It was found that the price exhibited an inverse and elastic relationship to gold demand and the gold demand was significantly and positively responsive to income. The jewelry demand for gold was more elastic than fabrication with respect to price, income and wealth effect. In the short run the gold demand can be modulated with policy actions through

interest rates, exchange rate, taxes and government spending which constitute monetary and fiscal instruments.

It is understood from the above literatures that an increase in the consumer's income will increase the demand for gold in the long run. The demand for gold is highly responsive to the changes in the price and an increase in the price reduces the its demand. Increase in the production does not mean that its price will go up, but increase in the price will cause more production. The negative movement in the stock markets directly increases the physical gold demand.

2.7 RESEARCH GAP

From the previous researches, it is observed that there exists a vast area that requires further research. The appropriate gaps are identified in order to proceed to new areas of study. Taking up research in these areas would add more value to the existing literature. In spite of being the largest consumer of gold in the International gold market, India lacks research especially in the field of gold market. We could find only few studies in India. R. Kannan, Sarath Dhal (2008), Ganesh Mani a and Srivyal Vuyyuri (2001), Arti Gaur and Monica Bansal (2010), Pantisa Pavabutr & Piyamas Chaihetphon (2008), P K Mishra , J R Das , S K Mishra (2010), A. Vaidyanathan (1999), Natalie Dempster (2006), I.G.Patel and Anand Chandavarkar (2006) documented the demand determinant, gold price relationship with the macro economic variables and they have not focused on the area of comparing our gold market with the other major gold markets in the world. Very recently the study made by World Gold Council (2011), R.Kannan and Sarath Dhal (2008) from India have suggested to make a study to see the impact of our changes in the gold demand in the world gold price.

In the International level there are studies such as Xiaoqing Eleanor Xu, Hung-Gay Fung (2005), Larry A. Sjaastad (2008), Larry A. Sjaastad, Fabio Scacciavillani (1996) and Risto Laulajainen (1990) documented the relationship between the USA, Japanese and European gold markets. However they did not consider the Indian gold market in their study. Larry A. Sjaastad (2008) and Larry A.

Sjaastad, Fabio Scacciavillani (1996) tested price maker concept by observing the impact of the major currencies on the world gold price. However the impact of Indian rupees on the world gold price is ignored in the study.

Hence a new study is required to see, in order to test the existence of the relationship among the major gold markets in the world and to assess whose information from the domestic gold markets contributes a lot to the price determination process. The big question that always lies in the minds of the bullion business people in India is, who is the actual price maker in the world gold markets. This study made an attempt to study the existing gap in the literature through the empirical analysis and evidence. It also compares Indian gold market with the major Gold markets in the world and to identify the real price maker in the world gold markets.

There are studies by Eily Ong et al (2011), R. Kannan and Sarath Dhal (2008), Mykhaylo Demkiv (2010), Martha Starr and Ky Tran (2008), M.H Govett and G.J.S Govett (1981) and A.Vaidyanathan (1999) available in the literature that have analysed the demand and supply determinants in the world gold markets. However there are a only few studies by I.G.Patel and Anand Chandavarkar (2006) that have addressed the measuring of the price and income elasticity in gold market. There is a need to address the efficiency of the gold markets in terms of its elasticity. This study also measures the efficiency of the world gold markets by empirically analyzing which market gets back to its equilibrium at a very fast.

Chapter

3

Dynamic Interactions of the World Gold Markets

Methodology

CHAPTER – III

METHODOLOGY

3.1 INTRODUCTION

Research methodology is a way to systematically solve the research problem[3]. In this way the various steps that are adopted in the empirical analysis are explained in detail in this chapter. The objective of this chapter is to provide in detail about the necessary information related to methodology of the study and to make step by step understanding about the econometrics models used in the study.

The data, variables and the econometric models to test the data is selected based on the review. This chapter deals with the major objectives of the study, data and period of the study, hypothesis to be tested with respective to the objectives, scope and significance of the study and limitations of the study. The econometric models that are employed to test empirically the objectives are discussed in details in this chapter.

3.2 OBJECTIVES OF THE STUDY

The overall objective of the study is to assess the dynamic interactions of World Gold Markets. But it specifically intended:

1. To Study the long run and short run relationship among world gold markets.
2. To examine the information spillover or transmission mechanism among world gold markets
3. To empirically assess and identify the price maker in the world gold markets
4. To measure the efficiency of the world markets with respect to their elasticity

[3]C.R. Kothari., "*Research Methodology, methods and techniques*"., 2nd and revised Edition., New Age International Publication. Page. 8

3.3 NULL HYPOTHESIS

$H_{0.}1$ There is no co integration among the prices of world gold markets

$H_{0.}2$ Indian gold price does not cause the world gold price (AM & PM Fix price of LBMA)

$H_{0.}3$ Volatility of world gold markets do not influence the world gold price (AM & PM Fix price of LBMA)

$H_{0.}4$ There is no significant information spill over among the world gold markets

$H_{0.}5$ There is no impact of changes in Aggregate demand of world gold markets on the world gold prices

$H_{0.}6$ There is no relationship between the demand for gold, real gold price and income of the consumers of world gold markets.

3.4 SIGNIFICANCE OF THE STUDY

The importance of the study is to test empirically the price maker in the world gold markets. In spite of its largest consumer of gold in the world gold markets, India's role in influencing the world gold price is yet to be addressed empirically. In this context, this study is an attempt to test empirically the real price maker in the world gold markets. The LBMA AM fix and PM fix prices are fixed based on the information received from the world gold markets every day. The significance of the study is to analyse whose information from the world gold markets influence this price is yet to be documented. It will help the policy makers and the bullion business people of our country whether India can become a price maker in the world gold markets, if so, what are the ways it can be achieved.

The dynamic relationship and information spill over tested in the study will help the consumers and the investors to forecast the future prices based on the movements of the other major gold markets in the world. The investors and the business people would be benefitted a lot by understanding the demand trend and how the demand is affected by an increase in the income of the consumers and the price of gold. This study is taken up in the right manner and at the right time to help the bullion business people.

3.5 SCOPE OF THE STUDY

The study considered only four Major Gold Spot markets in the world, namely Indian Gold Market, Japanese Gold Market, Europe Gold Market and the USA Gold market. The aggregate demand of these four countries alone represents more than 60% of world's total gold demand. Since the objective of the study is to examine the demand effect, the major gold supplying countries and their impacts on the world gold price are not considered. The other variables such as stock markets, exchange rates and gold demand are also chosen based on the selected countries. The daily spot gold price that prevails in their respective domestic markets are analysed and the futures price that are traded in their commodity exchanges are not included. This study address only the interactive relationship among the world gold markets and the lead lag relationship among these markets is not analysed. Due to the constraint in the availability of data, the study covers the period from 1st January 2000 to 31st December 2011.

3.6 DATA AND METHODOLOGY

3.6.1 Data and Period

The study considered both daily and monthly data for the period from 1st January 2000 to 31st December 2011. The daily data is employed for the first two objectives and monthly data is employed for the other two objectives. The daily data consisted of LBMA AM and PM fix price, Gold spot price per troy ounce from each market, and the volatility of these spot gold prices. The quarterly data of Gold demand and Gross Domestic Product are converted into monthly data based on Cubic Spline Method available in Eviews package. The Monthly data consisted of Gold demand in tonnes for each country, Gross Domestic product to proxy the income, average spot gold prices, Stock Market Index, Exchange rates of respective currencies. The data is sourced from many resources such as World Gold Council, Gold price network, Kitko, London Bullion Market Association, finance.yahoo.com, Reserve Bank of India and Econmagic.

3.6.2 Methodology

- Separate Analysis is done for LBMA AM Fix and PM Fix price as the objective of fixing these two prices differs from one another
- Preliminary Analysis is done through Descriptive Statistics, Correlation and Line Graphs for all the variables
- Stationarity properties of the variables are tested with Augmented Dickey – Fuller Unit Root test
- Optimum Lag Length was obtained from VAR Lag Length selection Criteria
- Long Run Relationship is determined with Johansen Maximum Likelihood Method
- Short Run Relationship is assessed with Vector Error Correction Model
- ARCH Effect is detected from the ARCH Hetroscedasticity test
- The Conditional Variance of the variables are estimated through GARCH (1,1) model
- Leverage Effect, Persistence of Volatility, information spill over from other independent variables are estimated with Exponential GARCH Model
- The short term influence and causality relationship between variables and all variables together is tested with VAR Granger Causality / Block Exogenity test
- Effect of shock in one variable and the response of other variables on that shock and its directions ar found by using impulse response function
- Proportion of shock transmitted from one variable to another due to shock in the same variable is determined by using Variance decomposition
- The Long Run and Short Run Elasticity of gold demand is estimated with the model adopted by R.Ramanathan (1999)

3.7 LIMITATIONS OF THE STUDY

The aim of the study is achieved through empirical analysis. However this study suffers from few limitations. Initially this study intended to include all major micro markets in India in order to observe whose price is really influencing world gold

prices. Due to non availability of data, the other major micro markets are not included in the study. Only Mumbai price is considered and its information is considered to represent whole India. The same is applied to the other countries also. Accesses to the gold price data of the micro markets in India are limited. The gold demand in India is influenced by its own seasonal activities such as wedding, Akshaya Tritiya, Diwali and etc. All these impacts on the demand is not documented and the behavior of the consumers are also not studied. The analysis and the conclusions are made within the spot price frame work in the local markets and the exchanges traded prices are not accounted. The findings, conclusions and suggestions are made with in the secondary data framework. The study is limited only one macr economic variable GDP and other factors such as Inflation, Money supply, impact of import duty on gold are not included.

3.8 ECONOMETRICS MODELS USED IN THE STUDY

3.8.1 Unit root tests

A time series is stationary if the probability distribution is stable over time. In practice, this condition is very difficult to obtain. Thus, stationarity usually means weak or order 2 stationarity and concerns only the stability of the first two movements of the distribution in time: mean and variance. A time series has a unit root (or integrated of order 1, I(1)) if it becomes stationary afterbeing differentiated one time. This means that P_t is not stationary but ($P_t - P_{t-1}$). To test for a unit root test, Dockey-Fuller (DF (1979) and Augmented Dickey-Fuller (ADF, 1981) tests are used. In 1988, Phillps and Perron proposed a new test which corrects some of the weaknesses of the ADF test. The details of these tests are presented below.

Augmented Dickey Fuller (ADF, 1981)

The price series P_t follows the auto-regression of order 1, AR(1). Dikey and Fuller (1979) proposed the below equation.

$$P_t = \phi P_{t-1} + \varepsilon_t \qquad \text{..... 1}$$

With ε_t a white noise. The stationarity of P_t depends on the value of ϕ. If ϕ <1, the series is stationary. It has a permanent tendency to return to the average and

constantly cross it. If ϕ=1, the series has a unit root or is integrated of order 1. It follows a random walk. ϕ>1, the series is explosive. It never returns to the average.

In most of the financial series, ε_t is not white noise. Thus, the residuals of the equation (1) are autocorrelated. Dickey and Fuller (1981) thus proposed a parametric solution which consists in adding the lagged values of the independent variables ΔP_t on the right side of the equation (1). If we want the residuals ε_t to become a white noise, we need number of lags. Hence the ADF test equation as follows

$$\Delta P_t = bP_{t-1} + \sum_{i=1}^{q} \phi_i \Delta P_{t-i} + \varepsilon_t \qquad \text{..... 2}$$

In the ADF equations, there are three possibilities: Equation without constant, Equation with constant and Equation with constant and time trend t.

Without Constant: $\Delta P_t = bP_{t-1} + \varepsilon_t$ $\qquad \Delta P_t = bP_{t-1} + \sum_{i=1}^{q} \phi_i \Delta P_{t-i} + \varepsilon_t$ 3

With constant: $\Delta P_t = \alpha + bP_{t-1} + \varepsilon_t$ $\qquad \Delta P_t = \alpha + bP_{t-1} + \sum_{i=1}^{q} \phi_i \Delta P_{t-i} + \varepsilon_t$ 4

Constant and trend: $\Delta P_t = \alpha + \beta^* t + bP_{t-1} + \varepsilon_t$

$$\Delta P_t = \alpha + \beta^* t + bP_{t-1} + \sum_{i=1}^{q} \phi_i \Delta P_{t-i} + \varepsilon_t \qquad \text{..... 5}$$

The number of lags q is determined by the autocorrelation order of ε_t.

Once q is determined, we have to determine the best model (without constant, with constant or with constant and trend). To test the stationarity of the variables, the ADF procedure is adopted. The testing procedure is begun with the most complete model with constant and trend. The significance of the trendis verified with the β do this, we apply the following rules. We begin by the most complete model, equation (5) with constant and trend. We then verify the significance of the trend by the coefficient β. If the coefficient is not significant, then this model is not the good one. The next model Equation No (4) is tried. The significance of α is tested and if it is not significant, then this model is not the good one and so on.

Phillips and Perron's test (PP, 1988)

In 1988 Phillps and Perron proposed a new unit root test based on the models of Dickey Fuller (1979, 1981). Their objective was to correct the shortcomings the ADF test in order to cancel the effect of the hetroscedasticity of the residuals ε_t. To do this, Phillps and Perron used nonparametric tests, without adding any lag to the original equations. The principles of this test are:

Estimate, by the Ordinary Least Squares method, the three initial models proposed by Dickey and Fuller (1979)

Estimate the variance of the residuals: $\sigma_\varepsilon^2 = \frac{1}{T-1}\sum_{t=1}^{T} (\varepsilon_t - \varepsilon_{t-1})^2$..... 6

Then, instead of directly using the variance of the residuals in the test statistic, Phillps and Perron (1988) estimated a correction factor s_t^2 from the structure of the covariance of the residuals of three models.

$$s_t^2 = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_t^2 + 2\sum_{i=1}^{l} \left(1 - \frac{i}{l+1}\right)\frac{1}{T}\sum_{t=i+1}^{T} \varepsilon_t \varepsilon_{t-i} \qquad \text{..... 7}$$

Thus there is a new value *l* which is called the Newey-West truncation estimated in function of the number of observations, $l \approx 4(\mathrm{T}/100)^{2/9}$

So we see that the covariance of the residuals is taken into account in the correction factor s_t^2. Calculate the test statistics

$$t_{ststst}(PP) = \frac{\phi - 1}{\sigma_\phi} + \frac{T(k-1)\sigma_\phi}{\sqrt{k}} \qquad \text{..... 8}$$

With ϕ the estimator of the coefficient of P_{t-1} in the initial equations of Dickey and Fuller, T the total number of observations, σ_ϕ the estimator of the standard deviation of ϕ and $k = \frac{s_t^2}{\sigma_\varepsilon^2}$

The decision rules and the strategy of the test stay the same as the DF test. The critical values are calculated by MacKinnon as for the DF test

3.8.2 VAR - Optimum Lag Length

Selection of the optimum lag length is an essential step in the process of testing long run relationship and building VECM models. This is because too few lags mean that the regression residuals do no behave like white-noise processes. Including too many lags reduces the power of the test to reject the null of a unit root, since the increased number of lags necessitates the estimation of additional parameters and a loss of degrees of freedom. The degrees of freedom decrease since, the number of parameters estimated has increased and the number of usable observations has decreased. We lose one observation for each additional lag included in the autoregression. In addition to the S-tests and t-tests, it is also possible to determine the lag length using an information criterion such as the LR test, AIC or SBC. This study uses the following three methods for selecting the optimal lag length period p :

Likelihood Ratio Test

$$(T-C)\left(\ln\left|\sum_R\right|-\ln\left|\sum_U\right|\right)\sim\chi^2(d) \qquad \text{..... 9}$$

AIC (Akaike Information Criterion)

$$AIC = T\ln(SSE)+2k \qquad \text{..... 10}$$

SBC (Schwartz Bayesian Criterion

$$SBC = T\ln(SSE)+k\ln(T) \qquad \text{..... 11}$$

Where T is the total number of samples, C is the number of unconstrained parameters which are to be estimated; χ^2 is the number of degrees of freedom; d is the number of the constraint parameters; k is the total number if parameters to be estimated; and SSE is the sum of squares of residuals.

3.8.3 Johansen Cointegration

Cointegration is one of the most important developments in time series econometrics in the last quarter-century. A group of non-stationary I (1) time series is said to have cointegration relationships if a certain linear combination of these time series is stationary. There are two major approaches for testing cointegration, the Engle–Granger two-step method (Engle and Granger 1987) and the Johansen

procedure (Johansen 1988, 1991; Johansen and Juselius 1990). This study applied the Johansen Cointegration method, because this method is suitable for testing the long run relationship of more than two variables. This model is as follows:

Suppose that a set of g variables ($g \geq 2$) are under consideration that are I(1) and which are thought may be cointegrated. A VAR with k lags containing these variables could be set up:

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots\ldots + \beta_k y_{t-k} + u_t \quad \ldots\ldots\ldots 12$$

g × 1 g × g g × 1 g × g g × 1 g × g g × 1 g × 1

In order to use the Johansen test, the VAR (12) above needs to be turned into a vector error correction model (VECM) of the form

$$\Delta y_t = \prod y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots\ldots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \quad \ldots\ldots\ldots 13$$

Where $\prod = \left(\sum_{i=1}^{k} \beta_i\right) - \mathrm{I}_g$ and $\Gamma = \left(\sum_{i=1}^{k} \beta_j\right) - \mathrm{I}_g$

This VAR contains g variables in first differenced form on the LHS, and k −1 lags of the dependent variables (differences) on the RHS, each with a Γ coefficient matrix attached to it. In fact, the Johansen test can be affected by the lag length employed in the VECM, and so it is useful to attempt to select the lag length optimally. The Johansen test centres around an examination of the $\prod$ matrix. $\prod$ can be interpreted as a long-run coefficient matrix, since in equilibrium, all the Δy_{t-i} will be zero, and setting the error terms, u_t , to their expected value of zero will leave $\prod y_{t-k} = 0$. Notice the comparability between this set of equations and the testing equation for an ADF test, which has a first differenced term as the dependent variable, together with a lagged levels term and lagged differences on the RHS.

The test for co-integration between the y_s is calculated by looking at the rank of the $\prod$ matrix via its eigenvalues. The rank of a matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero. The eigenvalues, denoted λ_i are put in ascending order $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_g$ If the λ_s are roots, in this context they must be less than 1 in absolute value and positive, and λ_1 will be the largest (i.e. the closest to one), while λ_g will be the smallest (i.e. the closest to zero). If

the variables are not cointegrated, the rank of $\prod$ will not be significantly different from zero, so $\lambda_i \approx 0 \forall i$. The test statistics actually incorporate $\ln(1 - \lambda_i)$, rather than the λ_i themselves, but still, when $\lambda_i = 0$, $\ln(1 - \lambda_i) = 0$.

Depending on whether yt and/or the cointegration vectors have an intercept and/or deterministic trend, there are five models in practice: (a) there are no deterministic trends in y_t and no intercepts in the cointegration vectors; (b) there is no deterministic trend in y_t but there are intercepts in the cointegration vectors; (c) there are deterministic trends in y_t and intercepts in the cointegration vectors; (d) there are deterministic trends in y_t and in the cointegration vectors; (e) there are quadratic trends in y_t and deterministic trends in the cointegration vectors.

Suppose now that rank ($\prod$) = 1, then $\ln(1 - \lambda_1)$ will be negative and $\ln(1 - \lambda_i) = 0 \ \forall i > 1$. If the eigenvalue *i* is non-zero, then $\ln(1 - \lambda_i) < 0 \ \forall \ i > 1$. That is, for $\prod$ to have a rank of 1, the largest eigenvalue must be significantly non-zero, while others will not be significantly different from zero.

There are two test statistics for cointegration under the Johansen approach, which are formulated as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln\left(1 - \hat{\lambda}_i\right) \qquad \text{..... 14}$$

and

$$\lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \qquad \text{..... 15}$$

where *r* is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the i^{th} ordered eigenvalue from the $\prod$ matrix. Intuitively, the larger is $\hat{\lambda}_i$, the more large and negative will be $\ln(1 - \hat{\lambda}_i)$ and hence the larger will be the test statistic. Each eigenvalue will have associated with it a different cointegrating vector, which will be eigenvectors. A significantly non-zero eigenvalue indicates a significant cointegrating vector.

λ_{trace} is a joint test where the null is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. It starts with p eigenvalues, and then successively the largest is removed. λ_{trace}

= 0 when all the $\lambda_i = 0$, for i = 1, . . . , g. λ_{max} conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of r + 1.

Johansen and Juselius (1990) provide critical values for the two statistics. The distribution of the test statistics is non-standard, and the critical values depend on the value of g − r , the number of non-stationary components and whether constants are included in each of the equations. Intercepts can be included either in the cointegrating vectors themselves or as additional terms in the VAR. The latter is equivalent to including a trend in the data generating processes for the levels of the series.

If the test statistic is greater than the critical value from Johansen's tables, reject the null hypothesis that there are r cointegrating vectors in favour of the alternative that there are r + 1 (for λ_{trace}) or more than r (for λ_{max}). The testing is conducted in a sequence and under the null, r = 0, 1, . . . , g − 1 so that the hypotheses for λ_{max} are

H_0 : r = 0	versus	H_1: 0 < r ≤ g
H_0 : r = 1	versus	H_1: 1 < r ≤ g
H_0 : r = 2	versus	H_1: 2 < r ≤ g
..	...	...
H_0 : r = g-1	versus	H_1: r = g

The first test involves a null hypothesis of no cointegrating vectors (corresponding to $\prod$ having zero rank). If this null is not rejected, it would be concluded that there are no cointegrating vectors and the testing would be completed. However, if H_0 : r = 0 is rejected, the null that there is one cointegrating vector (i.e. H_0 : r = 1) would be tested and so on. Thus the value of r is continually increased until the null is no longer rejected.

r is the rank of $\prod$. $\prod$ cannot be of full rank (g) since this would correspond to the original y_t being stationary. If $\prod$ has zero rank, then by analogy to the univariate case, Δy_t depends only on Δy_{t-j} and not on y_{t-1}, so that there is no long-run relationship between the elements of y_{t-1}. Hence there is no cointegration. For 1

< rank ($\prod$) < g, there are r cointegrating vectors. $\prod$ is then defined as the product of two matrices, α and β` of dimension (g × r) and (r × g), respectively, i.e.

$$\prod = \alpha\beta'$$

The matrix β gives the cointegrating vectors, while α gives the amount of each cointegrating vector entering each equation of the VECM, also known as the 'adjustment parameters'.

3.8.4 Vector Error Correction Model

Cointegrated series are tied together in the long term. In the short term they can drift apart, but over a period of time they must drift back together. This is because the spread – or some weighted difference of prices – has a finite, constant mean and variance. The Granger representation theorem states that when integrated variables are cointegrated a vector autoregressive model on differences will be misspecified (Granger, 1986). The disequilibrium term that is missed from the vector autoregressive representation becomes well specified, when lagged disequilibrium terms are included as explanatory variables. Such a model is called an error correction model because it has a self-regulating mechanism whereby deviations from the long term equilibrium are automatically corrected.

A vector error correction (VEC) model is a restricted VAR designed for use with nonstationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The estimation of ECM model is second stage of the cointegration analysis. It is a dynamic model on first differences of the integrated variables that were used in the cointegrating regression. Thus if log prices are cointegrated, the corresponding ECM is a dynamic model of correlation in the log returns. The ECM provides a short term analysis of dynamic correlations, quite distinct from the first stage of cointegration analysis, where we seek cointegrating relationships between integrated variables, each one corresponding

to different long term equilibrium. The connection between the two stages is that the new term called disequilibrium term is used in the ECM.

The reason for the name error correction stems from the fact that the model is structured so that short term deviations from the long term equilibrium will be corrected and the impact of the exogenous variables on the endogenous variables in the model is examined. ECM is true in case of single equation i.e when the model uses only two variables, ECM is applied. Vector error correction model is applied, when the model contains more than two variables. VECM also know as system of equations. The VECM model is build from the below equations.

$$\Delta AM_t = \alpha_1 + \sum_{i=1}^{m} \beta_{11}^{i} \Delta AM_{t-i} + \sum_{i=1}^{m} \beta_{12}^{i} \Delta EUROPE_{t-i} + \sum_{i=1}^{m} \beta_{13}^{i} \Delta INDIA_{t-i} + \sum_{i=1}^{m} \beta_{14}^{i} \Delta JAPAN_{t-i} + \sum_{i=1}^{m} \beta_{15}^{i} \Delta USA_{t-i} + \gamma_1 Z_{t-1} + \varepsilon_{1t} \quad \text{..... 16}$$

$$\Delta PM_t = \alpha_2 + \sum_{i=1}^{m} \beta_{21}^{i} \Delta PM_{t-i} + \sum_{i=1}^{m} \beta_{22}^{i} \Delta EUROPE_{t-i} + \sum_{i=1}^{m} \beta_{23}^{i} \Delta INDIA_{t-i} + \sum_{i=1}^{m} \beta_{24}^{i} \Delta JAPAN_{t-i} + \sum_{i=1}^{m} \beta_{25}^{i} \Delta USA_{t-i} + \gamma_2 Z_{t-1} + \varepsilon_{2t} \quad \text{..... 17}$$

The coefficient β represents the impact of the dependent variables on the dependent variable in the short run. It captures to what extent the changes in the dependent variable is affected by the changes in the independent variables. Z represents the disequilibrium term added in the ECM equation to capture speed of the adjustment from the disequilibrium caused. The optimum lag length and its coefficients are determined by OLS. The reason why Z is defined as error correction term, because when we estimate the model, the respective coefficients γ_1 and γ_2 have the appropriate signs. i.e

$$\hat{\alpha}\hat{\gamma}_1 < 0 \text{ and } \hat{\alpha}\hat{\gamma}_2 > 0$$

The magnitudes of the coefficient estimates $\hat{\gamma}_1$ and $\hat{\gamma}_2$ determine the speed of adjustment back to the long term equilibrium following an exogenous shock. When these coefficients are large, adjustment is quick so Z will be highly stationary and reversion to the long term equilibrium determined by E(Z) will be rapid.

3.8.5 ARCH LM test

The ARCH test is a Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity (ARCH) in the residuals (Engle 1982). This particular heteroskedasticity specification was motivated by the observation that in many financial time series, the magnitude of residuals appeared to be related to the magnitude of recent residuals. ARCH in itself does not invalidate standard LS inference. However, ignoring ARCH effects may result in loss of efficiency The ARCH LM test statistic is computed from an auxiliary test regression. To test the null hypothesis that there is no ARCH up to order in the residuals, we run the regression

$$e_t^2 = \beta_0 + \left(\sum_{s=1}^{q} \beta_s e_{t-s}^2 \right) + v_t \qquad \text{..... 18}$$

Where is the residual. This is a regression of the squared residuals on a constant and lagged squared residuals up to order. The output of the regression test contains two test statistics. The F-statistic is an omitted variable test for the joint significance of all lagged squared residuals. The Obs*R-squared statistic is Engle's LM test statistic, computed as the number of observations times the R^2 from the test regression. The exact finite sample distribution of the F-statistic under H_0 is not known, but the LM test statistic is asymptotically distributed as a χ under quite general conditions.

3.8.6 Multivariate EGARCH Model

The exponential EGARCH model was developed by Nelson (1991) for testing the US markets in order to capture the asymmetric impact of shocks on volatility. G.Koutmos and G G Booth (1995) extended this univariate model into multivariate EGARCH model to model simultaneously the volatility behaviour of three stock markets. This study also follows the same model in order to examine the price and volatility transmission mechanism among the major spot gold markets in the world.

Let $R_{i,t}$ be the return of spot gold prices at time t for market i, (i=1,2,3,4,5 where 1 = AM/PM (-1), 2 = Europe, 3 = India, 4 = Japan and 5 = USA), I_{t-1} the information set at time t-1, $\mu_{i,t}$ and $\sigma_{i,t}^2$ the conditional mean and the conditional variance respectively, $\sigma_{i,j,t}$ the conditional variance, $\varepsilon_{i,t}$ the innovation at time t (i.e

$\varepsilon_{i,t} = R_{i,t} - \mu_{i,t}$) and $z_{i,t}$ the conditional standardized innovation (i.e $z_{i,t} = \varepsilon_{i,t} / \sigma_{i,t}$) then, the multivariate EGARCH model used to describe price and volatility spillovers across spot gold markets are written as follows:

$$R_{i,t} = \beta_{i,0} + \sum_{j=1}^{5} \beta_{i,j}\varepsilon_{j,t-1} + \varepsilon_{i,t}, \text{ for i,j = 1,2,3,4,5} \quad \text{..... 19}$$

$$\sigma_{i,t}^2 = \exp\{\alpha_{i,0} + \sum_{j=1}^{5} \alpha_{i,j} f_j(z_{j,t-1}) + \gamma_i \ln(\sigma_{i,t-1}^2)\}, \text{ for i,j = 1,2,3,4,5} \quad \text{..... 20}$$

$$f_j(z_{j,t-1}) = (|Z_{j,t-1}| - E(|Z_{j,t-1}|) + \delta_j Z_{j,t-1}), \text{ for j = 1,2,3,4,5} \quad \text{..... 21}$$

$$\sigma_{i,j,t} = \rho_{i,j}\sigma_{i,t}\sigma_{j,t} \text{ for i,j = 1,2,3,4,5 and } i \neq j \quad \text{..... 22}$$

The equation (19) describes the spot returns of the selected major spot gold prices as a vector moving average (VMA), whereby the conditional mean in each market is influenced by own past innovations as well as innovations coming from the two markets to close. The term $\beta_{i,j}\varepsilon_{j,t-1}$ for i=j in (19) allows for autocorrelation in the returns due to non-synchronous trading even though the use of value weighted indices should minimize this problem.

Innovations in market j (independent variables such lagged AM/PM variable, Europe, India, Japan and USA) enter the information set of market i (AM/PM fix prices), take for example, the Japan and Indian spot gold market opens prior to the AM fix price and after the PM fix is over. To the extent that innovations coming from these markets are useful for fixing the AM fix price and PM fix price is set after the USA gold market opens. Hence both AM fix and PM fix prices are able to reflect the global information, there by the LBMA AM fix and PM fix prices incorporate both domestic as well as cross market information. Coefficients $\beta_{i,j}$ for $i \neq j$, then measure the extent of price spillover across markets.

The conditional variance process given by equation (20) follows an extended EGARCH process that allows its own lagged standardised innovations as well as cross market standardised innovation to exert an asymmetric impact on the volatility of market i. Asymmetry is modelled by equation (21) with the partial derivatives being

$$\partial f_j(Z_{i,t}) / \partial Z_{j,t} = 1 + \partial_j \; for Z_j > 0 \text{ and} \qquad \text{..... 23}$$

$$\partial f_j(Z_{i,t}) / \partial Z_{j,t} = -1 + \partial_j \; for Z_j < 0 \qquad \text{..... 24}$$

Asymmetry is present if ∂_j is negative and statistically significant. The term $|Z_{j,t-1}| - E(|Z_{j,t-1}|)$ measures the size effect and $\partial_j Z_{i,t}$ measures the corresponding sign effect. If ∂_j is negative, a negative $Z_{j,t}$ tends to reinforce the size effect, whereas a positive $Z_{j,t}$ tends to partially offset. This phenomenon has been attributed to the aforementioned leverage effect. The relative importance of the asymmetry or leverage effect, can be measured by the ratio $|-1+\partial_j|/(1+\partial)$. Volatility spillover from the major spot gold markets to the LBMA fix prices are measured by $\alpha_{i,j}$ for i,j = 1,2,3,4,5 and $i \neq j$. A significant positive $\alpha_{i,j}$ coupled with a negative ∂_j innovations in market j have higher impact on the volatility of market i than positive innovations, i.e the volatility spillover mechanism is asymmetric.

The persistence of volatility implied by equation (20) is measured by γ_i. The unconditional variance is finite if $\gamma_i < 1$ (see Nelson, 1991). If $\gamma_i = 1$, then the unconditional variance does not exist and the conditional variance follows an integrated process of order one.

3.8.7 Cubic Spline Interpolation Method

The study has converted the quarterly data into monthly data. The most suitable method for converting the low frequency data into high frequency data is the Cubic Spline Interpolation method. The conversion of data has been done in EViews, which supports the Cubic Spline interpolation method:

Cubic spline follows with last observation matched to the source data. This method assigns each value in the low frequency series to the last high frequency observation associated with the low frequency period, and then places all intermediate points on a natural cubic spline connecting all the points. A natural cubic spline is defined by the following properties. Cubic spline interpolation is a global interpolation method so that changing any one point (or adding an additional point) to the source series will affect all points in the interpolated series.

3.8.8 Granger Causality Block Exogenity wald test

It is likely that, when a VAR includes many lags of variables, it will be difficult to see which sets of variables have significance effects on each dependent variable and which do not. In order to address this issue, tests are usually conducted that restrict all of the lags of a particular variable to zero. A block exogeneity test is useful for detecting whether to incorporate a variable into a VAR. Given the aforementioned distinction between causality and exogeneity, this multivariate generalization of the Granger causality test should actually be called a "block causality" test. In any event, the issue is to determine whether lags of one variable-say W_t Granger-cause any other of the variables in the system. In the four - variable case with W_t, X_t, Y_t, and Z_t the test is whether lags of W_t Granger-cause either X_t or Y_t or Z_t in the system. In essence the block exogeneity restricts all lags of W_t in the X_t, Y_t and Z_t equations to be equal to zero. This cross-equation restriction is properly tested using the likelihood ratio test given by (25). Estimate the X_t, Y_t, and Z_t equations using lagged values of W_t, X_t, Y_t, and Z_t and calculate Σ_u. Re estimate excluding the lagged values of W_t and calculate Σr. Next, form the likelihood ratio statistic:

$$(T - C)(\log|\Sigma_r| - \log|\Sigma_u|) \qquad \text{..... 25}$$

This statistic has a chi-square distribution with degrees of freedom equal to 2p (since p values of W_t are excluded from each equation). Here = 3p + 1 since the unrestricted X_t, Y_t and Z_t equations contain p lags of W_t, X_t, Y_t, and Z_t plus a constant.

3.8.9 VAR Impulse Response Function

Impulse response analysis is another way of inspecting and evaluating the impact of shocks cross-section. In other words Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of g2 impulse responses could be generated. While

persistence measures focus on the long-run properties of shocks, impulse response traces the evolutionary path of the impact over time.

Impulse response analysis, together with variance decomposition, forms innovation accounting for sources of information and information transmission in a multivariate dynamic system. The way that this is achieved in practice is by expressing the VAR model as a VMA -- that is, the vector autoregressive model is written as a vector moving average. Provided that the system is stable, the shock should gradually die away. Considering the following vector autoregression (VAR) process:

$$y_t = A_0 + A_1 y_{t-1} + A_2 y_{t-2} + K + A_k y_{t-k} + \mu_t \qquad \text{..... 26}$$

Where y_t is an n × 1 vector of variables, A_0 is an vector of an n × 1 vector of intercept, Aτ (τ = 1, . . . , k) are n × n matrices of coefficients, μ_t is an n dimension vector of white noise processes with E(μ_t) = 0, Σ_μ = E(μ_t μ_t') being non-singular for all t , and E(μ_t μ_t') for t≠ s. Without losing generality, exogenous variables other than lagged y_t are omitted for simplicity. A stationary VAR process of equation (26) can be shown to have a MA representation of the following form:

$$y_t = C + \mu_t + \Phi_1 \mu_{t-1} + \Phi_2 \mu_{t-2} + K$$

$$= C + \sum_{\tau=0}^{\infty} \Phi_\tau \mu_{t-\tau} \qquad \text{..... 27}$$

Where C = E(y_t) = (I – A_1 - ... – A_k)-1 A_0, and Φ_τ can be computed from A_τ recursively $\Phi_\tau = A_1 \Phi_{\tau-1} + A_2 \Phi_{\tau-2} + K + A_k \Phi_{\tau-k}$, τ = 1,2, Λ with Φ_τ = I and Φ_τ = 0 for τ < 0.

The MA coefficients in equation (27) can be used to examine the interaction between variables. For example, $a_{ij,k}$, the ijth element of Φ_k, is interpreted as the reaction, or impulse response, of the ith variable to a shock τ periods ago in the jth variable, provided that the effect is isolated from the influence of other shocks in the system. So a seemingly crucial problem in the study of impulse response is to isolate the effect of a shock on a variable of interest from the influence of all other shocks, which is achieved mainly through orthogonalisation.

Orthogonalisation per se is straightforward and simple. The covariance matrix $\Sigma_\mu = E(\mu_t \mu_t')$ in general, has non-zero off-diagonal elements. Orthogonalisation is a transformation, which results in a set of new residuals or innovations ν_t satisfying $E(v_t v_t') = I$. The procedure is to choose any non-singular matrix G of transformation for $v_t = G^{-1}\mu_t$ so that $G^{-1}\Sigma_\mu G^{'-1} = I$. In the process of transformation or orthogonalisation, Φ_τ is replaced by $\Phi_\tau G$ and μ_t is replaced by $v_t = G^{-1}\mu_t$, and equation (27) becomes:

$$y_t = C + \sum_{\tau=0}^{\infty} \Phi_\tau \mu_{t-\tau} = C + \sum_{\tau=0}^{\infty} \Phi_\tau G \mu_{t-\tau}, \qquad E(v_t v_t') = I \quad \text{..... 28}$$

Suppose that there is a unit shock to, for example, the *j* th variable at time 0 and there is no further shock afterwards, and there are no shocks to any other variables. Then after *k* periods, $\mathbf{y}_t$ will evolve to the level:

$$y_{t+k} = C + \left(\sum_{\tau=0}^{k} \Phi_\tau G \right) e(j) \qquad \text{..... 29}$$

where e(j) is a selecting vector with its j th element being one and all other elements being zero. The accumulated impact is the summation of the coefficient matrices from time 0 to k. This is made possible because the covariance matrix of the transformed residuals is a unit matrix I with off-diagonal elements being zero. Impulse response is usually exhibited graphically based on equation (29). A shock to each of the n variables in the system results in n impulse response functions and graphs, so there are a total of n × n graphs showing these impulse response functions.

3.8.10 VAR Variance Decomposition

Variance decompositions offer a slightly different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. A shock to the i^{th} variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decompositions determine how much of the s-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory

variable. In practice, it is usually observed that own series shocks explain most of the (forecast) error variance of the series in a VAR. To some extent, impulse responses and variance decompositions offer very similar information.

Since the residuals have been orthogonalised, variance decomposition is straightforward. The *k*-period ahead forecast errors in equation (27) or (28) are:

$$\sum_{\tau=0}^{k-1} \Phi_\tau G v_{t-\tau+k-1} \qquad \text{..... 30}$$

The covariance matrix of the *k*-period ahead forecast errors are:

$$\sum_{\tau=0}^{k-1} \Phi_\tau G G' \Phi'_\tau = \sum_{\tau=0}^{k-1} \Phi_\tau \Sigma_\mu \Phi'_\tau \qquad \text{..... 31}$$

The right-hand side of equation (31) just reminds the reader that the outcome of variance decomposition will be the same irrespective of G. The choice or derivation of matrix G only matters when the impulse response function is concerned to isolate the effect from the influence from other sources.

The variance of forecast errors attributed to a shock to the jth variable can be picked out by a selecting vector e(j), with the jth element being one and all other elements being zero:

$$Var(j,k) = \left(\sum_{\tau=0}^{k-1} \Phi_\tau G e(j) e(j)' G' \Phi'_\tau \right) \qquad \text{..... 32}$$

Further, the effect on the ith variable due to a shock to the jth variable, or the contribution to the ith variable's forecast error by a shock to the jth variable, can be picked out by a second selecting vector e(i) with the ith element being one and all other elements being zero.

$$Var(ij,k) = e(i)' \left(\sum_{\tau=0}^{k-1} \Phi_\tau G e(j) e(j)' G' \Phi'_\tau \right) e(i) \qquad \text{..... 33}$$

In relative terms, the contribution is expressed as a percentage of the total variance:

$$\frac{Var(ij,k)}{\sum_{j=1}^{n} Var(ij,k)} \qquad \text{..... 34}$$

which sums up to 100 per cent.

3.8.11 Estimation of Long run and short run elasticity of gold demand

The short and long run elasticity is estimated to assess the efficiency of the major gold markets in the world. Hence the application of the model is done carefully in order to make sure that the results produced by the models are more reliable. In this way, this study adopted the econometric models suggested by R. Ramanathan (1999) who used model to study the short run and long run elasticities of gasoline demand in India. The same model has also been used by Dhal and Sterner (1990), Eltony and Al-Mutairi (1995) and Bentzen (1994). The long run elasticities of gold demand of all the major gold markets is estimated, after testing the stationary properties of the variables. The long run elasticity of gold demand of all the countries are estimated separately with the equation no (35)

$$G_t = \alpha_0 Y_t + \alpha_1 P_t + V_t \text{ , t = 1,2,3,.....T} \qquad \text{..... 35}$$

Where

G - Gold Demand in tonnes of respective countries (India, Europe, Japan and USA)

Y – Real GDP of respective countries (Proxy for Income of the consumers)

P – Domestic Price of Gold per Troy ounce in their respective currencies

V – Residuals

The coefficient obtained from the Equation No: (35) represents the long run elasticities of the respective countries. The coefficient of α_1 of Equation No: (35) represents the long run income elasticity of the respective countries, α_2 represents the long run price elasticity of the respective countries and the coefficient V_t represents the residuals of the equations. After estimation of this equation, the existence of the long run relationship is tested by applying the unit root test on the residuals (V_t) obtained from the Equation No: (35). If the residuals (V_t) obtained from the Equation No: (35) happens to be stationary at level, i.e when the residual variable follows I (0) process, this indicates the existence of the cointegrating relationship among the variables included in the model.

If the cointegrating relationship is found from the above long run model, then the short run elasticities of the gold demand is estimated through the Error Correction Model (ECM). This is because the cointegrating variables are expected to restore

themselves to their long run equilibrium, whenever there is a drift and the ECM model is constructed to estimate the short run behaviour. The ECM model is estimated using the following equation

$$\Delta G_t = \beta_0 \Delta Y_t + \beta_1 \Delta P_t + \beta_2 V_{t-1} + \beta_3 \Delta G_{t-1} + U_t \qquad t = 1,2, ...T \quad ..... 36$$

Where

ΔG_t - Gold Demand in tonnes of respective countries in first difference (India, Europe, Japan and USA)

ΔY_t Y – Real GDP of respective countries in first difference (Proxy for Income of the consumers)

ΔP_t – Domestic Price of Gold per Troy ounce in their respective currencies in first difference

V_{t-1} - Residuals with one period lag

U_t – Residuals

Δ - represents the difference operator in the equation

The short run elasticities of the variables and the speed of the adjustments are estimated from the Equation No: (36). The coefficient β_0 represents the income elasticity of the respective countries in the Short run, β_1 represents the price elasticity of the respective countries in the short run, β_2 measures the speed of adjustment toward long-run equilibrium and the coefficient β_3 represents the impact of the previous period changes in the gold demand on the dependent variable.

3.9 READER'S GUIDE

The study is divided into eight chapters – First chapter introduces the basics of the gold market, India's Position on the world gold markets, world gold demand and supply, brief historical events in the Indian and World gold markets. Second chapter extensively covers the literatures that are undertaken previously in the field of gold markets and provides the rationale of the study by providing the research gap at the end of the chapter. The Third chapter is associated with the methodology. This

chapter provides an overview of the Objectives of the study, Data and Methodology of the study, scope and significance of the study and a detailed explanation on the econometric models applied. Fourth Chapter examines the existence of the dynamic relationship among the major gold markets. Fifth chapter deals with the Information transmission mechanism and information spillover among the major gold markets. Sixth Chapter empirically evaluates the real price maker in the world gold markets. Seventh Chapter measures the efficiency of the world gold markets with respect to income and price elasticity of gold demand of the major gold markets. Eighth chapter covers the major findings and conclusion of the study and the scope for further research.

Chapter

4

Dynamic Relationship Among World Gold Markets

CHAPTER – IV

DYNAMIC RELATIONSHIP AMONG WORLD GOLD MARKETS

4.1 INTRODUCTION

The study of long run and short run relationships among the variables forms the basis of estimating empirical analysis. Testing the long run and short run relationship among the variables helps us to understand the co-movements of variables. If the results suggest the existence of the cointegration among the variables, it implies that the variables are capable of moving together in the same direction in the long run. This kind of analysis is very common in analyzing the relationship between the spot and future prices of both shares and commodities traded, for testing the efficiency and the co-movements of the shares and commodities. It is observed that a major portion of gold consumption goes into making jewellery, but analyzing the relationships among these spot prices are very few.

Risto Laulajainen (1990) documented the price dependencies among three countries namely USA, HongKong and Europe. Xiaoqing Eleanor Xu et al (2005) studied the cross market linkages among the futures prices of USA and Japaneese markets. Hui-Na Lina (2008) tested the relationship between TOCOM (Japan) and COMEX (USA). In India, Arti Gaur and Monica Bansal (2010) tested the relationship between Indian gold price and the global gold price. So also Piyamas Chaihetphon and Pantisa Pavabutr (2008) examined the information sharing and price discovery process between spot and futures prices of MCX. However their study considered only one price and not the other major gold markets in the world.

The above mentioned international studies did not consider Indian spot prices. Hence this study aims to fill the gap by testing the relationship considering the major gold markets in the world. The interrelationship among the spot gold prices is tested based on the theory that a commodity which is traded globally is expected to have the prices which are cointegrated.

Gold is one such commodity which is traded globally both in the exchanges as well as in the physical delivery markets. Gold is also considered as leader in the precious metal markets. The objective of buying gold also differs from one to another for example the central banks buy gold for reserve purpose, investors buy in the commodity exchanges in order to hedge against the stock markets movement and portfolio diversifications and ordinary consumers buy gold in the form of jewellery. It is observed that the quantity of gold consumption differ from one to another, but the objective of buying remains the same throughout the world.

The primary objective of this chapter is to explore the long term and short term relationship among the spot prices of India, USA, Europe and Japan with the international gold price like London Bullion Market Association (LBMA) AM fix and LBMA PM fix prices. Hence the empirical analysis focuses on testing the co movements of spot prices of four countries in the long run and to determine who influences the international prices AM fix and PM fix in the short run.

In order to make the empirical analysis more effective, the whole study (4th January 2000 to 29th December 2011) period is again subdivided into two sub periods Phase I (4th January 2000 to 29th December 2005) and Phase II (3rd January 2006 to 29th December 2011). This is because the performance of gold markets and the movement of gold prices highly differ from Phase I to Phase II. Hence the sub period analysis will add more meaning to the empirical results and help to capture the real impact of independent variables on the dependent variables.

4.2 VARIABLES AND METHODOLOGY

For testing the long run and short run relationship, considering the daily data would be more reliable than the monthly and yearly data. Since the daily data of spot gold price is available for all the markets, the study took daily data for the period from 04th January 2000 to 29th December 2011 which consisted of totally 2826 observations. The rationale behind for choosing the period from 2000 is due to the

fact that the spot gold price data is not available for two markets Europe and Japan prior to 2000. And also the Euro currency came into existence on 1st January 1999[4].

The study used spot gold price variables for analysis and most of the physical delivery of gold throughout the world is taking place on the basis of the price quoted by the London Bullion Market Association (LBMA). Gold fixing is a practice which determines the global price of gold. The LBMA fixes price twice a day known as AM fix and PM fix price. The Gold Fixing is conducted twice a day by telephone, at approximately 10:30 am and 3:00 pm. There are five Gold Fixing members - all of whom are Market Making members of the LBMA. The most advantage of this LBMA fix price is that it serves as benchmark price internationally and also it is a published price. Although it is officially used only to set the price of gold for members of the LBMA, it is used to establish a base price of gold all over the world. As a result, people who are active on the gold market eagerly wait for the outcome of the twice-daily gold fixing conferences.

Hence the study considered LBMA prices AM fix and PM fix price as dependent variables of the study and the spot prices of the major gold markets are considered as the independent variables. The Independent variables are the Spot gold prices of India, Japan, USA and Europe gold markets. The rationale for selecting these four countries as a major gold markets is that the gold demand of all these four countries alone represent more than 60% of world's total gold demand out of these countries India alone represents more than 20% of world's gold demand. The spot gold prices are expressed in per troy ounce.

Preliminarily analysis is done through summary statistics, line graph and the correlation coefficients. The unit root test such as Augmented Dickey Fuller and Philip Perron is used to test the stationary properties of the variables, optimum lag length for estimating the long run and short run relationship model is selected on the basis of the Akaike Information Criterion from the estimated results of VAR lag length criteria. The existence of the long run relationships among the spot gold price is tested with the help of Johansen Cointegration methodology with Trace statistics

[4] http://en.wikipedia.org/wiki/History_of_the_euro

and Max Eigen statistics which suggest the number of cointegrating vectors. Finally the short run relationship among the spot gold price is estimated through Vector Error Correction Model.

4.3 PROCEDURE FOR THE ANALYSIS

The following procedures are followed for testing the long run and short run relationship among the spot gold price during different study periods.

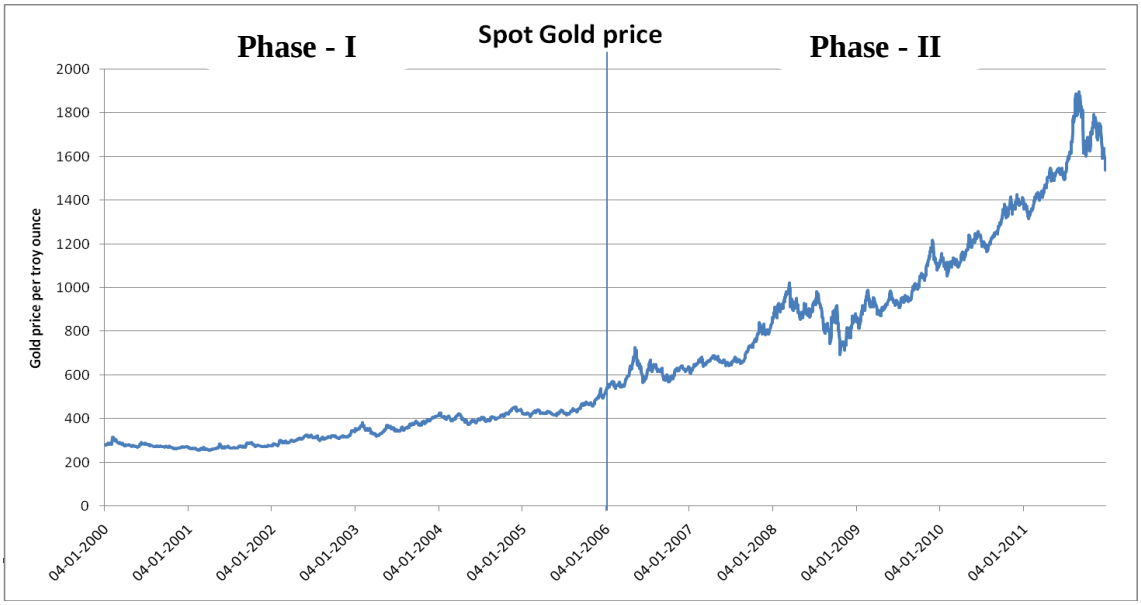
1. The daily spot gold price data of LBMA AM fix and PM fix, gold prices from India, Japan, USA and Europe gold market were collected.
2. The collected spot gold prices are rearranged based on homogeneous time frame in order to arrive at the common data points in which all the markets spot prices are available.
3. The spot gold prices have been converted into natural logarithms in order to smoothen and reduce the size of the data.
4. The whole study period is further subdivided into two sub periods Phase I and Phase II.
5. Summary statistics were determined for all spot gold prices.
6. As a step, the line graphs were plotted to the movement of spot gold price identity.
7. Simple correlation coefficients were determined between spot gold prices of all four countries.
8. Unit root test like ADF and PP were employed to examine the stationary property of variables considered in the study.
9. AIC information criteria were used to find the optimum lag length for further estimation.
10. Johansen Cointegration methodology was employed to examine the co movement of the variables in the long run.
11. VECM model was used to find out the speed of adjustment of the variables and the impact of the independent variables on the dependent variables in the short run.
12. Analysis is done considering LBMA AM fix and PM fix separately as dependent variable.

4.4 RATIONAL FOR DIVIDING THE DATA SET

As stated, the empirical analysis has been carried out for three different periods by splitting the whole study period into two sub periods. The three study periods are Whole period from 4th January 2000 to 29th December 2011 consisting of 2826 observations, Phase I from 4th January 2000 to 29th December 2005 consisting of 1429 observations and Phase II from 3rd January 2006 to 29th December 2011 consisting of 1397 observations.

Figure No: 4.1

Line graph of the Spot Gold Price Series showing the division of the study periods



The rationale for splitting the whole study period into two sub periods is due to the growth seen in Phase I (98%) is far less than the growth seen in Phase II (252%). The gold market started moving upward since 2006, whereas during the year 2006 the market has achieved growth which was not there in the previous 25 years[5]. Hence the whole period has been divided into two sub groups in order to observe the relationship among the spot gold price series. The above mentioned statement is clearly observed from the figure no: 4.1. It is clearly seen from the figure that the spot gold price has experienced only a small growth in the Phase I, where as its growth is enormous during the Phase II period.

[5] Bank for International Settlements 76th Annual Report, 2006. Page 82.

4.5 SUMMARY STATISTICS

The study of summary statistics helps us to understand broadly the nature of the data included in the study and this forms the basis of all analysis. This also provides information with regards to how well the given data is distributed. The summary statistics of the spot gold price series included for different study periods is given in the Table No: 4.1.

During the whole study period (4^{th} Jan 00 to 29^{th} Dec 11), the average logarithmic price of AM, PM, Europe and USA market prices are the same around 6, where as the average price of Indian and Japan spot gold prices are a little higher than the other spot gold prices. It is due to their exchange rate against the USD. The domestic prices include the taxes and other surcharges. The volatility of the spot gold price is measured though standard deviation shows that Indian and Japanese Spot gold prices are more volatile than the other spot gold prices.

The extent of asymmetry in the data is denoted by skewness. i.e when the frequency distribution is not symmetrical, it is said to be skewed. The zero skew occurs when mean, median, mode are same. All the spot gold prices show a non-symmetrical distribution, as they all are positively skewed and are skewed to the right. It also shows that the spot gold price is dominated by the positive growth than the negative growth in the spot gold market.

The Kurtosis statistics is also another indication of the distributional properties of the variables. Kurtosis refers to the degree of peakedness of the frequency curve. Two distributions may have same average dispersion and skewness, yet in one there may be high concentration of values near the mode showing sharper peak in the frequency curve than in other way. The Kurtosis is equal to 3 for a normal distribution.

If the frequency curve is highly peaked, a large number of observations are nearer to each other observations. Again if the curve is flat, a large number of observation have low frequency and are spread in the mid of the interval. It is observed from the values of kurtosis that all spot gold prices follow platykurtic distribution as all the values are less than 3. The Jarque-Bera Statistics also confirms that none of the spot gold price series is normally distributed.

Table No 4.1

Summary Statistics of the variables included in the study during various study periods

Study Periods		AM	PM	EUROPE	INDIA	JAPAN	USA
Whole period 4th Jan 00 to 29th Dec 11	Mean	6.328994	6.328547	6.150159	10.15794	10.99615	6.329409
	Median	6.208992	6.214358	6.047585	10.05037	10.98947	6.217379
	Std. Dev.	0.578159	0.578028	0.442828	0.576510	0.473322	0.578012
	Skewness	0.336622	0.335618	0.723699	0.422114	0.076323	0.335628
	Kurtosis	1.825113	1.823812	2.264381	1.953609	1.577328	1.823664
	Jarque-Bera	215.9084	215.9508	310.4005	212.8511	241.0693	215.9948
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	2826	2826	2826	2826	2826	2826
Phase I 4th Jan 00 to 29th Dec 05	Mean	5.824590	5.824254	5.775954	9.663576	10.56652	5.825128
	Median	5.782286	5.781052	5.771348	9.663671	10.59550	5.783364
	Std. Dev.	0.191820	0.192014	0.074746	0.186018	0.175123	0.192003
	Skewness	0.233539	0.233884	1.147243	0.070945	-0.019595	0.234193
	Kurtosis	1.663192	1.664060	6.004708	1.721909	2.320114	1.664478
	Jarque-Bera	119.3940	119.2942	851.0253	98.46108	27.61429	119.2622
	Probability	0.000000	0.000000	0.000000	0.000000	0.000001	0.000000
	Observations	1429	1429	1429	1429	1429	1429
Phase II 3rd Jan 06 to 29th Dec 11	Mean	6.844952	6.844392	6.532936	10.66362	11.43562	6.845242
	Median	6.825460	6.823830	6.465818	10.63961	11.43307	6.827304
	Std. Dev.	0.334601	0.334374	0.318042	0.362104	0.199435	0.334362
	Skewness	0.200569	0.198043	0.448926	0.232373	0.090350	0.198080
	Kurtosis	1.969129	1.967751	1.887966	1.944788	2.174853	1.965495
	Jarque-Bera	71.22416	71.15516	118.9056	77.38566	41.53282	71.42991
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	1397	1397	1397	1397	1397	1397

During Phase I (4th Jan 00 to 29th Dec 05) the average spot gold price is around 5 for all the markets except India and Japan in which the average price is 9.6 and 10.5 respectively. The European gold market shows high volatility as the standard deviation 0.07 is much high from its mean value and the other spot gold prices are showing similar and low volatility. The Japanese spot gold price skewed negatively -0.019 and the other spot gold prices are positively skewed.

The Kurtosis which measures the peakedness of the curve follows leptokurtic distribution for Europe as the kurtosis value 6.012 is greater than 3. This shows that large number of observations have the same value. The other spot gold prices show platykurtic distribution such that the observations are spread in the mid of interval. The existence of the non-normality is proved with the Jarque-Bera statistics.

The summary statistics of Phase II (3rd Jan 06 to 29th Dec 11) show little different from Phase I. The average spot gold price of all the markets is higher than Phase I. During this period the Japanese spot gold price shows higher volatility, as the standard deviation 0.19 is much higher than the other spot gold prices. All the markets are positively skewed and the observations follow platykurtic distribution as all the values of kurtosis is lesser than 3. The Jarque-Bera statistics also support the existence of the non-normality.

4.6 RESULTS OF CORRELATION ANALYSIS

The results of Karl Pearson correlation coefficient are given in Table No: 4.2. The results suggest that all the spot gold prices are positively correlated with one another. During the whole period and Phase II the correlation coefficient shows similar result as all the correlation coefficient values are more than 0.96, but during Phase I period the correlation differs from the other two periods.

The European spot gold price maintains low correlation with all the other spot gold prices; particularly it has low correlation with USA, AM and PM fix prices. It is to be noted that the correlation coefficient is positive in all the study period to indicate that the changes in one price or any deviation in one market will also be followed by the other spot gold prices.

Table No: 4.2

Results of correlation coefficient during different study periods

		AM	PM	EUROPE	INDIA	JAPAN	USA
Whole Period 4th Jan 00 to 29th Dec 11	AM	1.0000					
	PM	0.9999	1.0000				
	EUROPE	0.9764	0.9764	1.0000			
	INDIA	0.9955	0.9955	0.9819	1.0000		
	JAPAN	0.9855	0.9856	0.9501	0.9760	1.0000	
	USA	0.9998	0.9999	0.9763	0.9954	0.9855	1.0000
Phase I 4th Jan 00 to 29th Dec 05		**AM**	**PM**	**EUROPE**	**INDIA**	**JAPAN**	**USA**
	AM	1.0000					
	PM	0.9996	1.0000				
	EUROPE	0.7407	0.7418	1.0000			
	INDIA	0.9848	0.9850	0.7714	1.0000		
	JAPAN	0.9364	0.9370	0.8230	0.9671	1.0000	
	USA	0.9990	0.9994	0.7407	0.9845	0.9367	1.0000
Phase II 3rd Jan 06 to 29th Dec 11		**AM**	**PM**	**EUROPE**	**INDIA**	**JAPAN**	**USA**
	AM	1.0000					
	PM	0.9996	1.0000				
	EUROPE	0.9788	0.9790	1.0000			
	INDIA	0.9839	0.9836	0.9835	1.0000		
	JAPAN	0.9716	0.9720	0.9316	0.9269	1.0000	
	USA	0.9993	0.9996	0.9789	0.9833	0.9715	1.0000

This high positive correlation also indicates that any upward or downward movement in one market acts as an indication for the investors or the consumers who are in other spot gold markets. Hence the movement of one spot gold price is highly depending on the movement of the other prices. Their movements follow in the same direction of the other spot prices.

4.7 LINE GRAPHS

The line graph of the spot gold price series included in the different study periods are shown in Figure No: 4.2, 4.3 & 4.4. It is observed from the line graphs that the spot gold price has shown an upward movement over the past twelve years with small corrections in the short term.

Figure No: 4.2

Line Graph of the variables for the whole study period

(4th January 2000 to 29th December 2011)

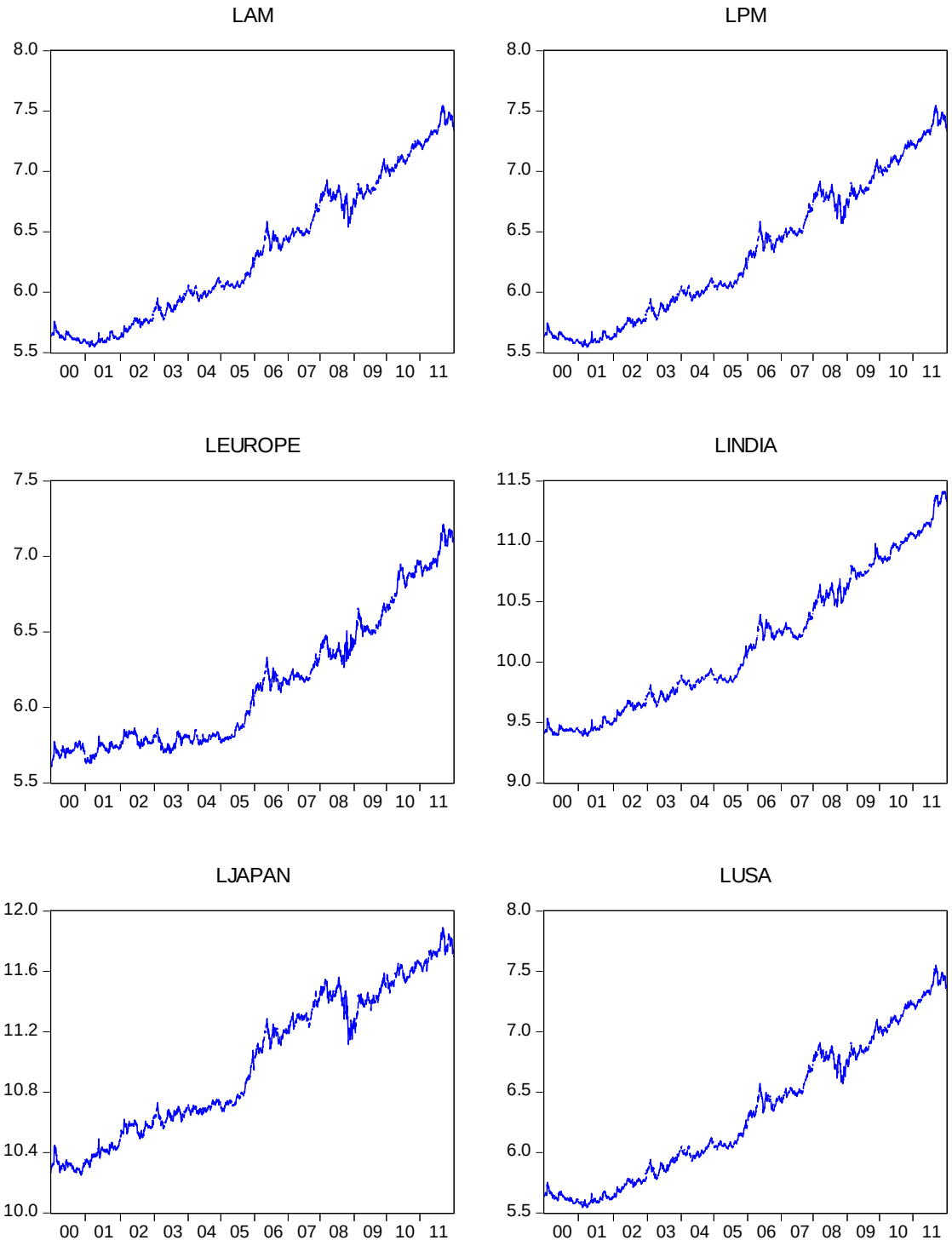


Figure No: 4.3

Line Graph of the variables for the Phase I study period

(4th January 2000 to 29th December 2005)

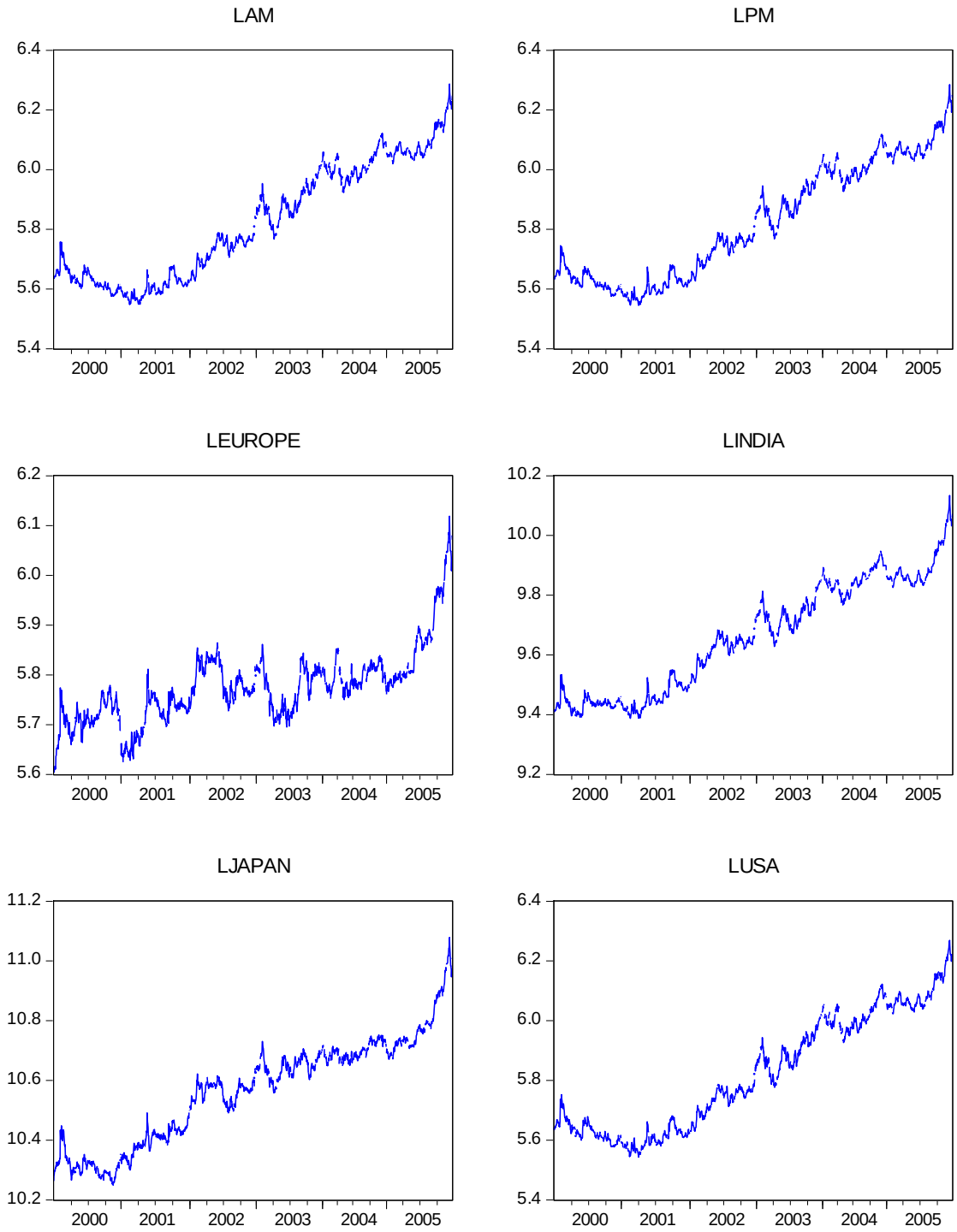
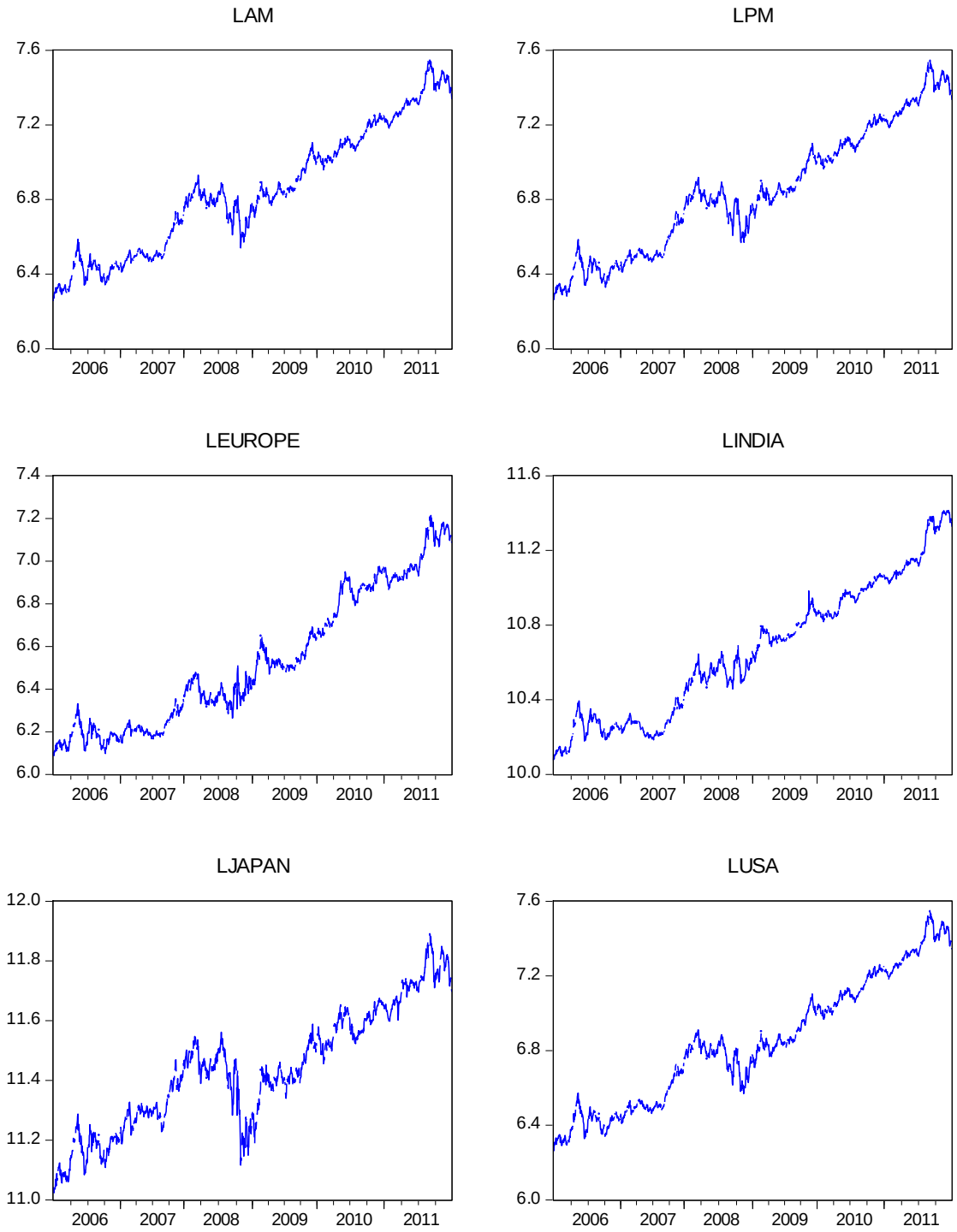


Figure No: 4.4

Line Graph of the variables for the Phase II study period

(3rd January 2006 to 29th December 2011)



Hence an investor who has invested in gold in the year 2000 would have gained 445% growth in the investment. Like stock markets and other commodities gold also experienced corrections in the short run. But in terms of long run , the spot gold price movement is much greater than stock markets and other metal commodities. This supports the inflation hedge properties of gold, as evidenced by many other studies.

It is obviously seen from the figures that the growth of the spot gold prices in Phase I is less than the growth seen in Phase II. During Phase II, the market has seen enormous growth. It may be due to the increase in the need for gold as investment and for making Jewellery, rise in the inflation, instability in the stock market movement and financial crisis.

Like stock markets and other metal commodities gold also has shown downward movement with a small correction in the short run. But the growth of the market especially after the financial crisis is much higher. The occurrence of the financial crisis reduced the confidence level among the investors about of the return from stock markets. Hence most of the investors and consumers started moving towards safe haven which is the unique property of gold. The beauty of gold is that it always loves bad news more than the good news, because the movement of the gold market and its price is greatly decided by bad news rather than by the good news. Hence the rise of the bad news especially in stock markets and other financial instruments play a vital role in the movement of the spot gold prices.

4.8 STATIONARITY OF THE VARIABLES

In modern time series econometrics the concept of stationarity / unit root test is of crucial. If the variables included in the analysis are found to be stationary, then inclusion of those variables in the regression model makes meaningful for the purpose estimating and testing the short run and long run relationship using cointegration methodology. On the other hand if one or more variables included in the analysis are found to be non stationary, then inclusion into the regression model results is spurious regression and the analysis will be faulty[6].

[6] Hamid R. Seddighi., *Introductory Econometrics A Practical Approach*, Routledge London 2012, Page: 286

Table No: 4.3

Stationarity of variables during different study periods

Periods	Variables	Level		First Difference	
		ADF	**PP**	**ADF**	**PP**
Whole Period 4th Jan 00 to 29th Dec 11	AM	0.324756 [0.9796]	0.144706 [0.9690]	-15.96288* [0.0000]	-55.41441* [0.0001]
	PM	0.164446 [0.9703]	0.172177 [0.9709]	-53.99996* [0.0001]	-53.99920* [0.0001]
	INDIA	0.692843 [0.9920]	0.694239 [0.9921]	-13.01940* [0.0000]	-56.52282* [0.0001]
	EUROPE	0.985952 [0.9966]	0.475400 [0.9859]	-11.88191* [0.0000]	-61.22127* [0.0001]
	USA	0.594998 [0.9896]	0.177083 [0.9712]	-12.14141* [0.0000]	-55.64395* [0.0001]
	JAPAN	-0.280548 [0.9253]	-0.748431 [0.8325]	-11.99402* [0.0000]	-56.23788* [0.0001]
Phase I 4th Jan 00 to 29th Dec 05	AM	0.174157 [0.9709]	0.348429 [0.9807]	-26.48975* [0.0000]	-41.13725* [0.0000]
	PM	0.188605 [0.9719]	0.317350 [0.9792]	-39.42411* [0.0000]	-39.58525* [0.0000]
	INDIA	-0.069474 [0.9508]	-0.027480 [0.9549]	-13.63558* [0.0000]	-39.58387* [0.0000]
	EUROPE	-0.771309 [0.8263]	-1.089515 [0.7220]	-15.36647* [0.0000]	-47.36130* [0.0001]
	USA	0.221938 [0.9740]	0.348551 [0.9807]	-26.41162* [0.0000]	-40.55716* [0.0000]
	JAPAN	-0.135159 [0.9437]	-0.157325 [0.9412]	-43.22854* [0.0001]	-43.23129* [0.0001]
Phase II 3rd Jan 06 to 29th Dec 11	AM	-1.108769 [0.7144]	-1.091172 [0.7213]	-38.32513* [0.0000]	-38.34168* [0.0000]
	PM	-1.047083 [0.7381]	-1.048559 [0.7376]	-37.45792* [0.0000]	-37.45884* [0.0000]
	INDIA	-0.284132 [0.9247]	-0.388237 [0.9087]	-11.46473* [0.0000]	-40.08850* [0.0000]
	EUROPE	-0.254380 [0.9289]	-0.373517 [0.9111]	-7.705746* [0.0000]	-41.53651* [0.0000]
	USA	-1.004251 [0.7537]	-0.990906 [0.7584]	-38.76355* [0.0000]	-38.74832* [0.0000]
	JAPAN	-1.347515 [0.6091]	-1.752099 [0.4047]	-8.737377* [0.0000]	-38.01790* [0.0000]

*****Significance at 1% level, [ ] p values,

It is therefore important to test the stationarity of time series variables included in the analysis. For a stationary series, 'shocks' (to denote a change (or) an unexpected change in a variable) to the system will gradually die away. That is a

shock during time t will have a smaller effect in time t+1, a smaller effect still in time t+2 and so on. A stationary series can be defined as one with a constant mean, constant variance and constant co variance for each given lag[7].

In other words a time series is said to be stationary when its mean, variance and auto covariance (at various lags) remain the same no matter at what point we measure them; i.e they are time invariant[8]. To put differently, a stationary process will not drift too far away from its mean value because of finite variance.

If a non time series y_t must be differenced d times before it becomes stationary, then it is said to be integrated of order d. The differenced series would be written as $\Delta X_t = X_t - X_{t-1.}$ In this case we say that the original non-stationary series X_t is integrated of order I and is denoted with I (1), Stationary if a non-stationary series has to be differenced twice ($\Delta^2 X_t = X_t - X_{t-1}$) before it comes stationary, the original series X_t is integrated of order I(2). Generally if a non-stationary series has to be differenced d times before it becomes stationary, the original series X_t is integrated of order d and is denoted with I (d)[9].

For testing the stationary properties of the variables included in the study for the different study periods, the unit root testing methodologies such as Augmented Dickey Fuller test (ADF) and Phillip and Perrorn (PP) test are adopted for testing the stationary properties of the variables. An important assumption of the DF test is that the error terms U_t are independently and identically distributed. The ADF test adjusts the DF test to take care of possible serial correlation in the error terms by adding the lagged difference terms of the regressand. Phillipand Perron (PP) has developed a comprehensive theory of unit root test of non-stationarity. The tests are similar but Phillips and Perrorn use non-parametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms[10]. Instead of

[7]Chris Brooks., *Introductory Econometrics for Finance*, Cambridge University Press, NewYork. 2008., Page:318

[8]Damodar N Gujarati, Dawn C Porter and Sangeetha Gunasekar, *Basic Econometrics*, Tata McGraw Hill, New Delhi. 2012. Page 784

[9]Chris Brooks., *Introductory Econometrics for Finance*, Cambridge University Press, NewYork. 2008., Page:326

[10]Damodar N Gujarati, Dawn C Porter and Sangeetha Gunasekar, *Basic Econometrics*, Tata McGraw Hill, New Delhi. 2012. Page 801

choosing between either one, it is safe to use both methodologies of unit root test. Since they reinforce each other, one can have confidence in the results[11].

The results of unit root test of ADF and PP using Akaike Information Criterion (AIC) is given on the table No: 4.3. The unit root test is applied to the levels and first difference of all the spot gold price series included in the study for the different study periods. The Null hypothesis tested is that the spot gold price series are non-stationary (or) the series has unit root. Rejection of the null hypothesis supports stationary. According to the results of ADF and PP at level for all the spot gold price variables, the null hypothesis of a unit root test / non stationary can not be rejected and confirms that the all the variables are non stationary at their levels in all the study periods.

However when the test are applied to the first difference of the series, the null hypothesis of unit root test is rejected indicating that they become stationary at their first difference for all the study period. It is concluded that all the spot gold price series are non stationary at their levels and become stationary at their first difference. i.e all the variables are integrated by order on I(1). Non stationary at level and stationary at first difference is a pre condition for testing the cointegration among the variables. Two or more non stationary time series are cointegrated, if a linear combination of the variables is stationary[12].

Hence all the spot gold price series during different study periods follow the same order of integration I(1) and satisfies the pre condition for testing the cointegration. It permits us to proceed further to examine the long run and short relationship among the spot gold price series included in the different study period.

[11] Walter Enders., *Applied Econometric Time Series*, Wiley India, New Delhi,2008. Page 545

[12] Gilmore et al (2009), *The dynamics of gold prices, gold mining stock prices and stock market prices comovements*, Mactothink Institute, Vol. I, No.1:E12

4.9 SELECTION OF LAG LENGTH CRITERIA

Selecting the appropriate lag length of the model for estimating the long run and short run relationship is very important because of Gaussian error terms. i.e the standard normal error terms that do not suffer from non normality auto correlation and hetroscedasticity etc[13]. Specifying the incorrect lag length will lead to faulty results and the results obtained from the estimated model will be unreliable. Hence specifying the optimum lag length plays a vital role in the process of estimating long and short run relationship among the variables. The most common procedure in selecting the optimal lag length is to estimate VAR model by including all the variables levels (non differenced data). The VAR model consisting of all the spot gold price series variables is estimated at their levels. The results of the estimated VAR model for choosing the optimal lag length is given in Table No: 4.4.

While examining the long run and short run relationship individual attention is paid to both the dependent variables AM fix and PM fix prices. The VAR model is also estimated separately with both AM fix and PM fix for the different study periods. The optimal lag length is selected on the basis of the lag length suggested by Akaike Information Criterion (AIC). As per AIC the optimal lag length for Whole Period for AM fix and PM fix price is 4 and 5 respectively. During the Phase I the AIC suggests 4 lags for both AM fix and PM fix price and for the Phase II. It suggests lag length 3 for both AM fix and PM fix prices. After obtaining the appropriate lag length for all the variables for different study periods the next step is to estimate the long run and short run relationship among the variables.

[13]Dimitrios Asteriou., *Applied Econometrics, A modern approach using Eviews and Microfit*, Palgrave Macmillan, 2006. Page:345.

Table No: 4.4

Selection of Optimum Lag length

Period	Variable	Lag	LogL	LR	FPE	AIC	SC	HQ
Whole period 4th Jan 00 to 29th Dec 11	AM Fix	0	16977.46	NA	4.09e-12	-12.03294	-12.02240	-12.02913
		1	48160.42	62233.28	1.04e-21	-34.12295	-34.05973	-34.10014
		2	48650.51	976.3653	7.50e-22	-34.45268	-34.33678*	-34.41086
		3	48707.11	112.5531	7.33e-22	-34.47509	-34.30650	-34.41425*
		4	**48733.08**	**51.55568***	**7.33e-22***	**-34.47577***	**-34.25450**	**-34.39593**
		5	48746.48	26.54461	7.39e-22	-34.46755	-34.19359	-34.36870
	PM Fix	0	17917.88	NA	2.09e-12	-12.70417	-12.69363	-12.70037
		1	47888.82	59814.34	1.25e-21	-33.94242	-33.87919	-33.91961
		2	48611.32	1439.363	7.62e-22	-34.43711	-34.32117*	-34.39527
		3	48707.32	190.9184	7.24e-22	-34.48746	-34.31882	-34.42661*
		4	48742.44	69.70680	7.19e-22	-34.49464	-34.27330	-34.41477
		5	**48768.02**	**50.69920***	**7.19e-22***	**-34.49505***	**-34.22101**	**-34.39617**
		6	48783.73	31.07181	7.24e-22	-34.48846	-34.16173	-34.37057
Phase I 4th Jan 00 to 29th Dec 05	AM Fix	0	13026.16	NA	7.86e-15	-18.28814	-18.26967	-18.28124
		1	25922.96	25684.92	1.11e-22	-36.36651	-36.25567	-36.32512
		2	26206.24	562.1770	7.70e-23	-36.72926	-36.52606*	-36.65336
		3	26258.41	103.1864	7.41e-23	-36.76744	-36.47186	-36.65704*
		4	**26286.13**	**54.62075***	**7.38e-23***	**-36.77126***	**-36.38331**	**-36.62636**
		5	26304.17	35.40528	7.45e-23	-36.76147	-36.28116	-36.58207
	PM Fix	0	13463.12	NA	4.20e-15	-18.91514	-18.89665	-18.90823
		1	26049.60	25066.83	9.03e-23	-36.57007	-36.45916	-36.52864
		2	26347.66	591.4981	6.15e-23	-36.95384	-36.75051*	-36.87789*

		3	26396.19	95.98299	5.95e-23	-36.98692	-36.69118	-36.87645
		4	**26437.69**	**81.76844**	**5.81e-23***	**-37.01010***	**-36.62194**	**-36.86512**
		5	26458.78	41.41594*	5.84e-23	-37.00461	-36.52403	-36.82511
		6	26474.23	30.23032	5.92e-23	-36.99119	-36.41819	-36.77717
Phase II 3rd Jan 06 to 29th Dec 11	AM Fix	0	10392.21	NA	2.27e-13	-14.92416	-14.90534	-14.91712
		1	22901.10	24909.94	3.68e-21	-32.86078	-32.74788	-32.81856
		2	23135.68	465.4616	2.73e-21	-33.16190	-32.95492*	-33.08451*
		3	**23179.92**	**87.44907**	**2.65e-21***	**-33.18954***	**-32.88847**	**-33.07696**
		4	23200.50	40.53448*	2.67e-21	-33.18318	-32.78804	-33.03543
		5	23212.94	24.41714	2.72e-21	-33.16514	-32.67591	-32.98220
	PM Fix	0	10871.12	NA	1.13e-13	-15.62346	-15.60464	-15.61642
		1	22596.73	23350.06	5.57e-21	-32.44677	-32.33380	-32.40453
		2	23020.14	840.1234	3.14e-21	-33.01961	-32.81251*	-32.94216
		3	**23090.63**	**139.3658**	**2.94e-21***	**-33.08502***	**-32.78378**	**-32.97237***
		4	23113.71	45.45079	2.95e-21	-33.08225	-32.68688	-32.93440
		5	23133.83	39.50119*	2.97e-21	-33.07524	-32.58573	-32.89219
		6	23152.79	37.07135	3.00e-21	-33.06656	-32.48291	-32.84831

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4.10 LONG RUN RELATIONSHIP AMONG THE VARIABLES

Estimation of the cointegration analysis tells us about the presence of long run relationship among two or more variables and cointegration analysis is estimated to find out the number of cointegrating vectors in the VAR models. The results of stationarity test i.e the variables are non-stationary at level and stationary at first difference permits to proceed further to examine the long run relationship among the spot gold prices variables during different study periods.

In order to test the long run relationship among the spot gold price series, the Johansen cointegration methodology is applied on the variables for the different study periods. This test helps us to identify the number of cointegrating vectors in a matrix of a Vector Autoregression (VAR) model of the series with the rank indicating whether there is cointegration as well as the number of cointegrating relationships. The two likelihood ratio tests such as the Trace test and Maximum Eigen value test are used to determine the number of cointegrating vectors.

The null hypothesis of there is a maximum of r cointegrating vectors is tested under the trace test against the alternative that the number is equal to n, the number of series in the model. In short the null hypothesis that r=0 is tested against the alternative hypothesis $r \geq 1$. If the null is rejected, the null of $r \leq 1$ is tested against the alternative hypothesis $r \geq 2$. If this null is rejected, the null becomes $r \leq 2$ tested against $r \geq 3$ and so on. If the null hypothesis r=0 is rejected, then there exist at least one cointegrating vectors that evidence the existence of the long run relationship among the spot gold price series included in the different study periods. The maximum Eigen value also test the same null hypothesis as tested in the trace test while the alternative is r+ cointegrating vectors.

Table No: 4.5 gives the results of the Johansen's Cointegrating test conducted on the spot gold prices of log level date for the different study periods. The Cointegration test is estimated on the dependent variables separately with the independent variables during the different study periods. The Trace statistics result indicates that in all the study periods for both the dependent variables AM fix and PM fix prices, the null hypothesis of no cointegrating vectors (r=0) is rejected at 0.05 level and suggested that there exist at least one cointegrating vectors.

Table No: 4.5

Results of unrestricted Cointegration rank test during various study periods

[Trace and Maxeigen value]

Periods	Variable	Hypothesis	Eigen Value	Trace Statistics	Critical Value at 5%	Prob	Max-Eigen Statistic	Critical Value at 5%	Prob
Whole Period 4th Jan 00 to 29th Dec 11	AM Fix	r = 0*	0.192321	631.0127	69.81889	0.0001	602.5375	33.87687	0.0001
		r ≤ 1	0.004705	28.47518	47.85613	0.7927	13.30501	27.58434	0.8674
		r ≤ 2	0.003755	15.17017	29.79707	0.7689	10.61372	21.13162	0.6857
		r ≤ 3	0.001578	4.556451	15.49471	0.8540	4.456026	14.26460	0.8084
		r ≤ 4	3.56E-05	0.100424	3.841466	0.7513	0.100424	3.841466	0.7513
	PM Fix	r = 0*	0.180322	589.3728	69.81889	0.0001	560.7379	33.87687	0.0001
		r ≤ 1	0.004333	28.63487	47.85613	0.7854	12.24469	27.58434	0.9224
		r ≤ 2	0.004157	16.39018	29.79707	0.6846	11.74626	21.13162	0.5729
		r ≤ 3	0.001582	4.643925	15.49471	0.8454	4.465068	14.26460	0.8073
		r ≤ 4	6.34E-05	0.178857	3.841466	0.6724	0.178857	3.841466	0.6724
Phase – I 4th Jan 00 to 29th Dec 05	AM Fix	r = 0*	0.191152	343.4093	69.81889	0.0001	302.0929	33.87687	0.0001
		r ≤ 1	0.013513	41.31639	47.85613	0.1788	19.37403	27.58434	0.3861
		r ≤ 2	0.010080	21.94235	29.79707	0.3017	14.42631	21.13162	0.3311
		r ≤ 3	0.005201	7.516049	15.49471	0.5185	7.424975	14.26460	0.4402
		r ≤ 4	6.40E-05	0.091074	3.841466	0.7628	0.091074	3.841466	0.7628
	PM Fix	r = 0*	0.187897	338.2963	69.81889	0.0001	296.3753	33.87687	0.0001
		r ≤ 1	0.013136	41.92100	47.85613	0.1609	18.82964	27.58434	0.4278

		$r \leq 2$	0.011239	23.09137	29.79707	0.2416	16.09464	21.13162	0.2194
		$r \leq 3$	0.004874	6.996731	15.49471	0.5780	6.957961	14.26460	0.4941
		$r \leq 4$	2.72E-05	0.038769	3.841466	0.8439	0.038769	3.841466	0.8439
Phase - II 3rd Jan 06 to 29th Dec 11	AM Fix	$r = 0^*$	0.223519	393.7546	69.81889	0.0001	352.4054	33.87687	0.0001
		$r \leq 1$	0.020121	41.34914	47.85613	0.1778	28.31371	27.58434	0.0403
		$r \leq 2$	0.005555	13.03544	29.79707	0.8900	7.759110	21.13162	0.9179
		$r \leq 3$	0.003759	5.276329	15.49471	0.7788	5.246254	14.26460	0.7105
		$r \leq 4$	2.16E-05	0.030074	3.841466	0.8623	0.030074	3.841466	0.8623
	PM Fix	$r = 0^*$	0.237760	419.1260	69.81889	0.0001	378.1905	33.87687	0.0001
		$r \leq 1$	0.019068	40.93545	47.85613	0.1907	26.81773	27.58434	0.0624
		$r \leq 2$	0.005892	14.11772	29.79707	0.8340	8.231953	21.13162	0.8890
		$r \leq 3$	0.004200	5.885767	15.49471	0.7090	5.863224	14.26460	0.6308
		$r \leq 4$	1.62E-05	0.022543	3.841466	0.8806	0.022543	3.841466	0.8806

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The results of Max-Eigen value also supports the Trace statistics results by rejecting the null hypothesis of (r=0) at 0.05 significance level in all the study periods for both AM fix and PM fix prices.

Hence both Trace statistics and Max-Eigen test statistics conclude that there exists long run relationship among the spot gold price series included in the study. The existence of Co integration among the variables suggests that the spot gold prices of all the countries move together in the long run. The spot gold markets face lots of disturbances and shocks due to arrival of new information and these shocks / disturbances causes deviation in the short run. In spite of these shocks and deviation all the spot gold prices are able to correct the errors by itself in the short run in order to move together in the long run. This result also supports the theory that a commodity traded internationally and its price should be cointegrated with each other.

Hence the spot gold markets are efficient enough to get back to the equilibrium in the long run from the short run deviations. This suggests that the spot gold prices are not independent of each other, and it is caused by the movement of other spot gold markets. Hence all the markets move together in the long run. The information of single market will have its impact in all the prices.

The unique feature to be noted here is the rejection of the null hypothesis (r=0) no cointegration equation in both Phase I and Phase II. The growth of the gold market in Phase I is not the same as seen in Phase II. And also the information and innovations that affected the spot gold market highly differ from one to another. It is clearly seen in the line graph Figure No: 4.1 that the market in the Phase I was free from shocks and it has experienced a steady growth, whereas during Phase II the market is affected by lots of information such as financial crisis in the world markets, imbalances in the exchange rate markets and growth of the oil prices and Macro Economic changes that caused the markets to move away from the equilibrium.

Due to this the spot gold market has shown lots of ups and downs in the movement of its prices. In spite of all these shocks the spot gold prices are capable of maintaining the equilibrium relationship in the long run. This is one of the unique features of the major gold markets. Though each gold market has its own shocks and information, they all converge together in terms of its movement in the long run. This also confirms that the spot gold market incorporates the domestic and international

markets information and this is reflected in the price in the form disequilibrium in the short run. At the same time it ensures that the market and the prices do move along with the other major gold markets in the long run.

The existence of the long run relationship among the spot gold price allows going for examining the short run relationship among the spot gold prices. This is estimated through Vector Error Correction Model (VECM). Estimation of the VECM helps to determine the impact of the independent variables on the dependent variables in the short run.

4.11 SHORT RUN RELATIONSHIP AMONG THE SPOT GOLD PRICE

The VECM also known as the system of equation model helps to measure the immediate impact of the changes in independent variables on the independent variables. It also helps to measure the feedback effect and shows how much of the disequilibrium or error that caused by the shocks due to arrival of new information is being corrected. As the VECM captures the response of the each dependent variable to departures from the long term equilibrium, the model converts the level data into first differenced data in the analysis. i.e the AM fix variable is converted into D(AM). This is because the speed of adjustment is better captured in the first difference data rather than in the level data.

When one or more variables are cointegrated, it implies that there is some adjustment process which prevents the error in the long run relationship[14]. Nasiruddin Ahmed (2001) points out that the main feature of the error correction (ECM) is its capability to correct for any disequilibrium that may shock the system from time to time. The error correction term picks up such disequilibrium and guides the variables of the system back to the equilibrium.

[14]Dimitrios Asteriou., *Applied Econometrics, A modern approach using Eviews and Microfit,* Palgrave Macmillan, 2006. Page:332.

Table No: 4.6

Short Run relationship among the spot gold price series

	Whole Period 4th Jan 00 to 29th Dec 11		**Phase – I** 4th Jan 00 to 29th Dec 05		**Phase - II** 3rd Jan 06 to 29th Dec 11	
	ΔAM	**ΔPM**	**ΔAM**	**ΔPM**	**ΔAM**	**ΔPM**
Coint Eq 1	-1.022536* [-23.35513]	-1.226613* [-15.94180]	-0.932564* [-15.43441]	-0.918947* [-10.25859]	-1.037782* [-18.72305]	-1.263730* [-14.04044]
$\Delta AM_{-1}/\Delta PM_{-1}$	0.002288 [0.054252]	0.135977*** [1.858921]	0.034347 [0.593058]	-0.024441 [-0.266412]	-0.045972 [-0.860275]	0.121924 [1.482075]
$\Delta AM_{-2}/\Delta PM_{-2}$	-0.016597 [-0.441944]	0.195877* [2.984141]	-0.000220 [-0.004238]	-0.019782 [-0.231239]	-0.069500 [-1.521175]	0.184593* [2.736183]
$\Delta AM_{-3}/\Delta PM_{-3}$	-0.005315 [-0.169747]	0.187277* [3.225068]	-0.062377 [-1.437142]	-0.124004*** [-1.636016]	-0.016922 [-0.519557]	0.171852* [3.361146]
$\Delta AM_{-4}/\Delta PM_{-4}$	-0.001598 [-0.077561]	0.078416*** [1.606729]	-0.059819** [-2.279223]	-0.147899** [-2.528568]	-	-
$\Delta EUROPE_{-1}$	-0.048777* [-2.874333]	-0.030066 [-1.198336]	-0.037647*** [-1.867589]	-0.022910 [-0.749847]	-0.073642* [-2.708170]	-0.048693 [-1.230731]
$\Delta EUROPE_{-2}$	0.007765 [0.447600]	0.008832 [0.345382]	0.012669 [0.619657]	0.000887 [0.028763]	0.017811 [0.638871]	0.009247 [0.229283]
$\Delta EUROPE_{-3}$	0.010685 [0.617176]	-0.007934 [-0.309686]	0.025037 [1.224746]	0.040450 [1.310650]	-0.002337 [-0.086541]	-0.052673 [-1.345600]
$\Delta EUROPE_{-4}$	0.004514 [0.268863]	0.021437 [0.841711]	0.011390 [0.574861]	0.062494** [2.106139]	-	-
$\Delta INDIA_{-1}$	-0.002983 [-0.140006]	-0.017266 [-0.645188]	-0.000626 [-0.019010]	0.009303 [0.193022]	0.022823 [0.712810]	-0.021546 [-0.585630]
$\Delta INDIA_{-2}$	0.049782** [2.167874]	-0.014129 [-0.479419]	-0.017019 [-0.470403]	0.042587 [0.806425]	0.097166* [2.875134]	-0.007711 [-0.195601]
$\Delta INDIA_{-3}$	-0.018503 [-0.804652]	-0.064823** [-2.186643]	0.033936 [0.933873]	0.057521 [1.089638]	-0.006666 [-0.207725]	-0.042821 [-1.398927]
$\Delta INDIA_{-4}$	-0.013460	-0.010509	0.060239***	0.091410**	-	-

	[-0.632751]	[-0.362614]	[1.849205]	[2.064586]		
$\Delta JAPAN_{-1}$	0.053336* [3.152084]	0.053125** [2.074568]	-0.004703 [-0.224309]	-0.007064 [-0.215292]	-0.029592 [-0.532594]	0.084751** [2.155291]
$\Delta JAPAN_{-2}$	-0.003531 [-0.204947]	-0.026349 [-1.016675]	0.020425 [0.964222]	0.005529 [0.168210]	-0.030957 [-0.654811]	-0.053195 [-1.340185]
$\Delta JAPAN_{-3}$	0.022732 [1.321525]	0.008256 [0.317902]	-0.003472 [-0.164260]	0.018493 [0.563634]	-0.051698 [-1.517476]	0.023142 [0.588795]
$\Delta JAPAN_{-4}$	-0.003964 [-0.235222]	-0.026882 [-1.037233]	0.001795 [0.085721]	-0.031802 [-0.975647]	-	-
ΔUSA_{-1}	-0.013988 [-0.322708]	-0.197573* [-2.739449]	0.059174 [1.010177]	0.028539 [0.342448]	0.099894* [3.713177]	-0.206267** [-2.490621]
ΔUSA_{-2}	-0.051352 [-1.347292]	-0.136216* [-2.088171]	-0.071936 [-1.415029]	-0.017418 [-0.238067]	-0.008197 [-0.300091]	-0.090096 [-1.285553]
ΔUSA_{-3}	-0.051024 [-1.595882]	-0.182117** [-3.207784]	-0.026994 [-0.637729]	-0.019750 [-0.322057]	0.040579 [1.532612]	-0.155528* [-3.135595]
ΔUSA_{-4}	-0.000466 [-0.020000]	-0.039198 [-0.833950]	0.013826 [0.435582]	0.066161 [1.519134]	-	-
C	0.000656* [5.255009]	0.000649* [3.627959]	0.000429* [3.264997]	0.000422** [2.178923]	0.000833* [3.920691]	0.000837* [2.790436]
R – Squared	0.730218	0.409801	0.747198	0.407483	0.726998	0.417713
Adj R-Squared	0.728194	0.404306	0.743411	0.398608	0.723824	0.410942
Durbin-Watson stat	1.999341	1.999047	1.996999	1.999729	2.000038	2.007870
Prob(F-statistic)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

[ ] – t – statistic . *, **, *** indicates the significance level at 1%, 5% and 10% respectively

The results of the VECM are given in Table No: 4.6. The table contains coefficient values and its t statistics value that shows the level of the significance. The VECM is estimated individually for dependent variables AM fix and PM fix prices in order to measure the impact of its own lagged information and to what extent influenced by the information coming from the independent variables especially in the short run. It also captures the speed of adjustment of the dependent variables which move away from its equilibrium level.

The result of the whole study period coint equation is significant for both AM and PM fix prices. The significance level and negative sign in the co-efficient value confirms the existence of the long run relationship among the spot gold prices. The AM and PM fix prices significantly adjust its error in the short run in order to maintain the long run equilibrium relationship. Both AM and PM Fix prices significantly reacts to the mew information in the market and at the same time market ensures that it maintains its equilibrium in the long run from the disequilibrium caused by the arrival of new information. 100% error correction occurs on the same day itself during whole period and Phase II. During Phase I the market corrects around 92% error on the same day itself.

The short term interactive relationship among the spot gold prices are shown by the coefficients with its respective significance and the lagged differenced terms. It is found that during the whole study period AM fix price is not influenced by its own lagged price. Instead its movement is influenced by all the other countries except USA. This is because the USA market will not be functioning when the AM price is fixed. On the other hand the PM fix price is influenced by its own lagged price as well as by other countries except Europe. This is because the information from the domestic market would have been accounted in the AM fix price itself.

During Phase I AM fix price is influenced by its own lagged value and also the Europe and Indian prices significantly influence the prices. The PM fix price is influenced by its own lagged values as well as by the Indian and the USA prices. During the Phase II the AM fix price does not consider its own information instead its price is determined by Europe, India and USA markets information, Where as the PM fix price is determined by its own lagged value and also by the Japan and USA Markets price.

From the results of the short term interaction, it is concluded that the fixation of the AM fix price depends highly on the information coming from Europe, Indian markets and also Japanese market to some extent. European and Indian spot gold prices play a dominant role in contributing information for the determination of the AM fix price. This is because Indian market is the largest consumer of gold in the international market and Europe market is domestic to the AM fix and PM fix prices.

On the other hand the fixation of PM fix price is highly determined by its own lagged price as well as USA's and Indian spot gold prices. Japanese market information is also considered to some extent. Hence both Indian and USA market play a dominant role in contributing information to PM fix price determination. This is because the USA Market would be functioning while the PM fix price is made. Hence the USA market's information play dominant role for PM fix price.

The important point to be noted here is that Indian market contributes significant information in the fixation of both AM and PM fix prices. The Europe market contributes only to AM fix price and the USA Market plays vital role only in the PM fix price. The Japanese market shows some significant role only in the whole period for AM fix price. The role of the Indian spot gold price is much greater and unique from the other three major gold markets, because only the Indian spot gold price is able to influence significantly both AM and PM fix price in all the study periods. Hence it can be concluded that India not only plays a dominant role in consuming gold in the world gold market, but also because its spot price in the domestic gold market is influential in determining the international gold prices.

4.12 CONCLUSION

This chapter focuses on examining the long run and short run relationship among the spot gold prices included in the study. In order to observe the relationship closely, the whole study period is further sub divided into two sub periods Phase I and Phase II. The null hypothesis of (r=0) there is no cointegration is rejected both in Trace statistics and Max Eigen statistics. Hence it is concluded from the results of the cointegration that there exists long run relationship among the spot gold price of the major gold markets in the world. The spot gold prices are capable of moving together in the long run even though there are lot disturbances from the domestic markets. This

shows that if one market moves in the upward direction, the others will also follow the same.

The short term interaction results estimated through VECM concluded that the fixation of the AM fix price is highly depend on the information coming from Europe, Indian markets and also Japanese market to some extent. Europe and India spot gold prices play a dominant role in contributing information for the determination of the AM fix price. The PM fix price is highly determined by its own lagged price, USA's spot gold price and Indian spot gold price. Hence both Indian and USA market play a dominant role in contributing information to PM fix price in its determination. As stated earlier, India is the largest consumer of gold in the international markets and most of the physical delivery of gold takes place by using both AM fix price and PM fix price as bench mark price.

The significance of this objective is to find the role played by Indian spot prices in the International bench mark price which is known as AM fix and PM fix price. From the empirical results it is observed that only the Indian spot gold price is able to influence significantly both AM and PM fix price in all the study periods. Hence it can be concluded that India plays a dominant role in consuming gold in the International gold market, and its spot gold price in the domestic gold market plays a dominant role in determining the international gold prices.

Based on the results of this chapter the study examines the information spill over among the major spot gold prices in the next chapter. This is because the existence of the cointegrating relationship only shows whether the spot gold prices move together in the long run or not. But it does not show whose information is causing the dependent variables AM fix and PM fix prices. The next chapter concentrates on examining the information spill over among the spot gold prices in such a way as to find who is playing dominant role in contributing information to the international price and whose information influences the international spot gold prices AM fix and PM fix prices.

Chapter

5

Dynamic Interactions of the World Gold Markets

Information Transmission Mechanism of World Gold Markets

CHAPTER - V

INFORMATION TRANSMISSION MECHANISM OF WORLD GOLD MARKETS

5.1 INTRODUCTION

The previous chapter discussed in detail empirically the existence of the long run relationship among the spot gold price considered in the study. Based on the empirical results it was concluded that there exists co movements in such a way that all the spot gold prices move together in the long run. And further the short run impact from the independent variables are studied and showed whose spot price influences the dependent variables AM fix and PM fix prices in the short run.

The existence of the long relationship among the spot gold price variables makes us to think and analyse the information spillover among the variables. The fix of AM and PM price of LBMA does not depend only on the information generated domestically but also on the information produced in other major gold markets in the world. Since gold is traded globally both in spot and futures market, the information of other major gold markets in the world are capable of exporting their information and volatility to the LBMA AM fix and PM fix prices.

Analysing the price and volatility spillover effect in the field of stock markets is very common and there are good numbers of studies that have documented, because there is a possibility that the performance of one stock markets will have its impact on the movement of others. Whereas, there are only few studies available in the field of commodity markets especially in gold. It is observed from the previous studies that many studies have analysed the information transmission and the volatility aspects of gold prices. Risto Laulajainen (1990), Liaoqing Eleanor et al (2005) studied the interlinkages among the USA and Japanese gold markets. Wo-chiang Hui-Na lin (2010), Hui-Na Lina et al (2008) analysed the share of information between COMEX and TOCOM. The above mentioned studies considered the futures prices and not spot prices, and also the futures prices of India are not included in the study.

Yuan Yuan (2008), Mei-Hsiu Chen (2010) and Ahmed A.A Khalifa et al (2011) studied the volatility aspects of the gold price in comparison with the volatility

of other commodities traded in the exchanges. These studies concluded that the volatility of gold is highly influenced by the positive shocks rather than the negative shocks. The nature of the volatility of different commodities is analysed and not addressed. The spillover effects and spillover effect across markets are not examined.

Gold price volatility is also compared with other financial assets like shares, stock market indices and exchange rates. P.K.Mishra et al (2010), R.Karthikeyan and M.G Saravana raj (2011), Subarna.K Samanta and Ali.H.M.Zadesh (2012) and Cvneyt Akar (2011) addressed the volatility relationship between gold price, stock markets and exchange rates. These studies also did not extend to other major gold markets in the world. Particularly countries like India are not the part of the analysis. It is restricted only to few countries. It is observed from the studies that the need of new research is realized to document the volatility transmission among the major gold markets and so this chapter is framed to fill the gap that exists in the current literature in the field of world gold markets.

This chapter focuses on analyzing the proportion of the information shared by each gold markets empirically examined. There is a need to test the leverage effect in the spot gold prices, because most of the studies that accounted the leverage effect are in the futures markets. Leverage effect is incorporated because it is argued that the quantity of news (size of innovation) as well as the quality (sign of an innovation) may be an important determinant of the degree of volatility spillover among the markets[15]. The leverage effect is nothing but the impact of the positive and negative news on the dependent variables. Examining the information sharing among the variables forms the crucial part of the study.

The information transmission mechanism is carried out in two different dimensions such as price spillover and volatility spillover. The price spillover denotes the transmission of the price changes in terms of levels from the major gold markets to the LBMA AM fix and PM fix prices and the volatility spillover refers to the co movement of the price variances among the major gold markets[16]. In simple terms,

[15] Koutmos and Booth (1995)., Asymmetric volatility transmission in International stock markets., *Journal of International Money and Finance*, Vol.14. No.6, pp.747-762

[16] George Rapsomanikis., Price transmission and volatility spillovers in food markets., "*Safeguarding food security in volatile global markets'* Edited by Adam Prakash., Food and Agricultural Organisation of the United Nations, Rome, 2011

the price spillover analyses the changes in the price at levels and the volatility spillover analyses the changes in the variances of the spot gold prices. This study is intended to test whether India can become price maker in the world gold markets. This analysis will help to document the amount of information that is exported to the world gold price.

5.2 VARIABLES AND METHODOLOGY

This chapter is aimed to analyse the information spillover between the LBMA AM FIX and PM fix prices and Major gold markets in the world. The volatility behavior is better captured in the high frequency data than the low frequency data. Hence the study employed the daily data rather than monthly or annual data. The daily spot gold prices from 04th January 2000 to 29th December 2011 which consisted of totally 2826 observations have been used in the empirical analysis.

The variables consists of the LBMA fix prices AM fix and PM fix price as dependent and the spot prices of the major gold markets were considered as independent variables of the study. The Independent variables are the Spot gold prices of Indian gold market, Japanese gold Market, USA gold market and European gold market. The rationale for selecting these four countries as a major gold markets is that the aggregate gold demand of all these four countries alone represent more than 60% of world's total gold demand and out of these India alone represents more than 20% of world's gold demand The spot gold prices are expressed in gold price per troy ounce. As the intention of this objective is to test the information spill over, all the variables are used in the form of log return variables.

The preliminary analysis of the return and volatility data are analysed through summary statistics, line graph and the correlation coefficients. The unit root test such as Augmented Dickey Fuller and Philip Perron is used to test the stationary properties of the variables, because all the variables should be stationary at their levels. Hetroscedasticity test is applied to detect the presence of the hetroscedasticity in the data. GARCH (1,1) model is used to estimate the conditional variances of the variances of the data series. Finally the EGARCH model is used to study the price and

volatility spillover, volatility persistence and to capture the leverage effect in the spot gold price data.

The concept of information spillover is more common in the stock markets rather than commodity market. Well established models are available from the studies undertaken in stock markets. Hence the study followed the methodology adopted by Koutmos and Booth (1995). He has extended the Nelson's (1991) univariate Exponential Generalised Autoregressive Conditional Hetroscedasticity (EGARCH) Model into Multivariate EGARCH model and used the same to study the price and volatility spillover among three stock markets in the world. As this study also focuses on examining the information spillover among the major gold markets, using this model would be more suitable and will give reliable results than the any other models.

It is suggested in the Koutmos and Booth (1995) study that the Multivariate EGARCH model is ideally suited to test the possibility of asymmetries in the volatility transmission mechanism, because it allows own market and cross market innovations to exert an asymmetric impact on the volatility in a given market. In other words, news generated in one market is evaluated in terms of both size and sign by the next market to trade. The additional advantage of EGARCH model is that no parameter restriction is required to insure positive variances at all times[17].

Based on this methodology, the information spill over is estimated in two different dimensions namely Price spillover and the volatility spill over. Price Spillover is the impact of an innovation from market i on the conditional mean of market j and the Volatility spillover is the impact of an innovation from market i on the conditional variance of market j.

The analysis has been carried out for three different periods such as whole period 4th January 2000 to 29th December 2011consisting of 2826 observations, Phase I 4th January 2000 to 29th December 2005 consisting of 1429 observations and Phase II 3rd January 2006 to 29th December 2011 consisting of 1397 observations. This is because the return and volatility behavior of the spot gold price differs from Phase I to the Phase II. Hence the sub periods analysis will provide the real impact of the

[17]Koutmos and Booth (1995)., Asymmetric volatility transmission in International stock markets., *Journal of International Money and Finance*, Vol.14. No.6, pp.747-762

independent variables on the dependent variables. The dependent variables such as AM fix and PM fix prices are estimated separately with the independent variables.

5.3 PROCEDURE FOR THE ANALYSIS

The following procedures are followed in the process of estimating the information spillover among the major gold markets.

1. The daily spot gold price data of LBMA AM fix and PM fix, gold prices from India, Japan, USA and Europe gold markets were collected.
2. The collected spot gold prices were rearranged based on homogeneous time frame in order to arrive at the common data points in which all the markets spot prices are available.
3. The whole study period is further subdivided into two sub periods namely Phase I and Phase II.
4. The data have been converted into natural logarithmic returns, as the analysis requires stationary data.
5. The Conditional Variance of each variables are generated through GARCH (1,1) model.
6. The summary statistics is calculated to observe the average return and volatility, standard deviation, non normality etc.
7. The line graphs are plotted to observe the movement of the spot gold price return and volatility behavior over the different study periods.
8. Simple correlation analysis is used to examine the relationships between the spot gold price return and its volatility for all the countries.
9. Unit root tests such as Augmented Dickey Fuller (ADF) and Phillp Perron (PP) were employed to test the stationary properties of the variables included in the study.
10. ARCH hetroscedasticity test is used to detect the presence hetroscedasticity in the data during the different study periods.
11. Multivariate EGARCH model is adopted to examine the leverage effect, volatility persistence, and price and volatility spillover among the variables during different study periods.
12. Analysis is estimated considering LBMA AM fix and PM fix prices separately as dependent variables.

5.4 SUMMARY STATISTICS

5.4.1 Summary statistics of Spot Gold Returns of World gold markets

The summary statistics of log return series of spot gold prices of the respective countries are given in the table no: 5.1. The table contains the log return series for different study periods namely whole study period, Phase I and Phase II. During the whole study period it is observed that the average return of all the countries is similar in nature. The return generated from all the gold market is same and none of the market showed extraordinary return. The standard deviation of all the market is very high and shows big deviation from the return.

The standard deviation of India is very less which implies that Indian market is able to generate same level of return with less risk. Hence the fluctuation of return from India is very less. The skewness which indicates the sign of asymmetry shows that AM fix, PM fix and USA are negatively skewed and India, Europe and Japan are positively skewed. The kurtosis which indicates the flattening of a distribution shows that all the countries follow leptokurtic as its values are greater than 3. This shows that all the values are fitted in and around the mean value and the curve is sharper. Both skewness and kurtosis show the existence of non normality in the data set. The Jarque Bera statistics is in also a supporting evidence for the existence of non normality in the data.

Comparing to the whole period, Phase I shows small return from all the market. It is less 0.04 in the phase I. This is due to the reason that during these periods the gold market has experienced only small growth and there is no much fluctuation in the price of gold. Due to this the deviation of return from its average and also it is very little for all the countries. All the markets are positively skewed as the market shows constant trend and stable movement in its prices. Hence all the countries experienced positive return from the gold market. The values of kurtosis of all the country indicate the platykurtic distribution. The observation during phase I is also not normal and the Jarque Bera is supporting evidence.

When we compare Phase II with the above period of study, the return of all the countries are little higher except Japan. This is because the gold market price had high growth and also lot of information from other sources like stock market made the gold market to move up and down.

Table No: 5.1

Summary Statistics of the Spot Gold Return of World Gold Markets

Period		AM	PM	INDIA	JAPAN	USA	EUROPE
Whole Period (4th January 2000 to 29th December 2011)	Mean	0.060029	0.059948	0.067699	0.050716	0.060199	0.051998
	Median	0.054970	0.059791	0.053519	0.062379	0.072853	0.035728
	Std. Dev.	1.242288	1.211120	1.152374	1.360786	1.224915	1.332991
	Skewness	-0.046048	-0.313104	0.355288	0.087354	-0.078005	0.497030
	Kurtosis	8.855641	7.681375	16.90875	9.812985	8.037004	14.92902
	Jarque-Bera	4037.045	2625.768	22830.51	5467.233	2989.291	16866.38
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	2825	2825	2825	2825	2825	2825
Phase I (4th January 2000 To 29th December 2005)	Mean	0.042434	0.042027	0.046142	0.052256	0.042371	0.031812
	Median	0.018746	0.031190	0.034778	0.057898	0.037233	0.028299
	Std. Dev.	0.959424	0.932868	0.921069	1.068254	0.955513	1.064471
	Skewness	0.705027	0.223538	0.972134	0.553200	0.233127	0.562484
	Kurtosis	12.04172	9.092787	15.16768	9.656821	7.797888	10.38413
	Jarque-Bera	4982.583	2220.655	9034.041	2709.475	1382.609	3319.564
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	1428	1428	1428	1428	1428	1428
Phase II (3rd January 2006 To 29th December 2011)	Mean	0.077553	0.075988	0.089610	0.046882	0.076127	0.070349
	Median	0.087028	0.097566	0.091231	0.075651	0.109180	0.061372
	Std. Dev.	1.477033	1.439181	1.348883	1.604407	1.447560	1.558788
	Skewness	-0.273373	-0.465355	0.106054	-0.058703	-0.188744	0.423052
	Kurtosis	6.802444	6.164606	14.87827	8.330316	6.823430	13.83278
	Jarque-Bera	858.3953	632.9086	8209.544	1653.449	858.6047	6867.447
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	1396	1396	1396	1396	1396	1396

Only Japan is showing less return, because the GDP of Japan came down drastically during the financial crisis period. This would have had indirect impact on its gold consumption. The standard deviation of India is less than all the other countries and at the same time the return of India is much higher than other countries. The skewness and kurtosis results confirm the non normality in the data. The Jarque Bera results of all the countries suggest the existence of non normality in the data.

It is observed from the summary statistics of all the countries from all the study periods that both India and Europe are positively skewed and India shows a higher return than the other countries with less risk. Hence the performance of Indian gold market is much better than that of the other major gold markets in the world.

5.4.2 Summary statistics of Spot Gold Price volatility of World gold markets

The summary statistics of the volatility series are given in the Table No: 5.2. The volatility series is estimated through GARCH (1,1) model. The volatility of the series is nothing but the estimated conditional variance series of GARCH (1,1) model. The volatility series is estimated separately for all the variables for all the study periods. It is observed from the summary statistics that the average volatility of all the variables is high during Phase II than the other two periods Phase I and whole period.

The movement of gold price during Phase I is very little. Hence the volatility is also very less during the period for all the countries. All the variables in all the study periods are positively skewed and the values of kurtosis are greater than 3. This implies the presence of Leptokurtic distribution and the curves are sharper than a normal distribution. The skewness and Kurtosis results indicate the presence of non normality in the data. The results of Jarque Bera suggest that the variables are not normally distributed. The standard deviation of all the country is very less in all the study period for all the variables. It indicates that the volatility of gold price return is always situated near its average volatility and evidence that the spot gold return was stable during the study periods.

Table No: 5.2

Summary Statistics of the Spot Gold Price Volatility of World Gold Markets

Period		AM	PM	INDIA	JAPAN	USA	EUROPE
Whole Period (4th January 2000 to 29th December 2011)	Mean	1.566665	1.483809	1.453712	1.807181	1.481630	1.749988
	Median	1.096911	1.061360	0.944654	1.383954	1.133587	1.273751
	Std. Dev.	1.368175	1.270224	1.766127	1.671997	1.090245	1.837828
	Skewness	3.067779	3.066734	7.577595	6.312494	3.131097	7.619589
	Kurtosis	15.11305	15.70721	96.53893	57.51478	15.86389	89.68187
	Jarque-Bera	21694.32	23426.55	1056554.	368443.9	24085.76	911443.5
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	2824	2824	2824	2824	2824	2824
Phase I (4th January 2000 to 29th December 2005)	Mean	0.935167	0.876619	0.899493	1.117570	0.903965	1.093910
	Median	0.750011	0.733768	0.692421	1.048620	0.823342	0.963840
	Std. Dev.	0.647188	0.591162	0.842410	0.281991	0.260219	0.513778
	Skewness	4.988034	6.926356	9.014796	5.238170	2.777606	5.419181
	Kurtosis	43.46856	70.90021	119.5781	45.12116	15.80744	49.53348
	Jarque-Bera	103292.6	285538.9	827393.0	112016.3	11587.88	135733.5
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	1427	1427	1427	1427	1427	1427
Phase II (3rd January 2006 to 29th December 2011)	Mean	2.192998	2.107886	1.967012	2.560054	2.120544	2.423275
	Median	1.556375	1.545689	1.392316	1.916580	1.631792	1.696538
	Std. Dev.	1.691398	1.586084	1.999101	2.491158	1.557212	2.473839
	Skewness	2.055509	2.195027	5.668237	4.848286	2.244469	5.169043
	Kurtosis	7.841384	8.799954	52.71166	32.79149	8.832902	40.08854
	Jarque-Bera	2344.731	3075.512	151111.3	57052.96	3148.824	86166.58
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	1395	1395	1395	1395	1395	1395

5.5 CORRELATION ANALYSIS

5.5.1 Correlation analysis of Spot Gold Returns of World gold markets

The Table No. 5.3 shows the results of correlation coefficient among the variables during different study periods. It is observed from the results that the return from India is highly correlated with the return of AM fix in all the study period. As stated already by Kannan and Sarath Dhal (2008) that India always follows AM fix price. It maintains very less correlation with USA in all the study period. Next to AM fix it maintains high correlation with Japan. It is because the Japan market would already be functioning when the Indian Market is about to start to function. Hence its impact is felt on Indian gold market.

The correlation of India with Japan highlights that the anticipation of movement of gold market in India would be done based on the information coming from Japan as it is the first market which begins its operation before all the other markets do. The correlation of India with USA is very lowest and indicates that Indian market is less affected by USA gold market.

The USA Market maintains very low correlation with AM fix return and high correlation with PM fix return in all the study periods. This result absolutely supports the practice. The objective of AM fix price is to incorporate the information coming from Europe and other ASIAN countries, where as the PM fix price was started to accommodate the information coming especially from USA gold market and also USA gold market would be in operation when the PM fix price is undertaken. When the AM fix is made the market would not be working.

The same kind of correlation is observed between European and PM fix. The Europe gold market also maintains high correlation with PM fix and not with the AM fix price in all the study period. It is because of the Europe information would be incorporated in AM fix. But only the PM fix could reflect the entire information effectively as the operation of the market is about to reach the end of the day.

Table No: 5.3

Correlation coefficients Spot Gold Return of World Gold Markets

Period		AM	PM	INDIA	JAPAN	USA	EUROPE
Whole Period (4th January 2000 to 29th December 2011)	AM	1.000000					
	PM	0.661901	1.000000				
	INDIA	0.831745	0.660503	1.000000			
	JAPAN	0.537099	0.785637	0.532587	1.000000		
	USA	0.271242	0.613293	0.290328	0.520690	1.000000	
	EUROPE	0.498965	0.752583	0.529828	0.818249	0.503261	1.000000
Phase I (4th January 2000 to 29th December 2005)		**AM**	**PM**	**EUROPE**	**INDIA**	**JAPAN**	**USA**
	AM	1.000000					
	PM	0.675919	1.000000				
	EUROPE	0.469058	0.713534	1.000000			
	INDIA	0.779376	0.826203	0.683815	1.000000		
	JAPAN	0.540545	0.777196	0.750761	0.725908	1.000000	
	USA	0.185188	0.556031	0.337887	0.363604	0.390164	1.000000
Phase II (3rd January 2006 to 29th December 2011)		**AM**	**PM**	**JAPAN**	**USA**	**EUROPE**	**INDIA**
	AM	1.000000					
	PM	0.656274	1.000000				
	JAPAN	0.535888	0.788954	1.000000			
	USA	0.308575	0.636906	0.578000	1.000000		
	EUROPE	0.512700	0.769710	0.849366	0.577837	1.000000	
	INDIA	0.855798	0.586604	0.443470	0.256624	0.456790	1.000000

5.5.2 Correlation analysis of Spot Gold Price volatility of World gold markets

The estimated correlation coefficient of volatility variables are given in Table No. 5.4. Unlike the correlation of the return series, the volatility of all the markets maintains high correlation with AM and PM fix prices. The Indian market maintains high correlation with AM and PM fix price volatility during only Phase I, where as its correlation is very small in the other two study periods. The USA market is highly associated with AM and PM fix price volatility in all the study periods. This indicates that the volatility of USA is highly correlated with AM fix. Hence AM fix plays significant role with the USA gold price volatility. It is also observed that the natures of volatility relationship among the major gold markets are very high in all the study period.

This shows that the variance that occurs in one market is not independent in nature. Instead it is interlinked with one another. Hence if the volatility of one market moves up, the other market also will react to this by moving in the same direction. The information that causes the variance in one market will also have its impact on the other market variance as well.

Table No: 5.4

Correlation coefficients of the Spot Gold Price Volatility of World gold markets

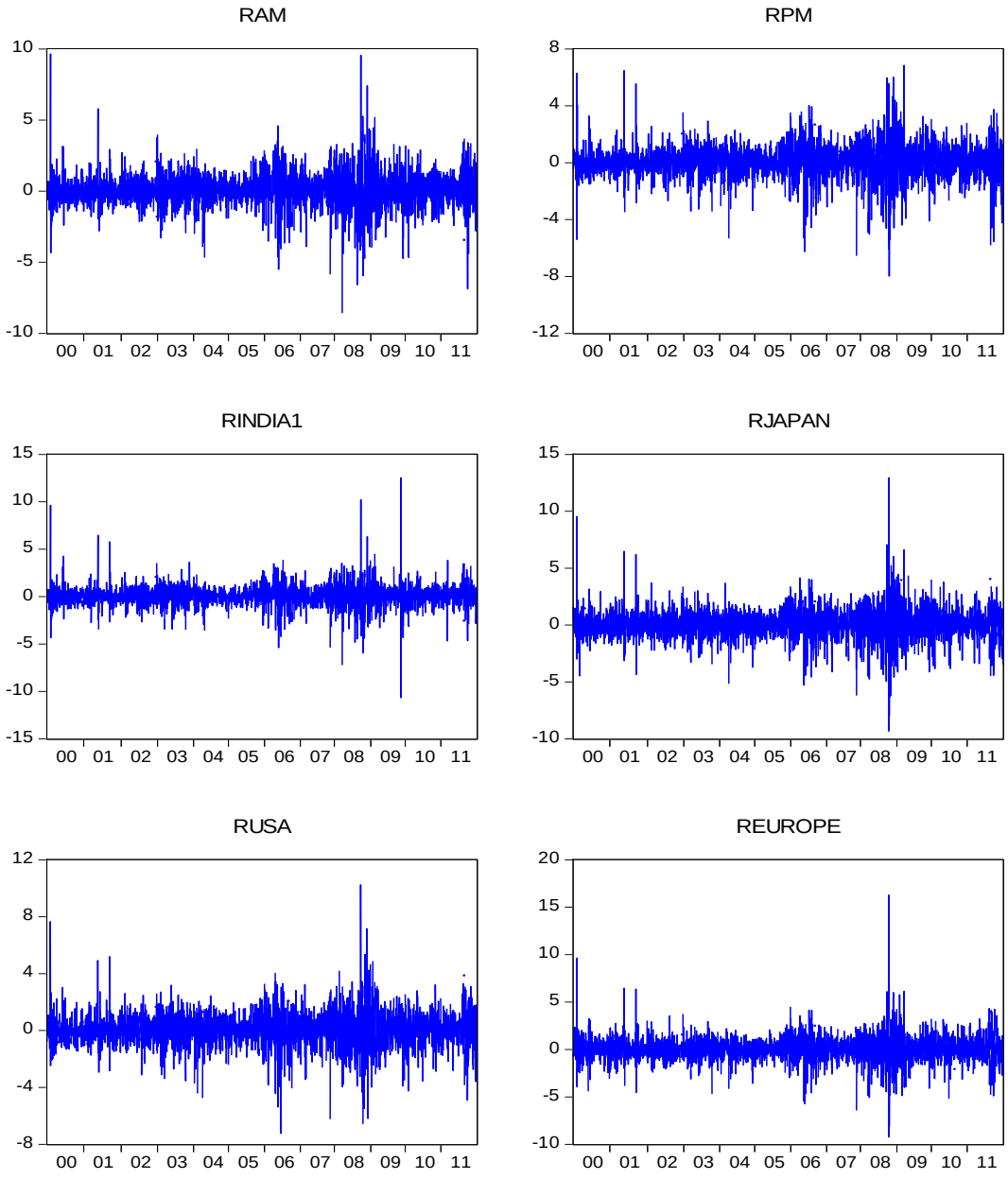
Period		AM	PM	EUROPE	INDIA	JAPAN	USA
Whole Period (4th January 2000 to 29th December 2011)	AM	1.000000					
	PM	0.898549	1.000000				
	EUROPE	0.780090	0.867329	1.000000			
	INDIA	0.647766	0.586307	0.513286	1.000000		
	JAPAN	0.807783	0.884431	0.948798	0.513900	1.000000	
	USA	0.904850	0.913972	0.804967	0.572640	0.852572	1.000000
Phase I (4th January 2000 to 29th December 2005)		**AM**	**PM**	**EUROPE**	**INDIA**	**JAPAN**	**USA**
	AM	1.000000					
	PM	0.768653	1.000000				
	EUROPE	0.759424	0.860924	1.000000			
	INDIA	0.809694	0.911485	0.881358	1.000000		
	JAPAN	0.811577	0.880956	0.922901	0.878618	1.000000	
	USA	0.788665	0.751975	0.706216	0.692260	0.762108	1.000000
Phase II (3rd January 2006 to 29th December 2011)		**AM**	**PM**	**EUROPE**	**INDIA**	**JAPAN**	**USA**
	AM	1.000000					
	PM	0.917860	1.000000				
	EUROPE	0.816643	0.883812	1.000000			
	INDIA	0.578493	0.505229	0.468432	1.000000		
	JAPAN	0.828321	0.882269	0.967358	0.468046	1.000000	
	USA	0.933056	0.927351	0.834440	0.526532	0.848949	1.000000

5.6 LINE GRAPHS

5.6.1 Spot Gold Return Series of World Gold markets

Figure No: 5.1

Spot Gold Return Series of World Gold markets



The Figure No: 5.1 show the movement of the return series of the world spot gold markets included in the study. During the year 2000 and mid of 2001 the gold market generated both positive as well as negative return at the extreme level such that the return in 2000 is more positive return than the following period. During the

year 2003 and 2004 the return is more negative than positive. There is a correction in the return series during 2004 and 2005 and a stable movement during this period. After 2005 there is another fall in the return during 2006 from which the data is subdivided into two sub periods for the empirical analysis.

The period between 2008 and 2009 is known for high deviation period where the financial crisis occurred and it is known as the crisis period. The figure shows that the USA market was affected more than the Indian market by financial crisis. In addition the impact was felt in India very late that was in the end of 2009. The financial crisis impact was felt in all the countries as the return during this period had high fluctuation. After the financial crisis all the countries faced its correction in the return series. It was observed that only India was able to generate constant return with stable movement in its return behaviour

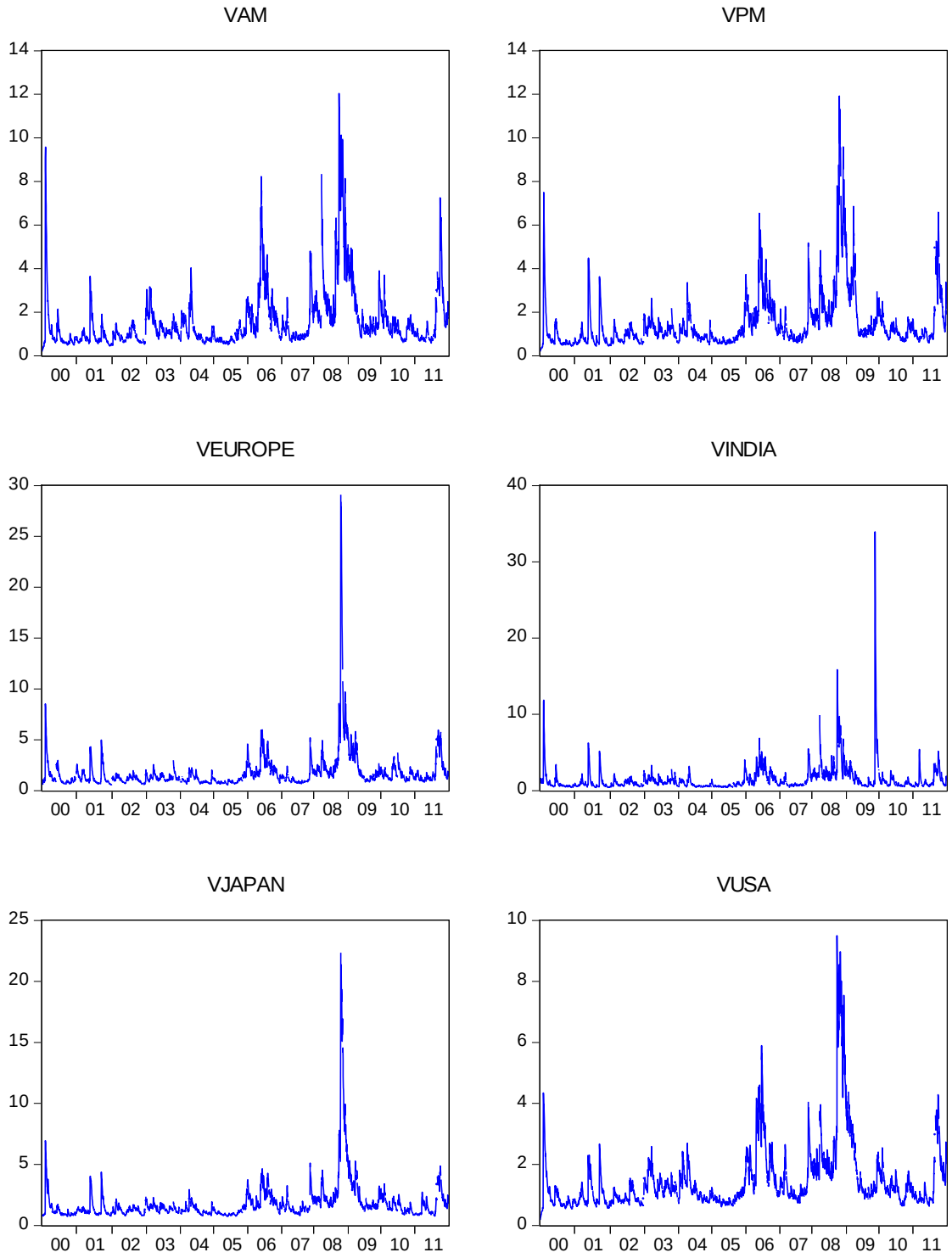
5.6.2 Spot Gold Price Volatility Series of World Gold markets

The Figure No. 5.2 shows the estimated volatility movement of the variables included in the study, for the whole study period from 2000 to 2011. It is observed that both AM fix and PM fix have high volatility during 2000 and the same is corrected in the following year. AM fix, PM fix and USA prices experienced again high volatility during 2005 and 2006 in which the gold market reached extreme high and showed some correction in the subsequent years. India, Japan and Europe show a similar kind of volatility from 2000 to 2007. All countries experienced a high volatility during the financial crisis period to the extreme level.

Except India all the other countries had the impact of 2008 crisis and the same is corrected in 2010. The impact is felt very late in India that the market faced large volatility only at the end of 2009 and the same is corrected immediately in the subsequent years. This shows the uniqueness of the Indian gold market. This result shows that the movement and volatility of gold price is not independent of the negative information that takes place in the financial markets.

Figure No: 5.2

Spot Gold Price Volatility Series of World Gold markets



Hence all the major events that take place in the financial market will have their impact on the movement of gold price. Spot gold price of all world gold markets is not an exception to the impact of financial markets. Though the performance of gold price is much better than the other financial products, it has to move along with the other financial products in such a way that all the major events that affect the other commodities and financial products will also affect the performance of the gold price.

5.7 STATIONARITY OF THE VARIABLES

Table No: 5.5

Stationarity the variables during different study periods

	Whole period 4th Jan 00 to 29th Dec 11		**Phase I** 4th Jan 00 to 29th Dec 05		**Phase – II** 3rd Jan 06 to 29th Dec 11	
Variables	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**
AM	-7.8991* [0.0000]	-7.2293* [0.0000]	-7.9548* [0.0000]	-7.6203* [0.0000]	-3.5624** [0.0335]	-3.4769** [0.0422]
PM	-6.7009* [0.0000]	-7.1602* [0.0000]	-12.2977* [0.0000]	-9.9905* [0.0000]	-3.5762** [0.0322]	-3.4383** [0.0468]
INDIA	-11.9820* [0.0000]	-10.5873* [0.0000]	-11.3899* [0.0000]	-12.0886* [0.0000]	-7.9474* [0.0000]	-7.0418* [0.0000]
EUROPE	-8.9083* [0.0000]	-7.3936* [0.0000]	-9.4766* [0.0000]	-9.5517* [0.0000]	-5.2647* [0.0001]	-4.6206* [0.0010]
JAPAN	-6.5199* [0.0000]	-6.1668* [0.0000]	-9.4052* [0.0000]	-9.4106* [0.0000]	-4.5837* [0.0011]	-4.0041* [0.0088]
USA	-5.6848* [0.0000]	-6.1066* [0.0000]	-7.9188* [0.0000]	-7.8768* [0.0000]	-3.6385** [0.0270]	-3.3170*** [0.0639]

[ ] – Prob values, *, **, *** indicates the significance level at 1%, 5% and 10% respectively

Testing of the order of the integration of the variables included in the study becomes an essential step before analysing of the information spill over. ADF and PP unit root tests are used for testing the stationary properties. The information spill over among the variables is to be tested with the help of EGARCH model which belongs to the GARCH family. These models are used particularly for studying the time varying

conditional variances. The variables should be stationary at their level itself. In order to estimate the EGARCH model, all the variables should be integrated by becoming stationary at their levels. Therefore, data are converted into logarithmic return series (first difference) on the assumption that the return data will become stationary at their first difference.

The estimated results of ADF and PP unit root test are given in the Table No: 5.5 with a Adjusted statistics and the respective p values. The p value for all the variables in all study periods are significant and hence rejected the null hypothesis. Hence all the variables are stationary at their level and they are all integrated in the same order I(0). The results of both ADF and PP test suggested that all the variables in all study periods become stationary.

5.8 HETROSKEDASTICITY OF THE ERROR TERMS

Homoskedasticity condition occurs when the variance of the error term is constant (σ^2) over a period of time. If the errors do not have a constant variance, they are said to be hetroscedastic. But in practice, there is a possibility that the variance of the error changes over time rather than systematically with one of the explanatory variables. This phenomenon is known as ARCH[18]. Unless otherwise the hetroscedastic exist in the variables, the volatility models cannot be applied. Hence the existence of the hetroscedastic is a pre condition for estimating and analysing volatility.

Many tests are available in the modern econometrics to test the presence of hetroscedasticity such as Breusch-Pegan LM test, The Glester LM test, The Harvey-Godfrey LM test, ARCH LM test etc. From the given above various test the most suitable one is ARCH LM test and therefore it is adopted in the study for testing the ARCH effect in the errors. The ARCH LM test is applied separately for both the dependent variables in all the study periods. The Table No. 5.6 gives the estimated results of ARCH LM test.

[18]Chris Brooks., *Introductory Econometrics for Finance*, Cambridge University Press, NewYork. 2008., Page:132

Table No: 5.6

Hetroskedasticity of the error terms during different study periods

Whole Period (4th January 2000 to 29th December 2011)	**AM Fix**	F-statistic	38.51077	Prob. F(1,2821)	0.0000
		Obs* R-squared	38.01906	Prob. Chi-Square (1)	0.0000
	PM Fix	F-statistic	71.30927	Prob. F(1,2821)	0.0000
		Obs* R-squared	69.60047	Prob. Chi-Square (1)	0.0000
Phase I (4th January 2000 to 29th December 2005)	**AM Fix**	F-statistic	34.53333	Prob. F(1,1424)	0.0000
		Obs* R-squared	33.76305	Prob. Chi-Square (1)	0.0000
	PM Fix	F-statistic	97.61905	Prob. F(1,1424)	0.0000
		Obs* R-squared	91.48464	Prob. Chi-Square (1)	0.0000
Phase II (3rd January 2006 to 29th December 2011)	**AM Fix**	F-statistic	10.28485	Prob. F(1,1392)	0.0014
		Obs* R-squared	10.22408	Prob. Chi-Square (1)	0.0014
	PM Fix	F-statistic	14.00319	Prob. F(1,1392)	0.0002
		Obs* R-squared	13.88364	Prob. Chi-Square (1)	0.0002

The null hypothesis tested is that the errors are homoscedastic against the alternative hypothesis the errors are hetroscedastic. The result of the F prob absolute value and the chi square for both the dependent variables in all the study periods suggests to reject the null hypothesis. Hence it is concluded that the errors are hetroscedastic and the errors change over time and do not remain constant and therefore the result supports to proceed further to analyse the information spill over among the variables during different study periods. Further analysis can be undertaken to examine the information spillover.

5.9 PRICE AND VOLATILITY SPILL OVER

The information spill over between dependent and independent variables is examined through Exponential Generalised Autoregressive Conditional Hetroscedastic (EGARCH) model proposed by Nelson (1991). This study has employed the methodology used by Koutomos and Booth (1998). He has extended the univariate EGARCH model into Multivariate EGARCH model and has used the same to study the price and volatility spill over among Major Stock Markets in the world. The primary motive of using multivariate EGARCH model is that it helps to model simultaneously the returns of four gold markets. It also takes into account the potential asymmetries that may exist in the volatility transmission mechanism. It means that a good or bad news in a given market may have a greater impact on the volatility of the returns of the next market to trade. The information spill over between dependent and independent variables is examined in two different aspects such as price spill over (First movement interdependencies) and volatility spill over (Second Movement interdependencies).

Price spill over is the impact of an innovation from market i on the conditional mean of market j, whereas volatility spill over is the impact of an innovation from market i on the conditional variance of market j[19]. In other words price spill over is testing of the first movement interdependencies among the variables and the volatility spillover is the second movement interdependencies among the variables. In order to capture the information spillover Multivariate EGARCH Model estimation is done separately with each dependent variables AM fix return volatility and PM fix return volatility for the different study periods.

The result of the estimated EGARCH model is given in the Table No. 5.7. The table gives the coefficient of each variable and their respective Z statistics. The coefficient of δ captures the leverage effect (asymmetries), γ measures the volatility of persistence, ω measures the magnitude effect / symmetric effect of the model and β captures the price spillover. β_1, β_2, β_3, β_4, β_5 represents the price spill over of lagged AM fix/PM fix, Europe, India, Japan and USA respectively.

[19] Koutmos and Booth (1995)., Asymmetric volatility transmission in International stock markets., *Journal of International Money and Finance*, Vol.14. No.6, pp.747-762

Table No: 5.7

Information Spillover among the variables during different study periods

Coefficients	**Whole period 4th Jan 00 to 29th Dec 11**		**Phase I 4th Jan 00 to 29th Dec 05**		**Phase II 3rd Jan 06 to 29th Dec 11**	
	AM Fix	**PM Fix**	**AM Fix**	**PM Fix**	**AM Fix**	**PM Fix**
MEAN EQUATION						
C	-0.014841** [-2.475255]	-0.035677* [-4.839765]	-0.151391* [-10.42104]	-0.058471*** [-1.838808]	-0.008859 [-0.872102]	-0.012450 [-1.322161]
β_1	0.788445* [129.5113]	0.775865* [90.25005]	0.749048* [103.0937]	0.566936* [45.92070]	0.877028* [93.07609]	0.816258* [75.23559]
β_2	-0.001097 [-0.209340]	0.053462* [7.349285]	0.014328** [2.281511]	-0.000473 [-0.023415]	0.005895 [0.741520]	0.063144* [6.265798]
β_3	0.074491* [11.27910]	0.015124* [3.531831]	0.144596* [15.04673]	0.158780* [13.86005]	0.077202* [8.261648]	0.001913 [0.451701]
β_4	0.005462 [0.820389]	0.042178* [5.157188]	0.006726 [0.458398]	0.142385* [3.466541]	0.006834 [0.786893]	0.033233* [3.931317]
β_5	0.140644* [18.38646]	0.106771* [11.02620]	0.253110* [16.62351]	0.129753* [4.179896]	0.035981* [3.558071]	0.068751* [6.804211]
VARIANCE EQUATION						
C	-9.988398* [-71.28995]	-10.18666* [-73.96127]	-7.349286* [-28.72368]	-12.52080* [-32.16947]	-10.56350* [-62.34624]	-9.893326* [-46.25797]
ω	0.331029* [14.44809]	0.188879* [6.430941]	0.902084* [19.68786]	-0.101596 [-1.432841]	0.025912 [0.779165]	0.030099 [0.676456]
δ	0.166041* [8.370433]	0.029851** [1.9363173]	0.311210* [7.481895]	0.33803** [1.889119]	0.069969* [2.651739]	0.118605* [3.629646]

γ	-0.522244* [-26.16759]	-0.467432* [-22.75872]	0.185582* [6.194793]	-0.232058* [-5.841208]	-0.679133* [-30.53135]	-0.588380* [-20.00609]
α_1	-0.267607* [-7.372086]	-1.350166* [-29.74343]	0.262632* [2.732542]	-2.024767* [-15.68467]	-0.203381* [-3.719588]	-1.512014* [-22.02309]
α_2	-0.389917* [-8.035062]	0.946667* [16.64385]	-0.497000* [-3.210840]	1.125580* [10.97593]	-0.243726* [-3.389676]	1.089498* [12.56216]
α_3	1.579115* [46.33597]	0.312218* [10.66377]	1.278744* [18.40594]	1.135261* [11.07695]	1.624717* [37.67248]	0.136154* [4.361102]
α_4	0.463087* [8.764537]	0.524912* [8.091247]	-0.388921 [-1.378581]	2.230637* [8.741404]	0.302542* [4.396447]	0.262291* [3.332076]
α_5	0.970207* [18.30732]	1.748807* [27.87220]	2.524008* [12.53123]	4.200252* [15.06616]	0.386299 [7.126120]	1.369932* [16.73024]
R – Squared	0.937006	0.949881	0.917242	0.837951	0.968795	0.969203
Adj R Square	0.936692	0.949631	0.916421	0.836343	0.968478	0.968891
Prob (F – Statistic)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
D W	1.928201	1.873696	1.949168	1.643564	1.803717	1.854079

[ ] – z- Statistic
( ) – Prob
*, **, *** indicates the significance level at 1%, 5% and 10% respectively

α captures the volatility spill over from other exogenous variables included in the model. α_1, α_2, α_3, α_4, α_5 represent the volatility spill over of lagged AM fix/PM fix, Europe, India, Japan and USA respectively. The impact of innovations from its own lagged value is also captured.

The results of whole period indicates that the first movement interdependencies of AM fix return volatility β, there exists a significant price spill over from its own lagged innovation as well as innovations from India and USA. More than 78% of information spillover is from its own lagged innovation and the remaining 22% is shared by India and USA. In the case of PM fix return volatility, price spillover significantly contributed by its own lagged innovation as well as from other exogenous variables. More than 77% of price spill over from its own lagged innovation and the remaining is shared by other countries significantly. The coefficient ω that measures the magnitude effect is highly significant and the coefficients are more than 0.1 implying that reaction of the return volatility is highly sensitive to the innovation that occurs in the gold market.

The leverage effect coefficient δ is positive and significant during whole period for both AM Fix and PM fix. This indicates that the volatility of both AM fix and PM fix prices are highly influenced by the good news in the market than by the bad news. It means that the volatility of AM fix and PM fix is highly influenced and determined by the past positive shocks or positive innovation than the negative shock or negative innovations from the gold markets. This result is same for both AM fix and PM fix volatility in all the study periods.

The volatility persistence coefficient γ is significant for both AM and PM fix in all the study periods. It shows that volatility is persistent in the gold market. The volatility persistent coefficient of AM fix is much higher than PM fix in most of the study periods. It implies that due to less volatility the PM fix price is able to get back to its equilibrium sooner than AM fix. Hence the convergence speed of AM fix slower than PM fix.

The impact of positive or negative news (innovation) of one gold market on the other market is assessed through the coefficient α. It is observed that all the exogenous variables are highly significant for both AM fix and PM fix. It is also identified that the second movement interdependencies of AM fix is highly influenced

by the negative news of its own lagged innovation -0.26 as well as European Market -0.38. India, Japan and USA's positive news influence the second movement interdependencies of AM fix. The contribution of volatility spillover from India 1.579 is much higher than those of other three countries. The next bigger volatility spillover is from USA with the coefficient of 0.97.

The second movement interdependencies of PM fix is also influenced by negative news from its own lagged innovation. Among the three countries Europe shows their positive news impact on the volatility of PM fix. The USA 1.748 is the highest volatility spillover contributor for the PM fix volatility. The next is Europe 0.94 amount of volatility spillover transmits to the PM fix. This is because Europe is the domestic and local market; its impact is felt in the volatility of PM fix. The important point to be noted here is the role of USA market. The contribution of volatility spillover of USA is 1.748 which is higher than all the other exogenous variables. Hence USA plays vital role in volatility spillover to the PM fix volatility.

The result of Phase I conveys that except Japan all the other countries play significant role in the price spillover of AM fix. On the other hand except Japan and Europe all the other markets significantly contribute to the first movement of interdependencies of PM fix. The lagged value of both AM fix and PM fix innovations contributes more price spillover to the dependent variable AM and PM fix return volatility. The volatility spillover during Phase I also coveys similar information in the whole study period. The coefficient of δ leverage effect is significant for both AM and PM shows in the volatility transmission mechanism. Except Japan all the other countries significantly spills over its volatility information to AM fix. The coefficient of USA 2.52 and India 1.27 are the higher contributor of volatility information and also positive information of these markets influence the volatility of AM fix.

During Phase I the coefficient ω that measures the magnitude effect of its volatility relationship is insignificant for PM fix. Though the coefficient is insignificant its coefficient value is greater than 0.1 which implies that the volatility is reacting to the news innovation in the market. All the exogenous variables are highly significant in the second movement interdependencies of the PM fix. It is found that USA play larger role in the volatility spill over to the PM fix. Its coefficient 4.20 is larger than that of other countries. During this period the Indian gold market's impact

came down and the Japan's spill over effect is quite big. This is because during this period the gold demand in India has seen much fluctuation.

The Phase II results conclude that other than Japan all the other markets significantly have price spill over effect on the AM fix and except India all the other exogenous variables show significantly their price spill over effect on the PM fix price. As seen in the other two study periods, the price spill over effect is more from its own past shocks than the shocks coming from the other three countries.

It is observed from the variance equation that the measurement of the asymmetric effect of coefficient is insignificant for both AM and PM fix return volatility and the coefficient also is less than 0.1. It implies that the return volatility of AM and PM fix is less sensitive to its own past innovations as well as the volatility of other major gold markets in the world. The leverage effect coefficient is significant for both AM and PM fix and it is inferred the presence of asymmetric effect as seen in the earlier study periods. The volatility of both AM fix and PM fix is highly influenced by the good news than bad news in the gold market. Volatility persistence is also significant implying that gold price is not exception from the volatility behaviour. The other exogenous variables included in the variance equation are highly significant and shows their effect in the volatility transmission mechanism.

To be specific India plays a crucial role with a large coefficient 1.62 in influencing the volatility of AM fix. Hence the second movement interdependencies of AM fix highly depend on the volatility of India rather than on the other major gold markets. The USA market becomes second largest spill over effect on the AM fix volatility. On the other hand the volatility of PM fix is highly influenced by the USA market rather than the other countries with a large coefficient 1.369 followed by Europe 1.089. India's spillover effect on the PM fix volatility is very little and its effect on the PM fix is not expected also.

5.10 CONCLUSION

It is concluded from the information spillover results that the lagged or past innovation of the dependent variables shows highly significant price spillover effect on the return volatility of AM and PM fix. India and USA exerts a significant positive effect on the price spillover to both the return volatility of AM and PM fix in all the study periods. Hence the first movement of both AM fix and PM fix is highly influenced by its own past innovation or information rather than the innovation and information of other major gold markets.

The leverage effect is significant for both AM fix and PM fix price and it is evident for the presence of the asymmetry effect in the volatility in such a way that the positive news show greater impact on the gold price volatility than the past negative news. In short the good news has more effect on the volatility of spot price of gold than the bad news had. The beauty of gold is that it always loves the bad news rather than good news, because all the bad news are transmitted as good news to its volatility movement.

The volatility of both AM fix and PM fix is highly sensitive to the innovation and information. All the countries show significance on the volatility of the AM fix and PM fix. In particular the second movement interdependencies of AM fix return volatility is highly influenced by India and the PM fix return volatility is influenced by USA. The Europe and Japan effect is highly seen on the PM fix volatility. This result satisfies absolutely the objective of fixing these prices, because the primary motive of AM fix is to incorporate the information coming from Asia and Europe zone and the PM fix is to account the information from USA.

The volatility spillover coefficient of both India and USA is significant and positive in all the study periods for both AM fix and PM fix. This result indicates that the positive news that arise from these countries gold markets spillover on to the international gold price rather than the negative news does. All good news of these two markets alone are capable of influencing and determining both AM fix and PM fix fluctuations.

Chapter

6

Price Maker in the World Gold Markets

CHAPTER - VI

PRICE MAKER IN THE WORLD GOLD MARKETS

6.1 INTRODUCTION

Gold is a universal commodity which is traded throughout the world. It is produced only in few countries, but is used in all the countries for many purposes. Gold is traded in most of the country's both in the commodity exchanges as well as in the physical delivery markets, which is known as spot markets. As it is stated earlier, the spot price which is called as the bench mark price is fixed by the LBMA known as AM Fix and PM fix prices. Though the spot gold price is actually fixed at LBMA by its members, there are few unanswered questions who is influencing the spot price? Which country's economic variables drive the spot gold price? And which country has the most economic influence on the spot gold market? Which country plays a vital role in determining the spot gold prices either the major producing countries or Major gold consuming countries?

All the above questions form the basis for this chapter. The primary objective of this chapter is to study who is actually dominating the world spot gold prices? Who is the real price maker in the world gold markets? Who plays a major role in the price discovery process? Gabriel M.Muller (2012) already stated that India's gold demand exerts greater effects on the gold price – notwithstanding some of the irregularities of the gold markets much more than USA does. He has also stated that when Indian government imposed additional taxes and import duties on gold earlier during 212, India's imports on gold dropped nearly 46% from 103 tonnes in Q1 2011 to only 55.6 tonnes in Q1 2012. This resulted in a huge price drop from almost $1880.02 in March to nearly $1550 in mid May. As Ajay Mitra stated (WGC): When India sneezes, gold catches a cold.

As per the economic theory, price of a commodity is determined by both supply and demand. Based on the theory, everyone will agree that the price of gold should also be set by supply and demand. Earlier studies such as Saroja Selvanathan and E.A. Selvanathan (1999) suggested that both gold price and production are not coitegrated and there is no long run relationship between price and production. Price was not caused by the production. I.G.Patel and Anand Chandavarkar (2006)

concluded that the demand for gold is highly responsive to the price changes. There are only few studies that have documented in the area of factors that determine the spot gold prices. Eric J.Levin and Robert E.Wright (2006) from World Gold council, Mika Vaihekoski and Eero Patari (2007) and Cengiz Toraman et al (2011) documented the macro economic factors that determine the price of gold.

It is observed that all the above studies considered the macro economic variables of USA, stock market index and the Exchange rates. However the demand and supply of gold is not considered. and also the Macro Economic variables of USA alone is considered and not the variables of other countries. Gabriel M.Muller (2012) pointed out that though USA is the biggest economy in the world, its economic performance does not influence the spot gold price.

The concept of Price maker is already undertaken by Larry A.Sjaastad and Fabio Scacciavillani (1996) and Larry A.Sjaastad (2008), where they examined the market power of the countries by taking the four major currencies such as US Dollar , Great Britain Pounds , Yen and Deutsche Mark. They concluded that Euro bloc dominates the world gold price. However this study did not consider the Indian Rupees in the study.

R.Kannan and Sarath Dhal (2008) and Eily ong et all (2011) from WGC conducted a study to examine the Macro Economic factors that determine the consumption of gold in India. After addressing the demand determinant issue in India empirically, they suggested to make a study to test the impact of changes in India's gold consumption in the world gold price. India has consistently been the largest gold consumer in the world. Hence this chapter is intended to examine the role of India's gold consumption along with the other three major gold consumers in the international price of gold.

From the above back ground, it is observed that there exists a vast research gap that needs to be filled and most of the studies have ignored to examine India's role. In spite of its biggest consumption role in the world gold markets, its gold consumption role in influencing the world gold price is ignored. Faugere and Van Erlach (2005) mentioned that assessing the fair value of gold largely remains a mystery in finance. However assessing empirically the country who is actually determining the spot gold price in the world gold market is possible. Hence this

chapter will fill the existing gap in the world gold markets by suggesting, who is the real price maker in the world gold market through the empirical analysis.

6.2 VARIABLES AND METHODOLOGY

This chapter focuses on analysing the role of Major Gold Consuming Country's variable in causing the International spot gold price known as LBMA's AM Fix and PM Fix prices. This objective is to test whose domestic variables such as Domestic gold demand, Price, Stock Market and Exchange rate movement decide and dominate the international spot gold prices. Monthly data split from the quarterly data, consist of 144 observations for the study period from January 2000 to December 2011 is considered in the study. As daily data are not available for certain variables like demand, this analysis considers only monthly data.

To test this objective empirically, LBMA's AM Fix and PM fix prices per troy ounce are used as the dependent variables. Literature has helped to identify the independent variables, which affect the dependent variables. The dataset are smoothened by converting them into percentage changes. The independent variables included in the study are i. Gold demand by countries which is subdivided into three categories like Demand for Jewellery, Demand for Investment and Aggregate demand, ii. Monthly average domestic spot gold prices, iii. Estimated price volatility of all the countries, iv. Exchange rates of respective domestic currency (USD, Euro, Yen and INR), v. The movement of stock markets of respective countries (Like SENSEX, FTSE100, NIKKEI 225 and S&P 500)

6.3 PROCEDURE FOR THE ANALYSIS

The following procedures are followed in the empirical analysis.

1. The quarterly and monthly data for the Period from January 2000 to December 2011 have been collected from GFMS Thompson Reuters, Yahoo finance, Economagic.com and LBMA.
2. Seasonal effects are removed from quarterly data collected through Eviews package.

3. The seasonally adjusted data are converted into monthly data based on the Cubic Spline Method available in the Eviews 6. This gives the total of 144 observations.
4. All the variables are converted into percentage changes from one period to other period through $(t_d-t_l)/t_l*100$
5. Descriptive statistics is used to do Preliminary analysis for all the variables
6. ADF and PP unit root tests are employed to check the stationary properties of the variables.
7. Information Criteria of the VAR Models is used to select the optimum lag length.
8. VAR Granger Causality / Block Exogenity Wald test is used to test the short term influence and causality relationship between variables individually and all variables together.
9. Effect of shock in one variable and the response of other variables on that shock and its directions are found by using impulse response function.
10. Proportion of shock transmitted from one variable to another due to shock in the same variable is determined by using Variance decomposition.

6.4 SUMMARY STATISTICS

The summary statistics of the percentage changes of spot gold prices of all countries are given in the Table No: 6.1. They are positive and also the values are close to each others. i.e the fluctuations in the spot gold price of all countries show similar trend during the study period. Except India and Europe, all the other countries are negatively skewed. India and Europe are positively skewed. It shows that spot gold market of both India and Europe are dominated by the positive movements than negative movements. The kurtosis of all countries is greater than 3 indicating the existence leptokurtic distribution.

Table No: 6.1

Summary Statistics of variables included in the study

Variables		EUROPE	INDIA	JAPAN	USA	AM	PM
PANEL : A							
Price	Mean	1.097763	1.357475	1.098083	1.312394	1.315692	1.315712
	Median	0.636119	1.062902	1.235126	1.169505	1.201915	1.203554
	Std. Dev.	4.760560	3.801006	3.851514	3.972887	3.979348	3.967357
	Skewness	0.227648	0.225590	-0.350073	-0.061675	-0.067886	-0.061995
	Kurtosis	3.159000	4.026806	3.400450	3.649861	3.670343	3.626283
	Jarque-Bera	1.385767	7.494950	3.876283	2.606975	2.787275	2.428642
	Probability	0.500132	0.023577	0.143971	0.271583	0.248171	0.296912
	Observations	143	143	143	143	143	143
PANEL : B							
Volatility		**EUROPE**	**INDIA**	**JAPAN**	**USA**	**AM**	**PM**
	Mean	13.94721	13.84153	14.20486	15.47524	15.41505	15.36486
	Median	13.09575	11.63338	12.54087	13.03089	12.60877	12.67419
	Std. Dev.	2.501303	5.475740	5.237354	7.454324	7.425864	7.521372
	Skewness	2.760932	2.134099	2.157120	2.399485	2.356221	2.445100
	Kurtosis	12.41253	8.479741	8.542023	10.49109	10.24197	10.90847
	Jarque-Bera	704.5961	285.4501	291.8495	468.2833	441.6985	511.5428
	Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Observations	142	142	142	142	142	142
PANEL : C							

Jewellery Demand		EUROPE	INDIA	JAPAN	USA
	Mean	-1.514584	0.651582	0.068605	-1.125894
	Median	-0.743703	0.354969	-0.125274	-0.877664

	Std. Dev.	7.885329	13.89633	4.958304	11.22393
	Skewness	-2.652862	0.876473	-0.565744	1.434884
	Kurtosis	32.46966	7.210639	9.980922	20.30217
	Jarque-Bera	5342.311	123.9470	297.9973	1832.788
	Probability	0.000000	0.000000	0.000000	0.000000
	Observations	143	143	143	143
PANEL : D					
Investment Demand		**EUROPE**	**INDIA**	**JAPAN**	**USA**
	Mean	-50.86462	-21.03763	35.57414	-24.56364
	Median	-8.195364	1.088179	-0.073909	2.420094
	Std. Dev.	662.5711	273.6218	419.6239	356.7545
	Skewness	-8.160817	-11.65350	11.38517	-11.41754
	Kurtosis	94.35375	138.2885	134.1402	134.8328
	Jarque-Bera	51312.59	112291.9	105559.2	106662.0
	Probability	0.000000	0.000000	0.000000	0.000000
	Observations	143	143	143	143
PANEL : E					
Aggregate Demand		**EUROPE**	**INDIA**	**JAPAN**	**USA**
	Mean	0.614266	1.146215	31.09211	-0.655815
	Median	1.090466	0.554115	-1.982884	-0.510535
	Std. Dev.	28.97634	16.49029	422.7764	5.496318
	Skewness	-3.312330	2.441816	9.875494	-0.576795
	Kurtosis	35.80885	20.25213	111.7718	9.219278
	Jarque-Bera	6675.160	1915.519	72819.19	238.3940
	Probability	0.000000	0.000000	0.000000	0.000000
	Observations	143	143	143	143
PANEL : F					

Exchange rate		**INR**	**USD**	**YEN**	**EURO**
	Mean	0.034495	-0.037153	-0.045947	8.981774
	Median	-0.003442	-0.030571	-0.001418	1.867074
	Std. Dev.	0.423623	0.472869	0.486283	75.20232
	Skewness	0.917726	0.099469	-0.247283	7.227801
	Kurtosis	6.280742	3.010544	2.910782	73.15614
	Jarque-Bera	84.20408	0.236469	1.504814	30571.30
	Probability	0.000000	0.888488	0.471231	0.000000
	Observations	143	143	143	143
PANEL : G					
Stock Market		**FTSE100**	**NIKKEI225**	**SANDP500**	**SENSEX**
	Mean	-0.012379	-0.057356	-0.011741	0.086192
	Median	0.082447	-0.004976	0.101729	0.185298
	Std. Dev.	0.469852	0.584078	0.607940	0.750035
	Skewness	-1.330815	-0.939154	-1.365440	-0.616724
	Kurtosis	6.975250	7.149326	8.147259	4.339813
	Jarque-Bera	136.3677	123.6053	202.2972	19.76078
	Probability	0.000000	0.000000	0.000000	0.000051
	Observations	143	143	143	143

The summary statistics of the estimated volatility series of all countries are given in the Panel B of the Table No: 6.1. The average volatility of India and Europe during the study period is very low compared to the other countries. The other three countries show much fluctuation in their volatility than Indian and Europe. The standard deviation of India and Europe are very higher than other countries showing that they move away from the mean very far. It is observed that the volatility of all countries is positively skewed. The kurtosis also follows the leptokurtic distribution. The results of skewness and kurtosis show the existence of non normality in the volatility of the variables. The Jarque Bera statistics also supports the non normality of volatility data.

Panel C of the Table No: 6.1 contain the descriptive statistics of the percentage changes in the Jewellery demand of all countries included in the study. It is found that the average gold demand for jewellery of India is 0.65 which is positive. It indicates that India's gold demand changes will always be positive and proves the continuous growth in the domestic gold market. The Japan jewellery demand shows very less fluctuation and shows that Japan jewellery market showing constant and stable trend with only small changes in the demand. The average percentage change of the demand for jewellery is negative and very high for Europe and USA. This shows that the jewellery demand of gold started decreasing over a period of time. The standard deviation is very high for India and USA showing that the demand for gold in India will go to the extreme either positive or negative in the study period. All four countries show negative skewness. The value of kurtosis is very high to indicate the leptokurtic distribution of the variables.

The summary statistics of the percentage change in the investment demand for gold is given in the Panel D of the Table No: 6.1. It shows that except Japan all other three countries show negative spot price. It means that the investment demand of gold for Japan changing positively and the other countries have sold out the gold from the investments. The standard deviation of all the countries except India shows a huge deviation. Only less portion of gold goes into investment purpose. Hence there is every possibility that the investment demand may go other extreme. The skewness of all the countries except Japan are negatively skewed and the kurtosis values are greater than 3, Indicating the leptokurtic distribution. The Jarque Bera statistics is also very high showing the existence of the non normality of the data.

Panel E of the Table No: 6.1 give the summary statistics of the percentage changes in the aggregate demand variables. The aggregate demand is nothing but the sum of both Jewellery demand and Investment demand. The results show that all the countries except USA are positively changing and USA shows negative trend in the percentage change in the demand. The positive sign shows the constant increase in buying of gold in the international market at the same time negative sign implies the sale of gold in the international markets. The gold is moving out of the country in the form of sales. The standard deviation of Japanese market is very high implying that huge deviation arises in the Japanese market. The other countries are showing less deviation. Both India and Japan are positively skewed. Europe and USA are negatively skewed. The skewness results show the positive trend in the consumption of gold in the domestic markets. India and Japan show positive growth in the gold consumption, where as Europe and USA show negative growth in the consumption during the study period. The kurtosis value is greater than 3 for all countries showing the existence of leptokurtic distribution.

6.5 STATIONARITY OF THE VARIABLES

The role of the stationary properties of the variables is an essential step in the modern econometrics, because when many variables are included in an empirical analysis, all the variables should follow the same order of integration. Otherwise the results will not be reliable. Unit root tests such ADF and PP tests are applied to test stationarity of the variables.

The estimated results of the unit root test are given on the Table No: 6.2. The table contains the estimated Adj t statistics and the respective p values. Seven panels from A to G are given in the table and each panel gives the results of the unit root test of each variable individually. The null hypothesis tested is that all the variables contain unit root at level or non stationary against the alternative hypothesis that variables are stationary. The results of both ADF and PP are highly significant at level for all the variables and the null hypothesis of non stationary is rejected at level. Hence the unit root test results show that all the variables are stationary at their level and of integrated in the same order I(0). This result shows that all the variables would be included in the analysis as they are integrated in the same order.

Table No: 6.2

Stationarity of the variables included in the study for all countries

	PANEL : A							
Sl No	Price		**INDIA**	**JAPAN**	**USA**	**EUROPE**	**AM**	**PM**
1		ADF	-11.76899* [0.0000]	-10.97254* [0.0000]	-11.62258* [0.0000]	-13.81054* [0.0000]	-11.62511* [0.0000]	-11.64166* [0.0000]
		PP	-11.77282* [0.0000]	-10.94793* [0.0000]	-11.62507* [0.0000]	-14.13271* [0.0000]	-11.62781* [0.0000]	-11.64404* [0.0000]
PANEL : B								
2	Volatility		**INDIA**	**EUROPE**	**USA**	**JAPAN**	**AM**	**PM**
		ADF	-3.753925** [0.0220]	-7.519065* [0.0000]	-3.973854** [0.0116]	-4.067979* [0.0088]	-4.088819* [0.0082]	-4.049495* [0.0093]
		PP	-3.864378* * [0.0161]	-7.448303* [0.0000]	-3.931386** [0.0132]	-4.072455* [0.0086]	-4.096864* [0.0080]	-4.015193** [0.0103]
PANEL : C								
3	Jewellery Demand		**INDIA**	**EUROPE**	**USA**	**JAPAN**		
		ADF	-6.765665* [0.0000]	-4.562289* [0.0018]	-3.461615** [0.0479]	-6.463512* [0.0000]		
		PP	-6.623934* [0.0000]	-12.05066* [0.0000]	-5.005239* [0.0003]	-5.841328* [0.0000]		
PANEL : D								
4	Investment Demand		**INDIA**	**EUROPE**	**USA**	**JAPAN**		
		ADF	-11.77231* [0.0000]	-11.96641* [0.0000]	-11.64868* [0.0000]	-11.69570* [0.0000]		

		PP	-11.77358* [0.0000]	-11.96695* [0.0000]	-11.64819* [0.0000]	-11.69861* [0.0000]
PANEL : E						
5	Aggregate Demand		**INDIA**	**EUROPE**	**USA**	**JAPAN**
		ADF	-9.280378* [0.0000]	-5.566088* [0.0000]	-7.252250* [0.0000]	-12.24861* [0.0000]
		PP	-7.464768* [0.0000]	-10.49431* [0.0000]	-4.649263* [0.0013]	-12.26079* [0.0000]
PANEL : F						
6	Exchange rates		**INR**	**EURO**	**USD**	**YEN**
		ADF	-7.764487* [0.0000]	-11.54770* [0.0000]	-8.666225* [0.0000]	-10.45521* [0.0000]
		PP	-7.725827* [0.0000]	-11.54947* [0.0000]	-8.609809* [0.0000]	-10.37671* [0.0000]
PANEL : G						
7	Stock market Index		**SENSEX**	**FTSE100**	**SANDP500**	**NIKKEI225**
		ADF	-5.140741* [0.0002]	-10.29794* [0.0000]	-9.195236* [0.0000]	-9.360876* [0.0000]
		PP	-8.492282* [0.0000]	-10.38962* [0.0000]	-9.228389* [0.0000]	-9.403107* [0.0000]

[ ] – p values

*, **, *** indicates the significance level of 1%, 5% & 10% respectively

6.6 SELECTION OF VAR LAG LENGTH

Inclusion of suitable number of lags in the model makes more meaningful to the results of the model. Whenever VAR model is estimated, specifying the appropriate lag length is an important work, because it shows that how long the changes in the variables should take to work through the system. The solution of appropriate lag length is done based on the various information criteria given in the VAR system. The estimation of the appropriate lag length selection model is estimated separately for the dependent variables like AM fix and PM fix prices. The results of the VAR lag length selection based on the information criteria is given in the Table No: 6.3. The selection of the lag length for all the variables is done on the basis of the lag length suggested by the Akaike Information criterion.

The information criterion of VAR model suggests one lag for the percentage change of the price series variables and four lags for the volatility series variables. The AIC suggest four lag for both the dependent variables for Jewellery demand, Investment demand and Aggregate demand. Since quarterly data converted into monthly data, the lag length is little high for the demand variables. Once the appropriate lag length is identified, estimation of the empirical analysis can be done. i.e analysis of the impact of percentage changes of the independent variables on the dependent variables individually and collectively. This is tested with the VAR Granger Causality Block Exogenity Wald test.

Table No: 6.3

Selection of VAR Optimum Lag Length

Variables		Information Criterion						
		Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
Price	AM Fix	0	-1366.191	NA	293.8153	19.87234	19.97840	19.91544
		1	-1261.221	200.8115	92.22613*	18.71335*	19.34971*	18.97196*
		2	-1243.676	32.29446	102.8936	18.82139	19.98805	19.29549
	PM Fix	0	-1312.642	NA	155.4417	19.23565	19.34222	19.27896
		1	-1229.817	158.3964	66.84526*	18.39149*	19.03090*	18.65133*
		2	-1206.733	42.46120	68.84117	18.41946	19.59171	18.89583
Volatility	AM Fix	0	-1490.46	NA	2084.216	21.83153	21.93810	21.87484
		1	-1259.459	441.7691	103.0390	18.82421	19.46362*	19.08405*
		2	-1233.323	48.07429	101.4920	18.80763	19.97989	19.28401
		3	-1201.395	56.39776*	92.06255*	18.70650*	20.41160	19.39941
	PM Fix	0	-1399.956	NA	556.0833	20.51030	20.61687	20.55361
		1	-1173.603	432.8786	29.42203	17.57085	18.21026*	17.83069*
		2	-1161.989	21.36386	35.82352	17.76626	18.93851	18.24263
		3	-1118.842	76.21579	27.58596	17.50134	19.20644	18.19425
		4	-1084.65	57.90209*	24.28693*	17.36715*	19.60509	18.27659
Jewellery	AM Fix	0	-2267.614	NA	1.76e+08	33.17684	33.28341	33.22015
		1	-2175.048	177.0231	65750579	32.19048	32.82990*	32.45033
		2	-2160.217	27.28006	76384161	32.33894	33.51119	32.81532
		3	-2086.717	129.8329	37764177	31.63090	33.33600	32.32381
		4	-2039.68	79.65318*	27563238*	31.30920*	33.54714	32.21865*

	PM Fix	0	-2267.157	NA	1.75e+08	33.17017	33.27674	33.21348
		1	-2174.394	177.4013	65125251	32.18093	32.82034*	32.44077
		2	-2159.679	27.06615	75786257	32.33108	33.50334	32.80746
		3	-2085.676	130.7200	37194894	31.61571	33.32081	32.30862
		4	-2039.431	78.31359*	27463055*	31.30556*	33.54350	32.21501*
Investment Demand	AM Fix	0	-4460.076	NA	1.40e+22	65.18359	65.29016	65.22690
		1	-4458.008	3.954533	1.96e+22	65.51837	66.15778	65.77821
		2	-4451.884	11.26590	2.58e+22	65.79392	66.96618	66.27030
		3	-4447.658	7.464103	3.51e+22	66.09720	67.80230	66.79011
		4	-4164.941	478.7609*	8.22e+20*	62.33491*	64.57285*	63.24436*
	PM Fix	0	-4459.708	NA	1.39e+22	65.17822	65.28479	65.22152
		1	-4457.427	4.361116	1.94e+22	65.50989	66.14930	65.76973
		2	-4451.159	11.53037	2.56e+22	65.78334	66.95560	66.25972
		3	-4446.782	7.731164	3.47e+22	66.08441	67.78951	66.77732
		4	-4164.047	478.7933*	8.11e+20*	62.32185*	64.55979*	63.23129*
Aggregate Demand	AM Fix	0	-2959.243	NA	4.28e+12	43.27362	43.38019	43.31692
		1	-2895.225	122.4284	2.42e+12	42.70401	43.34342*	42.96385
		2	-2871.577	43.49854	2.47e+12	42.72375	43.89600	43.20013
		3	-2795.399	134.5618	1.18e+12	41.97663	43.68173	42.66954
		4	-2750.991	75.20206*	8.91e+11*	41.69330*	43.93124	42.60275*
	PM Fix	0	-2958.785	NA	4.25e+12	43.26693	43.37350	43.31023
		1	-2894.833	122.3020	2.41e+12	42.69829	43.33770*	42.95813
		2	-2870.966	43.90159	2.45e+12	42.71483	43.88708	43.19120
		3	-2794.837	134.4753	1.17e+12	41.96842	43.67352	42.66133
		4	-2751.061	74.13129*	8.92e+11*	41.69432*	43.93227	42.60377*

Exchange rate	AM Fix	0	-1125.37	NA	8.960175	16.38217	16.48823*	16.42527*
		1	-1096.109	55.97726*	8.425910*	16.32042*	16.95678	16.57902
		2	-1084.831	20.75835	10.29439	16.51929	17.68595	16.99339
	PM Fix	0	-1134.183	NA	9.040755	16.39113	16.49668*	16.43402*
		1	-1105.192	55.47895*	8.538515*	16.33370*	16.96704	16.59108
		2	-1094.14	20.35609	10.45058	16.53438	17.69551	17.00623
Stock Market	AM Fix	0	-398.4015	NA	0.000219	5.762879	5.867938*	5.805572*
		1	-365.4367	63.10415*	0.000195*	5.649095*	6.279447	5.905252
		2	-354.7024	19.78172	0.000240	5.852892	7.008537	6.322511
	PM Fix	0	-398.8656	NA	0.000220	5.769508	5.874567*	5.812201*
		1	-365.954	63.00218*	0.000197*	5.656486*	6.286838	5.912642
		2	-355.5265	19.21645	0.000243	5.864664	7.020309	6.334284

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

6.7 INDIVIDUAL AND COLLECTIVE IMPACT OF THE VARIABLES

When many lags of variables are included in a VAR, it is very difficult to identify which sets of variables show significant effect on each dependent variables and which do not. In order to address this issue, a test is conducted by restriction all of the lags of a particular variables zero.

Table No: 6.4

Individual and Collective impact of the independent variables on Dependent variables

Panel No	Variables	AM/ PM	EUROPE	INDIA	JAPAN	USA	ALL
A	Price	AM	13.3221* [0.0003]	3.7724*** [0.0521]	0.4012 [0.5264]	2.0131 [0.1559]	41.6620* [0.0000]
		PM	18.7209* [0.0000]	3.7740*** [0.0521]	0.5229 [0.4696]	3.5236*** [0.0605]	37.4651* [0.0000]
B	Volatility	AM	10.3093** [0.0161]	22.625* [0.0000]	1.7490 [0.6261]	1.5068 [0.6807]	32.5936* [0.0011]
		PM	10.8195** [0.0287]	23.4396* [0.0001]	3.4945 [0.4787]	9.7932** [0.0441]	40.2504* [0.0007]
C	Jewellery Demand	AM	11.7100** [0.0196]	14.1078* [0.0070]	17.2940* [0.0017]	9.4959** [0.0498	43.9395* [0.0002]
		PM	11.7539** [0.0193]	13.8667* [0.0077]	18.2507* [0.0011]	9.5327** [0.0491]	44.8831* [0.0001]
D	Investmen t Demand	AM	1.06933 [0.8991]	0.6739 [0.9545]	4.7546 [0.3134]	1.7050 [0.7898]	8.0921 [0.9461]
		PM	0.9909 [0.9112]	0.7426 [0.9460]	4.8522 [0.3028]	1.5821 [0.8120]	8.0427 [0.9476]
E	Aggregate Demand	AM	6.0880 [0.1927]	10.4280** [0.0338]	4.0612 [0.3978]	6.0354 [0.1965]	28.9935** [0.0240]
		PM	5.8350 [0.2118]	10.1706** [0.0376]	4.1150 [0.3907]	5.8681 [0.2092]	28.6446** [0.0264]
F	Exchange Rates	AM	2.8517*** [0.0913]	3.2169*** [0.0729]	0.0087 [0.9253]	0.2681 [0.6046]	6.4380 [0.1687]
		PM	3.2039*** [0.0735]	3.3206*** [0.0684]	0.0029 [0.9569]	0.3104 [0.5774]	6.9095 [0.1407]
G	Stock Market Index	AM	8.3587** [0.0153]	4.9428*** [0.0845]	2.2772 [0.3203]	1.6854 [0.4305]	21.8029* [0.0053]
		PM	7.6323** [0.0220]	4.7648*** [0.0923]	1.9214 [0.3826]	1.4533 [0.4835]	20.5191* [0.0085]

Chi square values and [ ] – p values

*, **, *** indicates the level of significance at 1%, 5% and 10% respectively

The impact of independent variables individually and collectively on the dependent variables is estimated through the VAR Granger Causality / Block Exogenity Wald test and presented in Table No: 6.4. This model is estimated in order to determine whether the lags of one variable granger cause any other of the variables in the system. Under the Block exogenity test the lags of the variables is restricted by equating to zero in a system. This restriction will enable to identify the impact of the unrestricted variable on the dependent variables.

Panel A of the Table No: 6.4 contain the results for the percentage changes in the price variables. It is found that the percentage changes in the price of all the countries collectively cause the movements of AM fix. When individual effects are considered, only Europe and India are significantly causing the AM fix price changes. Japan and USA's price changes do not cause the AM fix price.

On the other hand the percentage change of PM fix price is influenced collectively by all the countries significantly. The individual effect exists from Europe (0.00), India (0.05) and USA (0.06). Hence except Japan, all the other countries are endogenous in the equation. It is inferred from the percentage changes in the price of Europe and India that they show significant effect on both AM fix and PM fix prices. USA is showing its effect only on the PM fix prices; whereas the price of Japan does not show any impact either on AM fix and PM fix price changes. Hence it is concluded that USA's role in causing the spot gold price is restricted to PM fix price only. The Domestic spot gold price level in India and Europe causes the international prices of both AM fix and PM fix prices.

Panel B of the Table No: 6.4 show the results of the impact of the volatility of independent variables on the dependent variables. The volatility of all the countries jointly show their effect on the volatility of AM fix. The individual effect is from Europe and India only and not from USA and Japan. The PM fix volatility is also jointly influenced by all the countries except Japan. India, Europe and USA significantly cause the volatility PM fix price. The volatility variables convey the same conclusion as provided by the price variables in the above panel A.

Panel C of the Table No: 6.4 contain the significant impact of the gold consumed for jewellery purpose. As stated earlier, the consumption of gold can be broadly grouped into two sub groups such as Jewellery and Investment. It is found

from the results that the jewellery demand of all the countries significantly individually and collectively influence the percentage changes of both AM and PM fix prices. Indian and Japanese jewellery consumption are highly significant. The result is an evidence for not to accept of the null hypothesis of excluding all the countries in the equation. Hence a percentage change in both AM Fix and PM fix is jointly and individually caused by the changes in the consumption of gold for jewellery purpose by all the major gold markets in the world.

This result also supports the practical aspects of the gold market. The changes in the spot price of gold is to be influenced by the jewellery demand, because jewellery is not traded in the commodity exchanges and also the major portion of gold consumption goes into making jewellery. The jewellery gold demand is influencing the spot gold price changes of all the countries.

Panel D of the Table No: 6.4 give the estimated GCBEW test results of the investment demand for gold. It is found that all the countries are insignificant both individually and jointly. Hence the null hypothesis of excluding all the countries cannot be rejected for both the dependent variables AM fix and PM fix prices. Hence the changes in the investment demand of gold of all the countries do not cause the changes in both AM fix and PM fix prices. It is because the gold physically consumed for investment purpose is very less and only small portion of gold is going for investment physically. The objective of buying gold for investment highly differs from the gold bought for jewellery. Investment in gold is made highly through the commodity exchanges that trade gold as one among the commodities in the exchanges.

Aggregate demand result of GCBEW is given in the Panel E of the Table No: 6.4. The aggregate demand is the sum of both jewellery demand and investment demand and it represents the total gold consumed by a country during the study period.

It is found that the changes in the aggregate demand of all countries jointly cause both AM Fix and PM Fix price changes and individually only Indian aggregate demand influences both AM fix and PM fix prices. Therefore it can be concluded that any changes in total gold consumption in USA, Europe and Japan do not affect the AM Fix and PM Fix price changes. The fluctuation in the gold consumption in India

alone is capable of causing the changes in the price of AM fix and PM fix prices and it supports the theory that India is the largest consumer of gold in the world gold markets. It also supports the statement made Gabriel M.Muller (2012) who stated that India's gold demand exerts great effects on the gold price.

The other three countries do not show their effect on the AM and PM fix prices, as they are not depending upon the world gold markets for their demand. Part of their need is satisfied by their own production, whereas India entirely depends upon the world gold market as production of gold is very less as against its demand. Gold that comes into India remains as a wealth and do not go out of India through sales. This only increases the wealth of India.

Influence of currency exchange rates changes of AM and PM fix prices are presented in Panel F of Table No: 6.4. This is done because the spot price of gold is fixed in the international currency known as the USD and hence any fluctuation of the domestic currency against USD will get affected in such a way that it will increase the price of gold in the domestic land. Due to the fluctuations in the domestic currency against the USD, the price of gold in the world gold markets will be costly or it becomes cheaper.

It is found from the analysis that the changes in exchange rates of all countries are insignificant. This implies that they jointly do not influence the AM fix and PM fix price changes. This shows that when all these currencies face fluctuations, they do not disturb the spot gold prices. Instead Individual country's effect exists from Euro and Indian Rupees for both AM fix and PM Price change. When Indian Rupees and Euro fluctuates against the USD, these directly affect the spot gold prices. This is because Euro currency is the domestic currency to LBMA and immediate currency also Euro currency is common to all the European countries. Rupee belongs to the major gold consuming country India. Any fluctuation of these currencies against US dollar will cause the spot gold price of AM fix and PM fix prices. This result supports the study made by Larry A.Sjaastad and Fabio Scacciavillani (1996) and Larry A.Sjaastad (2008). They have concluded that the fluctuation in the Euro currency against USD dominate and directly affects the spot gold price changes. Effect of Indian currency was not part of their study. This study has included Indian currency along with the other major currencies. It is found that Indian rupee showing high

significant effect than Euro. Hence fluctuation of Indian currency against the USD indirectly affects the spot gold prices.

Panel G in Table No: 6.4 provide the estimated results of GCBEW for the stock market index. The purpose of including the movement of stock market as one variable is to analyse its impact on the spot gold prices. Many studies have suggested that both gold and stock market move in the opposite direction. They are inversely related in the sense that an increasing trend of one (Stock market) will reduce the other (gold price). An extreme upward movement stock market will affect the gold price to reach the extreme down. This is because the investors in the gold markets will sell immediately and move to the stock markets when the stock markets start climbing up.

It is found from the analysis that the movement of all the stock markets jointly causes the effect on spot gold price changes significantly. Hence any fluctuation in all the major stock markets cause gold price to change both AM Fix and PM fix prices, whereas individually only Indian and European effect the changes. The significance level of India is less than Europe, because Europe's stock market functions in the same zone, where AM fix and PM fix prices are fixed.

It is concluded from the results of impacts; only India had showed significant effect in fixing AM fix and PM fix prices. Especially the changes in the aggregate demand is caused only from India and not from any other markets included in the study. As already stated, India is the largest consumer of gold in the world gold market, India's gold consumption play a significant role in causing the international spot gold prices. Hence it is concluded that if there is any huge fluctuation in the spot gold prices, it may be because India played significant role in altering such prices.

6.8 TRANSMISSION OF SHOCKS

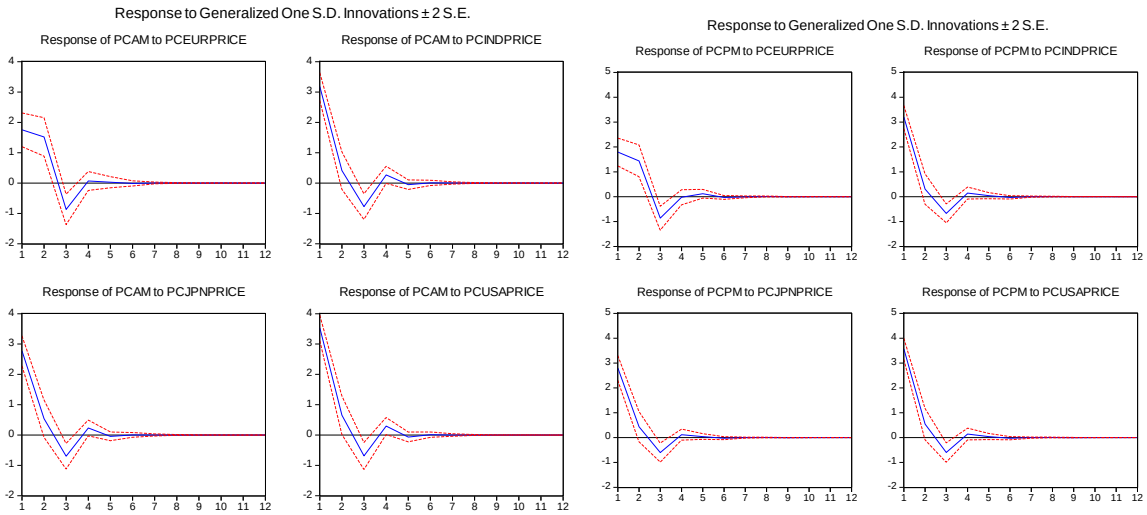
The short term causal relationship studied through GCBEW should be compared with IRF, because the results of GCBEW do not provide the direction of impact nor relative importance between the variables that simultaneously influence each other. Only the significant level can be concluded from the GCBEW but the sign of positive or negative causes are not determined through Wald test. Therefore

Impulse Response Function (IRF) is estimated in order to see the direction of the relationships among the variables included in the study.

An IRF traces the effect of a onetime shock to one of the innovations on current and future values of the endogenous variables. Under the IRF the shock of one variable is introduced and this impact is calculated in terms of the response of the other variables in the same system. The generalised impulse response of the dependent variables is given on the form of Figure Nos. 6.1 to 6.7. Like GCBEW, the IRF is also estimated individually with all the independent variables.

Figure No 6.1

Transmission of Shocks of Price on AM Fix and PM Fix prices



The Figure No: 6.1 show the reaction of AM Fix and PM Fix prices to a generalised standard deviation shock of other independent spot price variables included in the study. It is observed from the figures that both AM fix and PM fix price changes positively to the one standard deviation shocks of the other price variables of major gold consuming countries. It is also found that AM fix price response is high to the shocks from India and PM fix price response is very high to the shocks of the USA gold price changes. Both AM and PM fix price immediately respond to the shocks that occurred in major gold markets and the impact of the shocks disappear after the fifth month. That is AM and PM fix prices get back to the equilibrium after sixth month. Hence the equilibrium of AM Fix and PM fix prices are caused by India, USA and Japan. The positive response of AM fix and PM fix prices

imply that whatever the shock or innovation that arise in these markets, will make the AM fix and PM fix prices to react positively. The shocks due to the new information in India and USA are capable of causing disequilibrium in the AM fix and PM fix prices respectively.

Figure No 6.2

Transmission of Shocks of Volatility on AM Fix and PM Fix prices

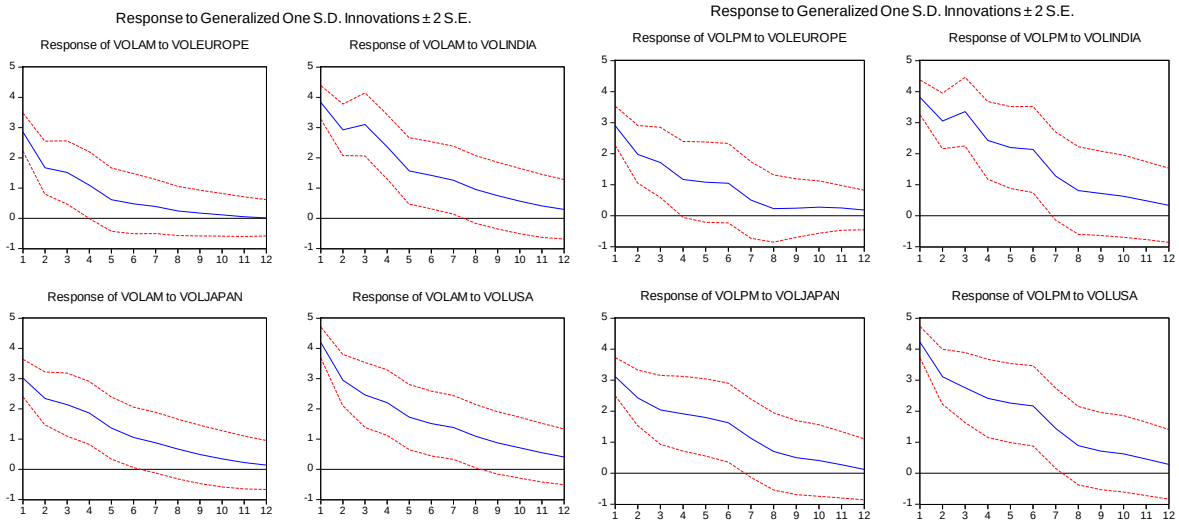
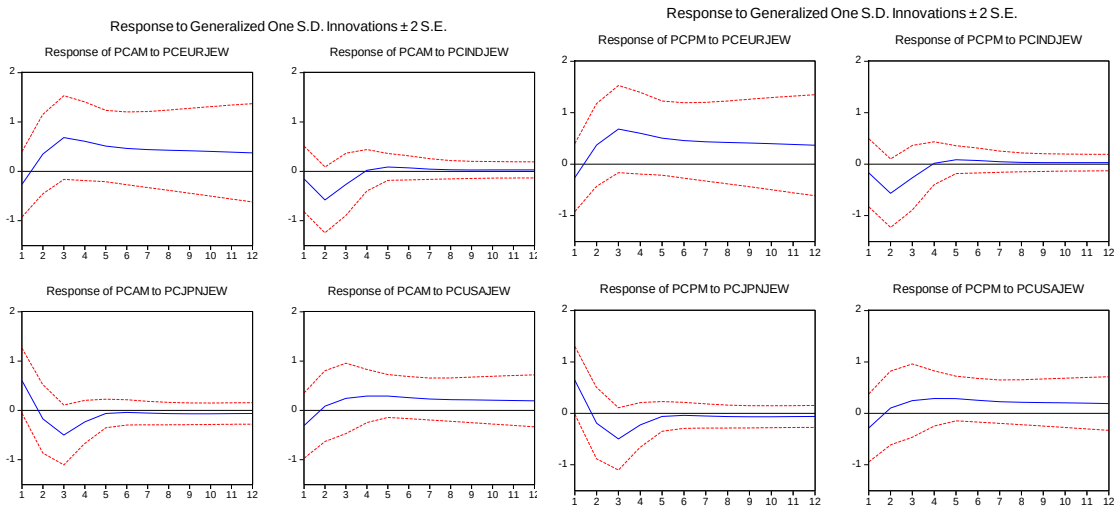


Figure No: 6.2 gives the impact of the volatility of markets on AM fix and PM fix price volatility. It is found that both AM and PM fix prices react immediately and positively to the volatility of major gold markets. The volatility of the spot price of major gold markets are capable of causing the equilibrium level of the AM fix and PM fix. Particularly the USA and Indian spot price volatility causes disequilibrium more than the other two markets. The impact of Europe volatility is less as the speed of convergence to the equilibrium is very quick. Both AM fix and PM fix price volatilities get back to the equilibrium from the volatility shocks of the Europe and Japan markets after seven months. The convergence speed is very slow and takes long period more than a year from the shocks caused by the Indian and USA spot price volatilities. The impact of volatility of India and USA is more than the impact of price variables as seen in the previous figures, because the speed of convergence is very quick from the shocks caused by the price variables than volatility variables.

Figure No 6.3

Transmission of Shocks of Jewellery Demand on AM Fix and PM Fix prices



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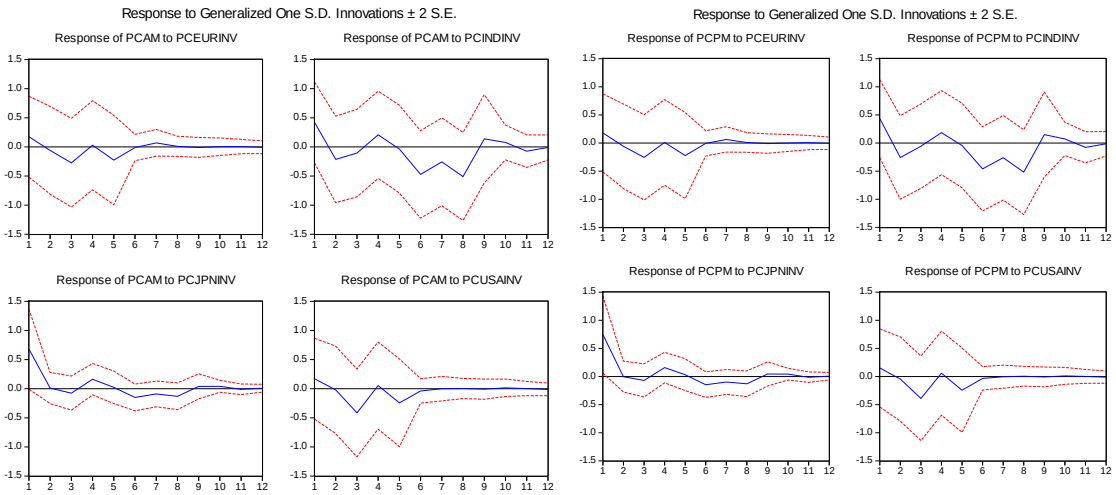
re No: 6.3 shows the response of AM fix and PM fix prices to the shocks coming from the changes in the Jewellery demand of all countries. It is found from the results that both AM fix and PM fix prices response immediately to the fluctuations in the jewellery demand of all countries. AM fix and PM fix prices response positively to the changes in the Japan jewellery demand and negatively to the changes in the jewellery demand of USA, Europe and India. Both India and Japan show same effect as both AM fix and PM fix prices get back to the equilibrium from the shock after four months. The shocks from Japan and India sustain only for four months, whereas the shocks from the USA and Europe sustain more than a year. Hence the effect from USA and Europe jewellery demand changes have constant effect on the AM fix and PM fix prices. It is concluded that the shocks from India and Japan are short term in nature and the shocks from USA and Europe show long term effect on the AM fix and PM fix prices. This is because the stability of the market, as the Indian gold market function efficiently (refer the results of the next chapter), the shocks coming from the India gold markets disappear faster than the other markets. The efficiency of the Indian gold market is able to make the AM fix and PM fix prices to converge to the equilibrium and increases their convergence speed.

Figure No 6.4

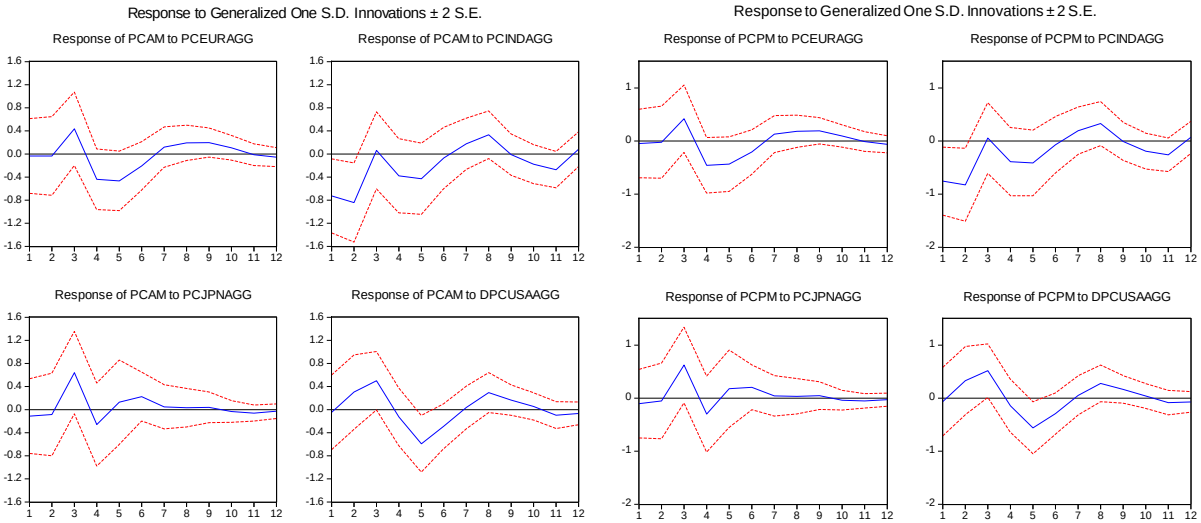
Transmission of Shocks of Investment Demand on AM Fix and PM Fix prices



The figure no: 6.4 show the impact of the shocks coming from the fluctuations of the investment demand of all countries. It is found that the impact of the shocks due to the changes in the investment demand is comparatively less than the shocks coming from the jewellery demand. The response of AM Fix and PM Fix prices are positive and insignificant. The changes in the investment demand of both India and Japan show more effect on the changes in the AM fix and PM fix prices than the other two countries. The response is immediate and positive. The AM fix and PM fix prices take very long time to get back to the equilibrium from the shocks caused by the India investment demand. They take around one year to get back to the equilibrium, where as they get back to the equilibrium very fast from the shocks caused by other three countries. i.e the equilibrium is attained at the end of seventh month. The changes in the investment demand of India causes more deviation and more fluctuation of the AM and PM fix prices. It is concluded that the shocks or innovations coming from the changes in the investment demand of all the countries are capable of causing small disturbances in the spot gold price movements in the short run and those shocks do not sustain in the long run. Only mild impact is felt in the short run from these variables.

Figure No 6.5

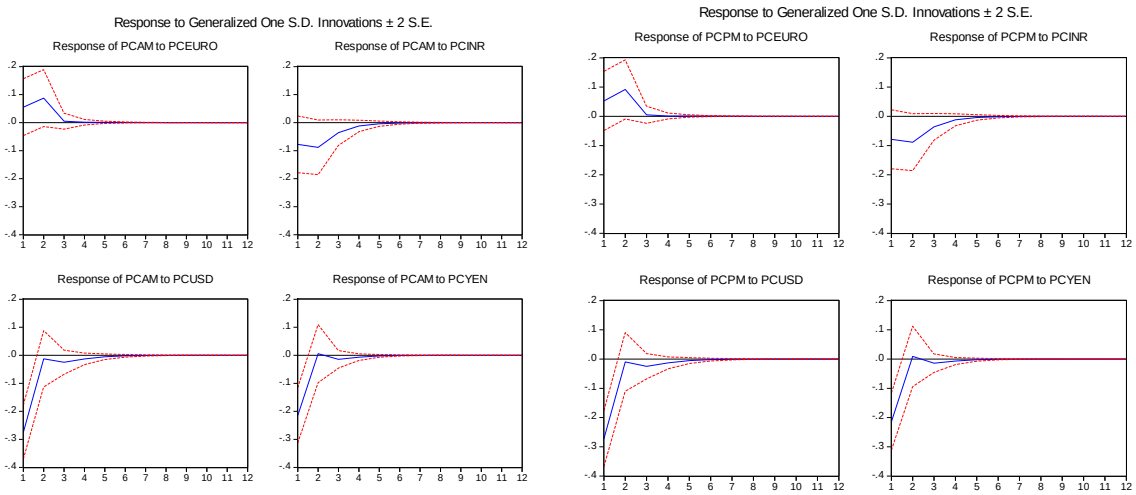
Transmission of Shocks of Aggregate Demand on AM Fix and PM Fix prices



The Figure no: 6.5 provides the response of percentage changes in AM fix and PM fix prices to the generalised one standard deviation of the aggregate demand of all the countries included in the study. It is found from the results that both AM and PM fix prices respond to the changes in the aggregate demand of India is significant and immediate. The response is negative and makes AM fix and PM fix prices to fluctuate more in the long run. The price touches equilibrium price at the end of each quarter in a period of one year. The response to the shocks of USA's aggregate demand is not immediate but it takes place in the subsequent months and the spot gold prices get back to the equilibrium at the end of eleventh month. The response of AM fix and PM fix to the Japan and Europe aggregate demand is similar in nature. Both the countries aggregate demand shocks create same impact on the AM and PM fix prices. The spot prices also do not respond to these two countries and the equilibrium are attained very shortly at the sixth month itself. Hence only India's aggregate demand is capable enough to create its disequilibrium in both AM and PM fix in the long run. The spot gold prices equilibrium movements are disturbed at each quarter by the changes in the aggregate demand of India.

Figure No 6.6

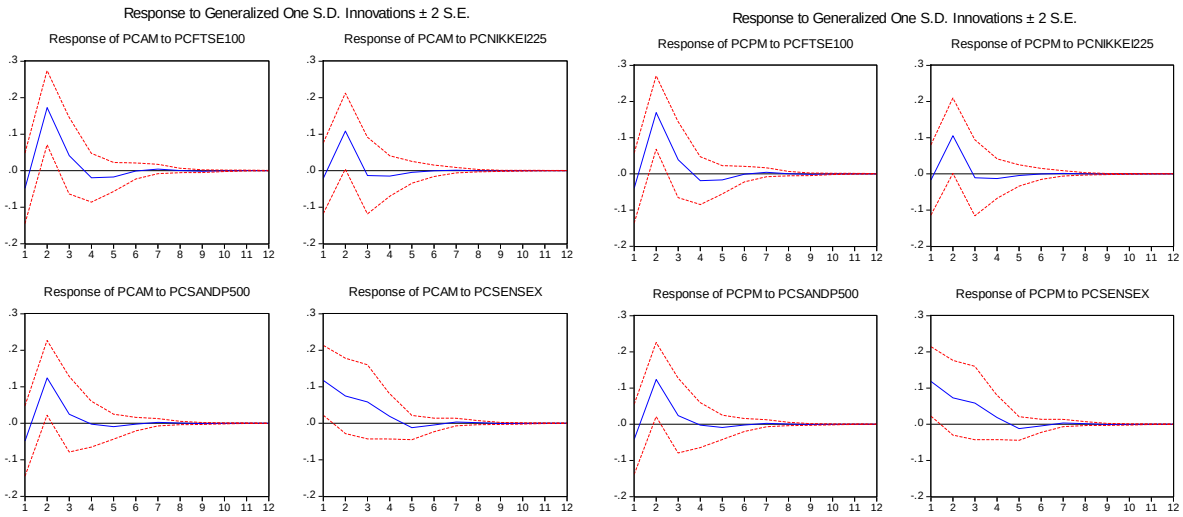
Transmission of Shocks of Exchange Rate on AM Fix and PM Fix prices



The Figure no: 6.6 shows the response of AM fix and PM fix prices to the changes in the one standard deviation shocks of exchange rates of the currency variables. These figures show that the response of both AM fix and PM fix prices to the generalised one standard deviation innovation to Euro is positive. It is Negative for all the other variables USA, INR and Yen. The response is very high for USD and Yen. As the price of spot gold price is fixed in the US Dollar its impact is greater than the other variables and this happens only in the short run. Since Euro is domestic currency, the response is positive. The reaction of AM and PM fix prices to the innovations of all the variables get back to the equilibrium quickly. The convergence is attained at the fifth month and the same is maintained in the subsequent months. Hence it is concluded that the impact of shocks from the exchange rate variables is immediate and they sustain only in the short run. The shocks are not persistent and impacts die away in the long run. It shows that the exchange rate of the currencies is capable of causing disequilibrium only in the short term periods. They do not survive for the longer periods in the spot gold price movements.

Figure No 6.7

Transmission of Shocks of Stock Exchange Index on AM Fix and PM Fix prices



The figure No: 6.7 represents the response of AM fix and PM fix to the shocks from the index of stock market index variables of all countries. The results conclude that both AM fix and PM fix prices significantly and immediately react to the shocks coming from the Indian stock market. The response is positive and the spot gold prices take six months to get back to the equilibrium. The response of AM fix and PM fix prices to the innovations of other three country's stock market is not immediate but the response takes place in the subsequent months.

The effect of innovations of stock market of Japan, USA and Europe is very less and the same die away in the third month itself. Hence they maintain the equilibrium from the fourth month on wards. It is concluded that only Indian stock market causes more disequilibrium of the AM fix and PM fix prices than the stock markets of other three countries. At the same time the shock from the stock markets also do not sustain long in the movement of spot price of gold markets.

6.9 PROPORTION OF SHARE OF VARIANCES

The GCBEW shows the significant variables that cause the dependent variables AM fix and PM fix in the short run by making restrictions on the independent variables. The IRF tells us the direction of relationship either positive or negative impact. It also shows how long the shock sustains in the price. Variance decomposition separates the variations in an endogenous variable into the component shocks to the VAR. In other words the variance decomposition provides information about the relative importance of each random innovation in affecting the variations of the variables in the VAR system.

A shock that arise in one variable will get impacted itself and the same will be transmitted to all other alternative structure of the VAR. The proportion of variances that is transmitted to the other variables in the system is examined. As done in the previous analysis, here also the dependent variables both AM fix and PM fix are estimated separately with the independent variables. The estimated results are available from the Table No: 6.5.

Table No: 6.5

Proportion of variances transmitted by AM Fix price on Spot Prices of Countries included in the study

Period	S.E.	AM	EUROPE	INDIA	JAPAN	USA
1	3.526467	0.306165	0.158517	79.95508	4.807583	14.77265
2	3.956152	1.259522	15.47222	64.89619	5.554016	12.81806
3	4.098942	1.804526	17.00473	62.22289	6.385867	12.58199
4	4.108406	1.799824	17.19626	61.95143	6.474066	12.57842
5	4.114331	1.816033	17.26194	61.86351	6.493966	12.56455
6	4.114567	1.820277	17.26494	61.85693	6.494153	12.56370
7	4.114689	1.820194	17.26627	61.85338	6.496372	12.56379
8	4.114698	1.820203	17.26621	61.85313	6.496434	12.56403
9	4.114700	1.820203	17.26624	61.85311	6.496438	12.56402
10	4.114700	1.820204	17.26624	61.85310	6.496440	12.56402
11	4.114700	1.820204	17.26624	61.85310	6.496441	12.56402
12	4.114700	1.820204	17.26624	61.85310	6.496441	12.56401

Table No: 6.6

Proportion of variances transmitted by PM Fix price on Spot Prices of Countries included in the study

Period	S.E.	PM	EUROPE	INDIA	JAPAN	USA
1	3.458249	0.242601	0.000000	0.000000	0.000000	99.75740
2	3.930463	11.53703	8.753086	0.559459	0.013169	79.13725
3	4.063029	10.81590	11.59657	1.123550	1.542294	74.92169
4	4.100687	12.01775	11.39469	1.287170	1.516938	73.78345
5	4.110044	11.98769	11.38020	1.608285	1.536934	73.48689
6	4.110860	11.99833	11.37921	1.610414	1.551697	73.46035
7	4.111316	12.00300	11.38465	1.610352	1.557916	73.44408
8	4.111417	12.00412	11.38640	1.610389	1.558595	73.44049
9	4.111435	12.00429	11.38631	1.610489	1.559023	73.43989
10	4.111443	12.00427	11.38635	1.610589	1.559162	73.43963
11	4.111445	12.00432	11.38638	1.610588	1.559169	73.43954
12	4.111446	12.00434	11.38638	1.610590	1.559169	73.43952

The estimated results of variance decomposition with the price variables are given in the Table No: 6.5 and 6.6 AM fix and PM fix respectively. It is found from the results that the forecast error variance of AM fix is largely explained by Indian price changes than rather the other three countries price changes. The innovations from India have more power to explain the AM fix variance. In the short run Indian shocks accounts for about 80% of AM fix price variance and in the long run 61% of AM forecast variance is explained by India. In the long run Europe's shocks contribute around 17% of information and USA 12% of its shocks causes the variance of AM fix price.

The Table No: 6.6 gives the variance decomposition of PM fix with the price variables. It is found 11% of variance of PM fix price is explained by its own lagged shocks in the system in the long run. The USA market is the highest contributor in the short run 99% of its variance is explained by USA and at the same time in the long run its proportion is reduced 73%. The variance decomposition of PM fix price from India is very small. In the long run the shocks from Europe accounts 11% of the variations in the PM fix price. Hence India's role in the AM fix price and USA's role in the PM fix price is again confirmed with this variance decomposition results.

Table No: 6.7

Proportion of variances transmitted by AM Fix price volatility on Spot Prices Volatility of Countries included in the study

Period	S.E.	AM	EUROPE	INDIA	JAPAN	USA
1	4.329104	17.35111	0.001440	82.64745	0.000000	0.000000
2	5.420621	12.23600	3.188186	83.19083	0.911426	0.473558
3	6.273528	9.135119	6.420450	80.19250	1.854423	2.397502
4	6.856363	7.698735	8.184354	78.56415	2.496587	3.056178
5	7.223610	6.965887	9.136955	78.09148	2.552333	3.253341
6	7.469581	6.524783	9.755857	77.93862	2.437868	3.342875
7	7.639197	6.242869	10.15615	77.88242	2.333858	3.384697
8	7.754274	6.062198	10.40215	77.87486	2.266280	3.394518
9	7.831368	5.945946	10.54850	77.88592	2.229517	3.390116
10	7.882812	5.870532	10.63410	77.89997	2.213702	3.381687
11	7.916999	5.821459	10.68326	77.91207	2.209922	3.373287
12	7.939587	5.789582	10.71094	77.92116	2.212034	3.366282

Table No: 6.8

Proportion of variances transmitted by PM Fix price volatility on Spot Prices Volatility of Countries included in the study

Period	S.E.	PM	EUROPE	INDIA	JAPAN	USA
1	4.347272	0.540798	0.000000	0.000000	0.000000	99.45920
2	5.494022	3.328364	3.518955	1.187577	0.095539	91.86956
3	6.255143	4.641006	6.773282	4.162803	0.736143	83.68677
4	6.766116	4.750910	7.790490	6.160647	0.986396	80.31156
5	7.107847	4.560146	8.239744	7.202864	0.935269	79.06198
6	7.353798	4.404224	8.638909	7.825735	0.873836	78.25730
7	7.535269	4.318281	8.986898	8.243498	0.834343	77.61698
8	7.667917	4.275984	9.247450	8.524634	0.810047	77.14189
9	7.763894	4.255780	9.432426	8.711094	0.796497	76.80420
10	7.833056	4.247835	9.564291	8.836043	0.789845	76.56199
11	7.882750	4.246919	9.658599	8.921555	0.786990	76.38594
12	7.918313	4.249439	9.725508	8.980943	0.786076	76.25803

The Table No: 6.7 and 6.8 show the results of the variance decomposition of AM and PM fix with the volatility variables included in the study. Looking at the table the volatility of AM Fix price is much explained by India such that in the short

run it accounts 80% of its variations and in the long run 77% of variation of AM fix. Only 6% of variation is explained by its own shocks in the long run. Europe's role is very less in the short run, but its impact increases in the long run and explains around 10% of variation in the seventh month. USA and Japan role is very less in explaining the AM fix price variations. From the Table No: 6.8 it is observed that again the USA plays a dominant role in accounting 99% of variation of PM fix price changes in the short run and It is showing a decreasing trend in the long run showing 76% at the ninth month. In the long run the shocks of its own lagged value only 4% of variances. Both Europe and India play a minor role in the long run namely they explain around 8% of AM fix volatility.

The results of both price and volatility variables proves that India plays a dominant role in explaining the variations of AM fix price and volatility and USA plays a dominant role in accounting the major portions of PM fix price and volatility variations.

Table No: 6.9

Proportion of variances transmitted by AM Fix price on Jewellery Demand of Countries included in the study

Period	S.E.	AM	EUROPE	INDIA	JAPAN	USA
1	3.938986	97.28682	0.486211	0.153920	1.990808	0.082240
2	4.005878	94.09784	1.073133	2.238008	1.977823	0.613196
3	4.149127	89.12256	3.587061	2.492696	2.544036	2.253648
4	4.210883	86.54883	5.588132	2.422510	2.516870	2.923661
5	4.250232	84.96729	6.976843	2.420577	2.490463	3.144826
6	4.282955	83.69285	8.076800	2.410137	2.480174	3.340036
7	4.312992	82.55837	9.028266	2.387679	2.460202	3.565482
8	4.341132	81.51553	9.895154	2.362254	2.435801	3.791265
9	4.367438	80.55356	10.69787	2.338070	2.411286	3.999214
10	4.391874	79.67346	11.43548	2.316339	2.388604	4.186110
11	4.414455	78.87316	12.10751	2.296981	2.368256	4.354096
12	4.435298	78.14557	12.71858	2.279534	2.349990	4.506320

Table No: 6.10

Proportion of variances transmitted by PM Fix price on Jewellery Demand of Countries included in the study

Period	S.E.	PM	EUROPE	INDIA	JAPAN	USA
1	3.933346	96.98453	0.032979	0.183748	2.274553	0.524190
2	4.001323	93.74564	1.203520	2.183121	2.294619	0.573101
3	4.142837	88.86240	4.827276	2.441705	2.976090	0.892527
4	4.202216	86.38681	6.939493	2.375098	2.957249	1.341346
5	4.240524	84.84438	8.088515	2.374209	2.917096	1.775803
6	4.272456	83.59572	9.042773	2.365781	2.892391	2.103336
7	4.301677	82.48784	9.952278	2.345572	2.861284	2.353029
8	4.328975	81.47258	10.80639	2.322113	2.828376	2.570544
9	4.354443	80.53760	11.59304	2.299631	2.796880	2.772851
10	4.378053	79.68346	12.30837	2.279433	2.767995	2.960745
11	4.399824	78.90797	12.95579	2.261492	2.741930	3.132809
12	4.419877	78.20409	13.54289	2.245368	2.718404	3.289240

The variance decomposition of AM and PM fix price changes with the jewellery demand variables are given in the Table No: 6.9 and 6.10 respectively. Looking at the table, around 97% of variance of AM fix price change variance is explained by its own shocks than the shocks from the jewellery demand changes. But in the long run the role played by its own shock showing decreasing trend that is only 78% is accounted in the 12^{th} month. The role of India, Japan and USA are very similar. In the long run USA shows an increasing trend. Europe contributes very less in the short run and it is easier over the period.

The Table No: 6.10 also gives the same conclusion as drawn from previous table 6.9. Hence the shocks in the jewellery market provides very less in explaining the variance of price of AM fix and PM fix. Any fluctuation in the jewellery demand of gold does contribute to the variances of the spot prices. However, only minor portion of the variation in the spot prices are explained by fluctuations in jewellery demand.

Table No: 6.11

Proportion of variances transmitted by AM Fix price on Investment Demand of Countries included in the study

Period	S.E.	AM	EUROPE	INDIA	JAPAN	USA
1	4.003886	98.51712	0.182762	0.831745	0.137328	0.331043
2	4.038683	97.01062	0.210120	1.323094	1.130541	0.325628
3	4.103986	95.29546	0.580157	1.377760	1.510971	1.235651
4	4.104417	95.27822	0.580117	1.388729	1.513981	1.238950
5	4.107069	95.23525	0.610020	1.389741	1.517148	1.247842
6	4.107106	95.23408	0.610015	1.390374	1.517668	1.247864
7	4.107191	95.23230	0.610782	1.390469	1.518010	1.248436
8	4.107192	95.23227	0.610782	1.390486	1.518015	1.248442
9	4.107195	95.23222	0.610812	1.390489	1.518023	1.248457
10	4.107196	95.23222	0.610812	1.390490	1.518023	1.248457
11	4.107196	95.23222	0.610813	1.390490	1.518023	1.248458
12	4.107196	95.23222	0.610813	1.390490	1.518023	1.248458

Table No: 6.12

Proportion of variances transmitted by PM Fix price on Investment Demand of Countries included in the study

Period	S.E.	PM	EUROPE	INDIA	JAPAN	USA
1	3.995508	98.50379	0.200046	0.868917	0.141535	0.285711
2	4.032490	96.87205	0.231790	1.506994	1.106069	0.283103
3	4.096038	95.30551	0.549705	1.510118	1.515976	1.118688
4	4.096535	95.28316	0.549863	1.526606	1.519233	1.121135
5	4.098900	95.24470	0.576908	1.525919	1.522450	1.130025
6	4.098933	95.24335	0.576899	1.526783	1.522951	1.130019
7	4.099001	95.24194	0.577543	1.526785	1.523244	1.130486
8	4.099001	95.24191	0.577542	1.526809	1.523250	1.130487
9	4.099003	95.24187	0.577564	1.526809	1.523255	1.130498
10	4.099003	95.24187	0.577564	1.526810	1.523256	1.130498
11	4.099003	95.24187	0.577565	1.526810	1.523256	1.130499
12	4.099003	95.24187	0.577565	1.526810	1.523256	1.130499

The Table No: 6.11 & 6.12 provides the results of the variance decomposition result of AM and PM fix from the percentage changes in the investment demand variables. The variance of both AM fix and PM fix is explained 98% of its own shocks and in the long run it is around 95%, A minor contribution exists from India, Japan and USA. It shows that the shocks or innovations arise in the investment demand market do not affect the variance of the spot prices of AM and PM fix.

Table No: 6.13

Proportion of variances transmitted by AM Fix price on Aggregate Demand of Countries included in the study

Period	S.E.	AM	EUROPE	INDIA	JAPAN	USA
1	3.800498	100.0000	0.000000	0.000000	0.000000	0.000000
2	3.912850	94.34385	0.007697	4.862703	0.033183	0.752564
3	4.010285	91.35899	1.162385	4.631557	1.669844	1.177228
4	4.069653	89.53900	2.271166	5.316793	1.693676	1.179368
5	4.176919	85.88755	3.382533	6.057136	2.161000	2.511784
6	4.224390	84.86336	3.553124	6.092616	2.613485	2.877416
7	4.235383	84.74198	3.610590	6.183961	2.599955	2.863515
8	4.262659	83.71853	3.767606	6.759220	2.574095	3.180548
9	4.269089	83.50386	3.969023	6.738973	2.570918	3.217221
10	4.274335	83.32165	4.022859	6.854077	2.590776	3.210641
11	4.285077	82.96332	4.003495	7.188492	2.594067	3.250628
12	4.286559	82.90955	4.016940	7.222124	2.592872	3.258516

Table No: 6.14

Proportion of variances transmitted by PM Fix price on Aggregate Demand of Countries included in the study

Period	S.E.	PM	EUROPE	INDIA	JAPAN	USA
1	3.795824	100.0000	0.000000	0.000000	0.000000	0.000000
2	3.906335	94.42209	0.003241	4.733791	0.010751	0.830132
3	4.002549	91.47135	1.074373	4.509283	1.592041	1.352950
4	4.064942	89.44826	2.282043	5.253359	1.674025	1.342308
5	4.171344	86.05025	3.227086	5.846596	2.304361	2.571708
6	4.215773	85.04509	3.411216	5.897047	2.697619	2.949027
7	4.229032	84.90076	3.480833	6.006843	2.681000	2.930569
8	4.254682	83.94031	3.622564	6.572395	2.654467	3.210259
9	4.260402	83.73155	3.814181	6.554865	2.649044	3.250362
10	4.265947	83.53548	3.854096	6.698666	2.669745	3.242009
11	4.275528	83.21929	3.837188	7.000742	2.669943	3.272838
12	4.276807	83.17104	3.854996	7.022754	2.668888	3.282319

The variance decomposition of both AM fix and PM fix with the changes in aggregate demand variables are given in the Table No: 6.13 & 6.14. By looking at the table it is very clear that 100% of AM fix and PM fix price variances are explained by its own shocks than the other variables in the short run. In the first month the fluctuations of AM fix and PM fix occurs due to its own innovations and information.

But in the following months it is decreasing and only 83% is explained from the eighth month onwards. On the other hand the shocks that occur in the aggregate demand gradually increases in the long run. The role of India in accounting the spot price variances due to the changes in the aggregate demand is zero in the short run. But it is increases gradually and accounts around 7% of variations of AM fix and PM fix in the long run. The role of USA, Japan and Europe are similar and they do not show any increasing trend like India. Their power to explain the variables of AM fix and PM fix is constant over the period of time. The variances accounted by changes in the aggregate demand of India keeps increasing every quarter. Every three months, the proportion keeps on increasing. This result again is an evident to prove India's role in explaining the spot prices of AM fix and PM fix. Unlike jewellery and Investment demand variables, the impact of aggregate demand changes shows much power in accounting the variances of the AM fix and PM fix prices.

Table No: 6.15

Proportion of variances transmitted by AM Fix price on Exchange Rates of Countries included in the study

Period	S.E.	AM	EURO	INR	USD	YEN
1	0.599693	74.54339	1.209642	2.259578	18.59793	3.389453
2	0.610936	71.99647	2.307239	4.338424	17.99072	3.367153
3	0.626583	71.23296	2.932566	4.435900	17.17507	4.223506
4	0.627058	71.20199	2.965313	4.433182	17.18132	4.218192
5	0.627490	71.21338	2.967814	4.446363	17.15813	4.214306
6	0.627551	71.20847	2.968286	4.448402	17.16126	4.213581
7	0.627569	71.20730	2.968860	4.448175	17.16138	4.214283
8	0.627572	71.20720	2.968942	4.448248	17.16131	4.214299
9	0.627573	71.20714	2.968959	4.448246	17.16136	4.214295
10	0.627573	71.20714	2.968965	4.448245	17.16135	4.214294
11	0.627573	71.20714	2.968966	4.448244	17.16135	4.214294
12	0.627573	71.20714	2.968966	4.448244	17.16135	4.214294

The estimated variance decomposition results of AM fix and PM fix with the exchange rates are given in the Table No: 6.15 & 6.16. It is found that the fluctuations of both AM fix and PM fix prices are more explained by its own shocks. In the long run more than71% of its own shocks is capable of being explaining its variances both in the short run and long run.

Table No: 6.16

Proportion of variances transmitted by PM Fix price on Exchange Rates of Countries included in the study

Period	S.E.	PM	EURO	INR	USD	YEN
1	0.597207	74.99013	1.117908	2.244045	18.20102	3.446894
2	0.609181	72.25973	2.469232	4.241541	17.59639	3.433113
3	0.625737	71.52988	3.171516	4.321006	16.69548	4.282119
4	0.626342	71.47922	3.208846	4.316686	16.71765	4.277598
5	0.626850	71.49341	3.211746	4.332558	16.69061	4.271681
6	0.626931	71.48474	3.212179	4.335602	16.69657	4.270907
7	0.626955	71.48345	3.213001	4.335309	16.69649	4.271752
8	0.626958	71.48324	3.213108	4.335414	16.69649	4.271752
9	0.626959	71.48318	3.213135	4.335412	16.69653	4.271745
10	0.626959	71.48318	3.213144	4.335411	16.69653	4.271743
11	0.626959	71.48317	3.213145	4.335410	16.69653	4.271744
12	0.626959	71.48317	3.213145	4.335410	16.69653	4.271744

The percentage change of USD has higher effect in explaining the variance of both AM fix and PM fix prices. More than 17% of its information explains the variances of AM fix and PM fix prices. The changes in INR and Yen information accounts only 4% of the variations of the AM fix and PM fix prices. Since USD is the international currency and the spot price is fixed in USD, its power in explaining the variances of AM fix and PM fix is much higher than the other major currencies in the markets.

Table No: 6.17 and 6.18 show the AM fix and PM fix variance decomposition results with the stock market variables. The results convey that the innovations of its own shocks explain more than the shocks from the stock markets. In the short run around 88% is accounted by its own lagged information. But it is reduced in the third month itself where only 79% from the second month onwards for both AM fix and PM fix price. The stock market in India is showing a constant impact on the AM fix and PM fix price changes. Around 9% of its information accounts the variances of AM fix and PM fix price and 10% of its information explain the variances of the PM fix price. The impact of Europe's stock market differs from AM fix price to the PM fix price such that 8% and 5% of its information accounts the variances of AM and PM fix in the long run respectively.

Table No: 6.17

Proportion of variances transmitted by AM Fix price on Stock Market of Countries included in the study

Period	S.E.	AM	FTSE100	NIKKEI225	SANDP500	SENSEX
1	0.573730	87.86916	3.707756	0.132681	0.000000	8.290403
2	0.606353	79.44844	8.699567	3.320047	1.079874	7.452075
3	0.623450	77.95656	8.751098	3.186085	1.217262	8.888996
4	0.626024	77.32526	8.856926	3.215003	1.470041	9.132768
5	0.627010	77.22798	8.902849	3.210180	1.521565	9.137422
6	0.627067	77.22186	8.901507	3.209618	1.523128	9.143884
7	0.627118	77.21494	8.904840	3.209493	1.525617	9.145107
8	0.627126	77.21421	8.904602	3.209409	1.525594	9.146182
9	0.627130	77.21364	8.904959	3.209443	1.525843	9.146113
10	0.627130	77.21359	8.904954	3.209436	1.525843	9.146180
11	0.627130	77.21356	8.904971	3.209437	1.525858	9.146176
12	0.627131	77.21355	8.904971	3.209437	1.525858	9.146180

Table No: 6.18

Proportion of variances transmitted by PM Fix price on Stock Market of Countries included in the study

Period	S.E.	PM	FTSE100	NIKKEI225	SANDP500	SENSEX
1	0.575486	88.15029	0.235189	0.126833	0.526069	10.96162
2	0.606132	79.95137	5.235548	0.237956	4.636605	9.938517
3	0.622932	78.72246	5.365652	0.682287	4.537247	10.69236
4	0.625302	78.12736	5.744481	0.747249	4.504440	10.87647
5	0.626258	78.05173	5.825664	0.747163	4.510513	10.86493
6	0.626311	78.04538	5.827097	0.747795	4.510843	10.86889
7	0.626359	78.03938	5.831994	0.747884	4.511889	10.86885
8	0.626367	78.03867	5.831866	0.748022	4.511892	10.86955
9	0.626370	78.03819	5.832367	0.748015	4.511969	10.86946
10	0.626371	78.03815	5.832364	0.748022	4.511978	10.86949
11	0.626371	78.03812	5.832390	0.748022	4.511980	10.86948
12	0.626371	78.03812	5.832391	0.748023	4.511981	10.86949

Its effect is much higher in the AM fix price and less in the PM fix price. The impact of USA stock market is very less in the AM fix price and more in the PM fix price. Only 1% of its information is accounted the AM fix price variance but 4.5% of its shocks explain the PM fix price variances. The Japan stock market is more in the AM fix price and less in the PM fix price. Around 3% of variation of AM fix is explained by the Japanese stock market. Hence it is concluded that the movement of

Indian stock market shows effect on the variances of both AM fix and PM fix prices in the long run.

6.10 CONCLUSION

This chapter is intended to suggest the real price maker in the world gold markets. It is known fact that LBMA fixes the gold price, which becomes the benchmark price throughout the world. The price is actually fixed by the members of the LBMA and they fix the price based on the existing supply and demand condition of the gold market. So the price is fixed on the basis of the orders received from various countries. It was intended to answer the question whose information really influences price fixing is answered in this chapter. It is found from the empirical analysis of GCBEW test that the price and volatility variables of India and Europe influence both AM Fix and PM Fix prices. The USA influences only the PM Fix price and not the AM fix price. There exists joint significance such that all the countries jointly influence both AM Fix and PM Fix prices.

The jewellery demand variables of all the countries jointly and individually influences both the spot prices. This is because most of the jewellery trading takes place on the basis of the LBMA fix prices and LBMA fix prices considered as a benchmark price for physical delivery of gold. On the other hand the investment demand variables of all the countries either individually or jointly do not show their significance. As the dependent variables are spot prices and the investment demand need not influence the spot prices. The distinctiveness of this chapter is the results of the aggregate demand variables. The aggregate demand of all the countries jointly influence both the spot prices, but only India could influence individually both the spot prices. It shows the individuality of India in the world gold markets, because Indian aggregate demand alone is capable of influencing the international spot gold prices. The exchange rates of the domestic currency and the performance of the stock markets of India and Europe show their significant impact on both the AM Fix and PM fix prices.

It is concluded from the Impulse Response Function results that in most of the cases, the AM Fix price respond immediately to the shocks in Indian gold market and the PM Fix price respond immediately to the shocks in USA gold markets. Hence all

the domestic events that causes not only causes disequilibrium in the domestic gold markets but also they affect the international spot gold prices. It is observed from the Variance Decomposition results that most of the cases, the variances of the AM fix prices are shared by the innovations from the Indian gold markets and the variances of PM fix prices are accounted by the innovations from the USA markets. Hence any innovations in these markets directly affect the equilibrium level of the international spot prices.

From the above results it is concluded that being the largest consumer of gold in the international markets, India shows its individual significant impact in causing the disequilibrium in the world spot gold prices. Studies conducted from India suggested that we do not fix the gold prices; instead we follow the international gold prices. Through the empirical analysis, this study proves that we follow the price which is actually influenced by our own domestic information in the world gold markets. Instead of practicing this, Indian gold market should have its own fixing for the all the transactions, and in future this should become the benchmark price for all the transactions that takes place throughout the world. Therefore, it suggests Government of India, to buy the gold through one agency and fixing the prices. It can distribute t other buyers in India. The price fixed by India can rule the prices of world gold markets.

Chapter

7

Elasticity of Gold Demand

CHAPTER - VII

ELASTICITY OF GOLD DEMAND

7.1 INTRODUCTION

The quantity the buyer wants to buy at a particular price is called the quantity demanded[20]. The income of the consumers and the price of a commodity are the key determinants of a particular commodity over a period of time. The main concept is started from here to analyze the demand of gold in India and the other major gold markets in the world. The price of gold and income of the consumers are the two main factors which can be changing whole style of product sale in the market. Gold is one of the metal commodities, which are consumed for making of jewellery, coins and medals, Investment purpose etc. Hence the income of the consumers and the price of gold are the major determinant of its demand in the market.

Academic researchers and the policy makers of a country especially India are often required to analyse and answer the following questions. How will the consumption of gold change if its national income rise by 1 percent? Is the demand for gold reduced with the fluctuations in the price? Whether the impact of the price fluctuations on the gold consumptions is positive or negative? Such questions become more complicated, when the variables in questions are not measured in the same units. To address and examine these issues, the concept of elasticity allows the researcher to answer these questions. Elasticity can be simply defined as a measure of the sensitivity of one variable to another[21]. In economics the word elastic means responsive. Elasticity is a measure of how one variable reacts when a second variable is changes[22]. Hence the relationship between the changes in the price of gold, income

[20]http://www.ukessays.com/essays/economics/demand-and-supply-of-gold-in-india-economics-essay.php

[21]M.K. King and D.L.Weimer. *Price and Income elasticities of Demand for Energy*, Theory and practices for Energy Education, Training, Regulation and Standandards. Encyclopedia of Life Support Systems (EOLSS) Page:01

[22] Chris Rodda (2010). *Price, Income and Cross elasticity of Demand*

of the consumers and the consumption of gold is measured through the elasticity concept.

The concept of elasticity has many different applications, but this study discusses only the demand elasticity of price and income. The estimation of elasticity is based on market demand of individual countries like India, Japan, Europe and USA. The elasticities of these countries are estimated separately with their own gold demand, domestic price and the real GDP, which is used as a proxy for the income of the consumers. This is because the markets vary geographically and also gold is not traded at single price throughout the world and therefore domestic market is considered as a whole. The variations in the price differ from one country to another country, because of transportation cost, difference in government policies that affect the prices, Import duty and retail taxes etc. All the above factors divide the world gold markets nationally. The price elasticity of gold in one country may vary from the other country. Hence this variation across geographic markets provides econometric leverage for estimating elasticities.

The concept of elasticity of market demand is also defined in terms of time as well. This is because the response of the consumers to the price and income changes may differ from short term to the long term. It is said that time affects the flexibility of consumers demand. Greater flexibility in capital stock over the longer run, means that the absolute value of price elasticity are generally larger in the long term than in the short term[23].

The primary objective of this chapter is to get an idea of how the gold demand of major gold consuming countries changes in response to the fluctuations in the spot gold price and the income of the consumers. The efficiency of each major gold market is also measured in terms of the speed of the adjustments. The variables and the methodologies are employed in such a way that the relationships are captured effectively.

[23] M.K. King and D.L.Weimer. *Price and Income elasticities of Demand for Energy*, Theory and practices for Energy Education, Training, Regulation and Standandards. Encyclopedia of Life Support Systems (EOLSS) Page:05

7.2 RATIONALE OF THE STUDY

This work is an extension of the study undertaken by I.G.Patel (1950) from IMF and I.G.Patel and Anand Chandavarkar (2006). The above mentioned studies were conducted during the period from 1925 to 1942. As far as the research is concerned in the area of demand and supply of gold markets, there are only few studies have documented this relationships. I.G.Patel (1950) from International Monetary Fund (IMF) undertook a study to examine the India's elasticity demand for gold. Probably this was the first study in the world gold markets that addressed the concept of elasticity. Based on this study, I.G.Patel and Anand Chandavarkar (2006) undertook a similar kind work in examining the elasticity of the gold demand in India.

It is observed from the above studies that they focussed on estimating the elasticity of the demand for gold only in India and not included any other major gold consuming countries in the world gold markets. There are limitations in the study in terms of the data used and the variables employed. The annual data consisted of consumption of sugar in tonnes was used as a proxy for the income of the consumers and the index of the relative price of gold is used for the price variable. These limitations are already quoted in the study itself. It is said that the decline in real income must be greater than the decline in the consumption of sugar underestimates the variations in the total income during the study period. The index of the relative price of gold may over estimates the variations in the relative price or purchasing power of gold[24]. The concept of elasticity is analysed with simple linear equation and the long run and short run elasticity of demand for gold is not addressed in these studies. The efficiency of the Indian gold market was not measured in the study.

Apart from the above studies, there are only few studies that documented in the area of demand and supply of gold. M.H.Govett and G.J.S Govett (1981) and Saroja Selvanathan and E.A. Selvanathan (1999) examined the relationship between gold price and gold production. G.F. Warren and F.A.Pearson (1933), Mohsen Bahmani-Oskooee (1987) and Roy Batchelor and David Gyrley (1995) estimated the relationship between the price of gold and the demand for gold. A.Vaidyanathan (1999), R.Kannan and Sarath Dhal (2006), Martha Starr and Ky Tran (2008) studied

[24] I.G. Patel and Anand Chandavarkar (2006). "*India's Elasticity of Demand for Gold*"., Economic and Political Weekly, Vol.41, No.6 (Feb.11-17,2006) pp. 507-516

the macro economic factors that determine the demand for gold. I.G.Patel study showed its own limitation in the inclusion of the variables in the empirical analysis.

It is observed from the above mentioned studies that except I.G.Patel (1950), they did not address the issue of the price and income elasticity of gold demand. The I.G.Patel (1950) study also was limited to only India and did not include the other major gold markets in the world. The above mentioned studies documented only the relationship between gold price, the demand and its production. They have restricted to only one country and not many other countries.

Hence this study is an attempt to address these issues by including the four major gold consuming countries in the world. The concept of price and income elasticity is estimated for two different periods namely long run and short run. The efficiency of each gold markets is examined through the speed of adjustment procedure, as which market is able to get back to the equilibrium at a faster rate than the others. As stated earlier, the study adopted the methodology which is used by R.Ramanathan (1999), who used this model to study the gasoline demand in India.

7.3 VARIABLES AND METHODOLOGY

The primary objective of this chapter is to examine the Long run and short run demand elasticity of the gold price and income of the consumers and accordingly variables are considered. The daily data is available only for the spot gold price variable and not for the other variables such as Gold demand, Real Gross Domestic Product. The available frequency of these Gold demand and GDP data are the quarterly. Hence the quarterly data of Gold demand and GDP has been collected and the same has been converted into monthly data based on the Cubic Spline method. Hence the monthly average data of spot gold price, converted quarterly data of Gold demand and GDP are considered in the study for the period from January 2000 to December 2011. The total monthly observation is 144 data points. The quarterly data has been converted into monthly and this will provide more number of observations than using the quarterly data as it is. The more number of observations will provide the reliable results. The real price of gold per troy ounce in rupees has been obtained by deflating the nominal price by WPI of India and CPI USA, Japan & Europe. The income of the consumers is proxied by the real GDP variable.

7.4 PROCEDURE FOR THE ANALYSIS

The following procedures are adopted in the estimation process of long run and short elasticity relationship among gold demand, income and price of gold.

1. The quarterly data of gold demand in tonnes, Real Gross Domestic Products (GDP) and the Monthly average spot gold price of all the countries are collected.
2. The collected quarterly data such as the gold demand and the GDP variables of all the countries has been seasonally adjusted.
3. The collected spot nominal gold price variables have been deflated by Consumer price Index of USA, Japan & Europe and Wholesale Price Index of India. This will remove the inflation effect in the spot gold prices.
4. Using the Cubic Spline Interpolation method available in E views, the quarterly data of gold demand and real GDP has been converted into Monthly data. This increases the number of observations in the study.
5. The price data consisted of the monthly average spot price per troy ounce in respective currencies of gold in the Indian Market.
6. All the variables are converted into natural logarithms in order to reduce the size of the observation and to bring normality for doing empirical analysis.
7. Summary statistics, line and Bar graphs are used to do the basic analysis of the gold demand, income and price variables of all the countries.
8. Stationary test like ADF and PP tests as used to test the stationary properties of all the variables.
9. The Cointegration regression technique is employed to examine the long run price and income elasticity of gold demand of all the countries.
10. Error Correction Model is adopted to study the short run elasticity of Price and Income of gold demand of all the countries.

7.5 SUMMARY STATISTICS

The descriptive statistics of gold demand of all the countries is given in the Table No: 7.1. The gold demand is expressed in tonnes of quantity demanded during the study period. It is observed from the table that the Indian gold demand in the world gold market is much higher than the other major gold consuming countries over the past twelve years. India is known for its gold consumption in the world gold market, as the production from the country is very less than the amount of gold demanded.

Table No. 7.1

Summary Statistics of the gold demand of all the Countries Included in the study

	INDIA	EUROPE	JAPAN	USA
Mean	45.72122	14.99937	2.565148	23.45331
Median	43.69740	15.64244	2.698649	27.76009
Std. Dev.	12.03090	5.143152	0.537132	8.788797
Skewness	0.199896	-0.282075	-0.351828	-0.597088
Kurtosis	2.165377	2.019979	2.163065	1.949257
Jarque-Bera	5.138578	7.672247	7.173551	15.18070
Sum	6583.856	2159.909	369.3813	3377.276
Probability	0.076590	0.021577	0.027687	0.000505
Observations	144	144	144	144

The statistics shows that India consumed on an average 45 tonnes of gold every month. The country consumed around 6584 tonnes of gold over the past twelve years. The next biggest consumer is the USA market whose consumption is around 23 tonnes of gold per month. When we compare the same with the Indian gold demand, it is only 50% of its demand. The next country is the Europe's gold demand with an average of 14 tonnes of gold per month and the last is Japan whose gold demand is around 2.5 tonnes of gold per month. The aggregate gold demand of all these four countries alone represents more than 60% of world gold demand.

The standard deviation shows to what extent the values move away from its mean. Japan shows little high deviation and followed by India. The skewness of India is positive and all the other three countries are negatively skewed. This indicates that Indian gold demand is highly dominated by the positive growth than the negative

growth. This implies that whatever increase in the spot price, the demand for gold is also going up to certain extent in the world gold markets. All the other three countries are dominated by the negative movement of the markets in such a way that their demand for gold is declining over a period of time due to increase in the price and other factors.

For India most of the observations are concentrated on the left of the mean with the extreme values to the right. The other three countries values are concentrated on the right of the mean with the extreme values to the left. The kurtosis which measures the peakdness of a distribution is platykurtic distribution for all the countries. The values of all the countries are less than 3. Hence all the countries observations follow platykurtic distribution. This indicates that the probability for extreme value is less than for a normal distribution and the values are wider spread around the mean. The Jarque-Bera statistics for all the countries support the results of skewness and kurtosis that the existence of non normality in the data.

7.6 LINE AND BAR GRAPHS

7.6.1 Line and Bar Graphs of India

The Figure No: 7.1 & 7.2 shows the movement of quarterly data of quantity gold demanded, spot gold price and the real GDP of India for the period of 12 years from 2000 to 2011. It is observed from the graph that the spot gold price shows an increasing trend during the study period. The price is not seen much growth until 2005. Prior to 2005 the quantity of demand is high because of the less price. After 2005, the spot gold price has experienced a tremendous growth.

During post 2005 the demand is highly altered according to the fluctuations in the spot price, as high demand is followed by the fall in the price. An increase in the price has reduced the demand but this reduction happened only to some extent. The increase in the GDP also contributes to the growth of the demand and the trend is more or less similar.

Figure No 7.1

Gold demand and price of India

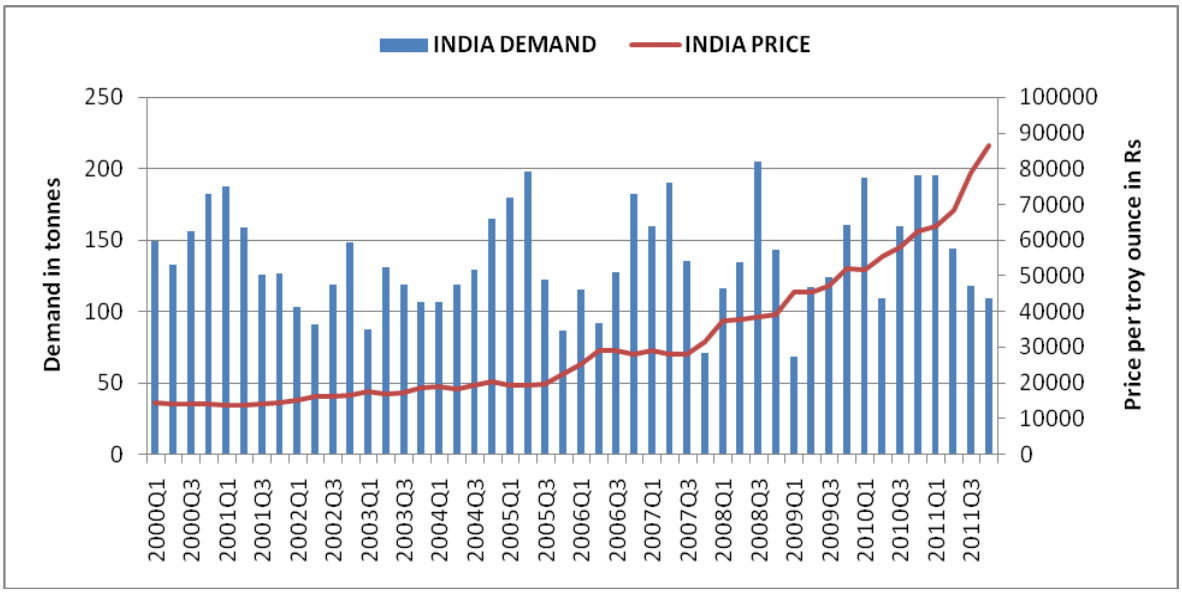
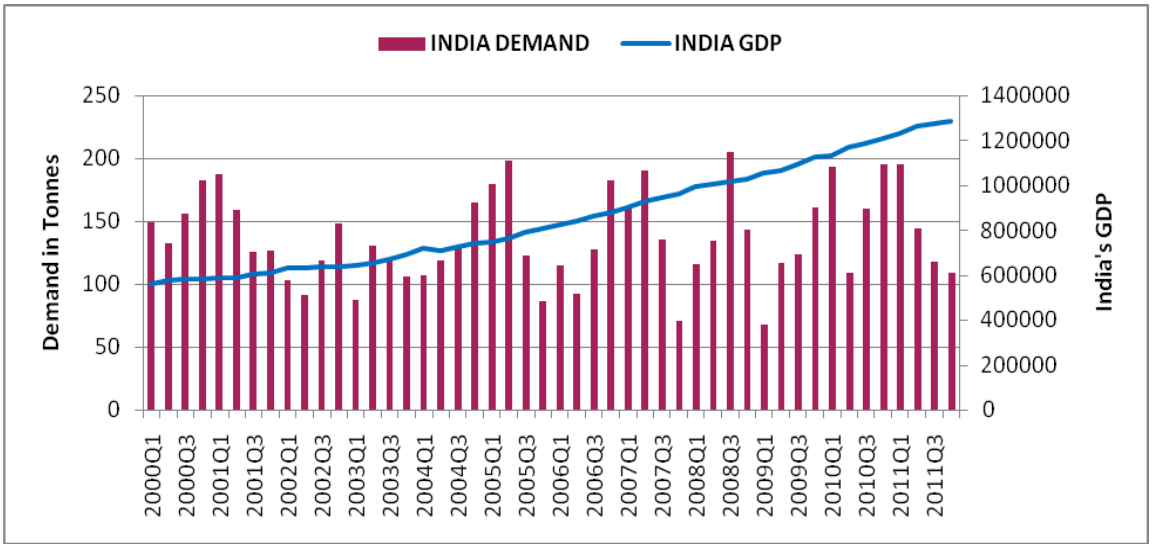


Figure No 7.2

Gold demand and GDP of India



The financial crisis occurred during the year between 2008 and 2009 has shown its impact on gold demand and price also. Due to the impact of the financial crisis, the demand has come down during the Q1 of 2009. The demand started moving up after the financial crisis period. The uniqueness of Indian gold demand is that it shows a kind of trend from 2005 in such a way that every alternative years showing high demand and decline in the demand in the followed year.

7.6.2 Line and Bar Graphs of Europe

Figure No 7.3

Gold demand and Price of Europe

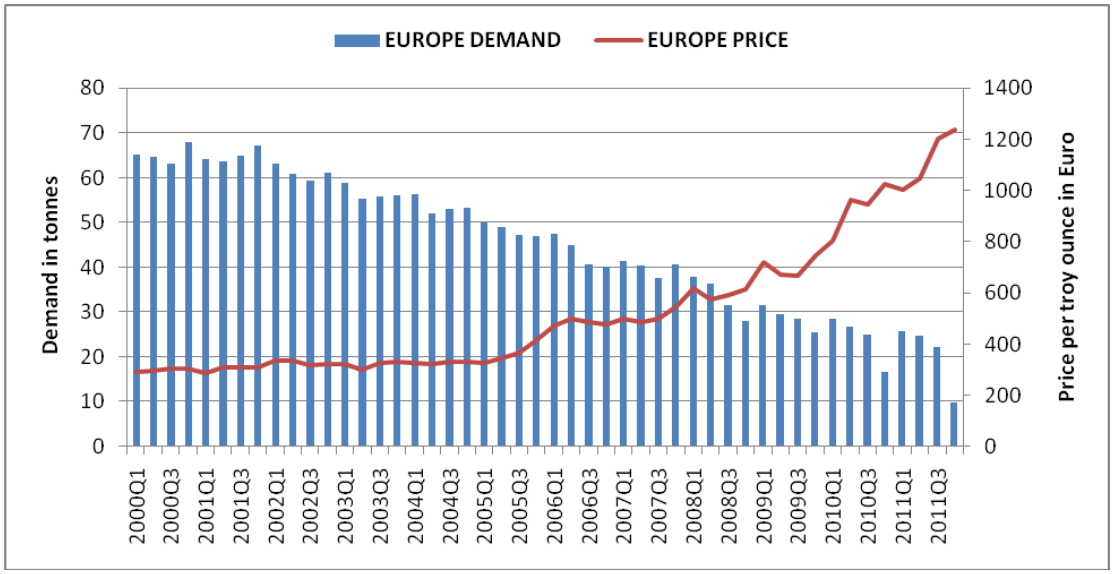
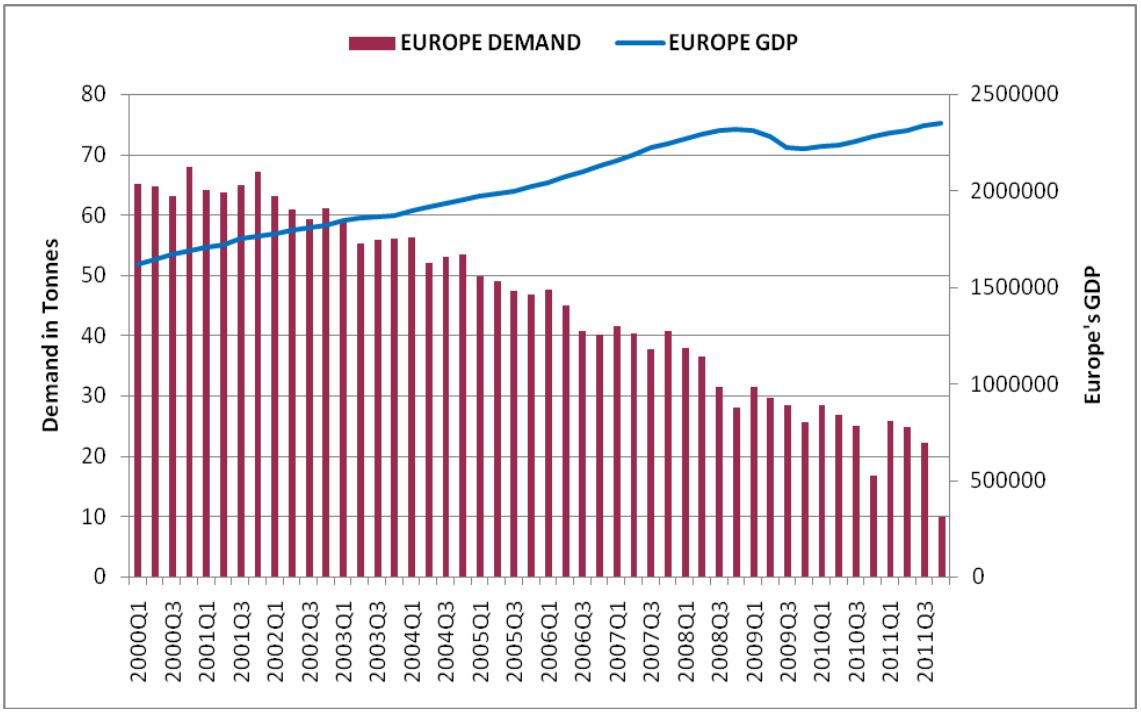


Figure No 7.4

Gold demand and GDP of Europe



The Europe's gold demand, spot price and the GDP is depicted in the Figure No: 7.3 & 7.4. The graph contains quarterly data for the study period considered. The demand for gold shows an inverse relationship with price as well with GDP. An increase in the price does not promote the gold demand; instead it reduces the demand drastically. The financial crisis impact is also felt in Europe, where the demand has come down drastically during the post crisis period. On the other hand the price of gold also started moving up. Hence the tendency of buying gold is going down in Europe especially due to sharp increase in the price.

7.6.3 Line and Bar Graphs of USA

USA's gold demand, spot price and the GDP is plotted in the Figure No: 7.5 & 7.6 for the study period. When comparing with India and Europe, this country shows a stable and constant demand trend especially during 2000 to 2005. Due to the financial crisis the demand for gold reduced and the spot price also came down during 2008 Q1 and 2008 Q3. After this period, the gold price of this country shows a tremendous growth. The drastic increase in the gold price would be due to the result of increasing lack of confidence in the other investment especially stock market. The GDP of USA has experienced a small correction in the financial crisis period. It is observed that the GDP and the demand relationship of USA and Europe are almost showing similar behaviour during the study period.

Figure No 7.5

Gold demand and price of USA

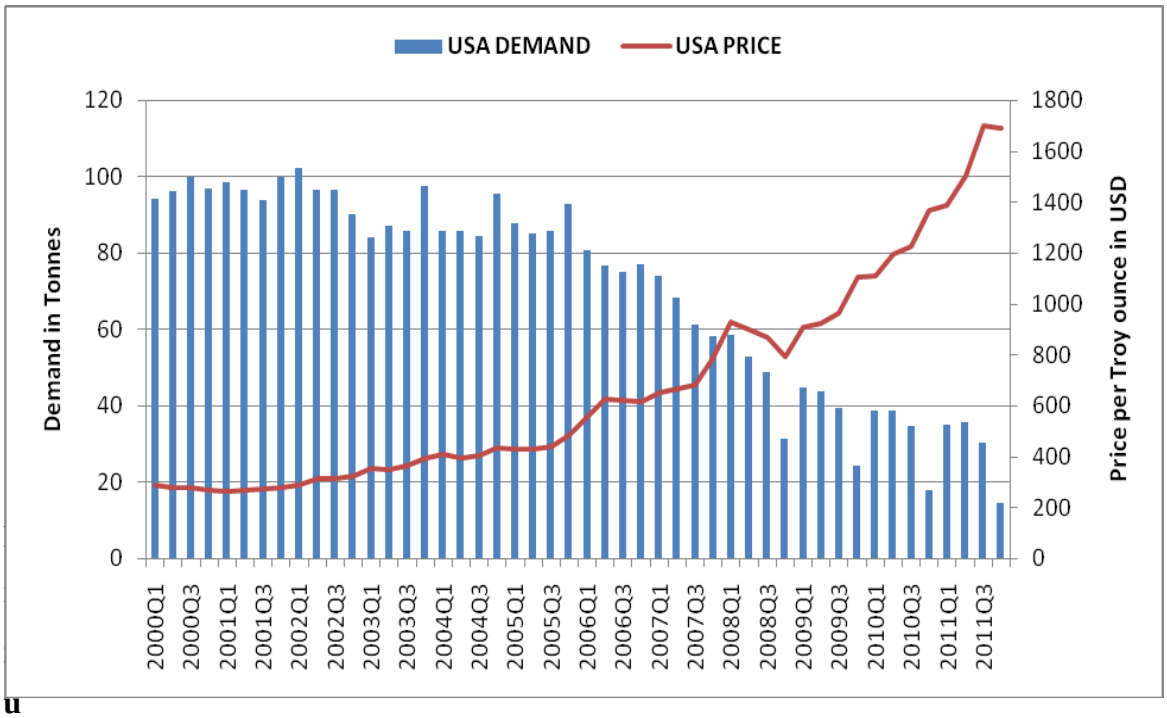
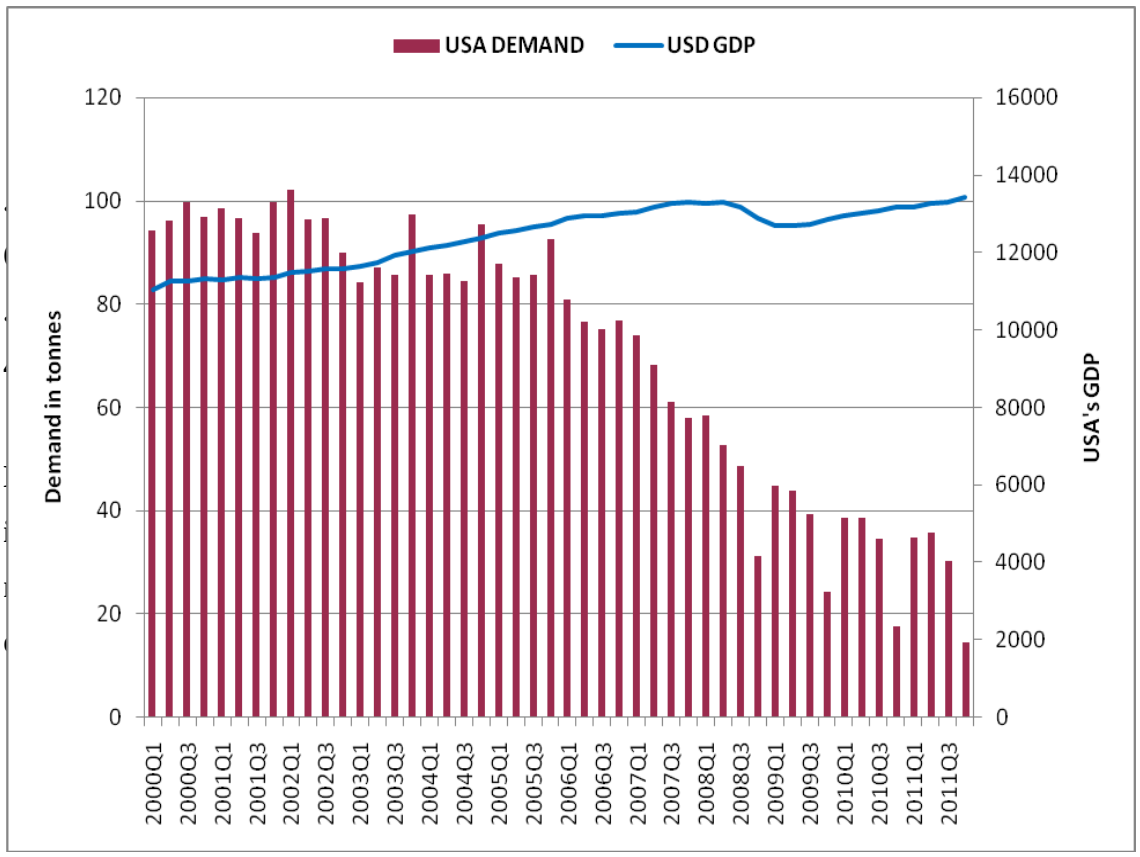


Figure No 7.6

Gold demand and GDP of USA



7.6.4 Bar Graphs of Japan

Figure No 7.7

Gold demand and Price of Japan

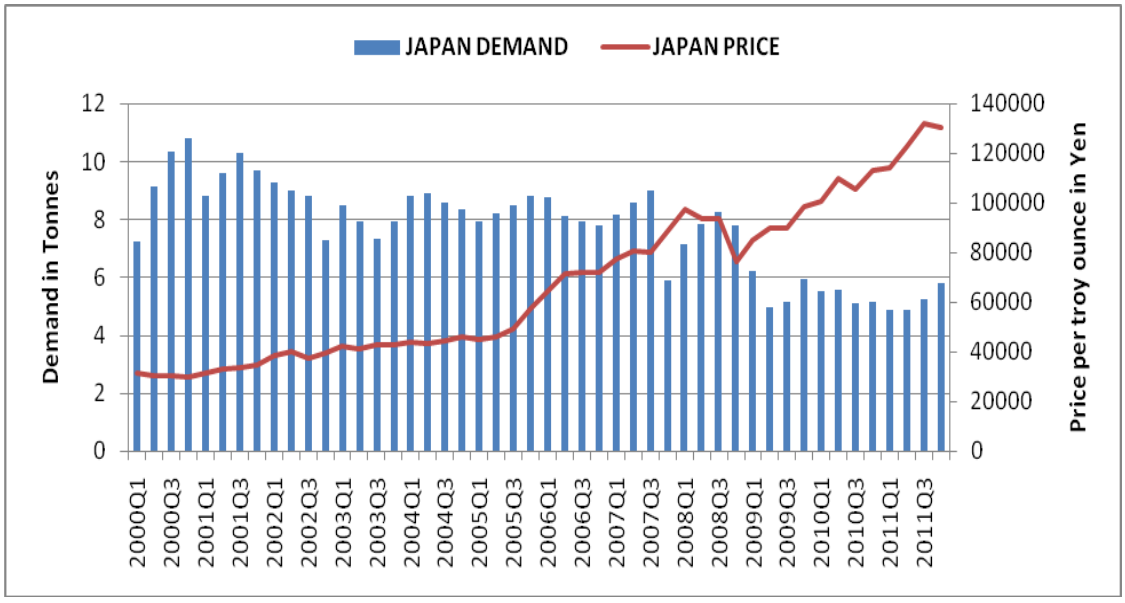
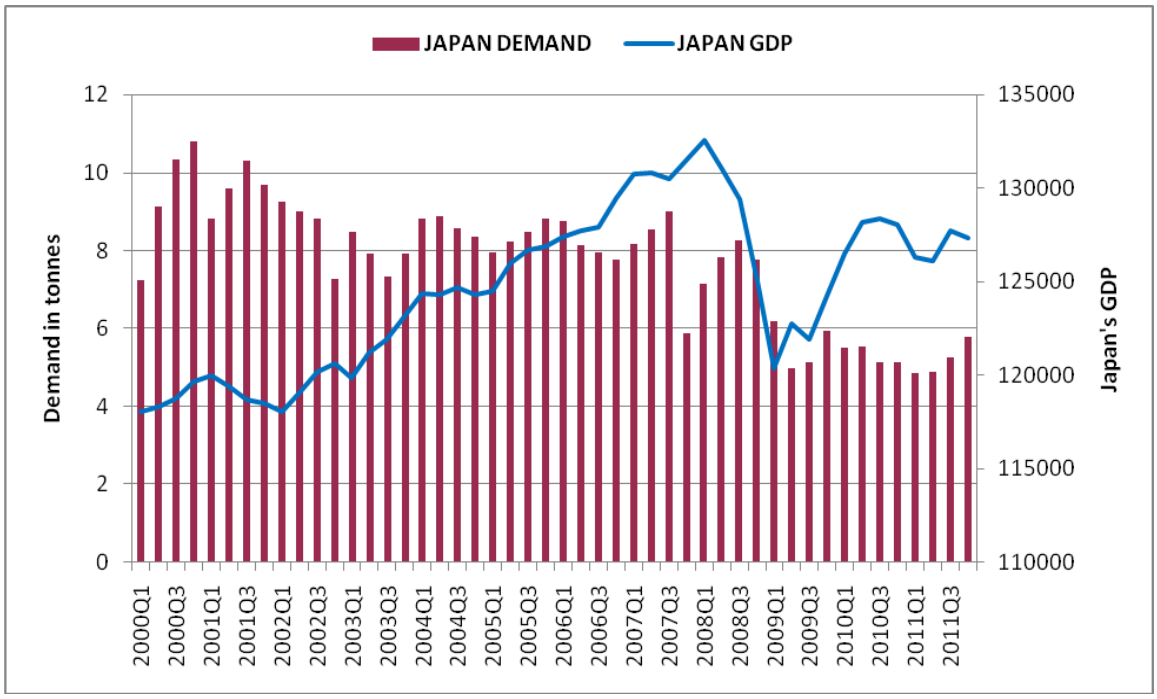


Figure No 7.8

Gold demand and GDP of Japan



The Figure No: 7.7 & 7.8 give the movement of Japan's Quarterly gold demand, spot price and its GDP. The Japan's gold demand shows a constant and stable trend during the study period without much fluctuation in the trend. Just opposite to the above three countries, the Japaneese gold demand went up during the financial crisis period due to fall in the price. The crisis period 2007 Q3 to 2009 Q1 the demand for gold went up. During the post financial crisis period the demand went down but the trend is stable.

As seen in other countries, the price of Japan shows similar trend. After 2005 the price started moving up and reached extreme level. This trend faced a correction during the financial crisis period and after the crisis period, the price again started moving up. The sharp increase in the price during post crisis period reduced the demand to certain level. The GDP of Japan experienced a big correction due to the financial crisis. During 2007Q4 and 2007Q4 the GDP came down drastically and the trend changed after some time.

7.7 STATIONARITY OF THE VARIABLES

The Augmented Dickey – Fuller (ADF) and Phllip – Perron unit root tests are employed to test the stationary of the variables. All the variables are converted into natural logarithms before getting into the estimation process. Testing of the stationary of the variables helps us to identify the order of integration of each variable. The variables included in the study should be integrated in the same order in order to go for further estimation namely long run and short run relationships among them. A stationary variable has a constant variances and covariance. When the variance and covariance of variables remain constant over a period, the reliability of the empirical analysis and its results will be high.

The results of the ADF and PP stationary test applied on the variables during the study period are given in the Table No: 7.2. The table gives the Adj t statistics and the respective P values. The null hypothesis tested is that the variables have unit root or non stationary against the alternative hypothesis of stationary.

Table No: 7.2

Stationarity of the variables included in the analysis

	ADF Test		PP Test	
Variables	**Level**	**First Difference**	**Level**	**First Difference**
INDIA DEMAND	-2.356070 [0.1443]	-4.446700* [0.0004]	-2.828014 [0.3321]	-6.239375* [0.0000]
INDIA PRICE	1.106458 [0.9974]	-11.41589* [0.0000]	1.159344 [0.9978]	-11.41957* [0.0000]
INDIA GDP	1.002078 [0.9965]	-3.610828* [0.0067]	0.609356 [0.9896]	-6.484194 [0.0000]
USA DEMAND	1.929089 [0.9998]	-3.249035* [0.0013]	1.348319 [0.9988]	-4.186673* [0.0010]
USA PRICE	0.864458 [0.9948]	-11.50570* [0.0000]	0.925491 [0.9956]	-11.49658* [0.0000]
USA GDP	-0.506925 [0.8853]	-3.526546* [0.0086]	-1.725599 [0.4162]	-5.039148* [0.0000]
JAPAN DEMAND	-0.547269 [0.8770]	-6.705218* [0.0000]	-1.229160 [0.6609]	-5.920284* [0.0000]
JAPAN PRICE	-0.248254 [0.9282]	-11.08846* [0.0000]	-0.249338 [0.9280]	-11.07685* [0.0000]
JAPAN GDP	-2.108635 [0.2417]	-3.150515** [0.0253]	-1.735420 [0.4113]	-5.199369* [0.0000]
EUROPE DEMAND	2.379655 [1.0000]	-5.656417* [0.0000]	2.215957 [0.9999]	-8.369357* [0.0000]
EUROPE PRICE	0.420888 [0.9832]	-13.67062* [0.0000]	0.777302 [0.9934]	-13.67732* [0.0000]
EUROPE GDP	-1.311343 [0.6232]	-6.682662* [0.0000]	-2.022313 [0.2771]	-3.334699** [0.0151]

[p values]

*, **, *** indicates the significance level at 1%, 5% and 10% respectively

It is found that the P values of all the variables at level become insignificant and tend not to reject the null hypothesis. When the null hypothesis is not rejected at level, it means that all the variables are non stationary at level and they have unit root during the study period. In contrast p values for the first differences are highly significant and hence the null hypothesis of non stationary is rejected at first difference. It is concluded that all the variables become stationary in their first

differences during the study period. Hence all the variables are integrated in the same order and this is denoted as I (1) variables.

7.8 LONG RUN ELASTICITY RELATIONSHIP BETWEEN GOLD DEMAND AND INCOME, PRICE OF THE WORLD GOLD SPOT MARKETS

While using the time series data, one of the recent econometric tools that used to study the long run relationship between two or more variables is cointegration. The present study adopted the model which is already used by R.Ramanathan (1999) for studying the long run and short run elasticity of gasoline demand in India. Prior to him the same model was also used by Eltony and Al-Mutairi (1995) and Bentzen (1994) in their study for analysing the gasoline demand.

Table No: 7.3

Long run elasticity relationship

Dependent Variable : Gold demand in tonnes				
Coefficients	**INDIA**	**USA**	**JAPAN**	**EUROPE**
α_0	0.435488* [10.95446]	0.489837* [94.89426]	0.324716* [22.03857]	0.325748* [64.46127]
α_1	-0.30319* [-3.356791]	-0.975779* [-26.30311]	-0.396774* [-16.22274]	-1.127067* [-26.40786]
T statistics of residual in the unit root test (without Intercept)	[-4.672949*] (0.0000)	[-2.987683*] (0.0030)	[-3.318067*] (0.0010)	[-2.128681**] (0.0324)
R – Squared	0.623153	0.365800	0.413637	0.212850
Adjusted R-Squared	0.599579	0.346869	0.396133	0.201442
D-W	2.015397	1.675731	2.013693	1.593245

[ ] – t statistics, ( ) – p values

*, **, *** indicates the significance level at 1%, 5% and 10% respectively

The second largest commodity that is imported next to crude oil in India is gold and also gold is one among the commodities that is traded in the commodity exchanges of major gold consuming countries. Hence adopting the same model to analyse the Long run and short run elasticity of demand for gold in India and the

major gold consuming countries would be more appropriate. This would add value to the empirical analysis in the present study.

Once the order of the integration of the variables I (1) are identified, the next step is to estimate the long run relationship among the variables included in the study. The cointegration relationship among gold demand, the spot gold price and the income of the consumers is estimated from the Equation No: 35. The Table No: 7.3 contain the results of the cointegration test. The table gives the co efficient value and the respective t statistics of the price and income elasticities in the long run.

It is found from the results that the sign of both price and income elasticity are satisfactory and follows the elasticity theories. According to the theory, the sign of price elasticity should be negative and the sign of income elasticity coefficient should be positive. It is found from the results of the unit root test on the residuals of the equation that the residuals are stationary at their levels I (1) during the study period for all the four countries and the p values are highly significant. This result indicates that there exist the long run relationship among gold demand, price and the income of the consumer for all the countries. Engle and Granger (1987) states that the null and alternative hypotheses for any unit root test applied to the residuals of a potentially cointegrating regression will be

$$H0 : Vt \sim I(1), H1 : Vt \sim I(0)$$

Thus under the null hypothesis there is a unit root in the potentially cointegrating regression residuals, while the alternative the residuals are stationary. When the null hypothesis of a unit root in the potentially cointegrating regression residuals rejected, it would be concluded that a stationary linear combination of the non-stationary variables has been found. Therefore the variables would be classified as cointegrated."

The coefficient for the long run price and income elasticity of gold consumption is estimated through Equation No.35. The long run price elasticity of gold demand is much high for Europe -1.13 followed by the USA which is -0.97. The long run price elasticity for India is -0.30 and for Japan it is -0.39. The long run price coefficient for all the countries are statistically significant and have negative sign. It is to be noted that India's price elasticity is the least coefficient among the major gold consuming countries.

Being the largest consumer of gold in the world gold market, India's reaction to the price changes is very less. i.e for every one percent change in the spot price of gold will alter only 30% of its consumption in the world gold markets. Hence a change in the gold price reduces only a small amount in the quantity demanded.

When we consider the Europe, It is highly elastic in such a way that for every 1% change in the gold price alters almost 100% of its consumption. Hence a decrease in the gold demand is expected when the price of gold is not constant over a period of time. This confirms that the fluctuations in the spot gold price will always make fluctuations in the gold demand. The USA shows almost similar reaction in response to the changes in the spot price as seen in the Europe. The results convey that for every one percent change in the price will change 98% of its consumption. Hence USA shows highly negative behaviour towards the changes in the price of gold.

The price elasticity of Japan also negative but its reaction to the changes of gold price is very less compared with both USA and Europe. The results show that a one percent change in the price causes to reduce only 40% of its consumption. Only 40% of its gold demand is reduced from the given price changes.

It is observed from the long run price elasticity results of all the countries that only India shows less reaction to the changes in response to the fluctuations in the price. It is because India's price elasticity is very less comparing to other three countries included in the study. The changes in the spot gold price will reduce only 30% of its consumption and the 70% of its consumption remains constant and unaffected by the price changes. Hence whatever be the fluctuation either increase or decrease in the price, the 70% of its gold consumptions remains unaffected in the world gold markets. The other three countries are showing huge response to the fluctuations in the spot gold price.

The income elasticity coefficient for all the countries is positive and highly statistically significant. The positive sign on the coefficient implies that a 1% increase in the income of the consumers increases the demand for gold. The results show that all the countries are showing positive reaction towards increase in the income. Thus an increase in the GDP signals positively for the growth of the gold demand in the future. The coefficient of income elasticity of Japan and Europe are almost similar and show relatively same kind of reaction to the changes in the income of the

consumer. Every one percent change in the income of the consumer will increase 32% of the gold demand. The income elasticity of USA and India is much higher than the above two countries where a one percent change in the income will increase the demand 49% and 43% respectively.

In other words 57% of the gold demand in India is unaffected by the changes in the income of the consumer. Whatever be the income of the consumer, the 57% of the gold demand always exist in the world gold demand. The estimated long run model is reliable for India as the R^2 is 62%. The R^2 of Europe 21% is little lower than the other countries. The Durbin Watson statistics is almost more than 1.6 for all the countries which indicates the absence of the serial correlation in the model.

7.9 EFFICIENCY OF THE WORLD GOLD MARKETS

The existence of the long run relationship among gold demand, income and price allows us to estimate the short run relationship. It is possible that cointegrating variables may deviate from their relationship in the short run but their association would return in the long run. In simple terms, whenever there is a drift due to the occurrence of a shock / innovation in the short run, the cointegrating variables are expected to restore themselves to maintain their long run relationship.

The estimation of the short run behaviour of the variables is done through the construction error correction model (ECM). The ECM is estimated from the Equation No: 36. All the variables are estimated in their first difference in ECM. The lagged value of the dependent variable (Gold demand) is also used as one among the independent variables, because it would implausible for them to appear without any lag (Dt-1) for this would imply that Demand (D) changes between t-1 and t in response to a disequilibrium at time t.

Table No: 7.4

Short Run relationship and Efficiency

Dependent Variable : Gold demand in tonnes				
Coefficients	**INDIA**	**USA**	**JAPAN**	**EUROPE**
β_0	-2.197499 [-1.197959]	-4.226798 [-1.514108]	-0.562345 [-0.723720]	-0.270637 [-0.158878]
β_1	-0.587946** [-2.350274]	-0.017440 [-0.085043]	-0.028612 [-0.329496]	0.117210 [0.911436]
β_2	-0.208387* [-5.945570]	-0.147548* [-3.180470]	-0.114459* [-4.299627]	-0.060113*** [-1.656204]
β_3	0.540693* [7.700234]	0.673535* [7.999076]	0.567695* [8.484081]	1.160746* [11.56084]
R – Squared	0.405509	0.327800	0.378393	0.496694
Adjusted R-Squared	0.388151	0.313187	0.364880	0.485753
D-W	2.142605	1.753887	1.989775	1.700829

[ ] – t statistics

*,**, *** indicates the significance level at 1%, 5% & 10%

The Table No: 7.4 contain the results of the estimated ECM from the Equation No: 36. The coefficient of β_0, β_1 & β_3 represent the price, income and lagged value of dependent variable for all the countries. The speed of adjustment is represented by the β_2 coefficient. The speed of adjustment coefficient β_3 measures the proportion of last period's equilibrium error that is corrected for.

It is found from the results that the short run price elasticity coefficient β_1 is insignificant for all the countries except India. Only for India, the price is showing significant impact on gold demand in the short run. The other three countries are free from the price change effect in the short run. Hence only India experiences the changes of price impact on its demand in the short run.

The short run income elasticity coefficient β_0 is insignificant for all the countries. Hence a change in the income of the consumer does not show any significant impact on the gold demand in the short run. In the short run, an increase in the income of consumers is not used for purchasing of gold, since gold is costlier than

any other commodities. This insignificance the income elasticity is due to the use of quarterly data of real GDP as the proxy for the income of the consumers. Hence the empirical results conclude that all the countries are free from the income effect on demand in the short run. The price of gold is much costlier than any other commodities traded in the world. It is purchased only on few important occasions and not purchased like other commodities very frequently. Hence the income of the consumers is accumulated / saved over a period of time for buying gold on the selected occasions. Due to the above reasons, the income is showing insignificant effect in the short run. But its impact and the significance level are high in the long run.

The short run coefficient of the lagged value of gold demand β_3 is highly significant for all the countries. Hence the consumption of gold in the short run is affected by its own lagged value. That is the changes / fluctuations in the previous period demand affect the current period consumptions. As stated earlier, the occurrence of disequilibrium at time t causes the changes in gold demand. Europe is showing high level of reaction than the other three countries. The impact is same for India, USA and Japan.

The speed of adjustment coefficient β_2 is highly significant for all the countries. The significance and the negative sign of this coefficient once again confirm the existence of long run relationship among the variables which is found from the previous cointegration analysis. In addition the β_2 coefficient also measures the speed of adjustment of the variables towards in the short run in order to maintain the long run relationship. The negative sign of the coefficient obtained from the estimations is what expected and it fulfils the required signs.

It is found that the speed of adjustment of all the countries is happening at a slow rate in particular Europe is showing a very little adjustment to the disequilibrium. The speed of adjustment of India is relatively happen at a higher rate than the other three major gold consuming countries. The Indian gold market is adjusting its error at the speed of 20% per month and roughly it takes five months to get back to its equilibrium from the shocks that caused the disequilibrium. India corrects only 20% of the error in the current month and the remaining errors are adjusted in the following months. Hence any disequilibrium occurs in Indian gold

market, the 100% error correction is done at the fifth month. The information that arises in the domestic and international gold markets are reflected in the movement of the demand for gold by causing disequilibrium in the markets. All the new information is incorporated in the demand for gold over a period of five months and the market reaches the normal stage after five months.

The USA market's gold demand speed of adjustment is 14% and it takes around seven month to get back to the equilibrium. 100% error correction is arrived at the seventh months and the market reaches equilibrium relationship from the mid of seventh month. The error correction of Japan is 11% per month. Only 11% of its error is adjusted in the same month and the remaining is corrected in the following months. The market arrives the equilibrium after ten months but the disequilibrium is adjusted in the same year. Europe is the slowest rate as it corrects only 6% of the error in the same month.

From the above results it is confirmed that India's gold market is more efficient than other three major gold consuming countries. It is because of its capability of speed of adjustment in the short run in response to the errors. Only India gets back to the equilibrium at the faster rate than other three countries within five months. The available new information are quickly reflected in the Indian gold markets than the other major gold consuming countries. To put it differently, Indian gold demand market incorporates all the new information at a faster rate than the other countries. Hence its efficiency is proved.

Though India is the largest consumer in the world gold market, the domestic gold market is efficient enough to correct its error which is caused by any shocks / innovations that leads to disequilibrium. The market is efficiently and effectively maintains its long run relationship by adjusting to the short term deviations. Hence the study concludes that India is not only the biggest consumer of gold but also it is functioning more efficiently and effectively than other major gold markets in the world. The models are reliable as all the countries have R^2 more than 40% except USA where its R^2 only 33%. All the models are free from its own autocorrelation as the Durbin Watson statistics are above 1.8 for all the countries.

7.10 CONCLUSION

This chapter examines the long run and short run elasticity of gold demand with respect to its spot price of gold and the income of the consumers. The estimated results prove the existence of a long run relationship between the demand for gold, real gold price and gold demand and the income of the consumer. There exists positive elasticity between gold demand and the income, and negative elasticity between gold demand and gold price. It is also found that Indian gold market is less sensitive to the price changes and also the domestic gold market is capable of incorporating all the new information at a faster rate than the other major gold consuming countries.

The income elasticity coefficient for all the countries is positive and highly statistically significant. The results show that all the countries are showing positive reaction towards increase in the income. Thus an increase in the GDP signals positively for the growth of the gold demand in the future. To be specific an increase in the income of the consumers from India and USA creates more demand of gold than Europe and Japan.

During the short run the demand for gold is highly influenced by its lagged demand than price of gold and income of the consumers. The income factor does not influence any of the market in the short run. The price factor is significant only for India in the short run. It is observed that the Indian consumers react significantly and quickly in the short run and their reaction to the price changes is stable in the long run. India is the largest consumer in the world gold markets and its gold consumption reflects all the information at a faster rate than the other major gold markets. Hence the study concludes that India is not only the biggest consumer of gold in the world gold markets but also it is functioning more efficiently and effectively than other major gold markets in the world.

Chapter

8

Findings and Suggestions

CHAPTER - VIII

FINDINGS AND SUGGESTIONS

8.1 INTRODUCTION

This chapter briefs about the major findings of the study from the empirical analysis. The aim of this study is to answer the questions in the minds of people who are involved in the bullion business in India. i) Who is the real price maker in the world gold markets? ii) Being the largest consumer of gold, what is the role played by India in world gold price? Hence the variables and the models are selected in order to provide effective results and conclusion. The long run and short run relationship and the information spillover among the world gold markets are tested and the efficiency of the world gold markets is measured in terms of their price and elasticity of gold demand. Many interesting facts have emerged from the empirical analysis. The major findings of the study and the suggestions are discussed below.

8.2 FINDINGS OF THE STUDY

8.2.1 Gold price movements are integrated

The spot gold prices of all the countries are positively correlated with each other and there exists a long run relationship among the world gold markets in all the study periods. This indicates that the movement of gold price of one country is not independent of other countries; instead their movements are integrated with one another. This suggests that a consumer in one country could make use of the information of another country to forecast his/her own price in the domestic markets. The movement of gold price pattern in Japan can be used to guess the gold price in India. The Japan market will initiate its trading first in the time zone, followed by India, Europe and USA markets. Based on the opening price in Japan the world gold price will move accordingly and particularly in ASIAN countries.

8.2.2 Gold price incorporates domestic and international markets information.

The arrival of new information in the gold markets is immediately reflected in the LBMA AM fix and PM fix prices. The domestic spot gold price of all the countries incorporates both domestic as well as international markets information, as there exists disequilibrium in their domestic prices in the short run. This prevents the arbitrage opportunity in the gold markets. Since the current price reflects the entire information arrived in the market, it is not possible for the consumers and the investors to make use of the information to go for the arbitrage process.

8.2.3 Gold prices are fixed afresh everyday

In spite of its deviation in the short run, spot prices of all countries are capable of maintaining their relationship in the long run. The market gets back to the equilibrium and hundred percent of the error is corrected on the same day itself. This shows that every day the gold price is fixed afresh and not from the historical information. Hence the historical information becomes useless.

8.2.4 India plays a vital role in the fixation of world gold prices

The influence of the consumption of gold on world gold prices was analysed thoroughly. The results reveal that fixation of the AM fix price is highly influenced by the information coming from Europe and Indian markets and the fixation of PM fix price is highly influenced by the information coming from USA and Indian gold markets. Europe and India play a dominant role in determining the AM fix and USA and India play a dominant role in the PM fix price. The gold consumption in India and the domestic market information is capable of making fluctuations in both the fixes. Hence India's gold consumption does not remain as a mere transaction; instead it plays a crucial role in fixing the prices of world gold markets.

8.2.5 No assurance for excess return from gold

It is found that the return of Indian gold market is highly correlated with the return of AM fix and the return of USA gold Market maintains high correlation with return of PM fix in all the study periods. This results shows that the existence of the co-movements in the return series may not allow the investors and the consumers to earn excess return.

8.2.6 Persistence of Volatility in the World Gold Markets

The persistence of volatility is found from analysis in the all the study periods. The volatility of gold market is highly sensitive to the innovations and new information that arrive in the markets. This shows that gold market is not an exception. Like other financial products such as stock market, currency markets etc, gold also face volatility characteristics in the financial market. The arrival of good news and positive news cause more volatility than bad and negative news. When there is more volatility in gold return, it indicates that the good news has already arrived in the markets. In other words good information is hidden indication to the consumers and investors that there is every possibility for the gold price to fluctuate more than usual. Increase in the Money Supply or drastic reduction in the stock market performance signals that the gold demand will shoot up in the near future, which will directly affect its price movements.

8.2.7 Possibility of assessing the gold price volatility

It is proved from the results that most of the variances of AM fix and PM fix prices are accounted by the information coming from the world gold markets and not by its own lagged values. The information in the domestic gold markets passed on to the AM fix and PM fix prices, causes the variances in their price movements. If one is able to collect all the related events and information throughout the world, he/she would be able to assess the gold price volatility.

The results also evidenced that there exists more volatility spillover from India to AM fix price volatility and USA to PM fix price volatility. The volatility characteristics of Indian gold market and USA gold market play a vital role in causing the variances of both the fixes. There is possibility for the consumers and the investors to make use of these two markets' information to assess the world gold price movements. However, the market is efficient enough to reflect those information in their prices.

8.2.8 World gold prices are influenced by a single country

The results showed that all markets together influence the changes of AM fix and PM fix price. But only India and Europe shows its individual effect on the AM fix price and USA shows its individual effect on the PM fix price. It is inferred from

these findings that there is possibility in the world gold markets that a single country can rule and dominate the entire movement of the world gold prices.

8.2.9 India's gold consumption plays vital role

It is proved through the results that the jewellery consumption of all the countries individually and jointly influence both the prices. Whereas the investment demands does not influence the spot price in any of the study period, when we put together these two, only India's aggregate demand is capable of effecting the world gold price changes and not any other countries included in the study. It shows the significant role played by India's gold consumption in the world gold prices. Therefore India's huge volume of gold consumption in the world gold markets plays a vital role in the world gold price fixing process.

8.2.10 Rupee Fluctuation causes world gold prices

Another major finding of the study is the role played by India's currency. It is not only the gold demand that influences the international price, but also rupee fluctuation against US dollar. Both show their significant effect on causing the world gold prices. The more the changes in India rupees, the more the changes in the world gold prices.

8.2.11 Indian stock market performance causes world gold prices

The results evidenced that the performance of stock market in India play a significant role in the world gold price changes. Hence the investors and consumers across world can make use of the Indian stock market information to assess the world gold prices.

8.2.12 World Gold prices react to the Shocks from countries

It is observed from the results that AM fix and PM fix prices react immediately to the shocks coming from the world gold markets. But their response is highly sensitive to shocks coming from India and USA. If there is drastic change in India's consumption, either positive or negative, this kind of shocks are able to cause more disequilibrium in the world gold prices. The stability of the world gold price is

much affected by the performance of the Indian and USA gold markets. Only these two markets cause more deviation in the prices.

The effect of innovations from stock markets of other countries like Japan, and Europe is very low and they die away in a short period of time. Their effect is short lived. But the effect of shocks coming from Indian stock market sustains in the system longer than those of any other country included in the study.

8.2.13 Gold price and income of investors do not stop the gold consumption

There exist long run relationship between gold demand and gold price and gold demand and income of consumers from all the countries included in the study. There exists positive elasticity between gold demand and the income, and negative elasticity between gold demand and gold price. It means that an increase in the price reduces the gold demand, and an increase in the income increases the consumption. India has less price elasticity than the other major gold consuming countries. It shows that Indian consumers and investors actively participate in the gold market and take right decision at the right time by reacting to the market information. They reduce their gold consumption when the price of gold goes up and increase their demand when their income level increases.

The gold consumption in India is less sensitive to the changes in the price, because certain occasions make the buyers to buy gold compulsorily. The special events such wedding and Akshaya Trithya induces the consumers to buy more gold than the other occasions. India always needs some amount of gold that is to be distributed in the market. Hence these occasions force our importers to import gold from the world gold markets.

8.2.14 Indian gold market is Efficient

The results proved that Indian gold market is able to function more effectively and efficiently than the other major gold markets in the world. In spite of demand fluctuations in the short run, the market shows stability and constant movement in its gold consumption. It indicates that Indian consumers and investors study the market thoroughly and make suitable decisions accordingly. At the same time government and the central bank in India are also able to have their control over the gold import

from the world gold markets. Indian consumers also function more effectively in the retail market than those in other countries. The uniqueness of Indian consumers is proved in this study.

8.3 SUGGESTIONS

8.3.1 Exploration of greater gold production opportunities

Government should take necessary step to set up the number of new refineries in the country in order to reduce the importing of gold from international markets. The increase in the production of gold in the country will eventually increase the supply of gold in Indian market. This will help India to become independent of the world gold markets for its consumption.

8.3.2 Regulation for Gold markets

Indian gold market lacks regulation. Strict regulations should be brought into the retail trading especially in fixing the wastages and making charges in order to protect the consumers from being charged huge amount, as this study proves that irrespective price consumption level is maintained

8.3.3 Ensure the quality of gold

A large number of Hallmarking centres should be established in order to protect consumers from purchasing of impure gold and surprise checks should be undertaken in all jewellery shops to check the quality and quantity of gold sold.

8.3.4 Single Govt agency to import gold

The import of gold by the Nominated agencies and Authorised banks can be channelized through a single agency in the country. This will bring control over the gold consumption and enable the gold market to function effectively. When a single buyer represents the country, there is a possibility that he may increase the bargain power in determining the gold price.

8.3.5 Remove restrictions on gold imports

The study proves that increase in the gold consumption indirectly increases the wealth of the country. Therefore effort should be made to import as much gold as possible. This can be done through removing or relaxing the restrictions on bringing gold into India by individual or business houses from abroad.

8.3.6 Need for innovative new investment products

Efforts may be taken to make the bankers and commodity exchanges to come up with new investment products in order to make use of the idle gold that simply lie in the households. Thereby the unused gold can also be brought into the economy.

8.3.7 Look at Japan price for India price

The study proved that gold prices are integrated with no opportunity for arbitrage between world gold markets. Also It is found that Japan price will be the lead price for India. Therefore, Investors or business houses advice to look for the closing prices of Japan to foresee the Indian price on the next day and take steps accordingly.

8.3.8 Active role of IBMA is required

One of the major objectives of establishing IBMA is to make India as a price maker in the world gold markets and create Bombay Fix price. This study empirically proved that India's consumption play a significant role in the world gold prices. Therefore IBMA should start to execute its objective with the help of other major bullion associations and commodity exchanges in different parts of our country. When India becomes price maker in the world gold markets, there is a possibility that India will get greater price advantages in the domestic market.

8.3.9 Encourage banks to bring in effective system for making idle wealth to give return to customers

In addition to the several existing sources, Banks sell gold to only the common people. After that banks do not have any other role in making the wealth to give return. In such cases, why should banks, especially nationalised banks get involved in

such action? Instead if they are able to bring out a system for producing return out of accumulated wealth, our country can prosper.

8.4 SCOPE FOR FURTHER RESEARCH

- Special attention is paid to India's consumption in the world gold market and only the impact of gold demands of major four countries is included and supply side is ignored in the study. A separate study may be undertaken to observe the impact of the supply on the world gold prices
- The study considered only the spot gold price of selected countries. The same can be conducted for the futures prices that are traded in the major commodity exchanges of these countries.
- MCX is number one in Gold and silver trading. Hence a separate study may be conducted, to examine the impact of the performance of MCX and its trading volume of gold on the world gold price discovery and the lead lag relationship among the futures prices.
- The same study could be extended to the upcoming major markets such as China, and Middle East in order to check whether India's impact still persists.
- The impact of the economic growth of a country on world gold price is not analysed in the study. A separate study may be conducted by considering the impact of the economic growth on major gold markets in the world.
- The efficiency of the gold market is measured in terms of their demand and not in terms of the price. A separate study is required to observe the efficiency of the gold markets in terms of their domestic price movements.

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Appendix

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