# Project Report on


# Analysis of Factors affecting Indian Gold Prices


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**(Formerly Known as Delhi College of Engineering)**

## <u>CERTIFICATE</u>

This is to certify that **Mr. Vibhore Maheshwari**, Roll No. **2K11/MBA/55**, a student of Delhi School of Management, DTU has developed a project titled **"Analysis of factors affecting Indian Gold Prices"** under the guidance of **Dr. Rajan Yadav** and has submitted a satisfactory report of the project as a partial fulfillment of the requirement for the MBA program. This work has not been submitted in part or full to this or any other university as part of project work to the best of our knowledge.

We wish him success in the future.

Date: …………………….                             Signature: ………………………..

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# DECLARATION

I **Vibhore Maheshwari – 2K11/MBA/55** Student of **Delhi School of Management** would like to state that the project titled **"Analysis of factors affecting Indian Gold Prices"** is an authenticated work carried out by me under the guidance of **Dr. Rajan Yadav** for the partial fulfillment of the award of the degree of **"Master of Business Administration (MBA)"** and have submitted a satisfactory report of the project. This work has not been submitted in part or full to this or any other university as part of project work to the best of my knowledge.

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# ACKNOWLEDGEMENT

I have always considered project development as a challenging task that requires a lot of concentration, hard work and versatility of human mind. The project that I am presenting in this dissertation report on the project titled **"Analysis of Factors affecting Indian Gold Prices"** has been an enriching experience for me.

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# EXECUTIVE SUMMARY

Gold is an important commodity all over the world primarily because of the varied uses and applications. India is the largest consumer of gold around the world and produces only 0.05% of its total consumption. With rising prices in the last two years, studying the gold prices and identifying gold price trends has on the whole become more important and challenging.

The objective of this dissertation is to develop a model to forecast the prices of Indian Gold. This is achieved by taking two set of independent variables: the exchange rates of top 10 countries from which India imports gold and macroeconomic variables like oil prices, nifty, silver prices. The model is tested in two stages: identification of currencies significant impacting the gold price and then determining the significant independent variables overall.

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# 1. Introduction

Among all worlds' commodities, Gold has a unique position. This is because it is traded internationally and it has been established as acceptable value store for a long time now. People consider it to be a better investment commodity than flat paper currency. Currency is fluctuating and unpredictable which is not so much the case with Gold. This is why it is popularity said that Gold is forever! It is recyclable and we see that gold mined years and years ago in history is still in circulation in some form or the other.

## 1.1 Why is Gold important

Gold plays dual role, as a commodity and as money too, due to which its price is not comparable to other commodities or services in market. Gold cannot be seen only in one perspective that is from US market alone. This is because political and economic events happening worldwide also impact the gold market outweighing the developments perceived to gold as a exchange medium.

Investors call an asset a safe haven where they know they can put their wealth even in financial turmoil. A stable real value and / or a stable nominal value prove to uncontroversial safe haven for Investors. It allows the holder to resell without losses at any given point of time. Even when markets collapse A safe haven was illustrated in year 2008 when a number of major investment fund companies channelled their portfolio and focus towards cash. Treasury Bills and bonds of government coming from low yield nations et this criteria to some extent. This is when it is known that they can be held to maturity and that the risk of defaulting is negligible.

In light of definition of safe haven above, we see that Gold appears to be a good candidate fitting into the definition parameters. This because of following reasons:

1. The nominal value is not very stable for Gold, but in history it is known that it acted as standard exchange preposition for international monetary system. This hints that it has proved to be an ultimate resort even in troubled times.
2. Though debatable, Gold has also been seen as hedge against Inflation as discussed by Jaffee in 1989. This means that gold preserves its real value on an average over a long period of time. According to Baur and Lucey (2010), it has also been researched that Gold prices do not correlate with stock prices. So they are inert to fluctuating stock values.
3. Gold is also considered as a liquid asset according to quotes form spot and futures markets. Also it has the property of being traded easily.
4. Another important thing about Gold is that it is an international asset independent of a particular state's decisions.

During the economic and financial unrest, assets considered to be safe haven are very sought after. The prices of risky assets tend to plummet in these periods via various infectious channels. There are several mechanisms that contribute to the spread of price falls. For example loss realization in one market force investors to withdraw their position form other markets. This increases the marginal calls and subsequent drying up of liquidity. Then there

are tighter risk management rules which further trigger the sell offs of assets that are risky. Now this results in rush to buy safe assets like government bonds, T-Bills and strong currencies too. In this list Gold is also included as safe asset commodity. These times force the prices of safe assets to surge. We can see that July 2 2007 to 9 March 2009 S&P stock index went down by 55% whereas the gold rallied by 40%.[1]

Since the rally in Gold started in 2001, Gold costs have climbed on the rear of a number of problems including: the weaker dollar, increased geopolitical risk, higher oil costs, portfolio diversification, producer dehedging, falling mine production and, till recently, reliable and resilient Asian jewellery demand. However, a number of these bullish underlying trends are currently changing, for instance producer dehedging has all however run its course, Gold production is climbing once more, jewellery demand has fallen sharply and oil costs are comparatively low. The one factor that has turned a lot of positive for Gold is that the reduction in official sector sales and therefore the possibility that this sector may flip a internet buyer. In any case the changes are negative for Gold's fundamentals. However, one issue that has not modified is investors' demand for Gold. The money crisis and therefore the sovereign debt crisis have increased the demand for safe-haven investments.

The 10-year gold rally continues nearly unabated. Gold has been one in every of the few beneficiaries of the global money crisis and its aftermath. It rallied at every stage of the crisis as this evolved from a neighbourhood subprime mortgage blow-up, starting in 2007, to a full-blown world credit and economic turndown in 2008-09, before morphing once more, this point into a sovereign debt calamity from 2010. Gold simply outperformed competing asset categories throughout this entire amount. The response to the crisis was unprecedented among policymakers across Organization for Economic Cooperation and Development (OECD) member states in terms of huge fiscal expenditures, unconventional financial policies, and therefore the lowest interest rates on record. This sparked fears of inflation and issues concerning long term implications of deep government deficits, and investors flocked to gold.

## 1.2 Factors Driving Gold Costs

**The dollar** – because the money crisis took hold in mid-2008, the dollar found some support as safe-haven shopping for into US Treasuries led to dollar shopping for too. However, the irony is that the US's reliance on QE in result threatens to debase the dollar, turning it even a lot of into a fiat currency. Indeed, there's a worry that debt levels might get therefore high that governments' solely hope of repaying the debt would be to permit inflation to cut back its price. When inflation takes to the air in a country the currency weakens because it devalues against alternative currencies. However, when 2 or more currencies devalue at constant time their exchange rates might not register a lot of modification, but the shopping for power of those currencies is reduced. This can be one reason why we have a tendency to expect Gold prices to still rise. As Europe, Japan and therefore the US take measures, such as QE, to underpin their economic growth and fend off deflation, they risk debasing their currencies, and therefore it's not shocking that Gold costs are rising across these currencies. As a result of competitive devaluation is impacting several of the currencies that structure the dollar index (which includes the euro, the yen, the pound, the Swiss franc and therefore the Swedish krona) the extent of weakness within the dollar might not be exposure within the index.

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[1] India Gold Rush and Its Sustainability, Assocham India, April 2010

However, a glance at the dollar vs the Swiss franc, clearly shows the down trend within the dollar continues, see chart opposite. During the sovereign debt scares in Europe in the initial 0.5 2010, the inverse relationship between the dollar and Gold has been sporadic with each typically rising at the same time, that highlights each are seen as safe-havens. However, more recently the dollar has been falling and Gold has been rising.

**Deflation - Inflation[2] -** At this time, the prospects of deflation appear to be a much bigger cause for concern than inflation, though the inflation / deflation risk has currently become a lot of a geographical issue. Asia and rapidly developing economies face inflation, whereas developed economies are worried concerning deflation and with interest rates already as low as they will be, governments are using QE in a trial to avoid deflation. As QE debases a currency, we feel Gold can stay in demand even throughout an amount of deflation. One argument against robust Gold costs during times of deflation is that deflation is probably going to examine a lot of demand for US Treasuries and in flip that's possible to underpin the dollar. Once sustainable economic growth is seen once more, we expect inflation to require hold within the West, either as governments permit it to, in an endeavour to reduce the worth of their debt mountains, or as a result of they find you being slow to tighten monetary policy. This might happen if growth returns whereas unemployment remains high, or the housing market remains fragile. Therefore even if inflation is unlikely to be a problem within the West in the medium term, it's an extended term threat, particularly given all the QE.

**Stagflation** – Given there's a degree of unknown consequences within the measures central banks are applying in their effort to prompt growth and avoid deflation, there's a risk that they might be making the conditions for stagflation. Indeed though official inflation within the West is low, asset costs are already rising strongly and that they don't seem to be doing therefore on the rear of a powerful pick-up in demand. Therefore it might seem that one in every of the implications of QE is that liquidity is pumping into equity and commodity markets and is chasing costs higher. As such, we have a tendency to are becoming high prices, however very little economic growth and as growth remains subdued unemployment is remains high. During this state of affairs governments are possible to refrain from raising interest rates and in flip that is possible to steer to inflation.

**De-hedging** – At the beginning of the bull marketplace for Gold, that roughly coincided with the beginning of de-hedging, the entire hedge book stood at three, 107 tonnes (99.9Moz). At the tip Q2'10, the hedge book stood at 195 tonnes (6.75Moz). Because the hedge book shrinks the amount of de-hedging has, not surprisingly, slowed: in H1'10 the hedge book was cut by forty tonnes. The 'de-hedging era' is currently returning to a detailed and so one in each of the steady drivers of the bull market is petering out. At present, the angle towards hedging has not modified and new hedges solely seem to be placed on when bankers/financiers demand it for brand spanking new comes. However, at some stage Gold's bull market can finish and even if the present desires of shareholders of mining companies is for no, or restricted hedging, that angle is probably going to vary when the prospect for economic recovery improve, the requirement for safe-havens recedes and long liquidation emerges. For the instant the mood amongst producers is, within the majority, still bullish for the Gold value.

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[2] The impact on inflation and deflation on case of gold, Oxford Economics, July 2011

**Central Bank Official Sales[3]** – For several years central banks are internet sellers of Gold however that may currently be close to modification. Because the initial year of the third Central Bank Gold Agreement (CBGA-III), which permits for sales of four hundred tonnes of Gold every year, involves a finish, it appears like EU central banks have reported sales of but three tonnes; the IMF has sold 222 tonnes to central banks (India two hundred tonnes, Mauritius two tonnes, Sri Lanka ten tonnes and Bangladesh ten tonnes) and eighty eight.3 tonnes on the open the market, therefore collectively official sales look to be so as of some 333 tonnes. Outside their acceptance of IMF sales, European Central Banks would seem to own had a major modification of heart as their sales are minimal whereas beneath CBGA-II annual sales averaged 377 tonnes. Alternative countries are adding to their Gold reserves; between January and therefore the finish of April IMF information shows official holdings increased forty three tonnes, with Russia and Venezuela the 2 main patrons. Alternative reports also recommend that Russia has continued to create up its Gold reserves and at the tip of July reportedly held some 726 tonnes, up 13.6 % up to now this year. With restricted IMF sales next year, (they still have an estimated ninety two.7 tonnes to sell) and with European central banks maybe refraining from selling, we might not be shocked to examine central banks become internet patrons in 2011. As of the tip of July 2010, central banks still held thirty,520 tonnes of Gold – this can be value remembering once we worry concerning sovereign debt as if things did become important then central banks might flip to their Gold reserves to bail themselves out. Note how the Bank of International Settlements, BIS, completed a 346 tonne Gold swap in July with numerous commercial banks, whereby it lent them cash and took Gold as collateral.

**Central Bank diversification:**
Countries have already started to take steps to diversify their reserves. Traditionally and for some time future no doubts that S dollar is likely to remain as world's reserve. China for example has already cut its dollar reserve holding and has started to buy Japanese bonds. China's held 843.7 billion US debts reduced from 938 Billion dollars as on September 2009. In first half of 2010 china bought 20 billion worth Japanese bonds. China is further thinking of buying debt from other Asian trading counties. Though China has clarified that they are not interested in buying Gold reserves as the market is too small, but they could buy a proportion of country's mine output. Even though China is not too bullish on Gold reserves other Asian counties are. It is expected that trend will continue and maybe spread to oil producers too. China, Japan and Saudi Arabia only have 2% to 3% of their reserves in Gold compared to 62% in the European counties.

**Oil:**
In Bull Run, Oil and gold prices have been seen as correlated. Since March oil prices have been oscillating in a sideways trend. Gold prices on the other hand have continued to rise. This weak correlation shows that oil prices struggle in light of economic struggle, whereas Gold prices remain strong as a sign of anticipation of more financial unrest. If Oil prices see a growth in tandem with economic growth, it can be considered as a warning to Gold price bull run. This final stage of Gold price Bull Run can still prove to be very powerful as return to growth might be inflationary in nature.

**Jewellery demand**

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[3] Factors that determine gold price, Kim Hyuon, September 6, 2011

Jewellery consumption accounted for bulk of Gold demand, on an average 78% between 1993 to year 2000.Then in 2001 Gold's Bull Run started. In Mid 2000's it started to go down to around 62%. Since 2009, jewellery consumption has gone down to less than 50% of Total Demand for Gold. High Gold prices are the reason for this decline in jewellery consumption. Moreover economic issues have further pushed the consumption down. This is a worldwide pattern with China as an exception. Global jewellery demand fell 20% year on year to around 1,760 tonnes in the year 2009. It is expected to fall a further 15% this year to 1,500 tonnes. China on the other hand saw demand reach 340 tonnes, a 7.6 % rise. The demand for jewellery is only expected to go further down. Prices are going to become more volatile in coming years which will only decrease the demand for jewellery.

**Investment demand**
Exchange Trade Funds are popular Investment means. They are used in investment circles like with retail Investors, pension funds, hedge funds and sovereign wealth funds too. The overall trend in the amount of Gold help in ETF has been going upwards, with few instances of large redemptions.
The financial crisis of 2008 and sovereign debt crisis this year both saw a quick increase in size of ETFs. Amount of Gold held peaked in mid July 2008 at 2095 tonnes and redemptions in rally equities recently saw holding of 2046 tonnes of Gold. This was followed by fear of double dip recession and then by weakening of dollar value. This caused the holding to return to a new high of 2106 tones.
Investors do not confine their investment to ETF only, but they are interested in huge amounts of Gold coins and bars. Retail Investment demand in Europe and North America in year 2008 jumped to first 327 tonnes and then to another high of 414 tonnes in 2009. The average level of buying in 2006 and 2007 was 50 tonnes.
In Q1 2010, American Gold Eagle Coins sold about 82875 ounces. They jumped to 190,000 ounces by May and averaged to 164500 ounces over 3 months of May, June and July. They then dropped to 41500 ounces in August of same year.

## 1.3 Scope of the dissertation

The objective of the paper is to develop a model for predicting the prices of Indian Gold. For this two models are identified. The approach used is as follows:

The Top 10 countries from which India imports gold are identified and their currency's exchange rates are regressed with gold price to identify the currencies which have a significant impact on the gold price. The countries are Britain, China, Switzerland, UAE, USA, Hong Kong, Germany, Netherlands, South Africa and Australia. The currencies which are considered significant at 1%, 5% and 10% significant levels are taken to the next stage.

As part of the second regression stage, the currencies are regressed with other variables oil prices, silver price & Nifty (closing price). All the series are tested for statistical problems like stationarity, hetroskedasticity, multicollinearity, autocorrelation and Causality.

In the later stage ARIMA modelling is done to further improve the results. The Final ARIMA model is selected on the basis of the model which gives the highest $R^2$ value and least MAPE (mean Average Percentage Error).

# 2. Historical Background



**Chart 1: Gold (Rs/oz) and total gold demand (Rs bn) in India**

Note: Indian gold consumption figure includes jewellery consumption, investment and industrial demand only.

Source: WGC estimates, Bloomberg, GFMS
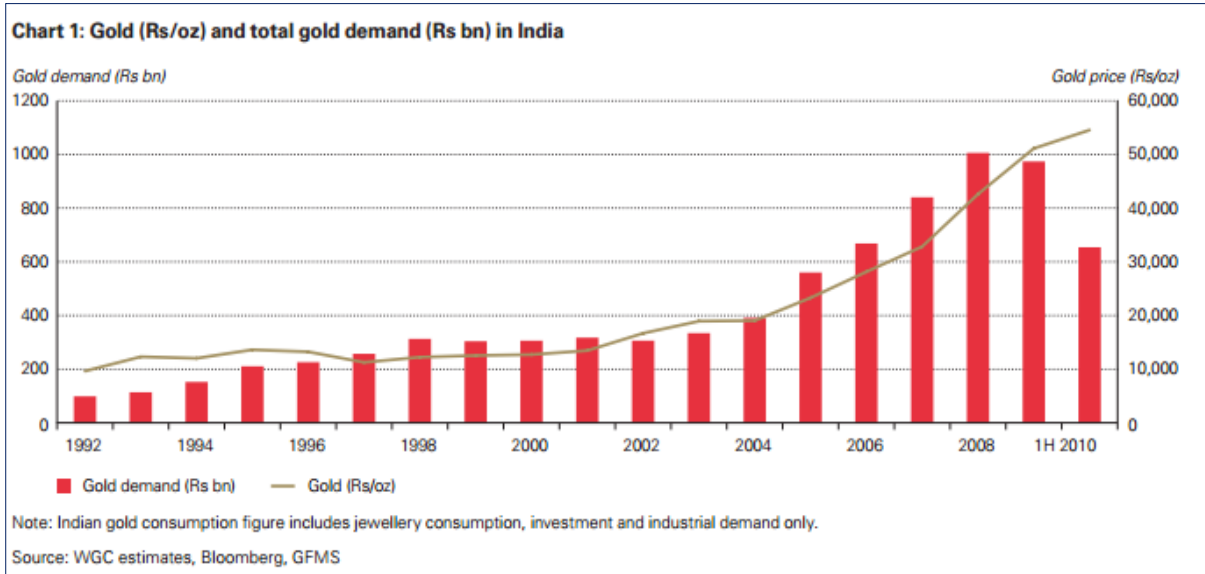
## 2.1 Demand of Gold in India

In India possession of Gold signifies both great wealth and good fortune too. Gold is used for daily consumption as jewellery and ornaments. After Declining by considerable levels, Indian market in 2009 saw a good recovery in spite of economic unrest worldwide.

Being the Largest Gold market, India sees Gold consumption in Jewellery, investment and in lot of industries. This consumption amounts to almost 600 tonnes of demand for gold in 2009, which is 15% of world's demand for same year. WGC estimated that India owns about 18000 tonnes of gold stocks which are above ground, and which are worth approximately 800 billion US$ taking the current gold prices. This stock represents 11% of world's global stock and is equivalent to ½ ounce/per capita of the nation.



Source: WGC estimates, GFMS, IMF
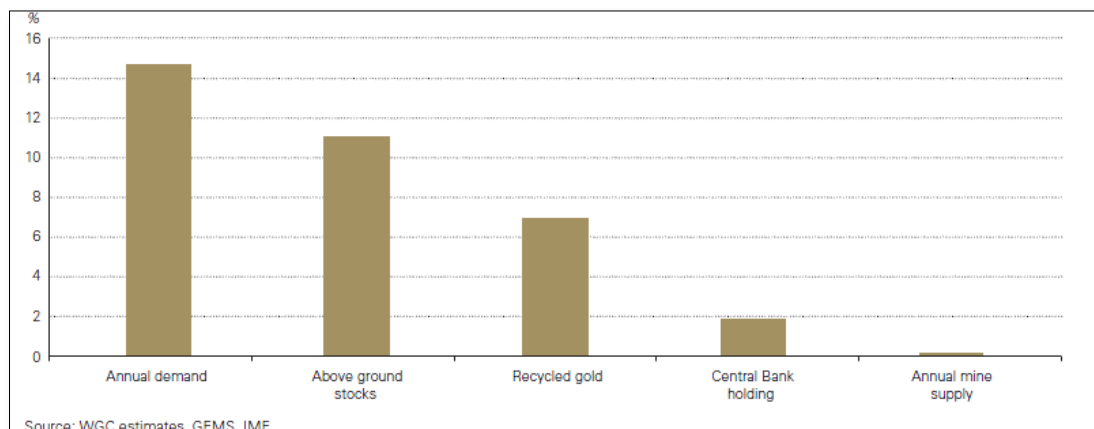
**Figure 1: India Gold market as % of global gold market, Tonnage Terms, 2009**

Year 2009 saw Indian gold consumption going to 974bn. Percentage increase of gold consumption has been at 13%, which is higher than country's real GDP (6%) and population growth (8%).

India's economy and recent growth has been compared to that of china. In past 4 years India's domestic economy has grown at 8% for 4 years. The projection by RBI for FY2010 is 8.5 %. Looking at these statistics, India is among the world's fast growing economies.

Also according to the Consensus Economics forecasts, country's growth is expected to be 8.3 % in FY2011. Similar forecasts have come from IMF, expecting India's real GDP above 8 % from 2010 to 2015. This is a very good growth in comparison to most of the economies and is second among BRIC nation economies.

Year 2009 also saw a growth in Year on year increase of Broad money supply, going from 7tn in 2008 to 8tn in 2009.Bloomberg data shows that supply of rupee grew 1383% between 1992 and 2009. On the other hand gold price over the same period increased by 430%, i.e. Rs 51115 per ounce.

India is seen as important target destination for global foreign investment due to its rapid economic growth, its high saving rate and good demographics. FDI inflows for India grew from 13% YoY to 1.5bn USD for the year 2009.This resulted in a gain in rupee by 5% against USD for the same period. Rupee is considered to be one of best performing Asian currencies, and the consensus is that it will continue to grow rather than decline over long term. The implication for this rupee appreciation will be positive for gold market of India, creating better balance on global gold market. India's consumption is highest in terms of tonnage, and with factors such as appreciating rupee along with strong affinity to gold will only drive gold demand to a higher side.
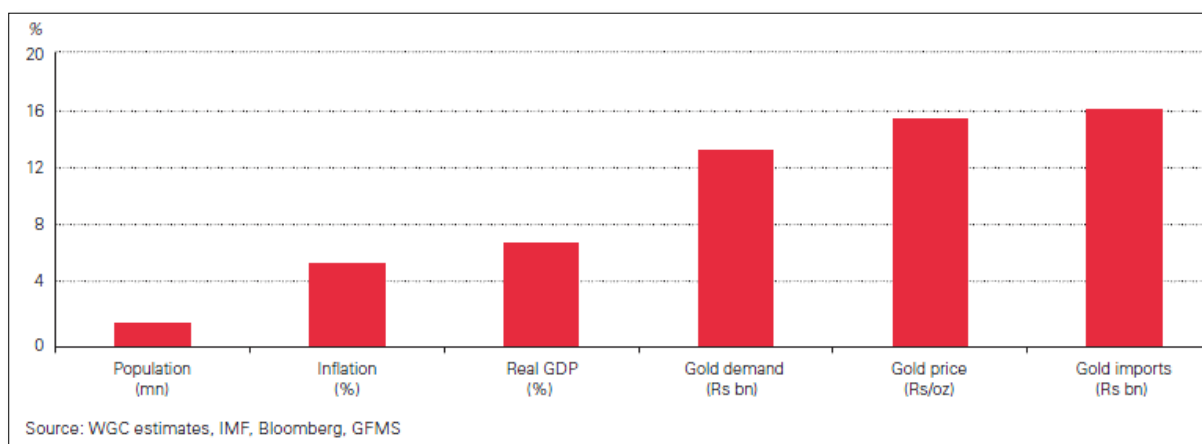


**Figure 2: Average Annual 10 year growth rates in India (%)**

## 2.1.1. Jewellery consumption
The breakup of gold demand in Indian market in year 2009 is as follows:

1. Jewellery ~ 75 %
2. Investment ~ 23%
3. Decorative & Industrial ~ 2%

This shows that Indian consumers are well versed with investment capabilities of Gold and understand its storage as a value preposition.

Marriage ceremonies attract largest consumption of Gold jewellery. In Indian setup wedding, Gold is a necessity rather than luxury. Gold Jewellery is a medium of inheritance for a girl. Hence the Gold Gifts given during wedding are called Streedhan (women's wealth). As per Hindu tradition family assets are only inherited by sons, so this way a portion of it is inherited to daughter indirectly.

This Gold Gifted during marriage is very important from parent's point of view, since this is an asset to secure their daughter financially. This Gold is directly under wife's Control, and that she may not be privy to family's other financial matters.

The wedding related demand for Gold is a substantial proportion of overall demand. In south India, wedding jewellery is traditional, intricate but bulky in style. On the contrary, northern cities have seen a trend of demand shifting toward western and lighter wedding sets. Also Diamond is becoming more and more popular in northern cities.

Year 2010 will see Gold consumption on a recovery side, nearing a pre-credit crisis level following a fall in 2009.A rise in demand is anticipated also due to the fact that consumers have adjusted their price expectation now.

Initiatives from Jewellers such as "save and buy schemes" have also lifted the Gold jewellery demand. These saving schemes provide consumers the opportunity to buy Gold using instalments over few months timeframe. By the time instalment matures, the jeweller also contributes some bonus amount as part of the scheme. This very well fits the Indian mindset and culture about Gold as a form of Investment.

Even though India is seen as a largest source of global gold demand, the intensity is relatively low as compared to Italy and US. Nation's Gold jewellery consumption per capita in 2009 was .4 grams only.
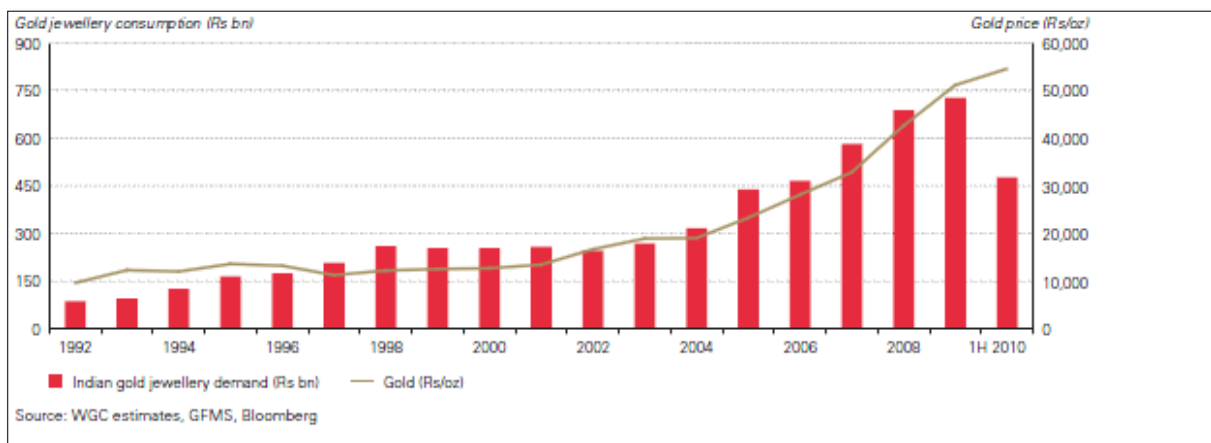


**Figure 3: Gold (Rs/ oz) and total jewellery demand in India (Rs bn)**

### 2.1.2 Investment demand

Indian households see gold as one of the foundation assets in form of both jewellery and as Investment too. It is perceived as a secure liquid investment and a capital value preserver. After bank deposits, it is the second preferred investment medium.

It is estimated that approximately 30% of income goes in saving, and around 10% from this is in form of Gold. India's net retail investment in gold increased 264% YoY to 93 tonnes. This net retail investment is in form of coins and gold bars, accounting for 25 % of Indian Gold demand during same period. High savings ratio and increase in investment opportunities available to Indian investors, there has been growth in interest for Gold Investment.
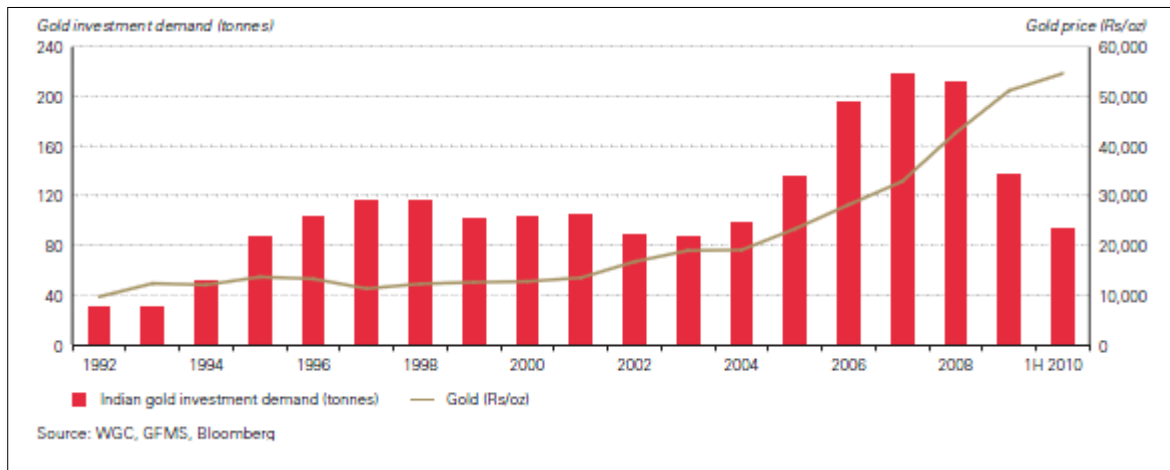


**Figure 4: Gold(Rs/ oz) and total gold investment demand in India**

1. **Characteristics of Gold that infuse confidence to invest**

   a. Diversification: Analysis has been done to try and correlate the gold and domestic financial assets over periods such as 1 year, 3 year and 5 years. The conclusion was that there is no significant relationship between Gold and Indian stocks, making it ideal to achieve a diversified portfolio.

   b. US Dollar hedging: In the circumstances when there is depreciation in value of US Dollar against other currencies, Gold proves to be a good hedge. Indian Investors se Gold as one of the limited ways to diversify their currency exposure, considering that Indian rupee is not fully convertible.

   c. Volatility: In analysis of Gold and other few equity indices, it has been found that Gold exhibits low volatility and is independent from factors that drive equity markets. Gold's annualised volatility has been 23% in rupee as compared to 27% for BSE Sensex 30 Index and 30% for BSE500Index. So it can be seen that Gold's volatility is relatively low.

   d. BSE Sensex 30 Index on an average for over 5 years ending 30 September 2010 gave annual rate of return as just 1%. In contrast for Gold for over same period the average rate of return was 37 %.

   e. Gold has been acknowledged as a virtue of inflation hedge. And additionally the pressure of inflation is expected to rise in India. This Inflation has been eroding the value of saving for the country. The purchasing power reduces significantly as people pay more for necessary goods and services. This is more impacting for middle class citizens. IMF predicts that FY2010 will see an average inflation of 13% whereas FY2011 will see an average of % Inflation.

   f. The real interest rate for India remains negative due to high inflation rates. This influences the saving power. The base rate thigh was increased to 8.5 % by Central Bank, however still the cash yield is still not attractive.

## 2. Gold Exchange Traded Funds (ETFs)

The tonnage of gold is relatively small in ETF. However there have been some important recent developments with the Investors of Indian ETF market seeking access to more liquid gold investments. With the Introduction just 4 years ago, ETF's have grown in popularity. Now Investors seek exposure to gold within a fund structure. Following amounted to approximately 11 tonnes by end of 2010 August, which also is 250% up form June 2007:

- Gold Benchmark Exchange Traded Scheme
- KOTAK Gold ETF
- Quantum Gold Fund
- Reliance Gold Exchange Traded
- UTI Gold Exchange Traded Fund
- Religare Gold Exchange Traded Fund
- State of Bank of India (SBI) Gold Exchange Traded Scheme

The Price corrections, as suggested by historic figures, haven't triggered significant redemptions; however encouraged the investors to increase holdings. Still it is too early to know whether holdings are "sticky" or longer term in nature.

Though currently all Indian ETF are backed by Gold, the ETF are structures in a way that includes investments other than gold for about 10% of their assets. Looking at the recent growth in holdings, though after a slow start, banks and financial institutions are now eager to launch new Gold ETF and gold schemes to a market which is world's largest gold consumer market.

Recently SBI and Religare innovated in ETF space with their Gold Exchange Trading schemes.WGC believes that there will be growth in Gold ETF, given that there is good appetite for gold investment from mutual funds and Pension funds.

## 3. India Post Gold Retail Programme

India Post, Country's national postal service launched a pilot project along with WGC and Reliance Money. This project was called India Post gold retail programme, and was launched in 2008 October. This project planned to sell gold coins through its network of 100 outlets in 4 states, Delhi, Maharashtra, Tamil Nadu and Gujarat. Reliance Money is the project vendor, selling pure gold coins (99.9 %) in .5, 1, 5 and 8 grams denominations.

This programme then extended to 700 postal offices after seeing strong demand for gold coins. In this light, WGC launched India Post branded gold medallion.

## 2.1.3 Decorative and industrial demand
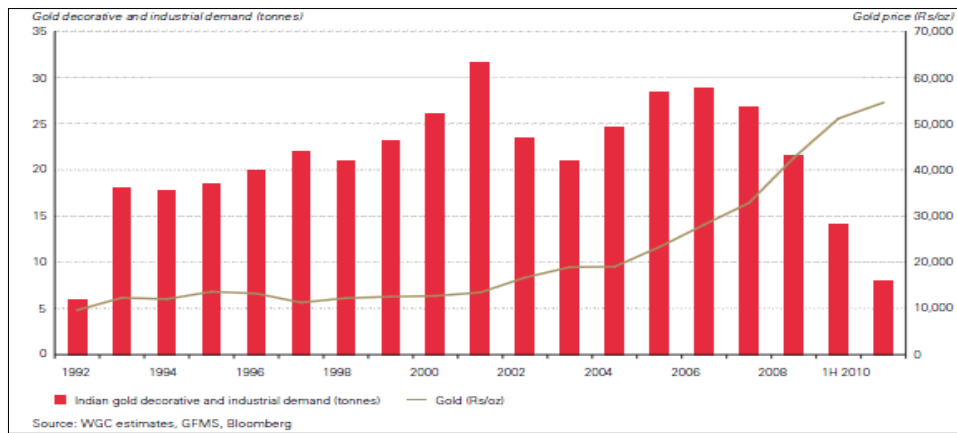


**Figure 5: Gold (Rs/ oz) and total Gold decorative and Industrial Demand in India (tonnes)**

The domestic decorative and Industrial usage of gold is approximately 3% of total demand for Gold. Since 1992, 22 tonnes of gold per annum is used on average in domestic decorative and industrial applications. The main driving factor for Gold in this sector is the usage of gold in wedding saris, called *jari*.

Price increase in Gold over recent years has had mixed impact on jari and costume jewellery. Demand for jari has gone down considerably since the usage of expensive of gold in sari has been replaced by artificial jari in sarees. Gold used in plating salts has responded positively. This is due to the increase in demand for costume jewellery. As the affordability for pure gold has gone down, lot of consumers have gone for gold plated, low weighted gold jewellery. The low gold quantity in costume jewellery is deemed price inelastic. The decision to move into imitation jewellery or plated jewellery is more of forced necessity rather than choice. The gold jewellery Imitation produced in India is not same as that in west. It is very close to 22k jewellery satisfying the desire of Indian consumers to own real thing.

The electronic manufacturing sector has grown in India. Particularly regions like Bangalore have seen considerable increase. This can be an additional driver for gold demand in coming years. The electronic microchips, connectors and contacts use gold, and the demand for such products is expected to increase. Devices such as Iphone which use these gold microchips, and there has been strong demand of these devices by Indian consumers.

There is room for recovery in this sector. This phase can be considered as trough in a continual pattern, where there will be increase in acceptance of higher prices in future. Also recovery in global economic outlook and improving domestic living standard will drive the increase of gold demand in this sector.

## 2.2 Gold imports

India currently produces around only .5% of its gold consumption, and hence the gold imports play an important role in domestic gold market. The annual gold import value increased by 1000% between 1992 to 2009, i.e. from 88bn in 1992 to 881 bn by end of 2009. WGC believes that gold demand trend indicates a robust YoY recovery in imports moving from 2009 onwards.
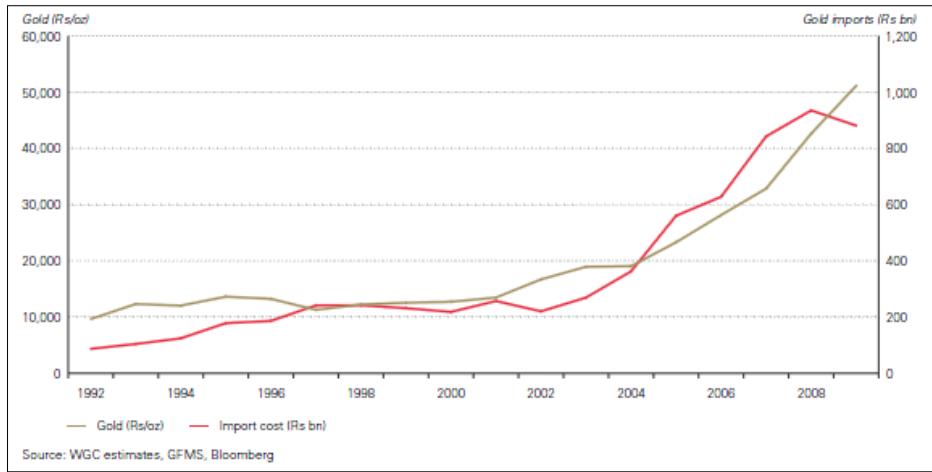
**Figure 6: India Gold import cost (Rs. bn) and Gold prices in India**

## 2.3 Supply

### 2.3.1 Mine production

Gold mining is done on every continent, with Antarctica as only exception. Around hundreds of Gold mines are currently active in world ranging from small/minor to huge. Overall level of production is stable today. Supply is approximately 2497 tonnes per year for last several years. There is no real expansion of production levels. It is only the replacement of older mines with newer ones to stabilise the production.

Mostly new mines are developed to replace older ones. New Mines take approximately 10 years to come up and start producing effectively. So long lead times for Gold mines have to be taken. This gives inelasticity to the mining output, and inability to respond quickly to the change in price. For last Seven years, Gold has had a sustained price rally, but there is no direct mapping to the production level.

### 2.3.2 Recycled gold

While gold mine production is relatively inelastic, recycled gold ensures there is a potential source of easily traded supply when needed. This helps to cater for an increase in demand and keep the gold price stable. The high value of gold makes recovery economically viable, as long as the precious metal is in a form that's capable of being extracted, melted down, re-refined and reused. Between 2005 and 2009, recycled gold contributed an average 32% to annual supply flows.

To make up for inelasticity of gold mine production, recycled gold is used. Recycled Gold acts are source of traded supply when needed.

1) Central banks

One fifth of global above ground stocks of gold are held by Central banks and IMF as reserve assets. This amounts to 30,500 tonnes dispersed across 110 institutions. Governments on an average hold about 10% of their reserves in form of Gold. However this statistic varies from country to country.

Since 1989 this sector has typically been a seller. But there has been a shift in attitude from central banks towards Gold. First two decades saw this sector as primarily net seller, selling substantial amounts to private sectors around the world. In 2009 this pattern changed. The advanced Countries like Western Europe and North America hold about 50% of their external reserves in Gold. The appetite for sale in these countries has trickled down to almost zero level. But for emerging markets, where economies are growing pretty rapidly, the countries hold only about 10% of external reserves in form of Gold. Recently these countries have been seen to buy significant amounts of Gold for their reserves. Since 1999, the bulk of sales have been regulated by Central bank of Gold Agreement which has tried to stabilise the sale of Gold among biggest holders of Gold. There were just 411 tonnes of sale in 2009 by Central Bank.

## 2.4 Gold production

The process of producing Gold is a 6 phase process as following:
• find ore body
• create access to this ore body
• mining or breaking the ore body
• transporting the mined material to the plants for treatment
• process mined material at plant
• refinement
These steps apply to both underground and surface operations.

**Bloomberg**
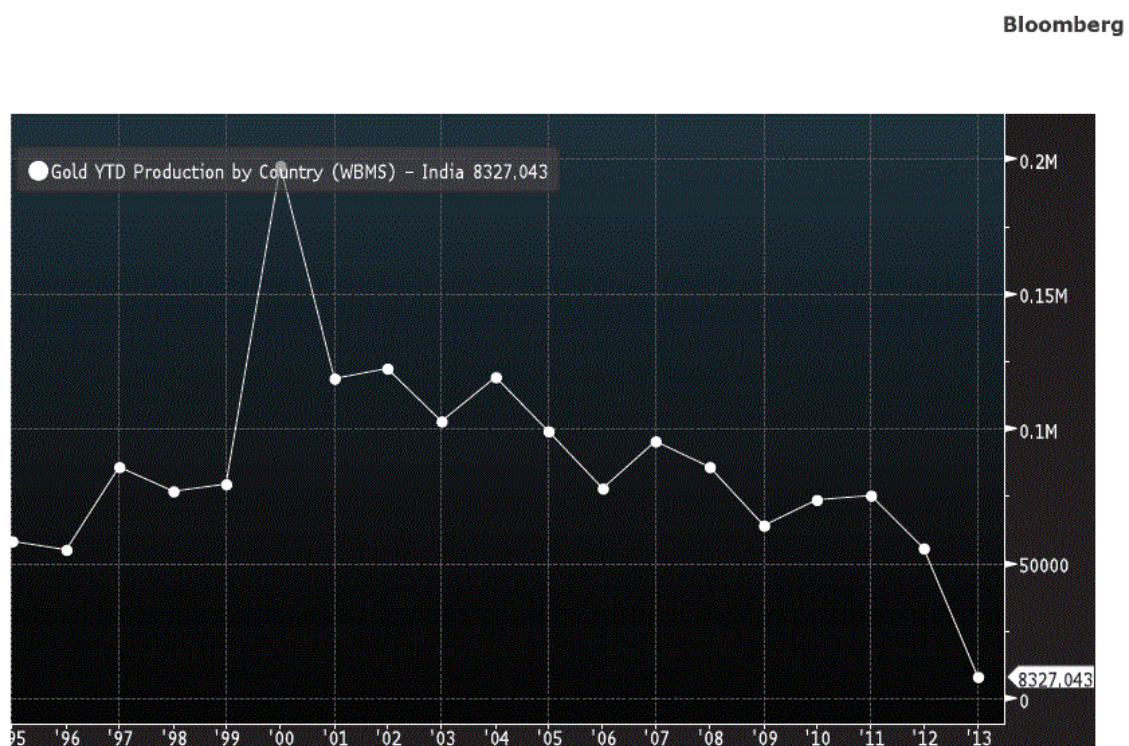
Usually world major refineries of material are near major mining sites. Rand Refinery in Germiston, South Africa is the largest in terms of capacity. The Johnson Matthey refinery in Salt Lake City, US is largest though in terms of output.

Bullion dealers but bullion bars (with 99.5 % purity) once the refinement is done. These dealers then deal with jewellers, investors and electronic manufacturers. This dealer-based bullion market avoids the large bilateral contracts between miner and fabricator.
Indian scene for Gold Production:

The demand in India is huge whereas the primary supply is very minimal. This imbalance is taken care by imports. Hutti mine is the only mine which produces good amount of gold, i.e. 3 tonnes of Gold a year. The mine is owned by Hutti Gold Mines Company Limited.

Gold production has gone down in recent year. As recorded from 2005 to 2008, Karnataka produces approximately 2-3 tonnes per annum whereas small quantity of Gold is produced by Jharkhand.

From 1940 to 1991, all supplies to gold in India were illegal. Annual imports to Gold were 37 tonnes a year between 1831 and 1931. Time of Great Depression saw an increase to 140 tonnes a year. However this declined appreciably to 31 tonnes in next decade of WW II. Then onwards the illegal import of Gold started to gain again, with about 80-0 tonnes per annum from 1947 to 1950's. This further increased to 150 tonnes by early 1970's. Then there was a sharp decline in 1970, and then a rise in 1980's. In 1992, the ban was lifted on import of Gold, and the rate of import grew sharply again.

After the relaxation on gold import in 1992, and economic liberalization, Indian gold consumption saw a big spurt in market. For next 2 years Gold consumption remained at about 400 tonnes per annum but it the increases by 70 % in next decade.
The share of smuggled Gold has declined since then, from 290 tonnes to 94 tonnes. Also the consumption has gone down from 705 in 1990 to 8 5% in 1998. This decline is direct result of realization of gold imports and considerable margin between international and national Gold prices. This margin was almost equal to import duty of Gold.

The authorization in July 1997 by RBI to import gold for sale or loan by commercial banks was a major change in the development of India's Gold market. To start with, 7 banks were selected on certain criteria like minimum capital adequacy, profitability, risk management expertise, previous experience in this area. This has now grown to 14 banks importing gold. These banks buy in range of 500 tonnes per year.

# 3. Literature Review

**Forecasting Gold Prices Using Multiple Linear Regression Method According to** Ismail, Yahya and Shabri[4] Forecasting is a process of estimation in unknown future situations which is often used by management to take sound decisions. Often for forecasting, researchers analyze the time series or the longitudinal type of data and then predict the value of the dependent variables. Gold is an important precious metal which has different uses – decorative, industrial and investment. The importance it enjoys in the world can be ascertained from the fact that before Bretton Woods, there was a gold standard. In the Gold Standard, every currency was pegged to the price of gold. But due to increasing complications, it was banned by USA 41 years ago, however with its unmatchable properties of being an inflation hedge in the long run, it is gaining importance again.

**Ismail, Yahya & Shabri** conducted a study was to develop a model for predicting gold prices based on economic factors such as currency price movements, inflation and interest rates. Due to increase in demand for gold in Malaysia, it is required to make a model that resembles the structure and trend of gold market and forecast changes in the price of gold. After the melt-down of US economy, investors around the world are putting their money in gold as gold can have an important role as a stabilizing influence for investment portfolios. According to them, Multiple Linear Regression (MLR) model is the most appropriate approach to predict the prices of gold. Like every MLR, they also suggested a study in which Gold is the dependent variable and factors like Commodity Research Bureau future index (CRB); Inflation rate (INF); Money Supply (M1); New York Stock Exchange(NYSE); US Dollar index (USDX) ; USD/Euro Foreign Exchange Rate (EUROUSD); Treasury Bill (T-BILL) and Standard and Poor 500 (SPX) were taken into consideration to have influence on the prices.

**Christian L. Dunis* and Anup Nathani**[5] carried out a study in which they tried forecasting the prices of gold and silver and resorted to advanced regression analysis using non-linear and linear models. They compared various non-linear models like Multilayer Perception (MLP), Nearest Neighbours with the ARMA model which is used as a benchmark for linear regression. The aim of the researchers was to establish which of the models generate the maximum returns and if non-linear models can be used to generate returns higher than average in the precious metals market. They did this by implementing a trading simulation where the forecasts were translated into a trading signal.
They concluded that non-linear models could be used to forecast the gold prices as there was some non-linearity which existed in the market and which can be exploited to generate returns in excess to those of the market.

According to a research paper (**Global Economics Paper No: 183**)[6] published by Goldman Sachs Global Economics, Commodities and Strategy Research the reason behind the large changes in price of gold is the monetary demand for it. There was huge sale of gold from the government reserves in the 1990's which led to drop in prices. But the surge in private

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[4] Ismail, Yahya & Shabri, 2009, Forecasting Gold Prices Using Multiple Linear Regression Method, Journal: American Journal of Applied Sciences

[5] Christian L. Dunis* and Anup Nathani2, Jan 2007, Quantitative Trading Of Gold And Silver Using Nonlinear Models, CIBEF and Liverpool John Moores University

[6] David Greely and Jeffrey Currie, March 2009, Global Economics Paper No: 183, Forecasting Gold as a Commodity

investments again pushed up the prices because of the current financial crisis. Thus price of gold is driven by policies followed by the government and the investor's view of the financial distress. But, if we see the whole picture of long cycle of gold prices, then there is a time period in which there is small rise over a small decade.

In this paper, the authors have followed a different approach to forecast the price of gold on the basis of monetary demand (gauged by selling of gold by central banks & demand of gold-etf's) and role of real interest rates determined by yield of long-term treasury bills.

As it holds for extraction industry, the rate of gold mine production increases in the case when real interest rates increase as the opportunity cost of leaving gold in the ground declines. This implies that low interest real rates support the rise in gold prices.

**Cengiz Toraman, Çağatay Başarır, Mehmet Fatih Bayramoğlu**[7] (Nov 2011) conducted a study whose objective was to study the factors affecting the gold prices. This included monthly data between June'92 to March'10. Some of the factors considered by them were: oil prices, USA exchange rate, inflation rate and real interest rate. According to statistical findings, the highest correlation was found between the gold prices and exchange rate and the correlation was negative. Also, a positive correlation was found between the oil prices and the price of gold. The variables which are thought to impact the prices of gold, i.e. oil prices, interest rate, inflation rate, exchange rate are analyzed using the MGARCH model. Stationarity tests were carried out and first differences of USA exchange rate and real interest rates were taken and return series of other variables were used. MGARCH model is estimated by the CCC model because it gives the best results for the estimation of coefficients. As per the findings, highest correlation (negative) is found between gold prices and oil prices. Also, a strong relationship was observed between the return of USA dollar and the price of gold. Other variables don't have a significant relationship with the price of gold. These results are valid both for conditional and unconditional correlation relationship.

On the contrary, significant relationships were found with other variables in the other previous studies. They are similar to the findings of Topcu (2010) that there is no significant relationship between the return of gold and the oil prices and also between inflation and return of gold.

Consequentially return of gold show a non-linear change in the relevant period i.e. the market is non-linear. This leads us to conclude when the markets are efficient the relationship is linear however when the markets are non-efficient the markets are non-linear. As part of this study, gold market is considered to be inefficient. These results are concluded both for developed and developing countries.

**Mika Vaihekoski, Eero Pätäri**[8] **(2007)** conducted a research on the price-determinants of the price of gold in the short-run and in the long-run after taking into account the different methods investors use for investing in gold. There are several methods of investing in gold with each of them having different benefits and shortfalls. Those who are looking for a long-run protection against uncertainty/ inflation should invest in physical gold in the forms of coins/ bars/ certificate/ gold account. Although these forms of gold do not have liquidity as promised by gold ETF but it has a security of a physical asset. Exchange traded funds/

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[7] Cengiz Toraman, Cagatay Basarir, Mehmet Fatih Bayramoglu, November 2011, Determination of Factors Affecting the Price of Gold: A Study of MGARCH Model, Business and Economics Research Journal

[8] Mika Vaihekoski, Eero Pätäri, August, 2007, Gold Investments And Short- And Long-Run Price Determinants Of The Price Of Gold, Lappeenranta University of Technology

derivatives should be used by investors looking for high risk/ reward ratio. Gold is traded in all major exchanges around the world in many forms and can be easily procured by an investor who has access to the Exchange. Also, physical gold can be bought from anywhere either in the physical form (gold/ bar/ coin) or in the form of certificates.

The authors chose the determinants on the basis of available literature. The variables used were: US and World Consumer Price Indices, US and World Inflation, beta of gold, credit risk default premium, US-world exchange rate and gold lease rate. Co integration regression techniques were used to determine the factors affecting the prices of gold. This method is used to isolate the factors that are correlated with the movements of a variable in both the short run and in the long run. According to their findings, gold price and US price level have the most significant relationship in the long run. Adter deploying an error correction mechanism to identify the long run relationship between the two variables, gold price and US price level are found to move together. Often economic shocks lead to diversion from this relationship, but there is slow reversion to this long-run relationship. The authors analyzed two short-run models for identifying the determinants: sub-period model and full period model. As per the statistical findings, US-World Exchange rate index, US inflation, credit risk default premium, beta of gold and world inflation volatility are all significant variables. World CPI was not taken into account as it was an I(2) variable and correlated strongly with US price Index. World inflation, gold lease rate and US inflation volatility were found to be statistically significant. Gold lease rate however was included in the sub period model and a formal bivariate analysis showed that when gold lease rate has been low, price of gold rallied up and when lease rate was high, price of gold was in stalemate. Also included were 19 statistically significant time-specific dummy variables in the model on the basis of statistical criteria. These dummies captured the high global uncertainty and oil crises during these periods. The results lend credibility to the idea that gold can be used as a long-run hedge against inflation and price of gold moves in line with the general price level. Movements in the long run are dominated by short run influences and long term relationship has less impact at any point of time.

There are two further issues which the authors researched upon: When gold can used as long run hedge against inflation in countries other than USA also? This case needs analysis because for an investor domiciled in a country whose currencies depreciate against the US dollar more than required for compensating the difference between the country's inflation and US inflation rate inflation may not be a strong hedge. The other issue is about the number of dummies to be included in the model. Studies by Ghosh (2004) and Levin & Wright (2006) faced the same problem. As per the authors, gold responds strongly to political turmoil and hence need better proxies for political risk. There will still be some shocks which will not be covered effectively in the model like one-time shocks (central bank agreement). Finally, we turn to policy implications of this analysis for potential investors in gold. An investor holding assets in US dollars should profit, if they are holding gold in their portfolio and if the expected depreciation of US dollar realises. The dollar depreciation would lower the price of gold to investors outside the USA and raise the demand for gold and raise the US dollar price of gold. Also, dollar depreciation would be likely to raise inflation in the USA and gold would act as an inflation hedge in this period.

For a non US investor, dollar depreciation would lower the price of gold for them and make it more attractive. However, we think that it is not possible to predict the price of gold with an adequate accuracy by using any statistical methods. There are simply too many ad-hoc determinants that cannot be accounted for in models. Our study can, however, give a good

insight of gold trading and how the price of gold should act in response to sudden changes in different macroeconomic variables.

**Kaspar Allese**[9] (April 2008) analyzed the effect of supply and demand on the price of gold and factors and trends which lead to fluctuations in their supply and demand. He also confirmed a positive relation between the prices of oil and gold and analyzed as to how gold orices get affected by various geopolitical factors. Finally, the author also analyses as to how gold can be used s a diversifying instrument in investment strategy. As per the author, gold has both immediate consumption demand and investment demand. This created the prices of gold to trend differently from other commodities and other investment possibilities. Factors affecting the price of gold are demand and supply of gold, changing stocks performance and oil prices given their relationship to dollar exchange rates and geopolitical shocks. None of the factors individually have a strong influence on the price of gold, except when combined together they can be used to explain the movement in price of gold. As per the previous researches, political and economic crisis and increasing inflation had the strongest impact on the price of gold. During war times earlier, economies use to crash and gold prices changed. But with investor's becoming smarter, best tools to be used for analyzing increase and decreases in the change of gold prices are other commodities. Also, when dollars weaken, gold prices shoot up as investors use gold to hedge against the exchange rates of USD. This explains the recent fall in the prices gold. As dollar is becoming stronger due to Euro losing its strength, investors don't have interest in hedging against the exchange rates. Hence Market participants are selling off their gold stocks and use it for trading, thereby increasing the supply of gold in the market and further lending a hand to drop in price of gold.

**Ali Moeini, Mehdi Ahrari, Parto Karimi**[10] modelled the daily gold prices starting from year 2007 till 2010 as dynamic nonlinear systems. This is because it is believed that dynamic non linear systems display differential characteristics which can be used to explain various economical phenomena which might look accidental prima facie. For this, the biggest Lyapunov exponent with peripheral dimensions for time series is calculated first and then the function controlling parameter in accordance with the exponent of active Lyapunov function is estimated. Logistic function is used for modelling daily gold price during 2007 to 2010 in this paper. For forecasting the price in different trends, this acquired logistic function is used. The acquired results for logistic trends have high accuracy. As a result, the authors claim that it is possible to model and predict real time series and logistic trends using offer method. To sum up, the authors conclude that in case the dynamic function can be evaluated for the assumed time series, non linear characteristics of this function can give many abilities to the economic analyst to analyse the function of time series.

**Yu-chin Chen Kenneth Rogo Barbara Ross**[11] (June, 2008) in their paper "CAN EXCHANGE RATES FORECAST COMMODITY PRICES?" suggest that "commodity currency" exchange rates have a very significant strong role in predicting global commodity

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[9] Kaspar Allese, April 2008, Understanding the Development and Influences of the Price of Gold, A thesis , School of Business, International University Audentes

[10] Ali Moeini, Mehdi Ahrari, Parto Karimi , 2010, Forecasting Gold Price via Chaotic Models and Lyapunov Exponent, ISSN: 1450-2889 Issue 8 (2010) , EuroJournals Publishing, Inc. 2010

[11] Yu-chin Chen Kenneth Rogo Barbara Ross, 2008, Can Exchange Rates Forecast Commodity Prices?, International Symposium on Forecasting, Nice

prices and against a variety of alternative benchmarks. This result of great interest to the researchers and to the policymakers as well due to naive forward markets in various individual commodities and in particularly the broad aggregate commodity indices. This result is of particular interest to policymakers, given the lack of deep forward markets in many individual commodities, and broad aggregate commodity indices in particular. They also explored the scope of the reverse relationship i.ie the commodity prices affecting the foreign exchange rates. They offered a theoretical solution based on the fact that the foreign exchange rates are more forward looking as compared to the commodity prices.

**Michael J. Naylor, Udomsak Wongchoti and Chris Gianotti[12]** studied the abnormal returns of gold and silver ETF's and how they affect heir price. Often in today's scenario, ETF's have become an important choice of investment with a significant impact on investor behaviour, however there is a limited research supporting the analysis of ETF's returns. An investment of 40.5 bn USD in gold and 5.22 bn USD in silver was observed in the ETF's respectively for the period 2006-2009. According to their analysis, inefficiency exists in the gold and silver ETF's, however when risk is taken into account these abnormalities evaporate. Abnormal returns are allowed in case of simple filter trading. Their ETF's provide similar characteristics as of underlying physical assets i.e. they provide the investors with greater returns as compared to the market if risk factor is ignored. They tested series of three gold and silver ETF's and tested their return performance against existing knowledge of gold and silver behaviour.

The primary focus of study was the largest silver and gold funds by AUM being GLD and SLV with an extension of the tests applied to AGQ, IAU, DBS and DGL. The tests reflected that there is a remarkable consistency between the return properties of ETF's and the physical assets of gold and silver identified in prior studies. The log of GLD and SLV is found to be stationary with a white noise distribution, in other words, the prices of GLD and SLV are inefficient and do not reflect all available information. For all the funds non-normality was proved except for AGQ, authors are of the opinion that some caution should be exercised given that ~22 funds are still about to achieve maturity and hence inefficiency is expected to a certain degree.

CAPM analysis reveals that normal return exists only when a risk-return framework is considered. This implies that when investors taken into account the risk factor then returns will not be greater than the market's risk adjusted performance. If filter trading rules at 3-5% are applied, then a marginal above average return can be expected, implying that a investor which follows an active strategy has a strong chance to outperform a passive investor.

To summarise, the fundamental behaviour which is applicable to physical gold and silver returns also applies to GLD and SLV ETF's/ returns. Their price movements do not follow a random walk as opposite to the popular notion. The authors contest that abnormal returns which were earlier not possible with physical gold and silver can be achieved now after applying a simple filter of trading rule. This finding is especially important in lights of David Swenson's Yale model. An important asset class which is both inefficient and liquid (best of both worlds) is now being seen in gold and silver ETF's. This finding is very important from market investor's point of view as markets interest in gold and silver ETF's has made the metals tangible substitutes to other traditional securities and is unlikely to stop in the future.

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[12] Michael J. Naylor, Udomsak Wongchoti and Chris Gianotti, Fall 2011, Abnormal Returns in Gold and Silver Exchange-Traded Funds, The Journal of Index Investing, Vol. 2, No. 2: pp. 96-103

With rise in prices of gold and growing interest in ETF's as investment vehicle, more investigation in performance of funds is gaining ground.

**Jun Cai, Yan-Leung Cheung and Michael C. S. Wong**[13] did extensive analysis on the characterization of intraday volatility in gold futures contracts traded on the COMEX division of the New York Mercantile Exchange. Study in inter-day ARCH effects, intraday patterns, announcement effects was carried out in a coherent framework. As per them, the intraday patterns exert a profound impact on the dynamics of return volatility. In the study of 23 US macroeconomic announcements, consumer price index, employment reports, gross income and gross domestic product have been found to have the greatest impact. After filtering out intraday patterns, it was found that high-frequency returns exhibit long-memory volatility dependencies in the gold market, having important implications on the pricing of long-term gold options and determination of long-term gold options and optimal hedge-ratios.

**Mu-Lan Wang, Ching-Ping Wang, Tzu-Ying Huang**[14] studied the impact of change in price of crude oil, gold price and exchange rates of US Dollar vs the other currencies on the stock price indices using daily data and time series method. The study focussed on the countries of United States, Germany, Taiwan, Japan & China. As per the statistical findings, co-integrations exist between fluctuations of oil price, exchange rates of dollar vs. other currencies, gold prices and stock markets in Japan, China, Taiwan & Germany. These findings were tested for long term stable relationships among the variables.
There is no co integration relationship between these variables and US stock market indices implying there is no long –term stable relationship between exchange rate, oil price, stock market index and gold price. Also, statistical results of the causal relation exhibits that oil price, stock price and gold price have two-way feedback relations.

**Dipak Ghosh**[15] (Dec 2000) attempted to summarise a clear contradiction among the short-run and
long-run movements in gold prices. He has developed a theoretical model which lists the set of conditions which have to be satisfied so that the price gold rises above the general rate of inflation and gold can be used as an hedge against inflation. As per the model the short run changes in factors like convenience yield, gold lease rate, the real interest rate, default risk, the covariance of gold returns with other assets and world currencies exchange rate can affect this equilibrium relationship and generate short-run price volatility. He has used the gold price data (1976-1999) and applied co integration regression techniques, this analysis confirmed the central hypotheses of the theoretical model. If the conditions developed in the theoretical model are developed then gold would be an effective hedge against inflation in the long-run. The equilibrium relationship is consistent with sizable short-run movements in the price of gold. However changes in factors like covariance of gold with other assets, real

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[13] Jun Cai, Yan-Leung Cheung and Michael C. S. Wong, Jan 2001, What moves the gold market?, TheJournal of Futures Markets, Vol 21 , issue 3

[14] Mu-Lan Wang, Ching-Ping Wang, Tzu-Ying Huang, September 2010, Relationships among Oil Price, Gold Price, Exchange Rate and International Stock Markets, International Research Journal of Finance and Economics Issue 47

[15] Dipak Ghosh, December 2000, GOLD AS AN INFLATION HEDGE?, Studies in Economics and Finance, ISSN: 1086-7376

interest rates, convenience yield, default risk and particularly gold lease rate can disturb this equilibrium and generate short run volatility to a great extent.

The empirical findings suggest the there is a long-run relationship between the USA retail price index and the nominal price of gold with an implied elasticity of one. This supports the finding that gold is a long-run inflation hedge; this relationship was used to construct an error correction model which was indicative of idea that short-run movements are driven by changes in the gold lease rate, gold's beta and USA/ world exchange rate. The author says that changes in the price of gold are dominated by short-run influences and consequently long-rum relationship doesn't hold so much of importance. The assumptions Deepak took are: the marginal cost of extracting gold may not rise at the rate if inflation, if it is believed that central banks are not required to hold any gold, then convenience yield of gold may systematically alter over time, leasing rate may be indicative of biased measure of real interest rates if default risk is not a random variable, supply of gold may not be a positive function of the price if high gold prices focus on extracting more gold from a small quantity of ore rather than extracting ore.

**Bank of Canada Working Paper[16] (June 2007)** assessed the leading indicator properties of gold ranging from 6 to 24 months using data for 14 countries over the 1994 to 2005 period. As per the paper, gold prices contain significant information about future inflation for several countries. This is because of the manner in which inflation expectations are formed in these countries. Gold remains statistically significant when combined with variables such as the output gap of the growth rate of a broad monetary aggregate. If we consider investment demand of gold which is around 12% of the gold market, the demand for gold would be a function of current and expected price of gold, the opportunity cost of holding gold (risk-free assets rate of return, such as Treasury bills), income, expected future inflation and overall stress of the financial market.

As per the analysis gold prices lead inflation up to two years in advance in any country. Its performance as a statistically significant indicator is most pronounced in the case of OECD countries which have adopted inflation targets. The arrival of inflation targets improved the formulation of expectations for inflation in these countries and hence if expectation errors are reduced, then prices of financial assets may prove to be more reliable indicator of inflation.

He also found that when gold is paired with other variables like money, oil price, output gap and U.S. inflation, then it is more statistically significant. To understand inflation dynamics in a country like Canada, it requires more depth than a standard Philips curve graph.

**Shih-Jen Liao's[17]** paper focussed on analysing the relationship between oil prices, gold prices                                                                                                    and Individual Industrial Sub-Indices rather than that of national stock exchange which was Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) in this case. As per the authors, gold prices have different degree of influences on individual countries instead of the whole market. As per the previous research, the stock markets have volatility clustering and volatility asymmetric characteristics. He also applied TGARCH model to describe the relationship between oil prices, gold prices and individual industrial Sub-indices. He

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[16] Greg Tkacz, June 2007, Gold Prices and Inflation, Bank Of Canada, working paper 2007-35

[17] Shih-Jen Liao's, The Relationship Among Oil Prices, Gold Prices And The Individual Industrial Sub-Indices In Taiwan

concluded that oil prices and gold prices make the volatility spill over effects; the fluctuations in gold prices are affected to a great extent by fluctuations in the gold prices. Oil prices are influenced by both Electronic Industrial sub indices and Rubber industrial sub-indices. The correlation between them was found to be positive. The Automobile Industrial Sub-Indices, Chemical Industrial Sub-Indices, Textiles Industrial Sub-Indices, Cement Industrial Sub-Indices, Food Industrial Sub-Indices, and will be influenced by fluctuations in gold prices.

**Ai Han, Shanying Xu, Shouyang Wang**[18] explored the relationship between the exchange rate of Australian dollar against the US dollar and the gold price using interval method. In this method, interval sample data was formed to present the volatility of variables. This method was extended to multi-model estimation and computational schemes were provided. These estimates characterized very efficiently how exchange rates are related to gold price both in the long run and in the short run. The difference between the point and the interval method increased when moved from weekly data to quarterly data. This was because the lowest frequency data point lost the most important information of volatility. Relationship between the AUS/ USD exchange rate and gold price was captured via traditional econometric models. When volatility was present in the data, then interval
method was used instead of the point data. The statistical findings were indicative of the fact how gold prices and exchange rates are related to each other both in the long run and in the short run.

**Ramazan Sari**[a]**, Shawkat Hammoudeh**[b]**, Ugur Soytas**[19] (**2009**) are of the opinion that a weak long-run equilibrium and strong feedbacks in the short run exists between the spot prices of four precious metals (Silver, palladium, gold and silver) and other factors like oil prices and exchange rates. The spot prices of precious metals respond significantly to exchange rate and shock in any one of the precious metals. However there are certain situations in which there was an overreaction in case of some precious metals like palladium and platinum and in the exchange rate market. The risk in the portfolio can be diversified by investing in precious metals like silver, gold, platinum and palladium.

**C. Ciner (1999)**[20] observe the long term relationship between the gold and silver future contracts traded on the Tokyo commodity exchange and conclude that the consistent relationship between the gold and silver prices has disappeared in the 1990's. He studied the long term linkages between the prices of the gold and silver future contracts being traded on TOCOM.
The disappearance of long term relationship between the gold and silver prices is very critical for participants in the gold and silver markets. He concludes the markets of both these metals should be treated as fairly independent markets and change in gold to silver ratio should not be used to predict the prices in the future.

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[18] Ai Han, Shanying Xu, Shouyang Wang, 2008, Australian Dollars Exchange Rate and Gold Prices: An Interval Method Analysis, The 7th International Symposium on Operations Research and Its Applications (ISORA'08)

[19] Ramazan Saria, Shawkat Hammoudehb, Ugur Soytas, March 2010, Dynamics of oil price, precious metal prices, and exchange rate, Energy Economics

[20] C. Ciner, August 2000, On the long run relationship between gold and silver prices, Global Finance Journal 12 (2001) 299–303

Also, it can be concluded that these two markets should not be used as substitutes for hedging against risks which are similar in nature. This is in accordance with the understanding that two different commodities have different uses in different areas and are affected by different economic fundamentals. With monthly data for 30 years starting from 1971, co integration could have occurred during some periods and especially during the post bubble and bubble periods. Non linear models perform better as compared to random walk in sample and out of sample for long run prices of gold. On the contrast, in sample non linear models perform better than the random walk for the price of silver but this predictive capacity is lost out of sample, primarily due to structural change that occurs in variance of the out of sample models. An interesting observation to note was that in sample and out of sample predictive capacity of the non linear models is reduced when the variables are in logs. A strong proof is found for a concurrent relationship between the rates of return of gold and silver. In the three types of relationships that we have analysed between the prices of gold and silver, the dependence is less out of sample, possibly meaning that the two markets are becoming separated. For gold the non linear models perform better in sample and out of sample. The in and out of sample predictive capacity of the non linear models is reduced when the models are logs. With monthly data from 1971 to 1990, it is found that co integration could have occurred during some periods and especially during the bubble and post bubble period. In sample non linear models for silver perform better than the random walk but this predictive capacity is lost out of sample, mainly due to the structural change that occurs with a reduction in the variance of the models during the out of sample period. That gold and silver prices have been strongly related is evident from their behaviour during the bubble period. The long run relationship appears to be complicated and one that varies at particular dates.

**Andrew C. Worthington, Mosayeb Pahlavani**[21] tested the relationship between the gold prices and inflation using a unique root testing method. For this they used the monthly data for the period starting from 1945-2006 and from 1973-2006. The novel unit root testing procedure which estimates the timing of significant breaks is adopted as price of gold and inflation in United States have been subjected to structural changes over time. A modified co integration approach is followed after taking into account endogenously examined structural breaks. This is indicative of strong co-integrating relationship between gold and inflation in both the post-war period and the early 1970's. These results lend a strong support to the view that direct and indirect gold investment can serve as an inflationary hedge. The presence of a stable long-term relationship between the price of gold and rate of inflation determines the hedging quality of gold. As both the variables suffer from significant structural changes, Zivot and Andrews (1992) test procedure is used to endogenously determine the most significant structural breaks impacting this relationship. The results suggest the most significant structural breaks in both markets correspond to the gold market moving to purely open market
operations and the acceleration of inflation in the 1970s. Strong co integrating relationship is highlighted on applying a modified co integration method after incorporating the endogenously determined breaks implying gold can be used as an inflation hedge in the post war and post-1970s period.

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[21] Andrew C. Worthington, Mosayeb Pahlavani, 2007, Gold investment as an inflationary hedge, Applied Financial Economics Letters

**Shaun K. Roache and Marco Rossi**[19][22] investigated how macroeconomic announcements affect commodity prices by using event study methodology. Their research suggests that commodity prices are influenced by the surprise element in the macroeconomic news with evidence of a pro-cyclical bias especially when we look for the effect of US dollar. In the past commodities were considered to be less sensitive as compared to financial assets for example, crude oil which was one of the most actively trade commodity futures contract shows no significant responsiveness to almost all announcements.

As per the authors, Gold is sensitive to the following scheduled macroeconomic announcements: retail sales, inflation and non-farm payrolls. Gold has a counter cyclical reaction to surprise news as it has high sensitivity to real interest rates changes and perform a unique role as a safe haven and store of value. It also reflects a great degree of sensitivity to negative surprises that might lead financial investors to become more risk averse. This results in traders timing their orders flow to avoid the release of information shown to affect prices and thus impact the uncertainty of the return of gold. These results also confirm the pro-cyclical bias of other commodities and gold's role as a safe-haven for periods of economic uncertainty for the longer-term market participants. The key aspect affecting price of gold is the degree to which increasing financialiazation of commodities will increase sensitivity to macroeconomic developments.

**William D. Lastrapes (2001) George Selgin**[23] have analysed in their paper the relationship between the precious metals and the monetary policies adopted by the central banks. In effect, they analyzed the interaction between instruments of Federal Reserve monetary policy – non-borrowed reserves and federal funds rate and the prices of gold, platinum and silver. They also underscored the effect of monetary policy on the markets and the economic activity and methodology for devising appropriate investment and portfolio strategies regarding precious metals. Prices of precious metals respond to inflationary pressures quite quickly. This is because when Feb injects money into the system the liquidity increases and this ultimately leads to inflation, markets participants react by using their surplus dollars in buying precious metals driving their price northwards. Similarly, if we look at the situation in a reverse order, then rise in prices of precious metals can be seen as excess of liquidity in the system. This is handled by restricting supply of bank reserves thereby raising the federal funds (interbank/ overnight borrowing) rate. Reduced bank reserves lead to reduced money stock. As precious metals are traded continuously in active markets, policymakers may consider it favourable to base such policy decisions on the trend observed in the prices about long-run changes in policy variables (e.g. the long-run rate of inflation), as opposed to the actual results.

Their research has found evidences supporting the belief that Federal Reserve uses information contained in prices of precious metals while setting monetary policy. However, the relationship observes some shocks during mid 1990's. This breakdown is relationship is less pronounced for the silver metal as compared to gold and platinum. The authors however are inconclusive about the fact whether silver plays a more predominant role in federal policy

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[22] Shaun K. Roache and Marco Rossi, 2008, The Effects of Economic News on Commodity Prices: Is Gold Just Another Commodity?, IMF Working Paper, WP/09/140

[23] William D. Lastrapes (2001) George Selgin, October 2011, An Analysis of the Statistical Relationship between Precious Metals Prices and Monetary Policy

decision making as they were unable to omit the sources of fluctuations in the relative prices of gold and platinum. They claim apart from the precious metals there might be some other information which is possibly relevant for monetary policy decision making. This analysis they believe can be used for the design of optimal investment portfolios as well.

**Stephen W. Salant and Dale W. Henderson**[24] in their paper published in The Journal of Political Economy, Vol. 86, No. 4 (Aug., 1978) analysed the effects of anticipations of sales policies followed by the government on the real price of gold. It is found that the price of gold is depressed by the risk of a future government gold auction, but it also leads to increase in price rise (in percentage terms) faster than the real rate of interest. This rate of return is required by risk-neutral investors as an inducement to hold gold in the event of an asymmetric risk of a price collapse. A sudden price drop is often caused by an announcement of a government auction. Pegging of price/ defence of price ceiling by sale of stockpile by the government leads to a sudden attack by speculators.

**Uwe Böwer, André Geis and Adalbert Winkler**[25] studied the impact of commodity prices on economic developments in 24 Western and Central African Countries (WCA). As per their analysis between the periods 1999 to 2005 when commodity prices soured, then the countries which were net exporters of oil witnessed strong growth rates and countries which imported oil displayed somewhat slower growth. This is despite the fact that oil exporting nations benefitted from increase in non-oil commodity export prices. However inflation rate for most of the WCA countries was impacted strongly by the exchange rate regime and monetary and fiscal policies as compared to commodity price changes. There were significant pass-through effects in oil importing nations, however second rounds effects on overall prices were limited. Governments of oil rich countries reacted sharply to windfall revenues partly running sizeable fiscal surpluses. Inflationary pressures were dampened by favourable supply response to rising spending, sterilization efforts and increasing money demand.
The commercial banks having substantial excess reserves are indicative of challenges in financial sector developments and effectiveness of monetary policy in WCA countries. The main burden of macroeconomic adjustment and sustenance of non-inflationary growth will continue to rest on the shoulders of fiscal policy as most of the countries use follow fixed exchange rate regimes and this is one of the key policy challenge which WCA authorities are facing.

**Dirk G. Baur, Duy T. Tran**[26] (2012) tried establishing relationship between the gold and the silver prices in the long run. For this purpose, they used a 40-year sample period and took note of the bubbles and the financial crises which took place during that period. They reached to the conclusion that gold and silver are not co-integrated in 'normal' periods, however extreme price changes in certain periods contributed to creation of long-run relationships. The time period for which analysis was carried out was from 1970 till 2011. As per the authors, if bubbles are taken into account then there exists no evidence for a long term

[24] Stephen W. Salant and Dale W. Henderson, August 1978, Market Anticipations of Government Policies and the Price of Gold, The Journal of Political Economy, Vol. 86, No. 4

[25] Uwe Böwer, André Geis and Adalbert Winkler, April 2007, Commodity Price Fluctuations And Their Impact On Monetary And Fiscal Policies In Western And Central Africa, Occasional Paper Series, no 60

[26] Dirk G. Baur, Duy T. Tran, Feb 2012, The Long-run Relationship of Gold and Silver and the Infuence of Bubbles and Financial Crises, University of Technology, Sydney Business School, Finance Discipline Group

relationship and in fact the relationship weakens to a great extent. However, global financial subprime crisis of the year 2008 did not have any significant effect on the price of gold and hence can be excluded from such bubble episodes. The error correction model and further the granger causality tests further testify the fact that gold drives the prices of silver and thus is the reason for the long term relationship between the two metals despite the greater volatility displayed by the silver price. In addition to this, the authors have carried out a sub-sample analysis which has led to confirmation that price of silver and gold are often decoupled in some time zones. This is probably because of the relationship between them being weak with possibly strong implications for efficient market hypothesis and arbitrageurs.

**Jedrzej P. Bialkowski, Martin T. Bohl, Patrick M. Stephan and Tomasz P. Wisniewski[27]** (march 2011)

analyzed whether the rapid increase in gold prices due to sudden increase in its investment demand has caused a new asset price bubble. A stable long-run relationship is established drawing on the convenience yield model, approximating the commodity dividends with the help of future contracts and thus concluding the explanations for gold price. After this regression, a Markov regime switching ADF test was applied and as shown by simulation this exercise detects speculative bubbles. As per the authors, no speculative bubble was found from the 1979-1982 or during the recent global meltdown. The reason behind the results is sharp inflation (caused by expansive monetary and fiscal policy & second oil crisis) and geopolitical problems (Afghanistan's invasion by Soviet Union & Iran-Iraq problems). These problems forced to investor to fled to safer investment avenues causing excess demand and corresponding price surge.

Also, a high future inflation and weakening of US dollar is expected on account of the expansive monetary policy being followed in US. The portfolio weight of gold was expanded significantly as it is seen as a globally accepted currency which does not lose its purchasing power.

The authors are of the view that model developed by them (application of convenience yield model and Markov-regime switching ADF test) could be applied for other commodities which have been blamed for speculative bubbles. In the last couple of months starting from 2010, risk of new speculative bubbles is feared because of increase in prices of other foodstuff. It could be statistically verified if the speculators driving commodity prices to new heights are responsible for food shortages in developing countries. Also, it would help the market participants to under the market better and help them take sound investment decisions by giving information about the commodities which have had abnormally high returns.

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[27] Jedrzej P. Bialkowski, Martin T. Bohl, Patrick M. Stephan and Tomasz P. Wisniewski, March 2012, Is There a Speculative Bubble in the Price of Gold

# 4. Research Design

The objective of the dissertation is to find the variables affecting the prices of Indian gold in the short run and in the long run. For this purpose the dependant variable is: Price of Gold in India in INR. The price of the gold is taken from World Gold Council[28]and is the price of 10 gms gold in INR.

Two models are developed in the dissertation for the purpose of variable identification and price prediction.

## 4.1 Multiple Variable Regressions

It starts with an estimation of variables which are believed to have an impact on the gold prices. Then statistical tests are performed on these variables in order to ensure that results are non-biased and free from any error. Some of the variables incorporated in the model earlier might be removed because of insignificant results. Finally the model is complete and can be used for prediction.

### 4.1.1 Variables Identification

The independent variables considered in the paper are of two kinds: economic and non-economic.

1. **Currency Exchange Rate**: The top 10 countries from which India imports gold are analyzed and their exchange rates with respect to INR are taken into account. These exchange rates have an impact on the gold price in India because if the domestic currency appreciates, then gold imports become cheaper and gold prices will fall. Also, there will be an increase in competition among the gold producing nations to export gold at a lower price.
The countries from which India imports gold are (2010-2011 millions USD):

**Table 1: Gold Sourcing Countries, India (2011, in tonnes)**

| | |
|---|---|
| SWITZERLAND | 22,572.04 |
| U ARAB EMTS | 7,508.28 |
| SOUTH AFRICA | 4,328.65 |
| AUSTRALIA | 3,027.45 |
| U S A | 1,070.71 |
| HONG KONG | 402.54 |
| U K | 386.17 |
| GERMANY | 180.12 |
| CHINA P RP | 147.58 |

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[28] http://www.gold.org/investment/statistics/gold_price_chart/

Also, the price of gold is closely linked to the state of the American economy than to worldwide economic conditions (Koutsoyiannis 1983). Hence, US dollars exchange rate is given prime importance. The exchange rates are taken in indirect quotes.

2. **Stock Performance:** Researchers have studied how gold prices have fluctuated with change in performance of stocks. Because gold is often used to diversify portfolio and often has above-average market returns, its prices are strongly related to the stocks. To account for this, Nifty is taken.

3. **Oil Prices:** Change in gold price has direct impact on Inflation. Since gold is believed to be an inflationary hedge in the short run, the demand for gold increases when inflation increase and this leads to an increase in gold price. The price of crude oil per barrel is factored in for the study. The units are INR/ Barrel.

4. **Silver Price:** Since the commodities'' prices trend together, hence silver is taken.

## 4.1.2 Model

The price is gold is considered as a function of the currency exchange rates of countries from which India imports gold, Oil prices (INR/ barrel), Stock performance(Nifty), Silver price(INR/KG). The econometric model that is studied in this dissertation is:

Gold Price (G.P.) = f {Foreign Exchange Rate (FE – Aus Dollar, USA Dollar, Swiss franc ,German Mark, UK pound, UAE Dirham, Yuan, HK dollars), Stock Market Performance (nifty), Oil Prices(oilprice), Silver Price (silverprice}

The actual model is as follows:
(G.P.) = a + b1 (franc) + b2 (USD) + b3 (AUSD)+ b4 (China Yuan) + b5 (HK Dollars) + b6 (UAE Dirham) + b7 (Euro) + b8 (Oil Prices) + b9(silver prices) + b10(pound) + b11(mark) + b12 (nifty)

### 4.1.3 Data Sources

| Variable | Source | Frequency |
|---|---|---|
| Swiss Franc | Bloomberg Terminal | weekly |
| Aus Dollars | Bloomberg Terminal | weekly |
| US Dollars | Bloomberg Terminal | weekly |
| Chinese Yuan | Bloomberg Terminal | weekly |
| Euro | Bloomberg Terminal | weekly |
| UAE Dirham | Bloomberg Terminal | weekly |
| HK dollars | Bloomberg Terminal | weekly |
| US Dollar | Bloomberg Terminal | Weekly |
| Oil Prices | Bloomberg Terminal | Daily |
| Stock Performance | Bloomberg Terminal | Daily |
| Gold Price | Bloomberg Terminal | Daily |
| Silver Price | Bloomberg Terminal | Daily |

**Table 2: Data Set Sources**

### 4.1.4 Time Selection

The regression is run in two stages:

1. **Currency regression**: Weekly (5 day) data is collected for 10 currencies, for last 5 years.

2. **Final Regression**: The currencies which are significant in regression stage 1, are regressed with other variables in stage 2. For this daily 5 day data is collected for a 5 year period, i.e. Jan 2007 till Dec 2011.

### 4.1.5 Steps Followed

1. **Stationary Test:** Check both the long of dependent and independent variables for stationarity. For this purpose, ADF Test (Augmented Dickey-Fuller) is performed. For a series to be stationary, its T-statistic value should be greater than values at the values at other significance levels. Also, Durbin-Watson stat should be high.

2. **Causality Test:** In economics data, it can happen that the relationship is both directions, that is dependant and independent variables affects each other and in that case we should not use regression model but vector models. We will use Granger causality test to test for same.

3. **Run regression for currency exchange rates** (stage 1): This helps in identifying the currencies which have a strong impact on the Indian gold price. The currencies whose' coefficients are higher than 0.05 are considered to be significant and are taken to the next level of regression where they are regressed with other variables like oil price, interest rates, inflation rates.

4. Identify currencies which have a significant impact on gold prices ($p < .05$ – for 5% significance level and $p < .1$ for 10% significance level)

5. **Run Final Regression:** After identifying the currencies which have a significant impact on Indian gold prices, they are regressed with other independent variables identified initially.

6. **Statistical Problems Checking:** The model is checked for three statistical problems:
   a. **Multicollinearity:** The independent variables should not have high correlation among them and should be unique to the extent that each one can be counted as separate and so we will check for the correlation among the independent variables. To check the problem of multicollinearity, the simplest way to use in this research is checking "Simple Correlation Coefficients". In statistics, if the independent variables have the correlation value among them lower than 0.8, it is considered as no Multicollinearity problem.

   b. **Heteroskedasticity:** The problem of Heteroskedasticity can be firstly checked by setting hypothesis;
   > Ho : Homoskedasticity
   > H1 : Heteroskedasticity

   The hypothesis is tested at 95% confident level. The value which is used to be a reference for the test is Obs*R-squared. This test is comfortably done White Heteroskedasticity Test function.

   The problem should be lessened by "White Heteroskedasticity-Corrected Standard Errors" provided in E-Views. The method will change the value of t-Statistic and P value for re-deciding whether which variable(s) should be taken out of the model to lessen the problem of Heteroskedasticity by not changing the value of intercept and co-efficient. This method is the way out of lessening the problem which may not get

rid of the problem. Still, this can be simply done in time limit constraint and when no variables should be taken out of the model.

c. **Autocorrelation:**
There are several methods for autocorrelation diagnosis. However, the simplest and well-known method is Durbin Watson Statistical value measurement which is used in this research. The Durbin Watson value should fulfil the following condition:

$$4- du > \text{Durbin Watson Value} > du$$

The method to solve the problem in this research is "The Cochrane-Orcutt Iterative Method". The model's co-efficient and all statistical values will be recalculated again and again for finding the best possible $\rho$ that reflects No Autocorrelation problem.

After this, we started making our model by taking dependant and all the independent terms and adjust the model for AR and MA terms in order to get the best model. The models can be checked and evaluated by using F-statistics, AIC and SIC and adjusted $R^2$ values. The F-statistics should be significant enough to reject the null hypothesis that there is no model possible. The value of AIC (Akaine Information Criterion) and SC (Schwarz Criterion) should be minimum possible and value of adjusted $R^2$ should be maximum possible

## 4.2 ARIMA Model

Autoregressive integrated moving average (ARIMA) models are generalizations of the simple AR model. This model can be used to find the regression line and identify the relationship if any exists.
It uses three tools to fit a model to serial correlation in the disturbance.

1. Autoregressive/ AR Term: This term corresponds to the use of a lagged value of the residual in the forecasting equation for the unconditional residual and lag is denoted by the number in the parenthesis.
2. Integration/ I (d) Term: It refers to the differencing of time series. At first-order integrated series, I (1) implies that an econometric model has been designed using the first difference of original time series and I (2) refers to second order differences.
3. Moving average/ MA Term: It uses the lagged value of the forecast error to improve the current forecast. A first order moving average, MA(1) term uses the most recent forecast error and MA(2) uses the forecast error from two most recent periods.

To identify the ARIMA model, the steps mentioned below need to be performed as the preliminary step.

1. Stationarity Test: Before the use of data to create ARIMA model, the data needed to be tested for
stationarity. The test is done to prove that the data is stationary. This implies that the series is not affected by other factors like seasonality, trends. In this research, stationarity test will be done by "Augmented Dickey-Fuller Regression's Unit Root Test" by setting hypothesis as;
Ho: $\gamma = 0$ (Non-Stationary)
H1: $\gamma \neq 0$ (Stationary)

### 4.2.1 Data Transformation
After the test of stationarity, it is found that the data will be stationary at $n^{th}$ difference. So, variable will be transformed by using the below formula:
Y't = Yt -Yt-n
Where;
Y't = A result of first differencing at time t
Yt = Data at time t
Yt-n = Data at tme t-n or the data before time t for n unit

### 4.2.2 ARIMA identification and estimation
ARIMA model can be identified by examining a correlogram in eviews. An estimation of ARIMA models consists of 4 steps (also known as the Box-Jenkins methodology)

1. Identification
2. Estimation
3. Diagnosis
4. Forecast

In step 1, estimated correlations of the residuals are compared with the theoretical correlations of the residuals. Existence of correlations between the residuals implies that an

ARIMA model can be set up. The nature of correlations helps us in estimating the p & q, autoregressive (AR) and Moving average (MA) components.

**Identification of models using SACF and PACF**

| Process | SACF | PACF |
|---------|------|------|
| AR(p) | Geometrically declining | Curtailed after lag p |
| MA(q) | Curtailed after lag q | Geometrically declining |
| ARMA(p,q) | Declining after lag q | Declining after lag p |
| If SACF shows a linearly declining sequence, the series should be differenced. | | |

Table 3: Identification of models using SACF and PACF

For Model Selection, after observing the lags there will be several possible models which can be used for Prediction. However, the best model to forecast will be the one with least MAPE value (Mean Absolute Percent Error) compared among the three. If the model includes MA component, then OLS method cannot be used as the model is non-linear. Instead, non-linear least squares estimation must be used.

Forecasted Result = Intercept + AR (n) +MA (n) + ε
Where; n = number of lag(s) which has been chosen

# 5. Analysis and Findings

## 5.1 Currency Regression

### 5.1.1 Statistical Tests

#### 5.1.1.1 Stationarity Test

Using ADF test, all the series are made stationary. The ADF results for all the series is appended in the Appendix. Below is a comprehensive table on the results of ADF test for dependent and independent variables.

$$H_o: \text{The variable has a unit root.}$$

All the series will be stationary if their returns are taken.

#### 5.1.1.2 Causality Tests

As seen below, we found little evidence to reject Null hypothesis that our dependant Variable (GoldPrice) Granger causes independent variables. Thus, we can use regression model.

**Table 4: Currency Granger Causality Tests**

Pairwise Granger Causality Tests
Date: 05/11/13   Time: 02:14
Sample: 1/01/2007 12/24/2012
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| DIRHAM does not Granger Cause AUD | 310 | 0.46297 | 0.6299 |
| AUD does not Granger Cause DIRHAM | | 2.10648 | 0.1234 |
| FRANC does not Granger Cause AUD | 310 | 0.24320 | 0.7843 |
| AUD does not Granger Cause FRANC | | 1.41645 | 0.2442 |
| HKD does not Granger Cause AUD | 310 | 0.38635 | 0.6799 |
| AUD does not Granger Cause HKD | | 2.07710 | 0.1271 |
| MARK does not Granger Cause AUD | 310 | 3.45957 | 0.0327 |
| AUD does not Granger Cause MARK | | 1.69323 | 0.1856 |
| POUNDS does not Granger Cause AUD | 310 | 1.55670 | 0.2125 |
| AUD does not Granger Cause POUNDS | | 1.33252 | 0.2653 |
| USD does not Granger Cause AUD | 310 | 0.39964 | 0.6709 |
| AUD does not Granger Cause USD | | 2.04275 | 0.1314 |
| YUAN does not Granger Cause AUD | 310 | 0.96891 | 0.3807 |
| AUD does not Granger Cause YUAN | | 1.85307 | 0.1585 |
| RAND does not Granger Cause AUD | 310 | 0.20695 | 0.8132 |
| AUD does not Granger Cause RAND | | 2.10633 | 0.1235 |

| | | | |
|---|---|---|---|
| FRANC does not Granger Cause DIRHAM | 310 | 1.83199 | 0.1619 |
| DIRHAM does not Granger Cause FRANC | | 22.3952 | 8.E-10 |
| HKD does not Granger Cause DIRHAM | 310 | 0.05946 | 0.9423 |
| DIRHAM does not Granger Cause HKD | | 1.75264 | 0.1751 |
| MARK does not Granger Cause DIRHAM | 310 | 1.62844 | 0.1979 |
| DIRHAM does not Granger Cause MARK | | 0.64485 | 0.5255 |
| POUNDS does not Granger Cause DIRHAM | 310 | 0.05357 | 0.9478 |
| DIRHAM does not Granger Cause POUNDS | | 0.17455 | 0.8399 |
| USD does not Granger Cause DIRHAM | 310 | 0.86070 | 0.4239 |
| DIRHAM does not Granger Cause USD | | 4.04371 | 0.0185 |
| YUAN does not Granger Cause DIRHAM | 310 | 6.02316 | 0.0027 |
| DIRHAM does not Granger Cause YUAN | | 10.4771 | 4.E-05 |
| RAND does not Granger Cause DIRHAM | 310 | 1.69506 | 0.1853 |
| DIRHAM does not Granger Cause RAND | | 1.14253 | 0.3204 |
| HKD does not Granger Cause FRANC | 310 | 21.7778 | 1.E-09 |
| FRANC does not Granger Cause HKD | | 1.83014 | 0.1621 |
| MARK does not Granger Cause FRANC | 310 | 1.98623 | 0.1390 |
| FRANC does not Granger Cause MARK | | 1.24041 | 0.2907 |
| POUNDS does not Granger Cause FRANC | 310 | 2.24802 | 0.1074 |
| FRANC does not Granger Cause POUNDS | | 0.87063 | 0.4197 |
| USD does not Granger Cause FRANC | 310 | 21.8480 | 1.E-09 |
| FRANC does not Granger Cause USD | | 1.90100 | 0.1512 |
| YUAN does not Granger Cause FRANC | 310 | 25.2544 | 7.E-11 |
| FRANC does not Granger Cause YUAN | | 4.01492 | 0.0190 |
| RAND does not Granger Cause FRANC | 310 | 0.17430 | 0.8401 |
| FRANC does not Granger Cause RAND | | 1.86465 | 0.1567 |
| MARK does not Granger Cause HKD | 310 | 1.42612 | 0.2418 |
| HKD does not Granger Cause MARK | | 0.65233 | 0.5216 |
| POUNDS does not Granger Cause HKD | 310 | 0.04657 | 0.9545 |
| HKD does not Granger Cause POUNDS | | 0.09818 | 0.9065 |
| USD does not Granger Cause HKD | 310 | 0.05733 | 0.9443 |
| HKD does not Granger Cause USD | | 0.07639 | 0.9265 |
| YUAN does not Granger Cause HKD | 310 | 7.02284 | 0.0010 |
| HKD does not Granger Cause YUAN | | 9.45156 | 0.0001 |
| RAND does not Granger Cause HKD | 310 | 1.85607 | 0.1580 |
| HKD does not Granger Cause RAND | | 1.12771 | 0.3251 |
| POUNDS does not Granger Cause MARK | 310 | 0.20407 | 0.8155 |
| MARK does not Granger Cause POUNDS | | 0.65405 | 0.5207 |
| USD does not Granger Cause MARK | 310 | 0.63765 | 0.5292 |
| MARK does not Granger Cause USD | | 1.52873 | 0.2185 |

| | | | |
|---|---|---|---|
| YUAN does not Granger Cause MARK | 310 | 1.94230 | 0.1451 |
| MARK does not Granger Cause YUAN | | 0.15019 | 0.8606 |
| | | | |
| RAND does not Granger Cause MARK | 310 | 1.28020 | 0.2795 |
| MARK does not Granger Cause RAND | | 1.36000 | 0.2582 |
| | | | |
| USD does not Granger Cause POUNDS | 310 | 0.08305 | 0.9203 |
| POUNDS does not Granger Cause USD | | 0.05467 | 0.9468 |
| | | | |
| YUAN does not Granger Cause POUNDS | 310 | 0.16613 | 0.8470 |
| POUNDS does not Granger Cause YUAN | | 0.07096 | 0.9315 |
| | | | |
| RAND does not Granger Cause POUNDS | 310 | 0.48968 | 0.6133 |
| POUNDS does not Granger Cause RAND | | 1.49629 | 0.2256 |
| | | | |
| YUAN does not Granger Cause USD | 310 | 7.07531 | 0.0010 |
| USD does not Granger Cause YUAN | | 9.69475 | 8.E-05 |
| | | | |
| RAND does not Granger Cause USD | 310 | 1.66736 | 0.1905 |
| USD does not Granger Cause RAND | | 1.10557 | 0.3323 |
| | | | |
| RAND does not Granger Cause YUAN | 310 | 2.29814 | 0.1022 |
| YUAN does not Granger Cause RAND | | 1.53201 | 0.2178 |

The hypotheses rejected are:

| | | | |
|---|---|---|---|
| HKD does not Granger Cause FRANC | 310 | 21.7778 | 1.E-09 |
| MARK does not Granger Cause AUD | 310 | 3.45957 | 0.0327 |
| DIRHAM does not Granger Cause FRANC | | 22.3952 | 8.E-10 |
| DIRHAM does not Granger Cause USD | | 4.04371 | 0.0185 |
| YUAN does not Granger Cause DIRHAM | 310 | 6.02316 | 0.0027 |
| USD does not Granger Cause FRANC | 310 | 21.8480 | 1.E-09 |
| YUAN does not Granger Cause FRANC | 310 | 25.2544 | 7.E-11 |
| FRANC does not Granger Cause YUAN | | 4.01492 | 0.0190 |
| YUAN does not Granger Cause HKD | 310 | 7.02284 | 0.0010 |
| HKD does not Granger Cause YUAN | | 9.45156 | 0.0001 |
| YUAN does not Granger Cause USD | 310 | 7.07531 | 0.0010 |
| USD does not Granger Cause YUAN | | 9.69475 | 8.E-05 |

## 5.1.1.3 Autocorrelation

|          | AUD       | DIRHAM    | FRANC    | HKD       | MARK     | POUNDS   | RAND      | USD       | YUAN      |
|----------|-----------|-----------|----------|-----------|----------|----------|-----------|-----------|-----------|
| AUD      | 1.000000  | -0.068906 | 0.506001 | -0.055282 | 0.506005 | 0.426854 | 0.528752  | -0.070087 | -0.049159 |
| DIRHAM   | -0.068906 | 1.000000  | 0.368478 | 0.998057  | 0.368491 | 0.435364 | -0.089658 | 0.999784  | 0.985936  |
| FRANC    | 0.506001  | 0.368478  | 1.000000 | 0.379186  | 1.000000 | 0.627676 | 0.315852  | 0.367251  | 0.410154  |
| HKD      | -0.055282 | 0.998057  | 0.379186 | 1.000000  | 0.379198 | 0.441815 | -0.082843 | 0.998202  | 0.984846  |
| MARK     | 0.506005  | 0.368491  | 1.000000 | 0.379198  | 1.000000 | 0.627671 | 0.315832  | 0.367264  | 0.410168  |
| POUNDS   | 0.426854  | 0.435364  | 0.627676 | 0.441815  | 0.627671 | 1.000000 | 0.227492  | 0.433740  | 0.456658  |
| RAND     | 0.528752  | -0.089658 | 0.315852 | -0.082843 | 0.315832 | 0.227492 | 1.000000  | -0.089609 | -0.081988 |
| USD      | -0.070087 | 0.999784  | 0.367251 | 0.998202  | 0.367264 | 0.433740 | -0.089609 | 1.000000  | 0.985776  |
| YUAN     | -0.049159 | 0.985936  | 0.410154 | 0.984846  | 0.410168 | 0.456658 | -0.081988 | 0.985776  | 1.000000  |

The currencies which are highly correlated are:

HKD, Dirham, Franc, usd, yuan

1. HKD, Dirham, Franc, USD, Yuan

The currencies which can be taken into account are (different sets can be regressed):

1. HKD/ Dirham/Yuan/ USD – If any of these are taken then AUD need not be taken
2. Mark/Fanc
3. Pound

Since rand causes all the currencies, hence Rand is not taken (Ref: Granger Causality tests)

## 5.1.2 Currency Regression Model

All the seven currencies are taken to be in the regression analysis to identify the currencies which have a really significant impact on the Indian Gold price.

**Table 6: Currency Regression Analysis**

Dependent Variable: GOLDPRICE
Method: Least Squares
Date: 05/11/13   Time: 2:16
Sample (adjusted): 1/14/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.457549 | 0.188663 | 2.425211 | 0.0160 |
| POUNDS | 0.011210 | 0.210048 | 0.053371 | 0.9575 |
| MARK | 0.488738 | 0.201142 | 2.429819 | 0.0158 |
| USD | -0.075914 | 0.200924 | -0.377824 | 0.7059 |

| | | | |
|---|---|---|---|
| R-squared | 0.035499 | Mean dependent var | 0.490248 |
| Adjusted R-squared | 0.024152 | S.D. dependent var | 3.053138 |
| S.E. of regression | 3.016043 | Akaike info criterion | 5.061092 |
| Sum squared resid | 2319.611 | Schwarz criterion | 5.116024 |
| Log likelihood | -651.4114 | Hannan-Quinn criter. | 5.083178 |
| F-statistic | 3.128467 | Durbin-Watson stat | 2.259242 |
| Prob(F-statistic) | 0.026327 | | |

This shows that mark/ franc significantly affect the gold price at 0.05 critical value. They have a positive correlation with the price of gold.

## 5.2 Final Regression

### 5.2.1 Statistical Problems Checking

### 5.2.1.1 Causality Tests

As seen below, we found little evidence to reject Null hypothesis that our dependant Variable (GoldPrice) Granger causes independent variables. Thus, we can use regression model.

**Table 7: Granger Causality Tests**

Pairwise Granger Causality Tests
Date: 05/11/13   Time: 02:19
Sample: 1/01/2007 12/30/2012
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| SILVERRET does not Granger Cause OILRET | 1302 | 0.91812 | 0.3995 |
| OILRET does not Granger Cause SILVERRET | | 2.19921 | 0.1113 |
| NIFTYRET does not Granger Cause OILRET | 1302 | 0.61278 | 0.5420 |
| OILRET does not Granger Cause NIFTYRET | | 0.42174 | 0.6560 |
| MARKRET does not Granger Cause OILRET | 1302 | 0.76643 | 0.4649 |
| OILRET does not Granger Cause MARKRET | | 0.59652 | 0.5509 |
| NIFTYRET does not Granger Cause SILVERRET | 1302 | 0.14405 | 0.8659 |
| SILVERRET does not Granger Cause NIFTYRET | | 0.57576 | 0.5624 |
| MARKRET does not Granger Cause SILVERRET | 1302 | 1.68874 | 0.1852 |
| SILVERRET does not Granger Cause MARKRET | | 0.44078 | 0.6436 |
| MARKRET does not Granger Cause NIFTYRET | 1302 | 1.57934 | 0.2065 |
| NIFTYRET does not Granger Cause MARKRET | | 0.51030 | 0.6004 |

Since for all Hypothesis, $p > .05$, hence $H_o$ is accepted.

## 5.2.1.2 Multicollinearity

To check the problem if multicollinearity, simple correlation coefficients are checked. If the independent variables have correlation of less than 0.8, then there is no problem of multicollinearity.

The table below shows the correlation between various independent variables taken in the analysis.

**Table 8: Correlation Matrix**

|  | MARKRET | NIFTYRET | OILRET | SILVERRET |
|---|---|---|---|---|
| MARKRET | 1.000000 | 0.019572 | 0.044109 | -0.003998 |
| NIFTYRET | 0.019572 | 1.000000 | 0.047073 | -0.003732 |
| OILRET | 0.044109 | 0.047073 | 1.000000 | -0.000820 |
| SILVERRET | -0.003998 | -0.003732 | -0.000820 | 1.000000 |

None of the factors are correlated.

## 5.2.1.4 Autocorrelation

The simplest and well-known method is Durbin Watson Statistical value measurement which is used in this study. Durbin Watson Statistical value for the model equals to 2.116918. Durbin Watson critical value (du) is 1.841.

$$4 - 1.841 > 2.116918 > 1.841 = 2.159 > 2.116918 > 1.841$$

This shows that there is no autocorrelation problem.

**Table 9: Autocorrelation Test**

Breusch-Godfrey Serial Correlation LM Test:

| | | | |
|---|---|---|---|
| F-statistic | 2.507932 | Prob. F(2,1295) | 0.0818 |
| Obs*R-squared | 5.023519 | Prob. Chi-Square(2) | 0.0811 |

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 05/11/13   Time: 02:25
Sample: 1/04/2007 12/30/2012
Included observations: 1532
Presample missing value lagged residuals set to zero.

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.000586 | 0.036592 | -0.016004 | 0.9872 |
| MARKRET | 0.004082 | 0.030558 | 0.133587 | 0.8937 |
| NIFTYRET(-2) | 0.000141 | 0.001496 | 0.094211 | 0.9250 |
| OILRET | 0.002613 | 0.015118 | 0.172853 | 0.8628 |
| SILVERRET | 0.001277 | 0.019402 | 0.065802 | 0.9475 |
| RESID(-1) | -0.061251 | 0.027947 | -2.191689 | 0.0286 |
| RESID(-2) | -0.016646 | 0.027964 | -0.595272 | 0.5518 |

| | | | |
|---|---|---|---|
| R-squared | 0.003858 | Mean dependent var | 3.93E-17 |
| Adjusted R-squared | -0.000757 | S.D. dependent var | 1.316133 |
| S.E. of regression | 1.316631 | Akaike info criterion | 3.393391 |
| Sum squared resid | 2244.905 | Schwarz criterion | 3.421196 |
| Log likelihood | -2202.098 | Hannan-Quinn criter. | 3.403823 |
| F-statistic | 0.835977 | Durbin-Watson stat | 2.000074 |
| Prob(F-statistic) | 0.542032 | | |

Since the probability is greater than .05 for obs*R-sqaured, this implies that there is no autocorrelation between the variables.

## 5.2.2 Regression

The results of the regression are as follows:

**Table 10: Final Regression**

Dependent Variable: GOLDRET
Method: Least Squares
Date: 05/11/13   Time: 02:29
Sample (adjusted): 1/02/2007 12/30/2012
Included observations: 1532 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C | 0.076042 | 0.036559 | 2.079975 | 0.0377 |
| NIFTYRET | 0.002506 | 0.001495 | 1.676191 | 0.0939 |
| MARKRET | 0.157486 | 0.030424 | 5.176333 | 0.0000 |
| OILRET | 0.056455 | 0.014979 | 3.768883 | 0.0002 |
| SILVERRET | 0.010616 | 0.019338 | 0.549003 | 0.5831 |

| | | | | |
|----------|-------------|------------|-------------|-------|
| R-squared | 0.034823 | Mean dependent var | | 0.090805 |
| Adjusted R-squared | 0.031851 | S.D. dependent var | | 1.337932 |
| S.E. of regression | 1.316453 | Akaike info criterion | | 3.391586 |
| Sum squared resid | 2251.230 | Schwarz criterion | | 3.411422 |
| Log likelihood | -2206.314 | Hannan-Quinn criter. | | 3.399027 |
| F-statistic | 11.71672 | Durbin-Watson stat | | 2.116918 |
| Prob(F-statistic) | 0.000000 | | | |

The significant variables at different levels of significance are:

At 0% significance level:
1. Mark/ Franc
2. Oil Prices

At 5% significance level:
1. Mark/ Franc
2. Oil Prices

At 10% significance level:
1. Mark/ Franc
2. Oil Prices
3. Nifty

For 10% significance level the equation becomes:

GOLDRET = 0.0760416946565 + 0.00250604184538*NIFTYRET + 0.157486411309*MARKRET + 0.0564545244806*OILRET

## 5.3 ARIMA Modelling
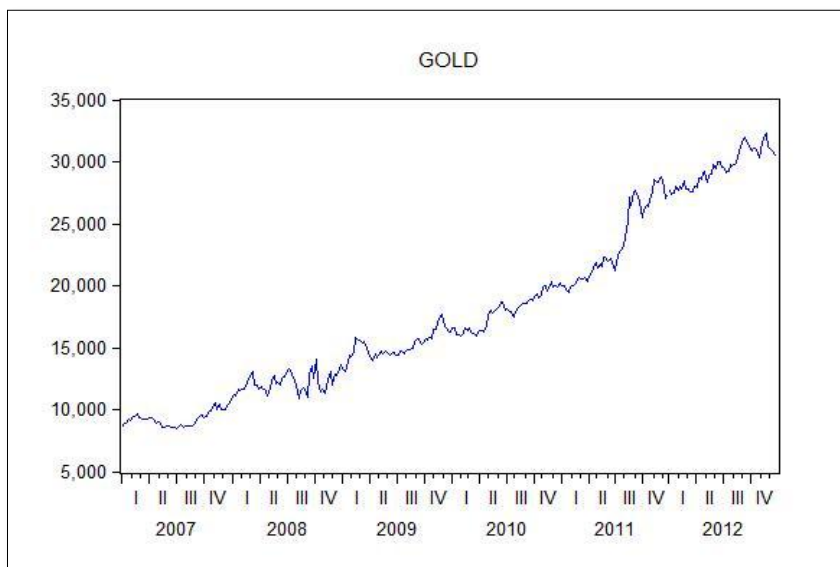


**Table 11: Correlogram of Gold Price**

Date: 05/11/13   Time: 02:48
Sample: 1/01/2007 12/30/2012
Included observations: 1532

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| \|******* | \|******* | 1 | 0.997 | 0.997 | 1300.1 | 0.000 |
| \|******* | \| \| | 2 | 0.994 | 0.013 | 2593.5 | 0.000 |
| \|******* | \| \| | 3 | 0.991 | -0.023 | 3879.9 | 0.000 |
| \|******* | \| \| | 4 | 0.988 | -0.027 | 5158.9 | 0.000 |
| \|******* | \| \| | 5 | 0.984 | -0.021 | 6430.2 | 0.000 |
| \|******* | \| \| | 6 | 0.981 | -0.007 | 7693.8 | 0.000 |
| \|******* | \| \| | 7 | 0.978 | 0.019 | 8949.9 | 0.000 |
| \|******* | \| \| | 8 | 0.974 | 0.001 | 10199. | 0.000 |
| \|******* | \| \| | 9 | 0.971 | -0.016 | 11440. | 0.000 |
| \|******* | \| \| | 10 | 0.968 | -0.016 | 12673. | 0.000 |
| \|******* | \| \| | 11 | 0.964 | 0.001 | 13899. | 0.000 |
| \|******* | \| \| | 12 | 0.961 | 0.013 | 15117. | 0.000 |
| \|******* | \| \| | 13 | 0.958 | -0.016 | 16327. | 0.000 |
| \|******* | *\| \| | 14 | 0.954 | -0.071 | 17529. | 0.000 |
| \|******* | \| \| | 15 | 0.950 | 0.018 | 18723. | 0.000 |
| \|******* | \| \| | 16 | 0.946 | 0.004 | 19908. | 0.000 |
| \|******* | \| \| | 17 | 0.943 | -0.009 | 21084. | 0.000 |
| \|******* | \| \| | 18 | 0.939 | -0.036 | 22252. | 0.000 |
| \|******* | \| \| | 19 | 0.935 | 0.023 | 23411. | 0.000 |
| \|******* | \| \| | 20 | 0.931 | -0.012 | 24561. | 0.000 |
| \|******* | \| \| | 21 | 0.927 | -0.004 | 25703. | 0.000 |
| \|******* | \| \| | 22 | 0.923 | -0.006 | 26836. | 0.000 |

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| \|******* | \| | 23 | 0.919 | -0.028 | 27960. | 0.000 |
| \|******* | \| | 24 | 0.915 | 0.038 | 29076. | 0.000 |
| \|******* | \| | 25 | 0.912 | 0.015 | 30183. | 0.000 |
| \|******* | \| | 26 | 0.908 | -0.005 | 31282. | 0.000 |
| \|******* | \| | 27 | 0.904 | 0.003 | 32372. | 0.000 |
| \|******\| | \| | 28 | 0.900 | 0.020 | 33455. | 0.000 |

From the line graph, it is clear that the variable has upward trends and seasonal cycles, which implies level non-stationary. Also, in the graph of correlogram, the ACFs is suffered from linear decline.

In order to remove stationarity from the series the return of the variable is taken.

**Table 12: Correlogram of Gold Returns**

Date: 05/11/13   Time: 2:52
Sample: 1/01/2007 12/24/2012
Included observations: 312

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| .\|******* | .\|******* | 1 | 0.990 | 0.990 | 308.84 | 0.000 |
| .\|******* | .\|. | 2 | 0.980 | 0.002 | 612.63 | 0.000 |
| .\|******* | .\|. | 3 | 0.970 | -0.024 | 911.16 | 0.000 |
| .\|******* | .\|. | 4 | 0.960 | -0.013 | 1204.4 | 0.000 |
| .\|******* | .\|. | 5 | 0.950 | -0.006 | 1492.3 | 0.000 |
| .\|******* | .\|. | 6 | 0.939 | -0.032 | 1774.6 | 0.000 |
| .\|******* | .\|. | 7 | 0.929 | 0.037 | 2052.0 | 0.000 |
| .\|******* | .\|. | 8 | 0.920 | 0.017 | 2324.5 | 0.000 |
| .\|******* | .\|. | 9 | 0.911 | 0.052 | 2593.0 | 0.000 |
| .\|******* | .\|. | 10 | 0.902 | -0.038 | 2857.0 | 0.000 |
| .\|******\| | .\|. | 11 | 0.893 | -0.032 | 3116.4 | 0.000 |
| .\|******\| | .\|. | 12 | 0.883 | -0.015 | 3371.0 | 0.000 |
| .\|******\| | .\|. | 13 | 0.873 | -0.040 | 3620.5 | 0.000 |
| .\|******\| | .\|. | 14 | 0.862 | -0.036 | 3864.5 | 0.000 |
| .\|******\| | .\|. | 15 | 0.850 | -0.012 | 4103.1 | 0.000 |
| .\|******\| | .\|. | 16 | 0.839 | -0.003 | 4336.2 | 0.000 |
| .\|******\| | .\|. | 17 | 0.827 | -0.032 | 4563.5 | 0.000 |
| .\|******\| | .\|. | 18 | 0.817 | 0.039 | 4785.7 | 0.000 |
| .\|******\| | .\|. | 19 | 0.806 | 0.011 | 5003.1 | 0.000 |
| .\|******\| | .\|. | 20 | 0.796 | -0.003 | 5215.6 | 0.000 |
| .\|******\| | .\|. | 21 | 0.786 | 0.004 | 5423.5 | 0.000 |
| .\|******\| | .\|. | 22 | 0.776 | -0.013 | 5626.8 | 0.000 |
| .\|******\| | .\|. | 23 | 0.766 | -0.010 | 5825.5 | 0.000 |
| .\|***** \| | .\|. | 24 | 0.756 | 0.019 | 6019.8 | 0.000 |
| .\|***** \| | .\|. | 25 | 0.746 | -0.015 | 6209.7 | 0.000 |
| .\|***** \| | .\|. | 26 | 0.735 | -0.019 | 6394.9 | 0.000 |
| .\|***** \| | .\|. | 27 | 0.725 | -0.016 | 6575.4 | 0.000 |
| .\|***** \| | .\|. | 28 | 0.714 | -0.011 | 6751.3 | 0.000 |
| .\|***** \| | .\|. | 29 | 0.703 | -0.020 | 6922.3 | 0.000 |
| .\|***** \| | .\|. | 30 | 0.692 | 0.023 | 7088.9 | 0.000 |
| .\|***** \| | .\|. | 31 | 0.682 | -0.033 | 7250.8 | 0.000 |
| .\|***** \| | .\|. | 32 | 0.671 | 0.018 | 7408.5 | 0.000 |
| .\|***** \| | .\|. | 33 | 0.661 | -0.001 | 7561.8 | 0.000 |
| .\|***** \| | .\|. | 34 | 0.651 | -0.000 | 7711.1 | 0.000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| .\|***** \| | .\|. \| | 35 | 0.641 | -0.027 | 7856.3 | 0.000 |
| .\|***** \| | .\|. \| | 36 | 0.630 | 0.010 | 7997.3 | 0.000 |

### 5.3.1 ARIMA Model

Since the regression model above has low $R^2$ value, the model can be improved by adding AR and MA Terms.

**Table 13: ARIMA Model Regression**

Dependent Variable: GOLDRET
Method: Least Squares
Date: 05/11/13   Time: 03:02
Sample (adjusted): 1/03/2007 12/30/2012
Included observations: 1532 after adjustments
Convergence achieved after 25 iterations
MA Backcast: 1/01/2007 1/02/2007

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.082674 | 0.004539 | 18.21255 | 0.0000 |
| NIFTYRET | 0.002516 | 0.001476 | 1.704893 | 0.0885 |
| MARKRET | 0.168496 | 0.030988 | 5.437444 | 0.0000 |
| OILRET | 0.057259 | 0.014842 | 3.857878 | 0.0001 |
| AR(1) | 0.976074 | 0.006275 | 155.5480 | 0.0000 |
| MA(1) | -1.045813 | 0.028640 | -36.51522 | 0.0000 |
| MA(2) | 0.046761 | 0.028597 | 1.635167 | 0.1023 |

| | | | |
|---|---|---|---|
| R-squared | 0.048028 | Mean dependent var | 0.089962 |
| Adjusted R-squared | 0.043620 | S.D. dependent var | 1.338100 |
| S.E. of regression | 1.308590 | Akaike info criterion | 3.381136 |
| Sum squared resid | 2219.282 | Schwarz criterion | 3.408923 |
| Log likelihood | -2195.810 | Hannan-Quinn criter. | 3.391561 |
| F-statistic | 10.89737 | Durbin-Watson stat | 2.003398 |
| Prob(F-statistic) | 0.000000 | | |

| | | |
|---|---|---|
| Inverted AR Roots | .98 | |
| Inverted MA Roots | 1.00 | .05 |

The ARIMA model – (1, 1, 2) improves the $R^2$ and the AR, MA terms are pretty significant.

## 5.4 Result

GOLDRET = 0.0826737397539 + 0.00251575737938*NIFTYRET + 0.16849562218*MARKRET + 0.0572589339761*OILRET + [AR(1)=0.976074411235,MA(1)=-1.04581264752,MA(2)=0.046760501824,BACKCAST=1/03/2007,ESTSMPL="1/03/2007 12/30/2011"]

The relationship of the various dependent variables with the gold prices is assessed below:

| Variable | Relationship |
|---|---|
| Oil Prices | Positive |
| Mark | Positive |
| Franc | Positive |
| AUD | Positive |
| Nifty | Positive |

**Table 14: Forecast Analysis**

# 6. Conclusion

Gold has been a commodity if interest since the beginning of its discovery. This is because of the scarcity of gold and its high mining costs. Historically, it has received great importance because of its widespread application in coinage, jewellery and other arts since the beginning of recorded history. This is supported by the widespread use of gold as a monetary standard in the early 20th century. A total of 1.65 lakh tonnes of gold have been mined in human history till now. All over the world gold is used for jewellery (50%), investment (40%) and industry (10%).

Throughout the world Gold was used as a vehicle of monetary exchange in early 20th century via gold convertible paper instruments or issuance/ recognition of gold coins or other bare metal quantities or by establishing gold standards in which total value of issued money is represented in a store of gold reserves. However world's economies have been growing at a very rapid rate and production of gold has not increased at such a fast pace. This has lead to decline in mined output of gold in contrast to the sharp growth of economies across the world. This lead to gold's reserves becoming a fraction of all the markets and thus exchange rate of the currencies to gold were no longer sustainable.

Gold is also used for investment in the sense that many investors store it in form of bullion coins or bars as a hedge against inflation. It a highly researched topic as to how gold acts as a hedge against inflation in the long run. Another prominent use of gold has been for the purpose of jewellery. Since it is soft when pure, it is usually alloyed with other base metals to increase its hardness and ductility.

Gold prices are determined via trading in the gold and derivatives markets. Gold Fixing in London since September 1919 provides a daily benchmark price to the industry. A system of afternoon fixing was also introduced in 1968 to provide a price when US markets are open.

In early 20th century, gold coinage was widely used as a currency, with introduction of paper money it was merely a receipt redeemable for gold coin or bullion. In the case of gold standard, certain weight of gold was given the name of a unit of currency. Till a long time, US government set the value of the dollar such that 1 troy ounce was equal to 20.67$, but in 1934 dollar was devalued to 35.00$ per troy ounce. In 1961, US and European banks decided to manipulate the market to prevent further currency devaluation against increased gold demand. In 1968, a two tiered pricing scheme was followed where gold was used to settle international accounts at $35 per troy ounce, but gold price in the private market was allowed to fluctuate. Finally in 1975, gold price was allowed to find its free market level.

Since 1968 the price of gold has ranged widely, from a high of 27,300/kg in 1980, to a low of $8,131/kg in 1999 (London Gold Fixing). Prices increased rapidly from 1991, but the 1980 high was not exceeded until January, 2008 when gold price reached to a new maximum of $865.35 per troy ounce was set.

In late 2009, gold markets experienced renewed momentum upwards due to increased demand and a weakening US dollar. Gold further reached new highs in May 2010 after the European debt crisis led to further purchase of gold as a safe haven.

India is the world's largest consumer of gold as India purchases around 800 tonnes of gold every year which is around 25% of world's gold. This also makes it the largest importer of gold in the world. Indian households hold 18000 tonnes of gold which is approximately worth 950$ bn and represents 11% of the global stock.

Thus a study of fluctuating gold prices in the Indian context is all the more necessary.
The dissertation has developed two models: Multivariable linear Regression Model and Auto regressive Integrated Moving averages Model (ARIMA). While Multiple linear regression helps in establishing a relationship between various dependent variables and 1 independent variable with taking into account the seasonality or trends ARIMA helps in building a model on the historical prices around trends and seasonal fluctuations if any.

The Top 10 countries from which India imports gold are identified and their currency's exchange rates are regressed with gold price to identify the currencies which have a significant impact on the gold price. The countries are Britain, China, Switzerland, UAE, USA, Hong Kong, Germany, Netherlands, South Africa and Australia. All the European Union countries are factored in via taking Euro in to account. In regression, all the currencies are considered to be significant and thus none of the currencies are rejected.

As part of the second regression stage, the currencies are regressed with other variables like real long term interest rates, inflation, oil prices, silver price & BSE 100 (closing price). All the series are tested for statistical problems like stationarity, hetroskedasticity, multicollinearity, autocorrelation and Causality. The four currencies UAE Dirham, HK Dollars, Chinese Yuan and US dollars are highly correlated and also Franc, Mark and Guilder. Thus only US dollars, Mark and Pounds are taken into account to avoid any biased results. Mark/Franc/ Guilder have greatest impact on the price of gold.

As per the regression results, the currencies exchange rates seem to have a great effect on the price of gold, especially so the Mark. Among the macroeconomic variable only oil prices have a significant impact on the gold prices.

In the second phase, ARIMA modelling, series is made stationary and then the number of AR and MA terms is identified in order to remove $R^2$. The Final ARIMA model is selected on the basis of the model which gives the highest $R^2$ value and has significant AR and MA terms. The model selected is (1,1,2)

## Conclusion

The Gold investors can use Multivariate ARIMA (1,1,2) for predicting the prices of gold. Although in the present scope of study, it is the best model, however it has certain errors. The factors affecting the gold prices are nifty, oil prices and Mark/ Franc

They all have a positive correlation with the price of gold. Since European nations are major gold exporting nations, any appreciation in their currencies will lead to increase in gold prices because of imports becoming costlier.

Gold also has a positive relationship with the price of oil because it acts as an inflation hedge. When oil prices indicative of inflation rise, demand for gold increases thus pushing the prices further high.

However, political events also have a great impact on the state of economies in the world and since the impact of these events cannot be quantified, further study on integrating these impacts with the proposed model would improve the predicting capabilities of the model.

# 7. References

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## Charts



**Gold Price Vs Mark**
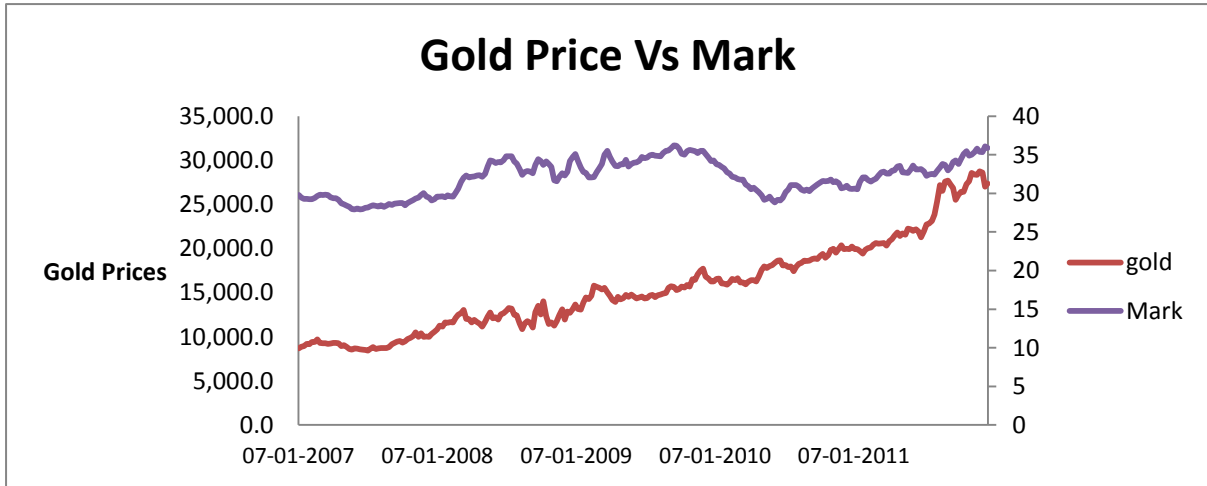
**Figure 8: Relationship between Gold price and Mark**
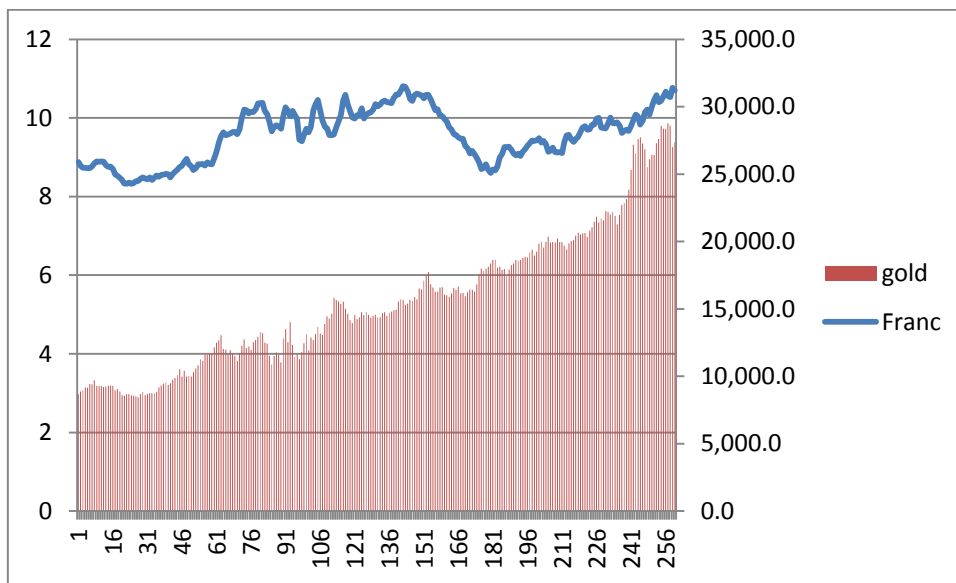


**Figure 9: Relationship between Gold prices and Franc**
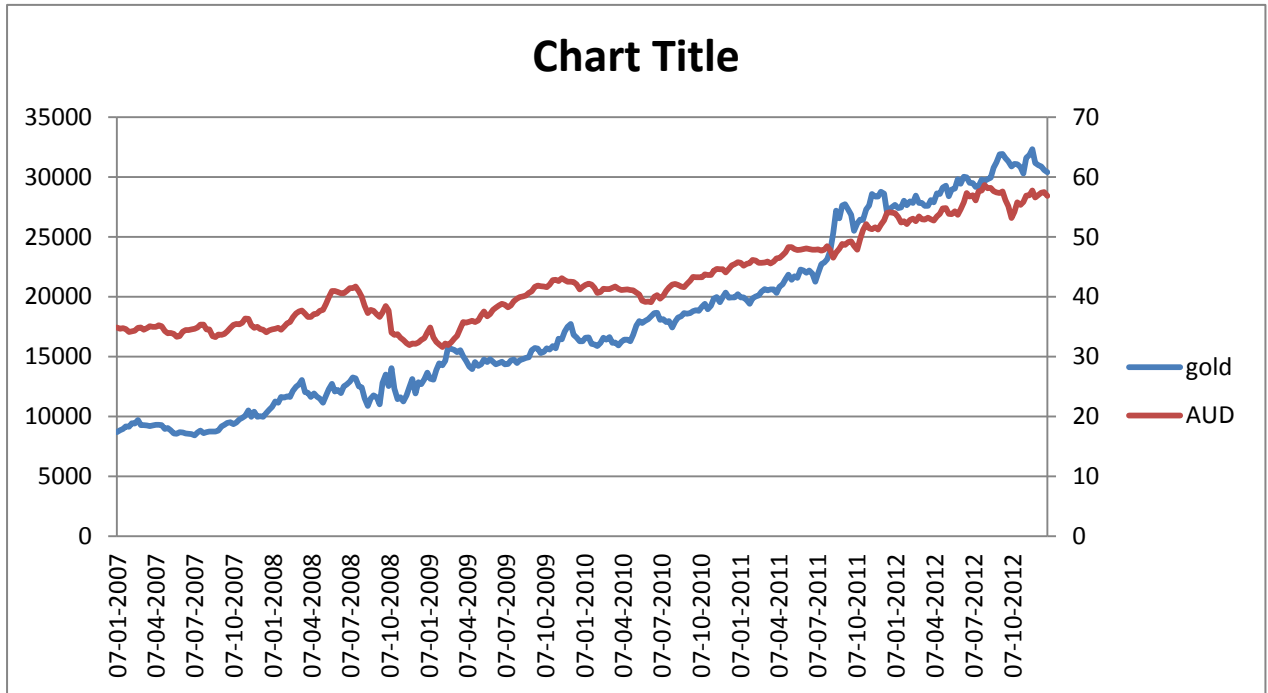
**Figure 7: Relationship between Gold price and AUD**
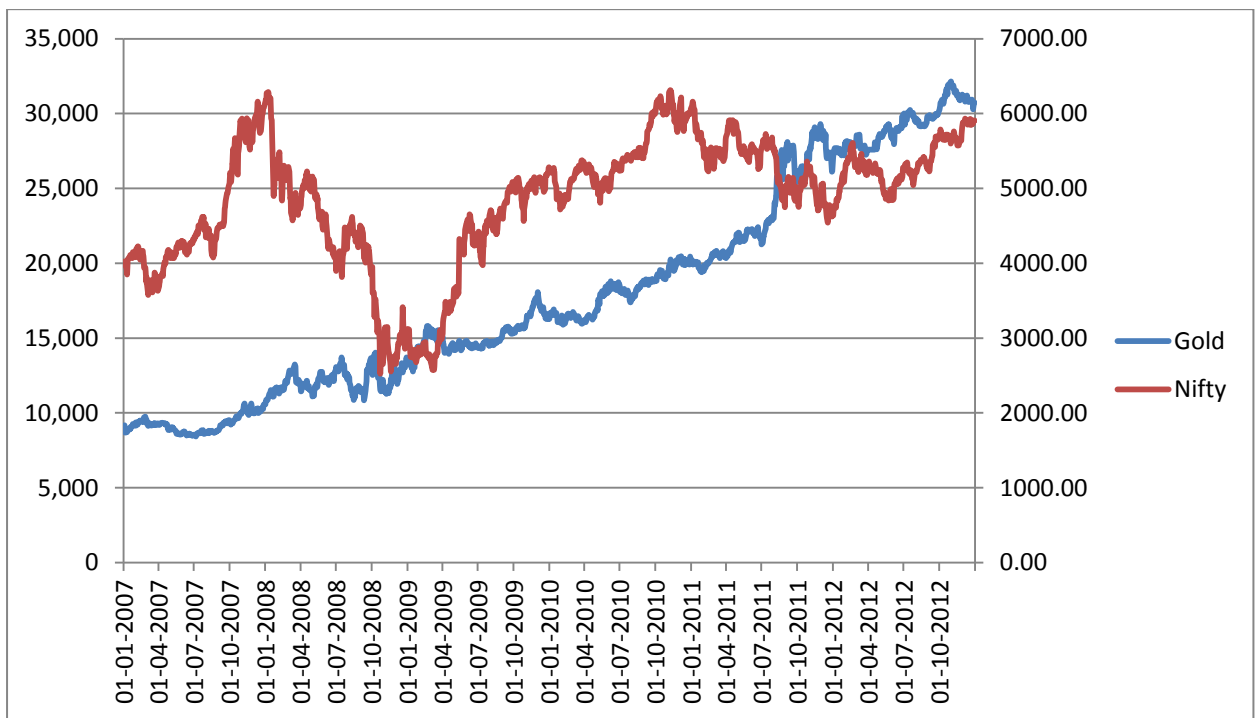


**Figure 8: Relationship between Gold prices and Nifty**
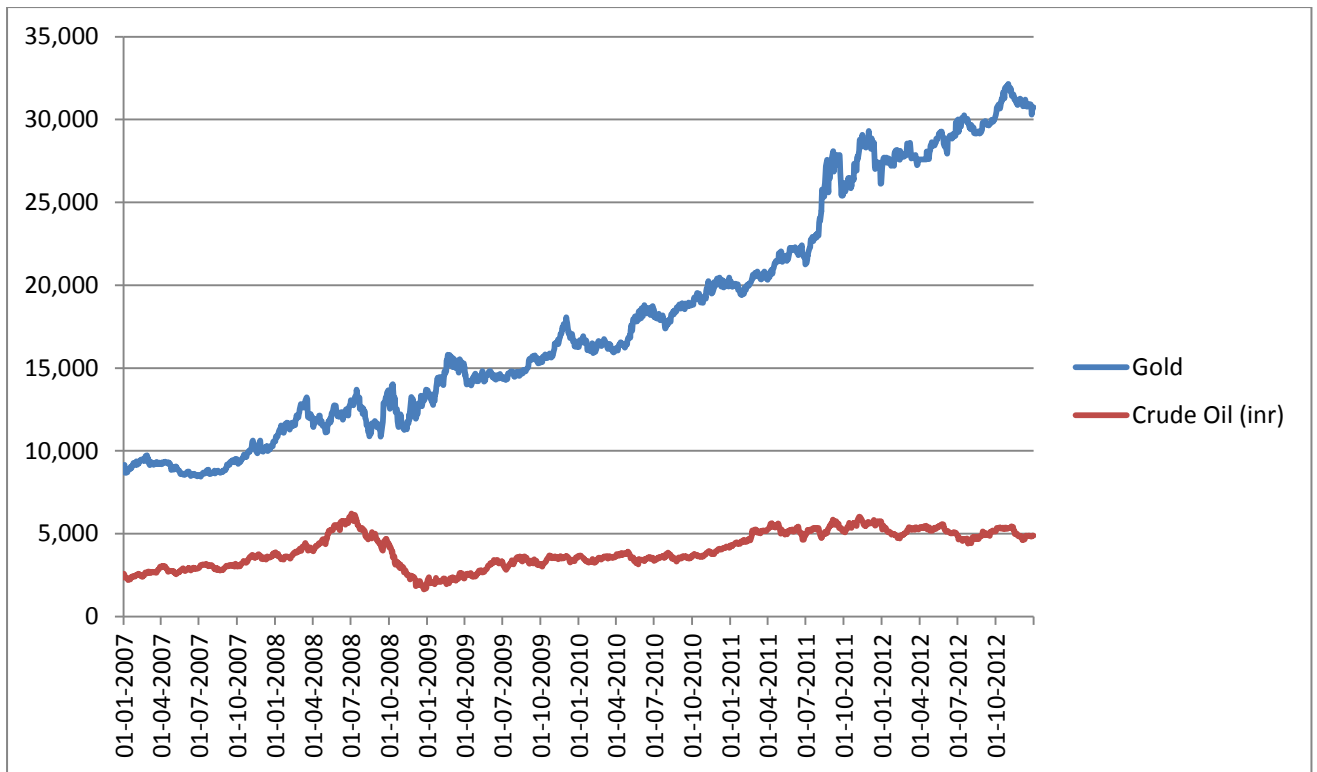
**Figure 9: Relationship between Gold price and Oil price**
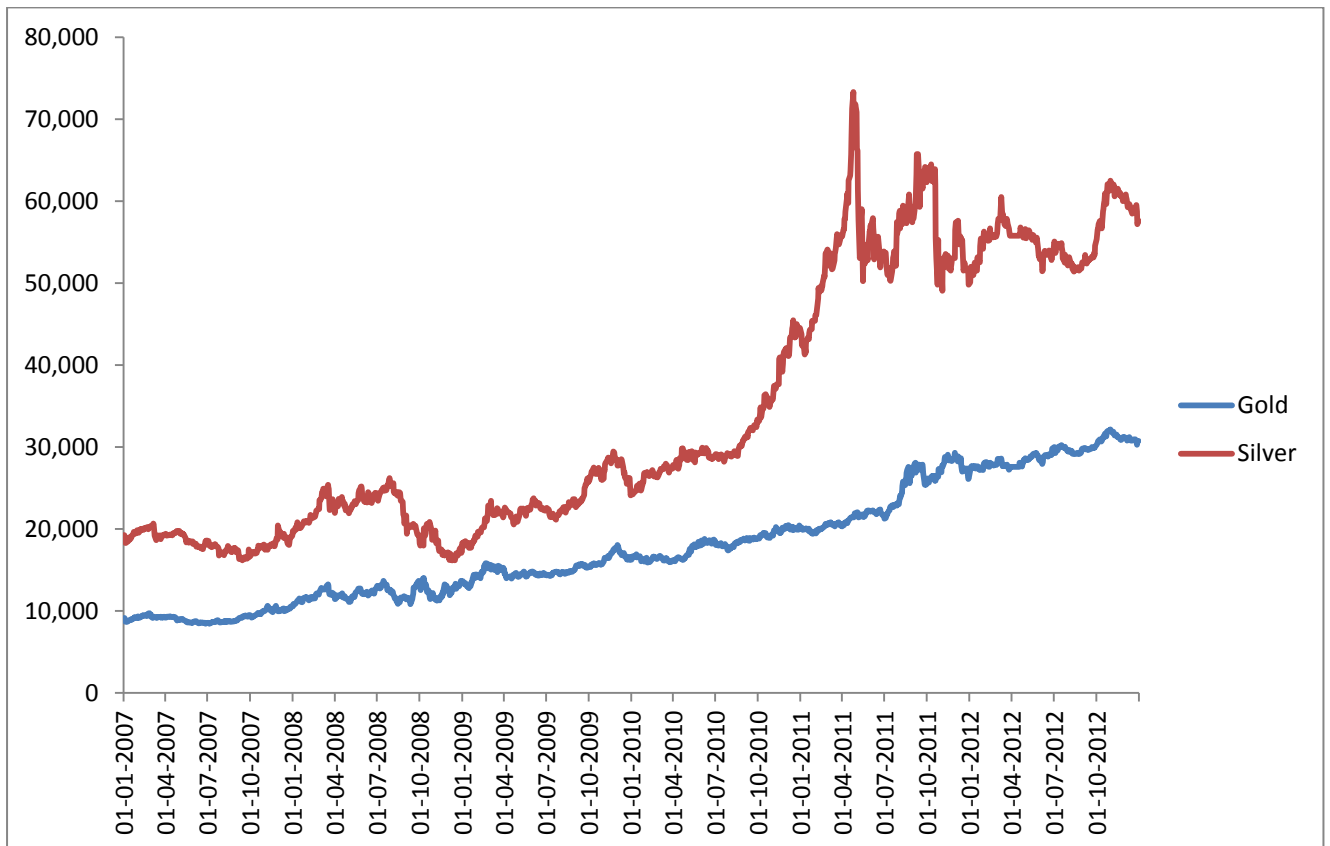


**Figure 10: Relationship between Gold price and Silver Price**

# Data sets

| Date | Gold | USD | ZAR | Franc | Pounds | AUD | Mark | Dirham | Yuan | HKD |
|------|------|-----|-----|-------|--------|-----|------|--------|------|-----|
| 07-01-2007 | 8682 | 44.2643 | 6.2593 | 47.0643 | 86.4029 | 34.8673 | 29.7698 | 12.0487 | 5.6592 | 5.6858 |
| 14-01-2007 | 8852 | 44.4165 | 6.0973 | 46.9165 | 86.1906 | 34.6668 | 29.4475 | 12.0901 | 5.6843 | 5.6966 |
| 21-01-2007 | 8951 | 44.2383 | 6.1316 | 47.2383 | 87.012 | 34.764 | 29.2707 | 12.0417 | 5.6768 | 5.6684 |
| 28-01-2007 | 9180 | 44.2059 | 6.1387 | 46.3659 | 87.1147 | 34.6006 | 29.284 | 12.0329 | 5.6786 | 5.6631 |
| 04-02-2007 | 9158 | 44.1384 | 6.071 | 46.2884 | 86.6238 | 34.1346 | 29.2557 | 12.0145 | 5.6751 | 5.6524 |
| 11-02-2007 | 9429 | 44.0712 | 6.117 | 46.2012 | 86.4418 | 34.228 | 29.2486 | 11.9965 | 5.6773 | 5.6416 |
| 18-02-2007 | 9408 | 44.0221 | 6.0921 | 46.8221 | 85.8828 | 34.3352 | 29.4059 | 11.9831 | 5.6696 | 5.6343 |
| 25-02-2007 | 9704 | 44.1622 | 6.1974 | 46.6622 | 86.3073 | 34.8139 | 29.6717 | 12.0213 | 5.6909 | 5.6527 |
| 04-03-2007 | 9287 | 44.217 | 6.1186 | 47.217 | 86.5873 | 34.849 | 29.8211 | 12.0374 | 5.7023 | 5.6565 |
| 11-03-2007 | 9270 | 44.3501 | 5.9826 | 46.5101 | 85.6689 | 34.4885 | 29.7888 | 12.0746 | 5.7202 | 5.6746 |
| 18-03-2007 | 9265 | 44.1771 | 5.9421 | 46.3271 | 85.4766 | 34.7454 | 29.8403 | 12.0278 | 5.6985 | 5.6533 |
| 25-03-2007 | 9194 | 43.7756 | 5.9509 | 45.9056 | 85.6049 | 35.095 | 29.7972 | 11.9187 | 5.653 | 5.6036 |
| 01-04-2007 | 9248 | 43.3278 | 5.9525 | 46.1278 | 85.094 | 34.9647 | 29.5131 | 11.7966 | 5.5968 | 5.5452 |
| 08-04-2007 | 9295 | 42.9414 | 5.9581 | 45.4414 | 84.6498 | 34.9756 | 29.3524 | 11.6918 | 5.5484 | 5.4938 |
| 15-04-2007 | 9319 | 42.7614 | 5.9642 | 45.7614 | 84.4109 | 35.2471 | 29.3815 | 11.6429 | 5.5275 | 5.4713 |
| 22-04-2007 | 9284 | 42.0333 | 5.9117 | 44.1933 | 83.9888 | 35.0834 | 29.1664 | 11.4431 | 5.4359 | 5.3794 |
| 29-04-2007 | 8950 | 41.2519 | 5.8464 | 43.4019 | 82.4792 | 34.2896 | 28.7074 | 11.2287 | 5.3352 | 5.2762 |
| 06-05-2007 | 9049 | 41.0913 | 5.8445 | 43.2213 | 81.934 | 33.9209 | 28.5873 | 11.1847 | 5.3243 | 5.2533 |
| 13-05-2007 | 8865 | 41.0371 | 5.9007 | 43.8371 | 81.61 | 33.9545 | 28.4288 | 11.1708 | 5.3275 | 5.2474 |
| 20-05-2007 | 8596 | 40.831 | 5.8418 | 43.331 | 80.7892 | 33.8062 | 28.2437 | 11.1157 | 5.3113 | 5.2225 |
| 27-05-2007 | 8552 | 40.6071 | 5.7368 | 43.6071 | 80.3552 | 33.3322 | 27.9469 | 11.0576 | 5.2965 | 5.1908 |
| 03-06-2007 | 8684 | 40.5907 | 5.6894 | 42.7507 | 80.407 | 33.4099 | 27.9031 | 11.0522 | 5.3 | 5.1936 |
| 10-06-2007 | 8666 | 40.7525 | 5.6644 | 42.9025 | 80.8196 | 34.1917 | 28.0299 | 11.0944 | 5.3218 | 5.2167 |
| 17-06-2007 | 8580 | 40.9217 | 5.6593 | 43.0517 | 80.6728 | 34.4139 | 27.9111 | 11.1394 | 5.3498 | 5.2352 |
| 24-06-2007 | 8554 | 40.7829 | 5.7116 | 43.5829 | 81.0838 | 34.4518 | 27.968 | 11.1014 | 5.3432 | 5.2177 |
| 01-07-2007 | 8518 | 40.8329 | 5.7112 | 43.3329 | 81.698 | 34.5553 | 28.1235 | 11.1154 | 5.3534 | 5.2245 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 08-07-2007 | 8436 | 40.5261 | 5.7752 | 43.5261 | 81.5648 | 34.6662 | 28.1727 | 11.0312 | 5.3245 | 5.1846 |
| 15-07-2007 | 8663 | 40.4256 | 5.7698 | 42.5856 | 81.8145 | 34.8737 | 28.3403 | 11.0047 | 5.3268 | 5.1709 |
| 22-07-2007 | 8837 | 40.3631 | 5.806 | 42.5131 | 82.564 | 35.3446 | 28.471 | 10.9884 | 5.3272 | 5.1608 |
| 29-07-2007 | 8605 | 40.3729 | 5.8061 | 42.5029 | 82.723 | 35.3385 | 28.3929 | 10.9912 | 5.3315 | 5.1607 |
| 05-08-2007 | 8698 | 40.424 | 5.665 | 43.224 | 82.0913 | 34.5209 | 28.2904 | 11.0041 | 5.3346 | 5.1643 |
| 12-08-2007 | 8735 | 40.4979 | 5.6795 | 42.9979 | 82.1948 | 34.5506 | 28.4716 | 11.0239 | 5.3432 | 5.1742 |
| 19-08-2007 | 8735 | 40.7889 | 5.5602 | 43.7889 | 81.4763 | 33.4405 | 28.2353 | 11.1036 | 5.3687 | 5.2164 |
| 26-08-2007 | 8732 | 41.0833 | 5.6138 | 43.2433 | 81.8827 | 33.2402 | 28.4305 | 11.1841 | 5.4093 | 5.2604 |
| 02-09-2007 | 8831 | 41.0407 | 5.6912 | 43.1907 | 82.6058 | 33.6999 | 28.6305 | 11.1716 | 5.4266 | 5.2614 |
| 09-09-2007 | 9171 | 40.8343 | 5.6465 | 42.9643 | 82.457 | 33.6216 | 28.5147 | 11.1158 | 5.4058 | 5.2402 |
| 16-09-2007 | 9318 | 40.5307 | 5.6218 | 43.3307 | 82.0346 | 33.7781 | 28.6731 | 11.0331 | 5.3819 | 5.205 |
| 23-09-2007 | 9457 | 40.1993 | 5.6435 | 42.6993 | 80.6756 | 34.2269 | 28.7033 | 10.9452 | 5.3431 | 5.1622 |
| 30-09-2007 | 9519 | 39.7793 | 5.7125 | 42.7793 | 80.5389 | 34.7873 | 28.7671 | 10.8339 | 5.2901 | 5.1183 |
| 07-10-2007 | 9356 | 39.6664 | 5.7497 | 41.8264 | 80.9482 | 35.2751 | 28.749 | 10.7994 | 5.2776 | 5.1092 |
| 14-10-2007 | 9485 | 39.3907 | 5.7658 | 41.5407 | 80.2395 | 35.4265 | 28.4687 | 10.7237 | 5.2392 | 5.0778 |
| 21-10-2007 | 9747 | 39.5343 | 5.7879 | 41.6643 | 80.6781 | 35.39 | 28.7506 | 10.7643 | 5.2548 | 5.0988 |
| 28-10-2007 | 9882 | 39.6086 | 5.9084 | 42.4086 | 81.1133 | 35.6429 | 28.9411 | 10.7857 | 5.2766 | 5.1099 |
| 04-11-2007 | 10068 | 39.45 | 6.0105 | 41.95 | 81.6888 | 36.3469 | 29.1251 | 10.7452 | 5.2755 | 5.0877 |
| 11-11-2007 | 10514 | 39.3264 | 5.9944 | 42.3264 | 82.3145 | 36.2959 | 29.3456 | 10.7093 | 5.2816 | 5.0622 |
| 18-11-2007 | 9985 | 39.3377 | 5.8612 | 41.4977 | 81.2119 | 35.2295 | 29.4362 | 10.7135 | 5.293 | 5.0524 |
| 25-11-2007 | 10406 | 39.4653 | 5.8192 | 41.6153 | 81.2661 | 34.7986 | 29.8068 | 10.7521 | 5.3163 | 5.0719 |
| 02-12-2007 | 9982 | 39.7243 | 5.77 | 41.8543 | 82.0225 | 34.9834 | 30.0341 | 10.8473 | 5.3654 | 5.1031 |
| 09-12-2007 | 10039 | 39.4829 | 5.8107 | 42.2829 | 80.7038 | 34.6163 | 29.5861 | 10.7602 | 5.3276 | 5.0669 |
| 16-12-2007 | 9987 | 39.3719 | 5.8145 | 41.8719 | 80.1364 | 34.4932 | 29.4426 | 10.7188 | 5.3272 | 5.0494 |
| 23-12-2007 | 10305 | 39.53 | 5.6723 | 42.53 | 79.175 | 34.0497 | 29.0792 | 10.7581 | 5.3541 | 5.0674 |
| 30-12-2007 | 10568 | 39.4501 | 5.6648 | 41.6101 | 78.3401 | 34.4014 | 29.2426 | 10.7373 | 5.3669 | 5.0548 |
| 06-01-2008 | 10813 | 39.3832 | 5.7384 | 41.5332 | 78.1268 | 34.55 | 29.5907 | 10.7205 | 5.3951 | 5.0461 |
| 13-01-2008 | 11259 | 39.2886 | 5.7201 | 41.4186 | 77.2176 | 34.645 | 29.591 | 10.6943 | 5.3994 | 5.0345 |
| 20-01-2008 | 11144 | 39.285 | 5.6877 | 42.085 | 77.0214 | 34.8083 | 29.6084 | 10.6928 | 5.4138 | 5.034 |
| 27-01-2008 | 11622 | 39.465 | 5.5377 | 41.965 | 77.4057 | 34.4694 | 29.4842 | 10.7448 | 5.452 | 5.0538 |

| 03-02-2008 | 11574 | 39.365 | 5.3986 | 42.365 | 78.0397 | 35.0349 | 29.7463 | 10.7197 | 5.4655 | 5.045 |
|---|---|---|---|---|---|---|---|---|---|---|
| 10-02-2008 | 11674 | 39.525 | 5.1941 | 41.685 | 77.4185 | 35.5306 | 29.6112 | 10.762 | 5.4911 | 5.0672 |
| 17-02-2008 | 11640 | 39.67 | 5.1254 | 41.82 | 77.6326 | 35.7935 | 29.5755 | 10.7997 | 5.5114 | 5.0857 |
| 24-02-2008 | 12146 | 39.9129 | 5.1615 | 42.0429 | 78.0726 | 36.5938 | 30.0621 | 10.8655 | 5.5721 | 5.117 |
| 02-03-2008 | 12499 | 39.9109 | 5.2063 | 42.7109 | 78.9684 | 37.218 | 30.6152 | 10.8646 | 5.5875 | 5.1236 |
| 09-03-2008 | 12671 | 40.3273 | 5.0974 | 42.8273 | 80.4576 | 37.5234 | 31.4666 | 10.979 | 5.6652 | 5.18 |
| 16-03-2008 | 13047 | 40.4567 | 5.085 | 43.4567 | 81.6758 | 37.6807 | 32.0129 | 11.0151 | 5.6901 | 5.196 |
| 23-03-2008 | 12032 | 40.492 | 4.9958 | 42.652 | 80.9011 | 37.1738 | 32.32 | 11.0226 | 5.7194 | 5.2073 |
| 30-03-2008 | 11982 | 40.1342 | 4.9466 | 42.2842 | 80.0372 | 36.6387 | 32.0736 | 10.9237 | 5.6996 | 5.1579 |
| 06-04-2008 | 11632 | 39.9987 | 5.01 | 42.1287 | 79.5428 | 36.6035 | 32.132 | 10.8882 | 5.693 | 5.1359 |
| 13-04-2008 | 11918 | 39.965 | 5.0991 | 42.765 | 79.0593 | 37.0823 | 32.205 | 10.8766 | 5.6985 | 5.1302 |
| 20-04-2008 | 11664 | 39.9374 | 5.0785 | 42.4374 | 79.0114 | 37.1697 | 32.3338 | 10.8701 | 5.7009 | 5.1245 |
| 27-04-2008 | 11497 | 40.0363 | 5.1867 | 43.0363 | 79.5127 | 37.6275 | 32.3436 | 10.8965 | 5.7146 | 5.1367 |
| 04-05-2008 | 11151 | 40.4237 | 5.3161 | 42.5837 | 80.0188 | 37.8044 | 32.141 | 11.0007 | 5.7719 | 5.1868 |
| 11-05-2008 | 11712 | 41.1778 | 5.4013 | 43.3278 | 80.8108 | 38.7871 | 32.5257 | 11.2065 | 5.8821 | 5.2823 |
| 18-05-2008 | 12270 | 42.2657 | 5.5439 | 44.3957 | 82.4364 | 39.8605 | 33.4796 | 11.504 | 6.036 | 5.4194 |
| 25-05-2008 | 12735 | 42.7388 | 5.6021 | 45.5388 | 84.0814 | 40.9483 | 34.2448 | 11.6325 | 6.1303 | 5.4783 |
| 01-06-2008 | 12090 | 42.7077 | 5.555 | 45.2077 | 84.4944 | 40.9308 | 34.1937 | 11.6243 | 6.1432 | 5.472 |
| 08-06-2008 | 12215 | 42.6345 | 5.4872 | 45.6345 | 83.7885 | 40.7866 | 33.9178 | 11.6041 | 6.1403 | 5.461 |
| 15-06-2008 | 11957 | 42.863 | 5.3531 | 45.023 | 83.9441 | 40.5976 | 34.0598 | 11.6666 | 6.1901 | 5.4875 |
| 22-06-2008 | 12524 | 42.9256 | 5.3282 | 45.0756 | 84.2119 | 40.5712 | 34.0285 | 11.6835 | 6.2224 | 5.4969 |
| 29-06-2008 | 12676 | 42.8595 | 5.3662 | 44.9895 | 84.7535 | 40.9819 | 34.2867 | 11.6658 | 6.2309 | 5.4908 |
| 06-07-2008 | 12921 | 43.1414 | 5.4966 | 45.9414 | 85.8264 | 41.4364 | 34.7841 | 11.742 | 6.2811 | 5.531 |
| 13-07-2008 | 13271 | 43.2029 | 5.5833 | 45.7029 | 85.4826 | 41.453 | 34.7917 | 11.7579 | 6.2966 | 5.5371 |
| 20-07-2008 | 13194 | 42.871 | 5.6096 | 45.871 | 85.593 | 41.6844 | 34.8194 | 11.668 | 6.2727 | 5.4958 |
| 27-07-2008 | 12507 | 42.3373 | 5.5741 | 44.4973 | 84.4397 | 40.8783 | 34.151 | 11.5231 | 6.195 | 5.4283 |
| 03-08-2008 | 12426 | 42.3443 | 5.7081 | 44.4943 | 83.9602 | 40.0195 | 33.8375 | 11.5241 | 6.188 | 5.4268 |
| 10-08-2008 | 11529 | 42.159 | 5.666 | 44.289 | 82.2249 | 38.4791 | 33.1635 | 11.4753 | 6.1419 | 5.4004 |
| 17-08-2008 | 10875 | 42.6187 | 5.4363 | 45.4187 | 80.5129 | 37.2931 | 32.4015 | 11.6 | 6.2005 | 5.4563 |
| 24-08-2008 | 11504 | 43.4518 | 5.5955 | 45.9518 | 80.9675 | 37.8118 | 32.7787 | 11.8264 | 6.3309 | 5.5633 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 31-08-2008 | 11767 | 43.7298 | 5.646 | 46.7298 | 80.3777 | 37.6665 | 32.9152 | 11.902 | 6.3845 | 5.6008 |
| 07-09-2008 | 11606 | 44.348 | 5.6389 | 46.508 | 79.1448 | 37.0403 | 32.815 | 12.0705 | 6.4764 | 5.6801 |
| 14-09-2008 | 11029 | 45.1011 | 5.6106 | 47.2511 | 79.7174 | 36.6165 | 32.6202 | 12.2757 | 6.5835 | 5.7811 |
| 21-09-2008 | 12803 | 46.1022 | 5.6915 | 48.2322 | 83.2128 | 37.3751 | 33.692 | 12.5454 | 6.7267 | 5.9211 |
| 28-09-2008 | 13498 | 46.0518 | 5.693 | 48.8518 | 84.9693 | 38.4491 | 34.4326 | 12.5315 | 6.7263 | 5.9249 |
| 05-10-2008 | 12533 | 47.2764 | 5.6768 | 49.7764 | 84.7238 | 37.6835 | 34.1664 | 12.8656 | 6.8965 | 6.0839 |
| 12-10-2008 | 14029 | 48.4839 | 5.3721 | 51.4839 | 84.113 | 34.0312 | 33.691 | 13.1942 | 7.086 | 6.2417 |
| 19-10-2008 | 12331 | 49.4458 | 5.1237 | 51.6058 | 85.4564 | 33.6195 | 34.1399 | 13.4568 | 7.2237 | 6.3717 |
| 26-10-2008 | 11446 | 50.7648 | 4.7344 | 52.9148 | 84.0534 | 33.7626 | 33.7871 | 13.815 | 7.4083 | 6.5463 |
| 02-11-2008 | 11618 | 51.5188 | 4.9442 | 53.6488 | 82.3479 | 33.1427 | 33.4509 | 14.019 | 7.5118 | 6.645 |
| 09-11-2008 | 11265 | 48.492 | 4.8793 | 51.292 | 77.002 | 32.8002 | 31.6934 | 13.196 | 7.0818 | 6.2563 |
| 16-11-2008 | 11774 | 48.7571 | 4.774 | 51.2571 | 74.2802 | 32.2312 | 31.5593 | 13.2685 | 7.1303 | 6.2904 |
| 23-11-2008 | 12460 | 49.946 | 4.8113 | 52.946 | 74.3479 | 31.9081 | 32.1335 | 13.5934 | 7.3023 | 6.4437 |
| 30-11-2008 | 13116 | 49.828 | 4.9282 | 51.988 | 75.853 | 32.1935 | 32.6013 | 13.5624 | 7.287 | 6.4272 |
| 07-12-2008 | 11938 | 49.8098 | 4.8458 | 51.9598 | 74.216 | 32.1491 | 32.3109 | 13.5575 | 7.2375 | 6.4258 |
| 14-12-2008 | 12873 | 49.1584 | 4.8132 | 51.2884 | 72.9087 | 32.3241 | 32.7608 | 13.38 | 7.1536 | 6.3423 |
| 21-12-2008 | 12699 | 48.16 | 4.8352 | 50.96 | 73.0274 | 32.7519 | 34.1875 | 13.1063 | 7.0207 | 6.2137 |
| 28-12-2008 | 13141 | 48.5312 | 4.9769 | 51.0312 | 71.6635 | 33.1098 | 34.7087 | 13.2068 | 7.0733 | 6.2609 |
| 04-01-2009 | 13662 | 48.934 | 5.1398 | 51.934 | 71.2273 | 34.0391 | 35.082 | 13.3164 | 7.1419 | 6.313 |
| 11-01-2009 | 13151 | 49.0519 | 5.1466 | 51.2119 | 73.0427 | 34.8562 | 34.2044 | 13.3508 | 7.167 | 6.3257 |
| 18-01-2009 | 13075 | 49.0911 | 4.9039 | 51.2411 | 72.5785 | 33.2291 | 33.3457 | 13.3602 | 7.1708 | 6.3279 |
| 25-01-2009 | 13870 | 49.1577 | 4.8475 | 51.2877 | 69.3637 | 32.4528 | 32.7861 | 13.3781 | 7.1779 | 6.3359 |
| 01-02-2009 | 14450 | 49.0144 | 4.8494 | 51.8144 | 69.2849 | 32.0408 | 32.6416 | 13.3389 | 7.1557 | 6.3187 |
| 08-02-2009 | 14288 | 48.7753 | 4.8769 | 51.2753 | 70.7156 | 31.5802 | 32.0617 | 13.2752 | 7.1232 | 6.2901 |
| 15-02-2009 | 14639 | 48.6048 | 4.944 | 51.6048 | 70.7248 | 32.1938 | 32.0755 | 13.2296 | 7.1013 | 6.2692 |
| 22-02-2009 | 15813 | 49.4442 | 4.8831 | 51.6042 | 70.673 | 31.8995 | 32.1275 | 13.458 | 7.2224 | 6.3761 |
| 01-03-2009 | 15653 | 50.2402 | 5.0022 | 52.3902 | 72.2578 | 32.4229 | 32.7723 | 13.6749 | 7.3366 | 6.4789 |
| 08-03-2009 | 15555 | 51.6042 | 4.947 | 53.7342 | 72.9838 | 32.9763 | 33.2672 | 14.046 | 7.5317 | 6.6522 |
| 15-03-2009 | 15361 | 51.7907 | 5.0417 | 54.5907 | 72.0873 | 33.4825 | 33.7973 | 14.0966 | 7.561 | 6.678 |
| 22-03-2009 | 15535 | 51.7234 | 5.2676 | 54.2234 | 73.4488 | 34.6779 | 35.0093 | 14.078 | 7.5588 | 6.6719 |

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|---|---|---|---|---|---|---|---|---|---|
| 29-03-2009 | 15025 | 51.3888 | 5.3899 | 54.3888 | 74.5456 | 35.7833 | 35.5107 | 13.9869 | 7.512 | 6.63 |
| 05-04-2009 | 14646 | 50.9788 | 5.4159 | 53.1388 | 73.8002 | 35.6486 | 34.7164 | 13.8754 | 7.448 | 6.5771 |
| 12-04-2009 | 14157 | 50.1287 | 5.4952 | 52.2787 | 73.819 | 35.8027 | 34.0882 | 13.6439 | 7.3229 | 6.4674 |
| 19-04-2009 | 13954 | 49.7857 | 5.5007 | 51.9157 | 73.8014 | 35.972 | 33.5562 | 13.5499 | 7.2753 | 6.4233 |
| 26-04-2009 | 14533 | 50.1923 | 5.6004 | 52.9923 | 73.5072 | 35.7715 | 33.5008 | 13.6614 | 7.3385 | 6.4759 |
| 03-05-2009 | 14229 | 49.9867 | 5.7913 | 52.4867 | 73.6662 | 36.0326 | 33.7499 | 13.6055 | 7.3148 | 6.4493 |
| 10-05-2009 | 14370 | 49.3496 | 5.8802 | 52.3496 | 74.2586 | 36.8687 | 33.7647 | 13.4323 | 7.2243 | 6.3671 |
| 17-05-2009 | 14757 | 49.4124 | 5.8091 | 51.5724 | 75.0664 | 37.5231 | 34.3486 | 13.4489 | 7.2316 | 6.375 |
| 24-05-2009 | 14537 | 47.767 | 5.6309 | 49.917 | 74.2999 | 36.7385 | 33.4835 | 13.0006 | 6.9886 | 6.1614 |
| 31-05-2009 | 14777 | 47.2309 | 5.7698 | 49.3609 | 75.5164 | 37.1195 | 33.7963 | 12.8533 | 6.9076 | 6.0921 |
| 07-06-2009 | 14571 | 46.9542 | 5.8418 | 49.7542 | 76.339 | 37.7994 | 33.9581 | 12.7793 | 6.8642 | 6.0567 |
| 14-06-2009 | 14347 | 47.5202 | 5.8748 | 50.0202 | 77.2586 | 38.162 | 34.009 | 12.934 | 6.9429 | 6.1301 |
| 21-06-2009 | 14457 | 48.1274 | 5.9415 | 51.1274 | 78.8937 | 38.5578 | 34.2422 | 13.1012 | 7.0301 | 6.2093 |
| 28-06-2009 | 14566 | 48.5616 | 6.0001 | 50.7216 | 79.8345 | 38.8366 | 34.7106 | 13.219 | 7.0944 | 6.2654 |
| 05-07-2009 | 14361 | 48.0939 | 6.1148 | 50.2439 | 79.1214 | 38.6313 | 34.5334 | 13.0908 | 7.0284 | 6.2051 |
| 12-07-2009 | 14383 | 48.6048 | 5.9952 | 50.7348 | 78.7964 | 38.25 | 34.6555 | 13.2284 | 7.1025 | 6.2709 |
| 19-07-2009 | 14688 | 48.6853 | 5.9452 | 51.4853 | 79.3891 | 38.5716 | 34.9213 | 13.2506 | 7.1167 | 6.2812 |
| 26-07-2009 | 14754 | 48.2746 | 6.1442 | 50.7746 | 79.3437 | 39.2447 | 35.0192 | 13.1425 | 7.0556 | 6.2284 |
| 02-08-2009 | 14476 | 48.1267 | 6.1478 | 51.1267 | 79.4048 | 39.6797 | 34.8837 | 13.1025 | 7.034 | 6.2094 |
| 09-08-2009 | 14707 | 47.591 | 6.0123 | 49.751 | 80.0642 | 39.939 | 34.8433 | 12.9527 | 6.9576 | 6.1401 |
| 16-08-2009 | 14790 | 47.9384 | 5.931 | 50.0884 | 79.3676 | 40.0358 | 34.7962 | 13.0476 | 7.0037 | 6.1847 |
| 23-08-2009 | 14888 | 48.5178 | 6.0471 | 50.6478 | 79.9646 | 40.194 | 35.2318 | 13.2053 | 7.091 | 6.2589 |
| 30-08-2009 | 14947 | 48.5708 | 6.2043 | 51.3708 | 79.3968 | 40.6354 | 35.5242 | 13.2193 | 7.0995 | 6.266 |
| 06-09-2009 | 15544 | 48.6671 | 6.2641 | 51.1671 | 79.2543 | 40.8783 | 35.5339 | 13.2454 | 7.1142 | 6.2784 |
| 13-09-2009 | 15714 | 48.475 | 6.4046 | 51.475 | 80.0948 | 41.6326 | 35.8596 | 13.1931 | 7.0857 | 6.2541 |
| 20-09-2009 | 15662 | 48.3529 | 6.5011 | 50.5129 | 79.7044 | 41.8652 | 36.2327 | 13.1612 | 7.0725 | 6.2385 |
| 27-09-2009 | 15292 | 48.0915 | 6.4498 | 50.2415 | 77.8461 | 41.7654 | 36.1803 | 13.0892 | 7.0331 | 6.2045 |
| 04-10-2009 | 15403 | 47.919 | 6.3544 | 50.049 | 76.3712 | 41.7303 | 35.7862 | 13.0431 | 7.0085 | 6.1825 |
| 11-10-2009 | 15690 | 46.8006 | 6.2506 | 49.6006 | 74.6043 | 41.5931 | 35.1489 | 12.7385 | 6.8459 | 6.0382 |
| 18-10-2009 | 15590 | 46.1144 | 6.266 | 48.6144 | 73.9499 | 42.0424 | 34.9965 | 12.5518 | 6.7459 | 5.9497 |

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|---|---|---|---|---|---|---|---|---|---|
| 25-10-2009 | 15875 | 46.355 | 6.2573 | 49.355 | 76.1333 | 42.7752 | 35.4684 | 12.6187 | 6.781 | 5.9809 |
| 01-11-2009 | 15704 | 46.9476 | 6.1118 | 49.1076 | 76.9558 | 42.8066 | 35.6296 | 12.7786 | 6.8662 | 6.0573 |
| 08-11-2009 | 16504 | 47.002 | 6.06 | 49.152 | 77.5121 | 42.6306 | 35.5435 | 12.7938 | 6.8761 | 6.0642 |
| 15-11-2009 | 16439 | 46.4642 | 6.2272 | 48.5942 | 77.3976 | 43.1106 | 35.4645 | 12.6471 | 6.7987 | 5.9949 |
| 22-11-2009 | 17082 | 46.2085 | 6.1616 | 49.0085 | 77.0755 | 42.7806 | 35.2176 | 12.5776 | 6.7597 | 5.9619 |
| 29-11-2009 | 17496 | 46.4156 | 6.1905 | 48.9156 | 76.7952 | 42.516 | 35.5218 | 12.6337 | 6.7886 | 5.9886 |
| 06-12-2009 | 17714 | 46.2513 | 6.2558 | 49.2513 | 76.5176 | 42.4928 | 35.5029 | 12.589 | 6.766 | 5.9674 |
| 13-12-2009 | 16816 | 46.522 | 6.1847 | 48.682 | 75.9769 | 42.4437 | 35.0868 | 12.6628 | 6.8049 | 6.0021 |
| 20-12-2009 | 16592 | 46.7196 | 6.2163 | 48.8696 | 75.8208 | 42.0652 | 34.6301 | 12.7179 | 6.8314 | 6.0248 |
| 27-12-2009 | 16279 | 46.6591 | 6.1206 | 48.7891 | 74.7788 | 41.2019 | 34.2009 | 12.7041 | 6.8294 | 6.0156 |
| 03-01-2010 | 16271 | 46.658 | 6.2458 | 49.458 | 74.8092 | 41.6427 | 34.2679 | 12.7014 | 6.828 | 6.0158 |
| 10-01-2010 | 16575 | 45.9555 | 6.226 | 48.4555 | 73.7199 | 41.9477 | 33.7489 | 12.5109 | 6.7234 | 5.925 |
| 17-01-2010 | 16604 | 45.5629 | 6.1484 | 48.5629 | 73.7706 | 42.1849 | 33.6849 | 12.4018 | 6.6666 | 5.8735 |
| 24-01-2010 | 16067 | 45.961 | 6.1187 | 48.121 | 74.6898 | 42.0069 | 33.4446 | 12.51 | 6.7235 | 5.9175 |
| 31-01-2010 | 16009 | 46.2862 | 6.0761 | 48.4362 | 74.6427 | 41.5102 | 33.2185 | 12.6009 | 6.7713 | 5.9564 |
| 07-02-2010 | 15894 | 46.2871 | 6.0741 | 48.4171 | 73.4243 | 40.655 | 32.7423 | 12.5992 | 6.7713 | 5.9584 |
| 14-02-2010 | 16150 | 46.5235 | 6.0162 | 49.3235 | 72.7947 | 40.8208 | 32.5586 | 12.6655 | 6.8041 | 5.987 |
| 21-02-2010 | 16566 | 46.1658 | 5.9984 | 48.6658 | 72.0913 | 41.3046 | 32.1436 | 12.5669 | 6.7484 | 5.9422 |
| 28-02-2010 | 16428 | 46.1756 | 5.9548 | 49.1756 | 70.9652 | 41.2916 | 32.0616 | 12.5681 | 6.7545 | 5.9471 |
| 07-03-2010 | 16642 | 45.8126 | 6.0471 | 47.9726 | 69.0454 | 41.2977 | 31.8721 | 12.4705 | 6.7029 | 5.9009 |
| 14-03-2010 | 16160 | 45.4706 | 6.1177 | 47.6206 | 68.5523 | 41.5029 | 31.7642 | 12.3775 | 6.6525 | 5.8596 |
| 21-03-2010 | 16174 | 45.4487 | 6.1628 | 47.5787 | 68.8809 | 41.6923 | 31.7659 | 12.3719 | 6.6481 | 5.8565 |
| 28-03-2010 | 15947 | 45.3659 | 6.1241 | 48.1659 | 67.823 | 41.3215 | 31.154 | 12.3484 | 6.6353 | 5.8445 |
| 04-04-2010 | 16217 | 44.9031 | 6.1106 | 47.4031 | 67.8529 | 41.1182 | 30.9534 | 12.2229 | 6.5696 | 5.7821 |
| 11-04-2010 | 16409 | 44.4556 | 6.1034 | 47.4556 | 67.8501 | 41.149 | 30.5174 | 12.1012 | 6.505 | 5.7267 |
| 18-04-2010 | 16408 | 44.3165 | 6.0418 | 46.4765 | 68.2769 | 41.2053 | 30.7255 | 12.0634 | 6.4844 | 5.7105 |
| 25-04-2010 | 16277 | 44.4419 | 5.966 | 46.5919 | 68.2512 | 41.1336 | 30.4655 | 12.0977 | 6.5086 | 5.7248 |
| 02-05-2010 | 16819 | 44.3836 | 5.9909 | 46.5136 | 67.9776 | 41.0782 | 30.1572 | 12.0812 | 6.4934 | 5.7159 |
| 09-05-2010 | 17580 | 44.8791 | 5.9159 | 47.6791 | 67.5163 | 40.6809 | 29.7269 | 12.2161 | 6.565 | 5.7751 |
| 16-05-2010 | 17975 | 45.1535 | 5.9749 | 47.6535 | 66.6366 | 40.3589 | 29.171 | 12.2906 | 6.6044 | 5.8016 |

| 23-05-2010 | 17806 | 46.1863 | 5.9579 | 49.1863 | 66.6098 | 39.375 | 29.2891 | 12.5716 | 6.7565 | 5.9216 |
|---|---|---|---|---|---|---|---|---|---|---|
| 30-05-2010 | 17992 | 46.882 | 6.0297 | 49.042 | 67.719 | 39.1209 | 29.5928 | 12.7615 | 6.8561 | 6.0142 |
| 06-06-2010 | 18130 | 46.7538 | 6.0618 | 48.9038 | 68.0332 | 39.1751 | 29.1287 | 12.7266 | 6.8372 | 5.9999 |
| 13-06-2010 | 18369 | 46.9616 | 6.0441 | 49.0916 | 68.1884 | 39.086 | 28.8527 | 12.7831 | 6.8656 | 6.0224 |
| 20-06-2010 | 18634 | 46.4123 | 6.0907 | 49.2123 | 68.4398 | 40.0092 | 29.1528 | 12.6335 | 6.7841 | 5.9585 |
| 27-06-2010 | 18657 | 46.0922 | 6.0774 | 48.5922 | 68.6775 | 40.2365 | 29.0669 | 12.5463 | 6.7629 | 5.9257 |
| 04-07-2010 | 18065 | 46.4655 | 6.0419 | 49.4655 | 70.0876 | 39.6664 | 29.3952 | 12.6482 | 6.8385 | 5.9661 |
| 11-07-2010 | 18135 | 46.7873 | 6.0977 | 48.9473 | 70.8405 | 40.1672 | 30.1577 | 12.7356 | 6.8953 | 6.0091 |
| 18-07-2010 | 17887 | 46.7605 | 6.1512 | 48.9105 | 71.0905 | 40.9609 | 30.4884 | 12.7281 | 6.893 | 6.0161 |
| 25-07-2010 | 17965 | 47.1188 | 6.2333 | 49.2488 | 72.074 | 41.5518 | 31.0643 | 12.8256 | 6.9413 | 6.061 |
| 01-08-2010 | 17441 | 46.7412 | 6.3395 | 49.5412 | 72.7564 | 42.0322 | 31.0656 | 12.7229 | 6.8885 | 6.0174 |
| 08-08-2010 | 17922 | 46.1402 | 6.3284 | 48.6402 | 73.2139 | 42.1158 | 31.0863 | 12.5586 | 6.8032 | 5.9423 |
| 15-08-2010 | 18257 | 46.3809 | 6.3642 | 49.3809 | 73.0038 | 41.9614 | 30.8472 | 12.6244 | 6.8315 | 5.9714 |
| 22-08-2010 | 18360 | 46.5911 | 6.3681 | 48.7511 | 72.611 | 41.7198 | 30.4814 | 12.6812 | 6.8481 | 5.994 |
| 29-08-2010 | 18626 | 46.7387 | 6.3517 | 48.8887 | 72.4445 | 41.5928 | 30.3444 | 12.7224 | 6.8656 | 6.0095 |
| 05-09-2010 | 18584 | 46.6328 | 6.3789 | 48.7628 | 72.0231 | 42.1445 | 30.4746 | 12.6938 | 6.8429 | 5.9968 |
| 12-09-2010 | 18621 | 46.4312 | 6.4121 | 49.2312 | 71.5286 | 42.6866 | 30.2958 | 12.6389 | 6.8336 | 5.9759 |
| 19-09-2010 | 18795 | 46.2915 | 6.4661 | 48.7915 | 71.8726 | 43.2854 | 30.6364 | 12.6011 | 6.8567 | 5.9597 |
| 26-09-2010 | 18871 | 45.549 | 6.4165 | 48.549 | 71.3716 | 43.2737 | 30.8965 | 12.3984 | 6.7804 | 5.8684 |
| 03-10-2010 | 18821 | 44.8066 | 6.3991 | 46.9666 | 70.849 | 43.28 | 31.1533 | 12.1965 | 6.686 | 5.7749 |
| 10-10-2010 | 19161 | 44.3303 | 6.3983 | 46.4803 | 70.3944 | 43.2478 | 31.3892 | 12.0667 | 6.6213 | 5.7143 |
| 17-10-2010 | 19396 | 44.2592 | 6.4485 | 46.3892 | 70.542 | 43.7363 | 31.6023 | 12.0478 | 6.6373 | 5.704 |
| 24-10-2010 | 18959 | 44.34 | 6.3903 | 47.14 | 70.027 | 43.6053 | 31.5646 | 12.0693 | 6.6594 | 5.7128 |
| 31-10-2010 | 19236 | 44.4551 | 6.3538 | 46.9551 | 70.4328 | 43.6438 | 31.6178 | 12.1016 | 6.6565 | 5.7303 |
| 07-11-2010 | 19838 | 44.3004 | 6.4116 | 47.3004 | 71.3701 | 44.3214 | 31.7878 | 12.059 | 6.6313 | 5.7148 |
| 14-11-2010 | 19974 | 44.5237 | 6.4546 | 46.6837 | 71.7506 | 44.6492 | 31.4523 | 12.1203 | 6.6896 | 5.7436 |
| 21-11-2010 | 19550 | 45.328 | 6.4616 | 47.478 | 72.5557 | 44.6012 | 31.5672 | 12.3398 | 6.817 | 5.8455 |
| 28-11-2010 | 19972 | 45.5798 | 6.4358 | 47.7098 | 72.0799 | 44.6033 | 31.3335 | 12.4069 | 6.8421 | 5.8742 |
| 05-12-2010 | 20355 | 45.405 | 6.4426 | 48.205 | 70.91 | 44.057 | 30.6367 | 12.3596 | 6.8036 | 5.8468 |
| 12-12-2010 | 19921 | 45.2653 | 6.5532 | 47.7653 | 71.3791 | 44.6617 | 30.754 | 12.3223 | 6.7914 | 5.8269 |

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|---|---|---|---|---|---|---|---|---|---|
| 19-12-2010 | 19951 | 45.6991 | 6.6509 | 48.6991 | 71.6919 | 45.2249 | 31.0004 | 12.4395 | 6.8543 | 5.8765 |
| 26-12-2010 | 19931 | 45.59 | 6.6792 | 47.75 | 70.5205 | 45.4711 | 30.6129 | 12.4096 | 6.8412 | 5.8609 |
| 02-01-2011 | 20206 | 45.2351 | 6.7529 | 47.3851 | 69.9622 | 45.7815 | 30.5794 | 12.3135 | 6.8338 | 5.814 |
| 09-01-2011 | 19947 | 45.42 | 6.7496 | 47.55 | 70.55 | 45.6765 | 30.6096 | 12.3636 | 6.8615 | 5.8436 |
| 16-01-2011 | 19947 | 45.5697 | 6.6308 | 48.3697 | 71.4779 | 45.1969 | 30.5265 | 12.4045 | 6.8844 | 5.8608 |
| 23-01-2011 | 19705 | 45.8355 | 6.551 | 48.3355 | 73.0498 | 45.4959 | 31.5034 | 12.4767 | 6.9506 | 5.8904 |
| 30-01-2011 | 19408 | 45.9235 | 6.4685 | 48.9235 | 73.0534 | 45.6054 | 32.0502 | 12.5003 | 6.9672 | 5.8942 |
| 06-02-2011 | 19863 | 45.8765 | 6.359 | 48.0365 | 73.6703 | 46.1557 | 32.0851 | 12.4881 | 6.9697 | 5.8895 |
| 13-02-2011 | 20035 | 45.6098 | 6.2717 | 47.7598 | 73.3192 | 46.0089 | 31.7141 | 12.4151 | 6.9241 | 5.856 |
| 20-02-2011 | 20107 | 45.4297 | 6.255 | 47.5597 | 73.1947 | 45.6631 | 31.5076 | 12.3656 | 6.8878 | 5.831 |
| 27-02-2011 | 20438 | 45.2451 | 6.3521 | 48.0451 | 73.2035 | 45.669 | 31.7354 | 12.3163 | 6.8727 | 5.8072 |
| 06-03-2011 | 20639 | 45.0568 | 6.4773 | 47.5568 | 73.1626 | 45.7376 | 31.9183 | 12.2653 | 6.8463 | 5.7836 |
| 13-03-2011 | 20533 | 45.4339 | 6.5773 | 48.4339 | 73.4302 | 45.8796 | 32.3138 | 12.368 | 6.9101 | 5.8332 |
| 20-03-2011 | 20599 | 45.7133 | 6.5345 | 47.8733 | 73.6613 | 45.5525 | 32.7195 | 12.4437 | 6.9458 | 5.8631 |
| 27-03-2011 | 20624 | 45.3587 | 6.5372 | 47.5087 | 73.5197 | 45.8801 | 32.8279 | 12.3474 | 6.9024 | 5.8177 |
| 03-04-2011 | 20331 | 45.0521 | 6.596 | 47.1821 | 72.276 | 46.4301 | 32.5438 | 12.2642 | 6.8611 | 5.7841 |
| 10-04-2011 | 20821 | 44.5398 | 6.6408 | 47.3398 | 72.4053 | 46.4476 | 32.5644 | 12.1252 | 6.7973 | 5.729 |
| 17-04-2011 | 21047 | 44.5876 | 6.5917 | 47.0876 | 72.7807 | 46.9188 | 32.9504 | 12.1378 | 6.8143 | 5.7355 |
| 24-04-2011 | 21460 | 44.6208 | 6.5647 | 47.6208 | 73.1443 | 47.4314 | 32.9655 | 12.1467 | 6.8367 | 5.7396 |
| 01-05-2011 | 21828 | 44.5723 | 6.6804 | 46.7323 | 73.8925 | 48.2758 | 33.4898 | 12.1337 | 6.8467 | 5.7359 |
| 08-05-2011 | 21406 | 44.653 | 6.6969 | 46.803 | 73.7854 | 48.2906 | 33.5482 | 12.155 | 6.8691 | 5.7471 |
| 15-05-2011 | 21720 | 44.826 | 6.5455 | 46.956 | 73.1576 | 47.9646 | 32.7132 | 12.2026 | 6.8962 | 5.7671 |
| 22-05-2011 | 21563 | 45.0212 | 6.4616 | 47.8212 | 72.966 | 47.7883 | 32.6724 | 12.2552 | 6.9147 | 5.7905 |
| 29-05-2011 | 22261 | 45.1265 | 6.4574 | 47.6265 | 73.4856 | 47.8466 | 32.6406 | 12.2843 | 6.9415 | 5.8005 |
| 05-06-2011 | 22184 | 44.8471 | 6.5564 | 47.8471 | 73.6883 | 47.9352 | 33.0653 | 12.2079 | 6.9111 | 5.7649 |
| 12-06-2011 | 21990 | 45.1187 | 6.6684 | 47.2787 | 73.8266 | 48.0473 | 33.5811 | 12.2825 | 6.9556 | 5.7984 |
| 19-06-2011 | 22178 | 45.2643 | 6.638 | 47.4143 | 73.508 | 47.9343 | 33.1135 | 12.3213 | 6.9787 | 5.811 |
| 26-06-2011 | 21913 | 45.3115 | 6.6393 | 47.4415 | 72.9516 | 47.8347 | 33.0885 | 12.3342 | 6.9945 | 5.816 |
| 03-07-2011 | 21257 | 45.1197 | 6.5934 | 47.9197 | 72.2396 | 47.8267 | 33.1481 | 12.2825 | 6.9713 | 5.7953 |
| 10-07-2011 | 21970 | 44.6217 | 6.619 | 47.1217 | 71.5668 | 47.9051 | 32.8509 | 12.1469 | 6.8967 | 5.7336 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17-07-2011 | 22713 | 44.6599 | 6.5217 | 47.6599 | 71.6337 | 47.7127 | 32.2644 | 12.1574 | 6.9106 | 5.7328 |
| 24-07-2011 | 22845 | 44.596 | 6.4746 | 46.756 | 72.1439 | 47.8458 | 32.4338 | 12.1403 | 6.9088 | 5.722 |
| 31-07-2011 | 23137 | 44.2406 | 6.5634 | 46.3906 | 72.3323 | 48.4182 | 32.5413 | 12.0433 | 6.8628 | 5.6772 |
| 07-08-2011 | 23857 | 44.4445 | 6.5231 | 46.5745 | 72.6744 | 47.7266 | 32.4279 | 12.0972 | 6.9007 | 5.6989 |
| 14-08-2011 | 25309 | 45.1301 | 6.3026 | 47.9301 | 73.5007 | 46.5217 | 32.8912 | 12.2837 | 7.0299 | 5.784 |
| 21-08-2011 | 27179 | 45.4412 | 6.3333 | 47.9412 | 74.6102 | 47.3916 | 33.3675 | 12.369 | 7.1141 | 5.8299 |
| 28-08-2011 | 26535 | 45.8564 | 6.3549 | 48.8564 | 75.2739 | 48.0143 | 33.8073 | 12.4831 | 7.1732 | 5.8811 |
| 04-09-2011 | 27604 | 45.8099 | 6.4696 | 47.9699 | 74.6118 | 48.8001 | 33.6775 | 12.4704 | 7.1705 | 5.8794 |
| 11-09-2011 | 27710 | 46.079 | 6.4206 | 48.229 | 73.8315 | 48.6788 | 32.9585 | 12.5434 | 7.201 | 5.9125 |
| 18-09-2011 | 27262 | 47.5335 | 6.4232 | 49.6635 | 75.1538 | 49.1383 | 33.3337 | 12.9398 | 7.4282 | 6.096 |
| 25-09-2011 | 26845 | 48.905 | 6.1833 | 51.705 | 76.2463 | 49.2605 | 34.039 | 13.3124 | 7.6334 | 6.2726 |
| 02-10-2011 | 25508 | 49.5735 | 6.1749 | 52.0735 | 77.1765 | 48.5036 | 34.2529 | 13.495 | 7.7335 | 6.3595 |
| 09-10-2011 | 26108 | 49.5766 | 6.1243 | 52.5766 | 76.7976 | 47.8528 | 33.817 | 13.496 | 7.7517 | 6.3681 |
| 16-10-2011 | 26443 | 49.3298 | 6.2381 | 51.4898 | 77.3685 | 49.615 | 34.482 | 13.4284 | 7.7245 | 6.3401 |
| 23-10-2011 | 26417 | 49.7209 | 6.1996 | 51.8709 | 78.598 | 51.1017 | 35.1021 | 13.535 | 7.7721 | 6.3917 |
| 30-10-2011 | 27290 | 49.5906 | 6.2779 | 51.7206 | 79.4349 | 52.1078 | 35.4716 | 13.4997 | 7.7754 | 6.3793 |
| 06-11-2011 | 27613 | 49.238 | 6.2109 | 52.038 | 78.8906 | 51.4201 | 34.8743 | 13.4029 | 7.7364 | 6.3381 |
| 13-11-2011 | 28573 | 49.9113 | 6.2742 | 52.4113 | 79.9209 | 51.2851 | 34.9988 | 13.5868 | 7.8579 | 6.4202 |
| 20-11-2011 | 28374 | 50.919 | 6.2734 | 53.919 | 80.7645 | 51.5783 | 35.342 | 13.8595 | 8.0097 | 6.5414 |
| 27-11-2011 | 28357 | 52.2188 | 6.1966 | 54.3788 | 81.4275 | 51.2218 | 35.7876 | 14.2134 | 8.181 | 6.7006 |
| 04-12-2011 | 28758 | 51.7814 | 6.2584 | 53.9314 | 80.7022 | 52.0224 | 35.3897 | 14.0953 | 8.1206 | 6.6529 |
| 11-12-2011 | 28591 | 51.61 | 6.3736 | 53.74 | 80.7135 | 52.77 | 35.3309 | 14.0493 | 8.1189 | 6.6379 |
| 18-12-2011 | 27013 | 53.7742 | 6.4628 | 56.5742 | 83.6329 | 53.9759 | 36.0959 | 14.6384 | 8.4099 | 6.9093 |
| 25-12-2011 | 27356 | 53.8011 | 6.499 | 56.3011 | 83.9593 | 54.1236 | 35.8939 | 14.6452 | 8.4339 | 6.9133 |
| 06-01-2012 | 27675 | 52.7225 | 6.4187 | 55.1955 | 81.3301 | 53.9266 | 34.2939 | 14.3547 | 8.356 | 6.79 |
| 13-01-2012 | 27403 | 51.5288 | 6.3228 | 54.4884 | 79.0885 | 53.3196 | 33.3415 | 14.0071 | 8.17 | 6.636 |
| 20-01-2012 | 27448 | 50.335 | 6.3169 | 53.8027 | 77.8179 | 52.3997 | 33.2197 | 13.6777 | 7.944 | 6.484 |
| 27-01-2012 | 28017 | 49.3162 | 6.3607 | 53.7082 | 77.5086 | 52.5857 | 33.3925 | 13.448 | 7.818 | 6.36 |
| 03-02-2012 | 27650 | 48.695 | 6.4895 | 53.2652 | 77.1613 | 52.1273 | 32.8474 | 13.2929 | 7.726 | 6.28 |
| 10-02-2012 | 27967 | 49.41 | 6.377 | 54.1455 | 78.2215 | 52.824 | 33.3742 | 13.4682 | 7.843 | 6.371 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17-02-2012 | 27820 | 49.275 | 6.3709 | 53.6226 | 78.0834 | 53.0392 | 33.1359 | 13.4182 | 7.823 | 6.355 |
| 24-02-2012 | 28440 | 48.945 | 6.4612 | 54.4532 | 77.3554 | 52.5896 | 33.7058 | 13.3447 | 7.772 | 6.312 |
| 02-03-2012 | 27825 | 49.5 | 6.5847 | 54.3994 | 78.8112 | 53.3856 | 33.4272 | 13.4684 | 7.859 | 6.38 |
| 09-03-2012 | 27834 | 49.855 | 6.5801 | 54.6882 | 78.6488 | 52.9375 | 33.4109 | 13.5572 | 7.899 | 6.426 |
| 16-03-2012 | 27594 | 50.1912 | 6.6386 | 54.359 | 78.9615 | 52.8839 | 33.7848 | 13.6551 | 7.938 | 6.466 |
| 23-03-2012 | 27594 | 51.2175 | 6.6777 | 56.2583 | 81.1339 | 53.1925 | 34.7893 | 13.9598 | 8.131 | 6.593 |
| 30-03-2012 | 28075 | 50.8763 | 6.6394 | 56.3788 | 81.5246 | 52.9186 | 34.7495 | 13.8701 | 8.077 | 6.551 |
| 06-04-2012 | 27875 | 51.105 | 6.4958 | 55.5713 | 81.0216 | 52.7344 | 34.2766 | 13.9328 | 8.116 | 6.582 |
| 13-04-2012 | 28638 | 51.3025 | 6.4871 | 56.2142 | 81.801 | 53.4285 | 34.4452 | 14.0144 | 8.14 | 6.611 |
| 20-04-2012 | 28588 | 52.085 | 6.6557 | 57.1647 | 83.8962 | 53.8598 | 35.2004 | 14.1759 | 8.256 | 6.711 |
| 27-04-2012 | 29115 | 52.5425 | 6.7887 | 57.8917 | 85.2385 | 54.738 | 35.5809 | 14.2949 | 8.327 | 6.771 |
| 04-05-2012 | 29281 | 53.475 | 6.8157 | 58.4554 | 86.5199 | 54.81 | 35.7073 | 14.544 | 8.48 | 6.89 |
| 11-05-2012 | 28380 | 53.635 | 6.6152 | 57.7544 | 86.3872 | 53.8462 | 35.3696 | 14.5591 | 8.5 | 6.907 |
| 18-05-2012 | 28945 | 54.425 | 6.5514 | 57.6198 | 86.0702 | 53.7594 | 35.7506 | 14.8911 | 8.6 | 7.007 |
| 25-05-2012 | 29030 | 55.375 | 6.5851 | 57.9652 | 86.9101 | 54.242 | 35.4311 | 15.0708 | 8.728 | 7.133 |
| 01-06-2012 | 29803 | 55.585 | 6.4668 | 57.1033 | 85.2302 | 53.6668 | 35.2797 | 15.106 | 8.727 | 7.163 |
| 08-06-2012 | 29430 | 55.455 | 6.6067 | 57.5335 | 85.5773 | 54.6024 | 35.4737 | 15.0898 | 8.705 | 7.148 |
| 15-06-2012 | 30031 | 55.4963 | 6.6329 | 58.3359 | 86.3838 | 55.7884 | 35.8837 | 15.1196 | 8.719 | 7.152 |
| 22-06-2012 | 29968 | 57.155 | 6.8095 | 59.6763 | 89.14 | 57.3316 | 36.7487 | 15.5418 | 8.981 | 7.365 |
| 29-06-2012 | 29510 | 55.6375 | 6.7797 | 58.2399 | 86.9006 | 56.706 | 35.8525 | 15.0762 | 8.757 | 7.172 |
| 06-07-2012 | 29472 | 55.455 | 6.7385 | 57.1551 | 86.1493 | 56.9401 | 35.0518 | 15.1606 | 8.713 | 7.152 |
| 13-07-2012 | 29160 | 55.145 | 6.6514 | 55.9951 | 85.2815 | 56.1082 | 34.4452 | 14.9728 | 8.645 | 7.109 |
| 20-07-2012 | 29227 | 55.3275 | 6.6798 | 56.3746 | 86.8405 | 57.5778 | 34.4074 | 15.0708 | 8.68 | 7.133 |
| 27-07-2012 | 29792 | 55.3413 | 6.7708 | 56.6375 | 86.9808 | 57.7175 | 34.7869 | 15.088 | 8.673 | 7.134 |
| 03-08-2012 | 29675 | 55.755 | 6.7967 | 56.9853 | 86.8468 | 58.6598 | 35.0837 | 15.0892 | 8.749 | 7.19 |
| 10-08-2012 | 29816 | 55.285 | 6.8183 | 56.4871 | 86.2656 | 58.1403 | 34.6708 | 15.022 | 8.695 | 7.127 |
| 17-08-2012 | 29941 | 55.745 | 6.685 | 57.352 | 87.4661 | 58.1451 | 35.0689 | 15.1621 | 8.767 | 7.186 |
| 24-08-2012 | 30771 | 55.495 | 6.5946 | 57.7796 | 87.8484 | 57.6588 | 35.4414 | 15.0815 | 8.733 | 7.154 |
| 31-08-2012 | 31219 | 55.5275 | 6.5994 | 58.2038 | 88.0192 | 57.4004 | 35.6308 | 15.0871 | 8.746 | 7.16 |
| 07-09-2012 | 31889 | 55.395 | 6.7514 | 57.9406 | 88.2626 | 57.3084 | 36.1554 | 15.0189 | 8.733 | 7.142 |

| 14-09-2012 | 31925 | 54.3063 | 6.5756 | 58.5468 | 88.1715 | 57.5975 | 36.2261 | 14.6896 | 8.599 | 7.006 |
|---|---|---|---|---|---|---|---|---|---|---|
| 21-09-2012 | 31562 | 53.465 | 6.435 | 57.3093 | 86.943 | 56.1219 | 35.3508 | 14.5018 | 8.479 | 6.895 |
| 28-09-2012 | 31301 | 52.86 | 6.361 | 56.4849 | 85.6275 | 55.1385 | 34.7665 | 14.3983 | 8.411 | 6.817 |
| 05-10-2012 | 30882 | 51.855 | 5.9275 | 55.6551 | 83.9155 | 53.1203 | 34.6688 | 14.1642 | 8.2 | 6.689 |
| 12-10-2012 | 31080 | 52.82 | 6.0555 | 56.6659 | 84.8553 | 54.1775 | 35.0179 | 14.3956 | 8.43 | 6.814 |
| 19-10-2012 | 31065 | 53.84 | 6.2331 | 58.1197 | 86.4077 | 55.7729 | 35.9729 | 14.7134 | 8.61 | 6.947 |
| 26-10-2012 | 30812 | 53.575 | 6.2195 | 57.1387 | 86.2973 | 55.3481 | 35.5661 | 14.6379 | 8.583 | 6.913 |
| 02-11-2012 | 30293 | 53.8112 | 6.1377 | 57.4341 | 86.5913 | 55.8387 | 35.3322 | 14.6615 | 8.621 | 6.943 |
| 09-11-2012 | 31588 | 54.755 | 6.2782 | 57.7579 | 87.3284 | 56.9113 | 35.5335 | 14.8798 | 8.771 | 7.064 |
| 16-11-2012 | 31829 | 55.175 | 6.2276 | 58.3593 | 87.4438 | 56.9211 | 35.9767 | 15.0297 | 8.849 | 7.117 |
| 23-11-2012 | 32328 | 55.515 | 6.2439 | 59.4303 | 88.4909 | 57.7634 | 36.7515 | 15.0842 | 8.913 | 7.163 |
| 30-11-2012 | 31173 | 54.265 | 6.1058 | 58.5889 | 87.0838 | 56.5736 | 36.1058 | 14.8094 | 8.715 | 7.002 |
| 07-12-2012 | 30983 | 54.475 | 6.2775 | 58.1785 | 87.2786 | 56.9891 | 35.8952 | 14.7812 | 8.752 | 7.029 |
| 14-12-2012 | 30885 | 54.485 | 6.32 | 59.0316 | 87.843 | 57.3558 | 36.6529 | 14.8283 | 8.723 | 7.03 |
| 21-12-2012 | 30590 | 55.0687 | 6.4133 | 60.2266 | 89.4502 | 57.4625 | 37.1625 | 15.0025 | 8.839 | 7.105 |
| 28-12-2012 | 30396 | 54.775 | 6.4617 | 59.7406 | 88.3052 | 56.8537 | 37.0392 | 14.9076 | 8.789 | 7.066 |

**Table 16: Economic Variables Dataset**

| Date | Gold | Nifty | Crude Oil (inr) | Silver |
|---|---|---|---|---|
| 01-01-2007 | 8,993 | 4005.11 | 2355 | 19100 |
| 02-01-2007 | 9,100 | 4007.40 | 2595 | 19250 |
| 03-01-2007 | 9,165 | 4024.05 | 2508 | 19208 |
| 04-01-2007 | 8,950 | 3988.80 | 2418 | 18639 |
| 05-01-2007 | 8,682 | 3983.40 | 2349 | 18292 |
| 08-01-2007 | 8,716 | 3933.40 | 2344 | 18366 |
| 09-01-2007 | 8,699 | 3911.40 | 2334 | 18911 |
| 10-01-2007 | 8,715 | 3850.30 | 2324 | 18911 |
| 11-01-2007 | 8,774 | 3942.25 | 2290 | 18861 |
| 12-01-2007 | 8,852 | 4052.45 | 2208 | 18564 |
| 15-01-2007 | 8,926 | 4078.40 | 2261 | 19028 |
| 16-01-2007 | 8,925 | 4080.50 | 2269 | 18787 |
| 17-01-2007 | 8,901 | 4076.45 | 2245 | 19048 |
| 18-01-2007 | 9,049 | 4109.05 | 2309 | 19022 |
| 19-01-2007 | 8,951 | 4090.15 | 2403 | 19218 |
| 22-01-2007 | 9,079 | 4102.45 | 2382 | 19394 |
| 23-01-2007 | 9,138 | 4066.10 | 2435 | 19653 |
| 24-01-2007 | 9,137 | 4089.90 | 2459 | 19616 |
| 25-01-2007 | 9,266 | 4147.70 | 2441 | 19505 |
| 26-01-2007 | 9,180 | 4088.91 | 2411 | 19414 |
| 29-01-2007 | 9,163 | 4080.11 | 2411 | 19580 |
| 30-01-2007 | 9,170 | 4083.60 | 2494 | 19854 |
| 31-01-2007 | 9,236 | 4082.70 | 2496 | 19836 |
| 01-02-2007 | 9,364 | 4137.20 | 2502 | 19594 |
| 02-02-2007 | 9,158 | 4183.50 | 2507 | 19521 |
| 05-02-2007 | 9,210 | 4215.35 | 2587 | 19720 |
| 06-02-2007 | 9,263 | 4195.90 | 2561 | 19986 |
| 07-02-2007 | 9,263 | 4224.25 | 2564 | 19885 |
| 08-02-2007 | 9,304 | 4223.40 | 2527 | 20004 |
| 09-02-2007 | 9,429 | 4187.40 | 2528 | 20022 |
| 12-02-2007 | 9,435 | 4058.30 | 2441 | 19937 |
| 13-02-2007 | 9,490 | 4044.55 | 2470 | 19885 |
| 14-02-2007 | 9,480 | 4047.10 | 2416 | 20100 |
| 15-02-2007 | 9,425 | 4146.20 | 2398 | 20129 |
| 16-02-2007 | 9,408 | 4151.12 | 2501 | 20066 |
| 19-02-2007 | 9,518 | 4164.55 | 2473 | 20183 |
| 20-02-2007 | 9,431 | 4106.95 | 2546 | 20212 |
| 21-02-2007 | 9,395 | 4096.20 | 2582 | 20236 |
| 22-02-2007 | 9,625 | 4040.00 | 2660 | 20125 |
| 23-02-2007 | 9,704 | 3938.95 | 2658 | 19987 |
| 26-02-2007 | 9,745 | 3942.00 | 2655 | 20252 |

| | | | | |
|---|---|---|---|---|
| 27-02-2007 | 9,613 | 3893.90 | 2616 | 20192 |
| 28-02-2007 | 9,455 | 3745.30 | 2651 | 20310 |
| 01-03-2007 | 9,541 | 3811.20 | 2695 | 20385 |
| 02-03-2007 | 9,287 | 3726.75 | 2728 | 20258 |
| 05-03-2007 | 9,136 | 3576.50 | 2642 | 20302 |
| 06-03-2007 | 9,203 | 3655.65 | 2632 | 20691 |
| 07-03-2007 | 9,247 | 3626.85 | 2696 | 20574 |
| 08-03-2007 | 9,324 | 3761.65 | 2686 | 19705 |
| 09-03-2007 | 9,270 | 3718.00 | 2657 | 19206 |
| 12-03-2007 | 9,213 | 3734.60 | 2672 | 18657 |
| 13-03-2007 | 9,251 | 3770.55 | 2713 | 19057 |
| 14-03-2007 | 9,152 | 3641.10 | 2685 | 19094 |
| 15-03-2007 | 9,215 | 3643.60 | 2664 | 19202 |
| 16-03-2007 | 9,265 | 3608.55 | 2687 | 19218 |
| 19-03-2007 | 9,284 | 3678.90 | 2668 | 19149 |
| 20-03-2007 | 9,273 | 3697.60 | 2651 | 19117 |
| 21-03-2007 | 9,214 | 3764.55 | 2654 | 19215 |
| 22-03-2007 | 9,323 | 3875.90 | 2715 | 18757 |
| 23-03-2007 | 9,194 | 3861.05 | 2783 | 18954 |
| 26-03-2007 | 9,229 | 3819.95 | 2841 | 19151 |
| 27-03-2007 | 9,208 | 3761.10 | 2833 | 19248 |
| 28-03-2007 | 9,225 | 3798.10 | 2917 | 19262 |
| 29-03-2007 | 9,301 | 3821.55 | 2963 | 19238 |
| 30-03-2007 | 9,248 | 3633.60 | 3020 | 19337 |
| 02-04-2007 | 9,199 | 3690.65 | 3040 | 19438 |
| 03-04-2007 | 9,197 | 3733.25 | 2999 | 19333 |
| 04-04-2007 | 9,309 | 3752.00 | 3003 | 19180 |
| 05-04-2007 | 9,295 | 3812.00 | 3050 | 19238 |
| 06-04-2007 | 9,295 | 3814.00 | 2983 | 19274 |
| 09-04-2007 | 9,292 | 3843.50 | 3025 | 19213 |
| 10-04-2007 | 9,329 | 3848.15 | 2990 | 19278 |
| 11-04-2007 | 9,349 | 3862.65 | 3033 | 19321 |
| 12-04-2007 | 9,329 | 3829.85 | 2959 | 19329 |
| 13-04-2007 | 9,319 | 3917.35 | 2926 | 19294 |
| 16-04-2007 | 9,255 | 4013.35 | 2870 | 19231 |
| 17-04-2007 | 9,285 | 3984.95 | 2744 | 19305 |
| 18-04-2007 | 9,303 | 4011.60 | 2705 | 19457 |
| 19-04-2007 | 9,224 | 3997.65 | 2712 | 19544 |
| 20-04-2007 | 9,284 | 4083.55 | 2763 | 19522 |
| 23-04-2007 | 9,229 | 4085.10 | 2752 | 19501 |
| 24-04-2007 | 9,113 | 4141.80 | 2771 | 19710 |
| 25-04-2007 | 8,996 | 4167.30 | 2760 | 19708 |
| 26-04-2007 | 8,850 | 4177.85 | 2759 | 19781 |
| 27-04-2007 | 8,950 | 4083.50 | 2746 | 19736 |

| | | | | |
|---|---|---|---|---|
| 30-04-2007 | 8,965 | 4087.90 | 2753 | 19733 |
| 01-05-2007 | 8,920 | 4091.77 | 2735 | 19789 |
| 02-05-2007 | 8,870 | 4068.12 | 2663 | 19664 |
| 03-05-2007 | 8,912 | 4150.85 | 2639 | 19442 |
| 04-05-2007 | 9,049 | 4117.35 | 2673 | 19579 |
| 07-05-2007 | 9,053 | 4111.15 | 2554 | 19418 |
| 08-05-2007 | 8,983 | 4077.00 | 2578 | 19326 |
| 09-05-2007 | 8,987 | 4079.30 | 2591 | 19472 |
| 10-05-2007 | 8,929 | 4066.80 | 2623 | 19274 |
| 11-05-2007 | 8,865 | 4076.65 | 2661 | 19331 |
| 14-05-2007 | 8,808 | 4134.30 | 2659 | 18946 |
| 15-05-2007 | 8,801 | 4120.30 | 2698 | 18846 |
| 16-05-2007 | 8,755 | 4170.95 | 2689 | 18357 |
| 17-05-2007 | 8,628 | 4219.55 | 2783 | 18653 |
| 18-05-2007 | 8,596 | 4214.50 | 2802 | 18597 |
| 21-05-2007 | 8,603 | 4260.90 | 2800 | 18544 |
| 22-05-2007 | 8,637 | 4278.10 | 2817 | 18345 |
| 23-05-2007 | 8,633 | 4246.20 | 2899 | 18351 |
| 24-05-2007 | 8,603 | 4204.90 | 2922 | 18508 |
| 25-05-2007 | 8,552 | 4248.15 | 2849 | 18427 |
| 28-05-2007 | 8,552 | 4256.55 | 2788 | 18468 |
| 29-05-2007 | 8,595 | 4293.25 | 2739 | 18496 |
| 30-05-2007 | 8,575 | 4249.65 | 2756 | 18487 |
| 31-05-2007 | 8,604 | 4295.80 | 2780 | 18176 |
| 01-06-2007 | 8,684 | 4297.05 | 2803 | 18291 |
| 04-06-2007 | 8,745 | 4267.05 | 2877 | 18224 |
| 05-06-2007 | 8,749 | 4284.65 | 2914 | 18081 |
| 06-06-2007 | 8,760 | 4198.25 | 2904 | 18198 |
| 07-06-2007 | 8,752 | 4179.50 | 2943 | 17869 |
| 08-06-2007 | 8,666 | 4145.00 | 2844 | 17804 |
| 11-06-2007 | 8,529 | 4145.60 | 2805 | 17845 |
| 12-06-2007 | 8,480 | 4155.20 | 2784 | 17832 |
| 13-06-2007 | 8,531 | 4113.05 | 2822 | 17916 |
| 14-06-2007 | 8,591 | 4170.00 | 2888 | 17736 |
| 15-06-2007 | 8,580 | 4171.45 | 2908 | 17822 |
| 18-06-2007 | 8,598 | 4147.10 | 2950 | 17644 |
| 19-06-2007 | 8,612 | 4214.30 | 2943 | 17665 |
| 20-06-2007 | 8,617 | 4248.65 | 2884 | 17632 |
| 21-06-2007 | 8,515 | 4267.40 | 2930 | 17556 |
| 22-06-2007 | 8,554 | 4252.05 | 2920 | 17889 |
| 25-06-2007 | 8,550 | 4259.40 | 2884 | 18000 |
| 26-06-2007 | 8,516 | 4285.70 | 2885 | 18358 |
| 27-06-2007 | 8,466 | 4263.95 | 2902 | 18530 |
| 28-06-2007 | 8,498 | 4282.00 | 2891 | 18533 |

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|---|---|---|---|---|
| 29-06-2007 | 8,518 | 4318.30 | 2905 | 18606 |
| 02-07-2007 | 8,558 | 4313.75 | 2938 | 18552 |
| 03-07-2007 | 8,529 | 4357.55 | 2993 | 18580 |
| 04-07-2007 | 8,507 | 4359.30 | 3037 | 18292 |
| 05-07-2007 | 8,463 | 4353.95 | 3085 | 17983 |
| 06-07-2007 | 8,436 | 4384.85 | 3101 | 17945 |
| 09-07-2007 | 8,596 | 4419.40 | 3137 | 17879 |
| 10-07-2007 | 8,592 | 4406.05 | 3127 | 17771 |
| 11-07-2007 | 8,613 | 4387.15 | 3152 | 17825 |
| 12-07-2007 | 8,689 | 4446.15 | 3144 | 17869 |
| 13-07-2007 | 8,663 | 4504.55 | 3136 | 18075 |
| 16-07-2007 | 8,645 | 4512.15 | 3115 | 18131 |
| 17-07-2007 | 8,650 | 4496.75 | 3137 | 17919 |
| 18-07-2007 | 8,661 | 4499.55 | 3152 | 18135 |
| 19-07-2007 | 8,749 | 4562.10 | 3194 | 17907 |
| 20-07-2007 | 8,837 | 4566.05 | 3152 | 17909 |
| 23-07-2007 | 8,834 | 4619.35 | 3051 | 17813 |
| 24-07-2007 | 8,862 | 4620.75 | 3029 | 17769 |
| 25-07-2007 | 8,755 | 4588.70 | 3108 | 17607 |
| 26-07-2007 | 8,691 | 4619.80 | 3080 | 16753 |
| 27-07-2007 | 8,605 | 4445.20 | 3060 | 17016 |
| 30-07-2007 | 8,625 | 4440.05 | 3102 | 17043 |
| 31-07-2007 | 8,640 | 4528.85 | 3105 | 16953 |
| 01-08-2007 | 8,659 | 4345.85 | 3114 | 17151 |
| 02-08-2007 | 8,658 | 4356.35 | 3081 | 17062 |
| 03-08-2007 | 8,698 | 4401.55 | 3061 | 17132 |
| 06-08-2007 | 8,723 | 4339.50 | 2950 | 16818 |
| 07-08-2007 | 8,680 | 4356.35 | 2869 | 17151 |
| 08-08-2007 | 8,802 | 4462.10 | 2912 | 17161 |
| 09-08-2007 | 8,633 | 4403.20 | 2879 | 17196 |
| 10-08-2007 | 8,735 | 4333.35 | 2847 | 17429 |
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| 27-09-2012 | 29941 | 5649.50 | 5140 | 53455 |
| 28-09-2012 | 30030 | 5703.30 | 5140 | 54550 |
| 01-10-2012 | 30271 | 5718.80 | 5139 | 55350 |
| 03-10-2012 | 30495 | 5731.25 | 5249 | 56531 |
| 04-10-2012 | 30716 | 5787.60 | 5353 | 56528 |
| 05-10-2012 | 30771 | 5746.95 | 5348 | 57163 |
| 08-10-2012 | 30922 | 5676.00 | 5348 | 57575 |
| 09-10-2012 | 30737 | 5704.60 | 5346 | 57372 |
| 10-10-2012 | 30809 | 5652.15 | 5379 | 57272 |
| 11-10-2012 | 30654 | 5708.05 | 5399 | 57155 |
| 12-10-2012 | 30735 | 5676.05 | 5313 | 56659 |
| 15-10-2012 | 31219 | 5687.25 | 5325 | 58767 |
| 16-10-2012 | 31115 | 5648.00 | 5325 | 58975 |
| 17-10-2012 | 31300 | 5660.25 | 5307 | 59760 |
| 18-10-2012 | 31447 | 5718.70 | 5373 | 59801 |
| 19-10-2012 | 31648 | 5684.25 | 5315 | 60920 |
| 22-10-2012 | 31277 | 5717.15 | 5265 | 59623 |
| 23-10-2012 | 31889 | 5691.40 | 5375 | 60924 |
| 25-10-2012 | 31962 | 5705.30 | 5375 | 62050 |
| 26-10-2012 | 31929 | 5664.30 | 5375 | 61950 |
| 29-10-2012 | 32063 | 5665.60 | 5293 | 62138 |
| 30-10-2012 | 31953 | 5597.90 | 5330 | 61264 |
| 31-10-2012 | 32147 | 5619.70 | 5347 | 62475 |
| 01-11-2012 | 31925 | 5645.05 | 5354 | 62213 |
| 02-11-2012 | 31825 | 5697.70 | 5354 | 62102 |
| 05-11-2012 | 31710 | 5704.20 | 5342 | 61605 |
| 06-11-2012 | 31895 | 5724.40 | 5395 | 61600 |
| 07-11-2012 | 31706 | 5760.10 | 5361 | 62025 |
| 08-11-2012 | 31562 | 5738.75 | 5451 | 61321 |
| 09-11-2012 | 31407 | 5686.25 | 5418 | 60575 |
| 12-11-2012 | 31491 | 5683.70 | 5418 | 60899 |
| 13-11-2012 | 31518 | 5666.95 | 5215 | 60899 |
| 15-11-2012 | 31201 | 5631.00 | 5170 | 60856 |
| 16-11-2012 | 31301 | 5574.05 | 4991 | 61500 |
| 19-11-2012 | 31097 | 5571.40 | 5022 | 60915 |
| 20-11-2012 | 31020 | 5571.55 | 5007 | 60783 |
| 21-11-2012 | 30954 | 5614.80 | 5007 | 60949 |
| 22-11-2012 | 31014 | 5627.75 | 4899 | 60620 |
| 23-11-2012 | 30882 | 5626.60 | 4891 | 60699 |
| 26-11-2012 | 31037 | 5635.90 | 4821 | 60338 |
| 27-11-2012 | 31230 | 5727.45 | 4891 | 60002 |
| 29-11-2012 | 31269 | 5825.00 | 4858 | 60338 |
| 30-11-2012 | 31174 | 5879.85 | 4858 | 60600 |
| 03-12-2012 | 31153 | 5870.95 | 4850 | 60808 |

| | | | | |
|---|---|---|---|---|
| 04-12-2012 | 31080 | 5889.25 | 4613 | 60480 |
| 05-12-2012 | 30922 | 5900.50 | 4767 | 60187 |
| 06-12-2012 | 30792 | 5930.90 | 4639 | 59853 |
| 07-12-2012 | 30934 | 5907.40 | 4639 | 59229 |
| 10-12-2012 | 30960 | 5908.90 | 4664 | 59382 |
| 11-12-2012 | 31213 | 5898.80 | 4839 | 59644 |
| 12-12-2012 | 31065 | 5888.00 | 4840 | 59412 |
| 13-12-2012 | 30901 | 5851.50 | 4886 | 59035 |
| 14-12-2012 | 30773 | 5879.60 | 4841 | 58930 |
| 17-12-2012 | 30781 | 5857.90 | 4841 | 58477 |
| 18-12-2012 | 30812 | 5896.80 | 4879 | 58730 |
| 19-12-2012 | 30916 | 5929.60 | 4864 | 58986 |
| 20-12-2012 | 30926 | 5916.40 | 4859 | 58956 |
| 21-12-2012 | 30931 | 5847.70 | 4878 | 59118 |
| 24-12-2012 | 30923 | 5855.75 | 4837 | 59130 |
| 26-12-2012 | 30688 | 5905.60 | 4837 | 59509 |
| 27-12-2012 | 30293 | 5870.10 | 4824 | 58760 |
| 28-12-2012 | 30610 | 5908.35 | 4886 | 57170 |
| 31-12-2012 | 30734 | 5905.10 | 4886 | 57597 |

# Appendix II (Statistical Results)

## Stationarity Tests: ADF Test

Null Hypothesis: DIRHAM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  |  | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic |  | -0.312495 | 0.9200 |
| Test critical values: | 1% level | -3.451214 |  |
|  | 5% level | -2.870621 |  |
|  | 10% level | -2.571679 |  |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DIRHAM)
Method: Least Squares
Date: 05/11/13   Time: 01:07
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DIRHAM(-1) | -0.002153 | 0.006891 | -0.312495 | 0.7549 |
| C | 0.036447 | 0.087609 | 0.416021 | 0.6777 |

| | | | |
|---|---|---|---|
| R-squared | 0.000316 | Mean dependent var | 0.009193 |
| Adjusted R-squared | -0.002919 | S.D. dependent var | 0.145995 |
| S.E. of regression | 0.146208 | Akaike info criterion | -1.001167 |
| Sum squared resid | 6.605398 | Schwarz criterion | -0.977117 |
| Log likelihood | 157.6815 | Hannan-Quinn criter. | -0.991554 |
| F-statistic | 0.097653 | Durbin-Watson stat | 1.443173 |
| Prob(F-statistic) | 0.754875 | | |

Null Hypothesis: FRANC has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  |  | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic |  | -0.395157 | 0.9068 |
| Test critical values: | 1% level | -3.451214 |  |
|  | 5% level | -2.870621 |  |
|  | 10% level | -2.571679 |  |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FRANC)
Method: Least Squares
Date: 05/11/13   Time: 01:30
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| FRANC(-1) | -0.003387 | 0.008571 | -0.395157 | 0.6930 |
| C | 0.207141 | 0.422945 | 0.489758 | 0.6247 |

| | | | | |
|---|---|---|---|---|
| R-squared | 0.000505 | Mean dependent var | | 0.040760 |
| Adjusted R-squared | -0.002730 | S.D. dependent var | | 0.704188 |
| S.E. of regression | 0.705148 | Akaike info criterion | | 2.145593 |
| Sum squared resid | 153.6454 | Schwarz criterion | | 2.169644 |
| Log likelihood | -331.6398 | Hannan-Quinn criter. | | 2.155207 |
| F-statistic | 0.156149 | Durbin-Watson stat | | 2.088787 |
| Prob(F-statistic) | 0.693000 | | | |

Null Hypothesis: GOLD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.050142 | 0.9614 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD)
Method: Least Squares
Date: 05/11/13   Time: 01:31
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| GOLD(-1) | 0.000185 | 0.003686 | 0.050142 | 0.9600 |
| C | 66.51466 | 70.83795 | 0.938969 | 0.3485 |

| | | | | |
|---|---|---|---|---|
| R-squared | 0.000008 | Mean dependent var | | 69.81897 |
| Adjusted R-squared | -0.003228 | S.D. dependent var | | 457.5347 |
| S.E. of regression | 458.2726 | Akaike info criterion | | 15.09922 |
| Sum squared resid | 64894251 | Schwarz criterion | | 15.12327 |
| Log likelihood | -2345.928 | Hannan-Quinn criter. | | 15.10883 |
| F-statistic | 0.002514 | Durbin-Watson stat | | 2.137988 |
| Prob(F-statistic) | 0.960042 | | | |

Null Hypothesis: HKD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  |  | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic |  | -0.264254 | 0.9269 |
| Test critical values: | 1% level | -3.451214 |  |
|  | 5% level | -2.870621 |  |
|  | 10% level | -2.571679 |  |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(HKD)
Method: Least Squares
Date: 05/11/13   Time: 01:32
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| HKD(-1) | -0.001771 | 0.006700 | -0.264254 | 0.7918 |
| C | 0.015028 | 0.040263 | 0.373243 | 0.7092 |
| R-squared | 0.000226 | Mean dependent var |  | 0.004438 |
| Adjusted R-squared | -0.003010 | S.D. dependent var |  | 0.068506 |
| S.E. of regression | 0.068609 | Akaike info criterion |  | -2.514387 |
| Sum squared resid | 1.454507 | Schwarz criterion |  | -2.490337 |
| Log likelihood | 392.9871 | Hannan-Quinn criter. |  | -2.504774 |
| F-statistic | 0.069830 | Durbin-Watson stat |  | 1.413580 |
| Prob(F-statistic) | 0.791760 |  |  |  |

Null Hypothesis: MARK has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  |  | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic |  | -1.219429 | 0.6669 |
| Test critical values: | 1% level | -3.451214 |  |
|  | 5% level | -2.870621 |  |
|  | 10% level | -2.571679 |  |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MARK)
Method: Least Squares
Date: 05/11/13   Time: 01:33
Sample (adjusted): 1/08/2007 12/24/2012

Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| MARK(-1) | -0.012288 | 0.010077 | -1.219429 | 0.2236 |
| C | 0.423305 | 0.328846 | 1.287244 | 0.1990 |

| | | | | |
|---|---|---|---|---|
| R-squared | 0.004789 | Mean dependent var | | 0.023374 |
| Adjusted R-squared | 0.001569 | S.D. dependent var | | 0.424423 |
| S.E. of regression | 0.424090 | Akaike info criterion | | 1.128670 |
| Sum squared resid | 55.57449 | Schwarz criterion | | 1.152720 |
| Log likelihood | -173.5082 | Hannan-Quinn criter. | | 1.138283 |
| F-statistic | 1.487007 | Durbin-Watson stat | | 1.421746 |
| Prob(F-statistic) | 0.223611 | | | |

Null Hypothesis: POUNDS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.316640 | 0.6226 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(POUNDS)
Method: Least Squares
Date: 05/11/13   Time: 01:33
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| POUNDS(-1) | -0.012682 | 0.009632 | -1.316640 | 0.1889 |
| C | 0.996757 | 0.754408 | 1.321244 | 0.1874 |

| | | | | |
|---|---|---|---|---|
| R-squared | 0.005579 | Mean dependent var | | 0.006117 |
| Adjusted R-squared | 0.002361 | S.D. dependent var | | 0.971205 |
| S.E. of regression | 0.970058 | Akaike info criterion | | 2.783487 |
| Sum squared resid | 290.7726 | Schwarz criterion | | 2.807537 |
| Log likelihood | -430.8323 | Hannan-Quinn criter. | | 2.793100 |
| F-statistic | 1.733541 | Durbin-Watson stat | | 1.395788 |
| Prob(F-statistic) | 0.188935 | | | |

Null Hypothesis: RAND has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  | t-Statistic | Prob.* |
|---|---|---|
| Augmented Dickey-Fuller test statistic | -1.570102 | 0.4967 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RAND)
Method: Least Squares
Date: 05/11/13   Time: 01:34
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| RAND(-1) | -0.016653 | 0.010606 | -1.570102 | 0.1174 |
| C | 0.100855 | 0.064047 | 1.574703 | 0.1163 |

| | | | |
|---|---|---|---|
| R-squared | 0.007915 | Mean dependent var | 0.000651 |
| Adjusted R-squared | 0.004704 | S.D. dependent var | 0.095191 |
| S.E. of regression | 0.094967 | Akaike info criterion | -1.864165 |
| Sum squared resid | 2.786786 | Schwarz criterion | -1.840115 |
| Log likelihood | 291.8777 | Hannan-Quinn criter. | -1.854552 |
| F-statistic | 2.465219 | Durbin-Watson stat | 1.650498 |
| Prob(F-statistic) | 0.117415 | | |

Null Hypothesis: USD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

|  | t-Statistic | Prob.* |
|---|---|---|
| Augmented Dickey-Fuller test statistic | -0.314294 | 0.9197 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(USD)
Method: Least Squares
Date: 05/11/13   Time: 01:37
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| USD(-1) | -0.002167 | 0.006894 | -0.314294 | 0.7535 |
| C | 0.134546 | 0.322009 | 0.417834 | 0.6764 |

| | | | |
|---|---|---|---|
| R-squared | 0.000320 | Mean dependent var | 0.033796 |

| | | | |
|---|---|---|---|
| Adjusted R-squared | -0.002916 | S.D. dependent var | 0.537505 |
| S.E. of regression | 0.538288 | Akaike info criterion | 1.605565 |
| Sum squared resid | 89.53407 | Schwarz criterion | 1.629615 |
| Log likelihood | -247.6654 | Hannan-Quinn criter. | 1.615178 |
| F-statistic | 0.098781 | Durbin-Watson stat | 1.421928 |
| Prob(F-statistic) | 0.753510 | | |

Null Hypothesis: YUAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.103117 | 0.9656 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(YUAN)
Method: Least Squares
Date: 05/11/13   Time: 01:38
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| YUAN(-1) | 0.000469 | 0.004549 | 0.103117 | 0.9179 |
| C | 0.006846 | 0.031530 | 0.217123 | 0.8283 |

| | | | |
|---|---|---|---|
| R-squared | 0.000034 | Mean dependent var | 0.010064 |
| Adjusted R-squared | -0.003202 | S.D. dependent var | 0.079647 |
| S.E. of regression | 0.079774 | Akaike info criterion | -2.212829 |
| Sum squared resid | 1.966440 | Schwarz criterion | -2.188779 |
| Log likelihood | 346.0950 | Hannan-Quinn criter. | -2.203216 |
| F-statistic | 0.010633 | Durbin-Watson stat | 1.468550 |
| Prob(F-statistic) | 0.917937 | | |

Null Hypothesis: AUD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=0)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.239296 | 0.9747 |
| Test critical values: | 1% level | -3.451214 | |
| | 5% level | -2.870621 | |
| | 10% level | -2.571679 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AUD)
Method: Least Squares
Date: 05/11/13   Time: 01:38
Sample (adjusted): 1/08/2007 12/24/2012
Included observations: 311 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| AUD(-1) | 0.001079 | 0.004508 | 0.239296 | 0.8110 |
| C | 0.024906 | 0.194332 | 0.128161 | 0.8981 |

| | | | | |
|---|---|---|---|---|
| R-squared | 0.000185 | Mean dependent var | | 0.070696 |
| Adjusted R-squared | -0.003050 | S.D. dependent var | | 0.596828 |
| S.E. of regression | 0.597738 | Akaike info criterion | | 1.815080 |
| Sum squared resid | 110.4027 | Schwarz criterion | | 1.839131 |
| Log likelihood | -280.2450 | Hannan-Quinn criter. | | 1.824694 |
| F-statistic | 0.057263 | Durbin-Watson stat | | 1.524229 |
| Prob(F-statistic) | 0.811035 | | | |

# Regression Results:

Currency regression

Dependent Variable: GOLDPRICE
Method: Least Squares
Date: 05/11/12   Time: 02:40
Sample (adjusted): 1/14/2007 12/24/2012
Included observations: 259 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C | 0.457549 | 0.188663 | 2.425211 | 0.0160 |
| POUNDS | 0.011210 | 0.210048 | 0.053371 | 0.9575 |
| FRANC | 0.488738 | 0.201142 | 2.429819 | 0.0158 |
| USD | -0.075914 | 0.200924 | -0.377824 | 0.7059 |

| | | | |
|---|---|---|---|
| R-squared | 0.035499 | Mean dependent var | 0.490248 |
| Adjusted R-squared | 0.024152 | S.D. dependent var | 3.053138 |
| S.E. of regression | 3.016043 | Akaike info criterion | 5.061092 |
| Sum squared resid | 2319.611 | Schwarz criterion | 5.116024 |
| Log likelihood | -651.4114 | Hannan-Quinn criter. | 5.083178 |
| F-statistic | 3.128467 | Durbin-Watson stat | 2.259242 |
| Prob(F-statistic) | 0.026327 | | |

Regression stage II:

Dependent Variable: GOLDRET
Method: Least Squares
Date: 05/11/13   Time: 02:42
Sample (adjusted): 1/02/2007 12/30/2012
Included observations: 1532 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C | 0.076042 | 0.036559 | 2.079975 | 0.0377 |
| MARKRET | 0.157486 | 0.030424 | 5.176333 | 0.0000 |
| NIFTYRET | 0.002506 | 0.001495 | 1.676191 | 0.0939 |
| OILRET | 0.056455 | 0.014979 | 3.768883 | 0.0002 |
| SILVERRET | 0.010616 | 0.019338 | 0.549003 | 0.5831 |

| | | | |
|---|---|---|---|
| R-squared | 0.034823 | Mean dependent var | 0.090805 |
| Adjusted R-squared | 0.031851 | S.D. dependent var | 1.337932 |
| S.E. of regression | 1.316453 | Akaike info criterion | 3.391586 |
| Sum squared resid | 2251.230 | Schwarz criterion | 3.411422 |
| Log likelihood | -2206.314 | Hannan-Quinn criter. | 3.399027 |
| F-statistic | 11.71672 | Durbin-Watson stat | 2.116918 |
| Prob(F-statistic) | 0.000000 | | |

# ARIMA Results

Dependent Variable: GOLDRET
Method: Least Squares
Date: 03/11/12   Time: 02:48
Sample (adjusted): 1/03/2007 12/30/2011
Included observations: 1532 after adjustments
Convergence achieved after 25 iterations
MA Backcast: 1/01/2007 1/02/2007

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.082674 | 0.004539 | 18.21255 | 0.0000 |
| NIFTYRET | 0.002516 | 0.001476 | 1.704893 | 0.0885 |
| MARKRET | 0.168496 | 0.030988 | 5.437444 | 0.0000 |
| OILRET | 0.057259 | 0.014842 | 3.857878 | 0.0001 |
| AR(1) | 0.976074 | 0.006275 | 155.5480 | 0.0000 |
| MA(1) | -1.045813 | 0.028640 | -36.51522 | 0.0000 |
| MA(2) | 0.046761 | 0.028597 | 1.635167 | 0.1023 |

| | | | |
|---|---|---|---|
| R-squared | 0.048028 | Mean dependent var | 0.089962 |
| Adjusted R-squared | 0.043620 | S.D. dependent var | 1.338100 |
| S.E. of regression | 1.308590 | Akaike info criterion | 3.381136 |
| Sum squared resid | 2219.282 | Schwarz criterion | 3.408923 |
| Log likelihood | -2195.810 | Hannan-Quinn criter. | 3.391561 |
| F-statistic | 10.89737 | Durbin-Watson stat | 2.003398 |
| Prob(F-statistic) | 0.000000 | | |

| | | |
|---|---|---|
| Inverted AR Roots | .98 | |
| Inverted MA Roots | 1.00 | .05 |