Time Varying Risk Premium in Gold Futures Market: Empirical Investigation in India

A project report submitted to India Gold Policy Research Centre, IIM Ahmedabad

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Foreword

It gives immense pleasure to write the foreword of the study "Time Varying Risk Premium in Gold Futures Market: Empirical investigation in India" funded by India Gold Policy Research Centre (IGPC), IIM Ahmedabad. This study is an independent report, commissioned, researched and written by Prof. Trilochan Tripathy, XLRI-Xavier School of Management Jamshedpur, India in February 2019.

With an aim to promote the gold policy research in India, XLRI has signed a MOU with the IGPC, IIM Ahmedabad. This study is the first endeavour in this direction. In this study Prof. Tripathy has explored that gold futures (gold ETFs) offers the benefit of portfolio diversification, hedging, hedge effectiveness and safe haven benefit to the equity index investors in India. I am quite hopeful that the contribution of this study has academic, managerial and regulatory policy implications.

I feel honoured to write the foreword to this manuscript and I fervently hope that the findings of the study would provide intellectual stimulus to the researchers and teachers who are engaged in gold policy research in India.

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Abstract

Abstract: This study fits the multivariate GARCH model to obtain the dynamic conditional correlations (DCCs) between gold futures returns (gold ETFs) and the excess returns of the equity index in India over the period of 2009-2018. Using the first stage DCC GARCH model inputs, study finds the presence of significant gold futures risk premium and lend support to the theory of Normal Backwardation (1930). The study also a reveals that gold future (gold ETFs) offers the benefit of portfolio diversification, hedging and safe haven benefit to the equity index investors in India. The portfolio and hedge effective analysis suggest that adding gold futures to a portfolio of stocks significantly improves its risk adjusted return and the equity risk exposure can be effectively hedged away over time. Further, it Is the idiosyncratic factors of gold such as gold futures basis, spot price realised variance and skewness are found to be the significant determinants of the risk premium in gold futures (gold ETFs). Finally gold futures risk premium can be used as a be a significant predictor of equity risk premium in India. The outcome of this study has academic, managerial and regulatory policy implications.

JEL classification: Q42; Q11; C32

Keywords: Multivariate GARCH; Dynamic conditional correlations; Gold Futures; Wavelet Coherency.

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1. Introduction

Importance of gold is immense in the world economy. The gold is also considered as a global monetary *asset*, which reflects global developments. Investors across the world largely believe that gold as a hedge against economic crisis, currency failure, national debt overhang, socio-political unrest and inflation. India is one of the major economies, which plays an important role in the world gold market and it's more often emerged as the largest gold consumer in the world. The gold is an integral part of the social cultural and economic fabric of India. The usage of gold in India is quite diverse, where it is used as investments, asset diversifiers, substitute for currency, insurance against financial stress, hedge against inflation, official reserves, jewellery manufacturing, industrial applications and medicinal ingredients. Even in the presence of wide array of investment options in the equity, bond, currencies, commodities, insurance, and real estate market, investor in India still prefer to invest in gold and gold related securities. Unprecedented growth of gold trade in the physical gold market, proliferation of wide array of gold based financial instruments in the form of mutual funds, gold bullion securities, exchange traded funds, gold certificates schemes, sovereign gold bonds, government intervention in gold trade, gold smuggling and confiscation, customs duty on legitimate imports and market regulations have drawn the attention of the researchers and policy makers to understand this market better. The prices of gold and gold back financial instruments in India are not only influenced by the global risk factor but also due to local and idiosyncratic risk factors as well. It's also widely believed that the gold market is subject to speculation especially through the use of futures contracts and other derivatives. A strong form of efficient gold futures market will ensure the fair game in the market, where risk premium in gold futures turns into zero. The researchers, academicians, practitioners and policy makers are still debating on diverse issues of Indian gold futures market. One such issue, which is highly under studied in the gold futures market is relating to its risk premium. Understanding presence of risk premium in gold futures, exploring the time varying conditional correlation of gold futures returns and excess equity returns, portfolio diversification, hedge and safe haven benefit of the gold futures and gold ETFs and their hedging effectiveness for the equity index investor, factors affecting risk premium in gold futures and gold ETFs and studying causal lead-lag relationships between time varying risk premium in gold based funds return and equity risk premium in India would trigger intellectual debates in the future.

Scholars, practitioners and policy makers have long since been interested in understanding the pricing of financial and commodity futures contract in different market set ups. The pricing of futures contract are applied to two popularly hypotheses i.e. The Cost of Carry Hypotheses (Kaldor, 1939; Working, 1948; Brennan, 1958; Telser, 1958; Fama and French, 1987; Deaton and Loroque, 1992) and Risk Premium Hypotheses (Keynes, 1930; Hicks, 1939; Cootner, 1960; Houthkker, 1968; Dusak, 1973; Breeden, 1980; Jagannathan, 1985; Fama and French, 1987; Makarov and Schornick, 2012). The Cost of Carry Hypothesis assumes that the price of a future contract is nothing but the price of the underlying asset in the spot market plus the cost of carrying the asset for the period of the futures contract.

According to Fama and French (1987) there is no empirical dispute on the Cost of Carry hypothesis. The Risk Premium hypothesis states that a futures price as comprising a forecast of a future spot price and an expected risk premium, which has received a great deal of attention in the applied finance literature. Despite over eight decades of research spearheaded by Keynes (1930), there is little agreement on whether the expected risk premium is zero or on whether the futures prices have power to forecast future spot prices. Risk premium accrued to speculators as a reward for accepting the price risk which hedgers sought to transfer (Hicks, 1939). This study is also an attempt to examine the second schools of thought (Risk Premium Hypothesis) in an emerging market commodity futures context. Failure of asset future price as an unbiased estimator of future spot price is an evidence of market inefficiency (Leuthold, 1974; Matrin and Garcia, 1981; and Bhattacharya and Singh, 2007). Some strands of studies suggest that futures markets are weak form of efficient as far as linear dependence between prices is concerned (Hodrick and Srivastava, 1986; Chowdhury, 1991; Brenner and Kroner, 1995; Fujihara and Mougoue, 1997; Gil Alana and Tripathy, 2014). Literature also suggests that the efficient market hypothesis holds for futures contracts closer towards maturity (Gebre-Mariam, 2011). The extent of futures market efficiency differs across the commodity types (Kristoufek and Vosvrda, 2014). In a nutshell, engaging diverse econometric techniques and different data frequencies over time and space a wide array of studies reject the unbiasedness hypothesis and establish the presence of time–varying risk premium in financial assets especially with respect to currencies, stocks, bonds and interest rates (Hodrick and Srivastava, 1984, 1987; Inci and Lu, 2007, Kiani, 2009).

Literature also suggests a wide array of factors affecting risk premium in the futures market. These factors can be broadly segmented into four categories: macroeconomic factors ((Bailey and Chan, 1993; Barkoulas and Baum, 1996), systematic risk factors and residual risk related factors (Hirshleifer, D, 1988; Bailey and Chan, 1993; Barkoulas and Baum, 1996; Acharya et al., 2010) and market microstructural related factors (Jian and Chiang, 2000; Roongsangmanoon et.al, 2009; Hong and Yogo, 2012; Kumar and Truck, 2014; Hambur and Stenner, 2016). Some of these factors are spot rate, dividend yield, residual risk and trading cost (Hirshleifer, D, 1988; Bailey and Chan, 1993; Baum and Barkoulas, 1996), hedging pressure (Bessembinder, 1992; Roongsangmanoon et.al, 2009), systematic hedging pressure

(Acharya et al., 2010), open interest, price volatility, variance of spot exchange rate (Jian and Chiang, 2000), open interest (Hong and Yogo, 2012), delivery risk (Roongsangmanoon et.al, 2009), contracts maturity period (Kumar and Truck, 2014[1]; Hambur and Stenner, 2016[2]), degree of market segmentation(Cheng, Raina and Xiong, 2014[3]) and process of price risk transfer ((Hambur and Stenner, 2016[4]). Literature also confirms that the time–varying risk premium in commodity market is more pronounced and significant in an emerging market economy, India, than other developed countries (Aysun and Lee, 2014). This pronounced risk premium in emerging market occurs due to host of reasons, namely a few reasons are obstruction in information flow across the markets, inadequate market infrastructure, market regulation, market imperfection and trade restrictions (Aysun and Lee, 2014). The gold risk premium declines with the currency appreciation and the demand for gold decelerates with many regulatory directives in India (Nath and Dalvi, 2014.). However, the literature has not much explored systematically the reasons for such a pronounced and significant time varying risk premium in gold futures market in India. This study will make an attempt to investigate the effect of global, local and asset specific risk factors on time varying risk premium in gold. Further the evidence of risk premium and its determinants in commodity futures markets are highly limited to the mature markets and not much explored in emerging markets. Further, rapid growth of investments in gold futures market, proliferation of wide array of gold based financial instruments in the form of mutual funds, gold bullion securities, exchange traded

[1] The time varying risk premia is also observed in the Indian currency market and the risk premia is more prominent with increasing maturity (Kumar and Truck, 2014).

[2] A recent study in Australia observes that risk premiums vary across futures contract maturities, and that the term structure of commodity risk premiums differs between commodities (Hambur and Stenner; 2016).

[3] The commodity futures market segmentation compared to other financial markets acts as deterrent to investors participation in the commodities markets, and prevents the risk premium from being competed away. Upon reduction of market segmentation, investors may enter the market to earn the risk premiums, which should cause the premiums to move towards zero (Cheng and Xiong 2014).

[4] Another reasons for the existence of commodity risk premiums is the process of transferring price risk amongst market participants via hedging (Hambur and Stenner; 2016).

funds, gold certificates schemes, sovereign gold bonds, government intervention in gold trade, gold smuggling and confiscation, customs duty on legitimate imports and market regulations in India would have influenced the risk premium in gold. Thus Indian market would be a new testing ground for investigating time varying risk premium in the gold futures market and the factors affecting time varying risk premium in gold in an emerging market space.

Information content in futures prices is important not only in predicting future spot prices (market efficiency), but also to understand the inter-market and cross-market linkages. Contemporaneous informational linkages among futures market have already been studied extensively (Tse, 1998; Bessembinder and Seguin, 1993; Li and Zhang, 2009; Chong and Miffre, 2010; Kumar and Pandey, 2011; Silvennoinen and Thorp, 2013). In addition, lead-lag relationships across futures market have also explored in the literature (Malliaris and Urrutia, 1996;, Fung, Leung, Xu, 2003; Hammoudeh et al., 2003; Bekiros and Diks, 2008; Feng-bin et al., 2008; Kaufmann and Ullman, 2009; Du et al., 2011; Ali and Gupta, 2011; Gebre-Mariam, 2011; Sari et al., 2012). Literature also supports the volatility spillover between derivative and spot markets. Extracting volatility risk and risk premium from the volatility surfaces of index time series and derivatives data, literature affirms that risk premium significantly predicts future stock returns (Carr and Wu, 2016). Thus, this study also attempts to study the comovement between the risk premium in gold futures and equity markets in India.

To briefly sum up, the extant review of literature do not find any consensus on whether there is presence of risk premium in gold market, hedge and safe haven characteristics of gold and hedge effectiveness of portfolio in the presence of gold. Further, I did not find much of the literature that deals with the determinants of risk premium in the gold futures market in India. Therefore, it is essential to examine whether there is presence of risk premium in gold futures market, if so, what are the determinants of risk premium in gold futures, does gold futures play a role of safe heaven, how does inclusion of gold futures enhance hedge effectiveness. Further the extant of literature on risk premium comovement is sparse in the empirical literature. Thus, the examination of aforesaid issues using emerging market data helps us to extend the related literature for a better understanding of this important issue.

2. Rationale of the study

The empirical literature on risk premium in the bullion asset class is still at its infancy and invisible in the emerging market space including India. Further, Indian story in emerging market is unique in relation to gold usages and gold market dynamics. The unprecedented growth of gold futures market, proliferation of wide array of gold based financial instruments in the form of mutual funds, gold bullion securities, exchange traded funds, gold certificates schemes, sovereign gold bonds, regulators vigilant eye on gold market development, government intervention in gold trade, gold smuggling and confiscation, customs duty on legitimate imports and market regulations and government policies for setting of gold spot exchange may have some informational impact on time varying risk premium in gold in India.

First, the aforesaid eventful developments in Indian gold market have become a fertile testing ground for investigating the statistical structure, properties and causes and effect of time varying risk premium in gold futures market in India and thus, firstly, this extends the motivation for this study. Secondly, browsing through the literature on risk premium in gold futures, I found not much literature on this domain thus, I propose to investigate in depth the gold futures risk premium in gold futures and gold ETFs in relation to index equity in India.

Secondly, the factors affecting time varying risk premium in futures market is well researched throughout the futures market history. Literature also documents that apart from the systematic factors, underlying assets in futures especially in commodity markets may also be exposed to idiosyncratic factors such as seasonality in production and demand, warehousing facilities, transportation costs, taxes, regulations etc. However, the literature on the factors affecting the time varying risk premium in gold futures is quite scanty and not much explored in the emerging market space. India being one of such unique market where gold plays an important role across the diverse socio-economic strata warrants in-depth understanding on the factors affecting time varying risk premium in gold futures market. To investigate the effect of explanatory factors on time varying risk premium, I propose to decompose these factors into systematic factors (global factors), local factors (country specific factors) and asset specific factors (idiosyncratic factors) and understand their impact individually and jointly. The findings from this segment may provide additional knowledge to the existing stock of literature.

Thirdly, literature amply supports the information flow between the futures and spot market both in the contemporaneous and lead lag frameworks. Further Extracting volatility risk and risk premium from the volatility surfaces of Index time series and derivatives data literature affirms that risk premium significantly predicts future stock returns (Carr and Wu, 2016). However, the eventful development in the Indian gold market including rapid growth of investments in gold futures market may tend to affect risk premium and the price volatilities in gold and information flows across the gold based mutual funds and exchange traded fund markets. It may be hypothesized that the time varying risk premium in gold futures market may transmit information to the gold based mutual fund and exchange traded fund markets. However, to the best of my knowledge, I did not find any literature that links between the time varying risk premium in gold futures and the gold based exchange traded funds. Such behavioural linkages among the stated variables are of interest to central banks, policy makers, investors, hedgers, business firms and consumers whose decisions depend on their expectations of future inflation.

Against this backdrop, this study is proposing to examine major issues related to risk premium in gold futures market in India namely This study broadly examines (i) the presence of conditional risk premia in the gold futures (gold ETFs) markets, (ii) size of risk premium in gold futures compared to the gold ETFs and equity, (iii) behaviour of the conditional correlation between returns of the gold futures (gold ETFs) and excess equity returns, (iv) gold portfolio diversification opportunities for equity index investors (v) gold is an asset for hedge against risky index equity (vi) gold futures (gold ETfs) offers safe haven opportunities for the equity index investor (vii) gold futures hedge effectiveness as compared to gold ETFs (viii) gold futures and gold ETFs hedging benefit, (ix) factors determine gold futures risk premium and (x) dynamic nexus between risk premium gold futures (gold ETFs) and equity risk premium. The empirical analysis in this study is based on data from diverse sources (MCX, Bloomberg, Thomson Reuters Eikon data base) for a period of 9 years.

The study is unique in several ways in Indian context. First, to the best of my knowledge it is the first study on the gold risk premium in India. Second, the hedge, safe haven benefit of gold futures compared to gold ETFs to the equity index investor explored in this study would initiate further debate in the academic circle. Third, time domain and frequency domain causality are explored very first time in studying the dynamic relationship between the gold futures risk premium 9gold ETFs) and the equity risk premium at least in the emerging market context.

The paper proceeds as follows. Section 2 presents literature review and motivation of the study. Section 3 is deals with the hypotheses development. Section 4 describes data, variable and methodology. Section 5 delineates the results and discussions of the study. Section 6 captures summery of findings, conclusions and policy implications.

3. Hypotheses Development

The pricing of futures contracts may be understood from three different theoretical perspectives such as cost of carry hypothesis and expectation theory and risk premium hypothesis. The cost of carry hypothesis states that the storage cost, financing cost and the convenience yields are the determinants of the futures price. Hull (2014) defines cost of carry, which is sum of the cost of storing the tradable asset and the interest paid for financing asset for a period of time, minus the income claimed on the asset during the period. The expectations (unbiasedness) theory delineates that the future rate is an unbiased predictor of the future spot rate with the conditions of rational expectations and risk neutrality information given at time t. This theory is developed on the premise of the rational expectations and assumes that the investors are risk neutral (Chen and Zahan, 2008). The earlier set of empirical studies have tested unbiasedness hypothesis using an estimation framework which regress the log of the current spot (St) on the one-period lagged log of the forward rate (F_{t-1}). In much of the research on this topic (Engel, 1996), have been tried to empirically test this theory and still remained to be a puzzle. Several authors even deploying diverse tests rejects the unbiasedness hypothesis (Chen and Zheng, 2008) However, owing to prevalence of non-stationarity in the spot and the forward rates, biasedness tests based on a level regression of the future spot rate on the forward rate resulted in spurious regression and the inference drawn would be invalid (Meese and Singleton, 1982).

The risk premium hypothesis (hedging pressure theory), originates from the work of Keynes (1930) theory of normal backwardation. He contends that in the normal market condition, the spot price must exceed the forward price by the amount which the hedger is ready to sacrifice in order to hedge himself against the price risk, thereby backwardation in the forward price. Keynes argued that in normal market scenario hedgers take net short position in futures market to hedge away declining price risk and speculators take net long position in turn, former should compensate later for providing insurance to the hedgers by hedging away the price risk in the market. Thus, the difference between the futures price and the expected spot price at maturity is attributed as risk premium. Hedgers can be producers and consumers of the underlying commodity. Producers hold the commodity with intentions of selling it in the future. To hedge decreasing price risk, they need to hold short positions in the futures market. Thus, the risk premium component should be reflected in the futures price and it is the claim of the speculators for taking away risk from the hedgers. The empirical studies (Bodie & Rosansky, 1980; De Room Nijmanand, & Veld, 2000; Donohue, Froot, & Light, 1992; Dusak, 1973; Fama & French, 1987; Froot, 1995; Gorton & Rouwenhorst, 2006; Jensen, Mercer, & Johnson, 2002; Kocagil, 1997; Kolb, 1992, 1996; Lee, Leuthold, & Cordier, 1985; Miffre, 2000,) have thus far obtained mixed evidence regarding the existence of risk premium. Kolb (1992, 1996) examine various commodity futures contracts and shows little evidence on risk premium in commodity futures market. Miffre (2007) finds positive risk premiums for 12 out of 19 commodities, including gold. The extant review of literature do not find any consensus on whether there is presence of risk premium in futures market. I didn’t find much of literature on India gold futures market that concentrates on the examination of the risk premium in the cold futures market. Thus, against this backdrop of the literature, I test my first set of hypotheses in the Indian gold futures market, which are given as follows:

1.1 Ha: That, gold futures (gold ETFs) market in India offers investors a significant amount of risk premium.

1.2 Ha: That, equity market offers significantly higher risk premium compared to the gold futures (gold ETFs) market.

1.3 Ha: That the Indian gold futures market supports the theory of normal backwardation

Scruggs (1998) reports that excess market returns are positively related to conditional market variance and negatively related to the conditional covariance between stock and bond returns. Studies also support that bond and gold act as hedging instruments for equity portfolio. The extant of literature discuss above that gold specific idiosyncratic factors, industry specific factors and macroeconomic factors have bearing on the risk premium in gold market. Investigating into the role of such factors in determination of gold futures risk premium in an aggressively gold consumption driven emerging economy may add diverse perspective to the existing stock of literature. Empirical evidence also confirms that tactical trading in commodity futures markets provides abnormal returns in the past (Vrugt et al., 2004; Erb and Harvey, 2006;). The optimal decision of asset allocation in a continuous time framework is extensively analysed some of the landmark works are Merton 1990; Ho and Stoll (1981), Krawczyk (2008) and others. There is no dearth of literature that examines gold act as a strategic asset allocation tool due to its low (negative) return correlation with traditional asset classes and especially with equity. The extent of portfolio diversification opportunities of gold and gold related assets are extensively examined by Carter et al.,1982; Jaffe,1989; Shishko,1977; Jensen et al., 2000; ciner, 2001; Erb and Harvey, 2006; and many others. Focusing on the correlation behaviour of gold with the other major assets in the portfolio framework they find evidence that the gold and other major assets are having either low or negative correlation, suggesting that gold offers the power of diversification benefit across wide array of assets. Gold also serves as a good hedge against inflation (Bodie and Rosansky, 1980; Bodie, 1983). Studding the conditional correlation behaviour between equity and gold in the Multivariate GARCH framework (Chong and Miffre, 2007) also concluded that gold futures plays an important role in the portfolio diversification in the equity portfolio. However, they also argued that the decision to engage gold in a diversified portfolio is not only based on the temporal risk-return dynamics but also how gold futures correlate with the rest of the portfolio over time (Chong and Miffire, 2007). James Ross McCown (2006) finds evidence of gold as a portfolio diversification tool for many investment portfolios, virtually uncorrelated with stock returns and also a good hedge against inflation risk. However, recent studies suggests that the correlations between commodities have increased, limiting the benefits of the diversification strategy (Daskalaki and Skiadopoulos, 2011; Sadorsky, 2014). Further, hedge and safe-haven properties of gold has empirically tested this claim and some of the recent works include (Capie et al., 2005; Chong and Miffre, 2007; Baur and Lucey, 2010, Baur and McDermott, 2010; Erb and Harvey, 2013; Reboredo, 2013; Hood and Malik, 2013; Nguyen et al. 2017). However, the evidences of hedge and safe-haven properties of gold are found to be mixed. Capie et al. (2005) investigate whether gold acts as an exchange rate hedge. Chong and Miffre (2007) also find the evidence of gold serve as hedge against equity and considered too be acting as safe heaven. Ciner et al. (2013) examine dynamic conditional correlation (DCC) GARCH models for crude oil, gold, currency, bond and stock markets using daily data from the U.S. and the U.K. Gold performs as a safe haven for exchange rates and bonds while crude oil acts as a safe haven only for bonds. Reboredo (2013) also finds, using copula techniques, that gold is both a hedge and safe haven against USD depreciation. Binh, Nguyen and Simen (2017) find that gold is not expected to serve as a hedge and safe haven, but it does serve as both ex-post. Against this backdrop of the extant literature, I test the second set of hypothesis in the study, which is given hereunder:

2.1 Ha: *that* gold futures (gold ETFs) is an asset for hedge against risky index equity

2.2 Ha: that gold futures (gold ETfs) offers safe haven opportunities for the equity index investor

The addition of gold to a portfolio improves its risk adjusted returns and the gold risk exposures can be effectively hedged away in portfolio of stocks over time (kroner and Sultan, 1993; Kroner and Ng, 1998; Harris and Shen, 2006; Cotter and Hanly, 2006; Arouri et al. 2013; Dey and Sampath, 2018). Based on these empirical evidences, I test the third set of following hypothesis:

3.1 Ha. That hedge effectiveness increases in an equity index portfolio with the gold futures compared to gold ETFs in India.

The theories of commodity price determination suggest that the risk premium depends on several factors. Pindyck (2001) ties the risk premium to the current spot price of the commodity. Literature also supports that the spot price (Pindyck, 2001; Konjhodzic and Narmo, 2017) future basis and realised variances are the significant and direct predictors of the risk premium in commodity futures market (Konjhodzic and Narmo, 2017) and also in currency market (Jiang and Chiang, 2000, Kumar and Truck, 2014) and and equity market (Guo and Whitelaw, 2006). Empirical literature also claims that positive skewness has a valuable impact on the utility investors derive from their investments (Barberis and Huang, 2008). Exploring skewness is a profitable signal in markets other than equities (e.g., Chang et al., 2013) and equity derivatives (Mitton and Vorkink, 2007; Barberis and Huang, 2008; Boyer and Vorkink, 2014). Considine and Larson (2001b) suggest the risk premium to be positively related to price volatility. Schwartz (1997) and Pilipovic (1998) argues that the risk premium should be negatively related to the risk-free rate and positively to the convenience yield. In addition, Schwartz (1997) also recommends that the risk premium should be positively related to the variability in the convenience yield as well as the time-varying interest rate, and the co-variances between the convenience yield and interest rate. Literature also suggests industry and macroeconomic factors (Capie et al., 2005; Baur, 2013; Reboredo, 2013) predicting the commodity risk premium. While authors like Sherman (1983), Jaffe (1989), Mahdavi & Zhou (1997), among others, investigate the relationship between gold prices and inflation. Empirical literature also engages the oil price dollar index as macroeconomic predictor variable for the gold risk premium (Capie et al., 2005; Tully & Lucey, 2007; Pukthuanthong & Roll, 2011; Baur, 2013; Reboredo, 2013,).

4.1 Ha: that idiosyncratic factors (future basis, realised variance and skewness) are the significant determinants of the risk premium in gold futures (gold ETFs) market.

Empirical evidence of time variation in conditional risk premium and conditional variances and covariance across the asset classes has drawn diverse attention in the academic and policy circles. However, empirical evidences in support for single period CAPM have remained a contentious. Earlier authors (Harvey, 1989a; Schwert and Seguin, 1990) and (Bollersleve et.al., 1988, Engel et al., 1990; Baillie and DeGennaro 1990) using one period said CAPM framework find evidence against and in support of time variation in conditional expected asset returns, variances and covariances respectively. Backus and Gregory (1993) demonstrate that the relationship between conditional risk premium and conditional variances of excess returns can take increasing decreasing , flat or even monotonic shape. However, the empirical evidence on risk premia comovement are not much evidenced in the empirical literature. However, extracting volatility risk and risk premium from the volatility surfaces of index time series and derivatives data, literature affirms that risk premium significantly predicts future stock returns (Carr and Wu, 2016). Against this back drop, this study also attempts to study the comovement between the risk premium in gold futures and equity markets in India. Keeping this in mind following hypothesis is tested in this study:

5.1 Ha: That gold futures (gold ETFs) risk premium predicts the equity risk premium in India

We contribute and extend the related literature in gold futures market in four ways. First, I show that investors who have invested in gold futures market in India has earned significant risk premia over the period 2009 -2018 but this premium is lower than the equity risk premium. The findings here also corroborate my realised risk premium results presented in the previous section (…….) that the presence of positive risk premium in the gold futures market strongly supports the normal backwardation theory (Keynes, 1930). The second contribution of the paper relates to the temporal variations in correlations between commodity futures returns and returns of S&P BSE SENSEX. It results here reveal that the time varying conditional correlations between gold futures and equity returns found to be negative. This suggests that by adding long positions in commodity futures to an equity portfolio provides the opportunity for risk reduction and portfolio diversification. My result here supports the literature that the commodity futures have become, over time, better portfolio diversifiers and thus better instruments for strategic asset allocation (Chong and Miffre, 2007). *Third,* the factors affecting gold risk premium in India is not much understood and this study provides systematically to explore these dimensions in an emerging market space. *Fourth*, it will introduce a set of global, local and asset specific risk factors to explain variations in time varying gold risk premium. Fifth, gold and equity mix proportion that extends the portfolio diversification benefit in Indian context would be a contribution to the exsting stock of literature in an emerging market context.

4. Data, variables and Methodology

4.1 Nature and Sources of data

I examine gold spot and futures contracts data of the Multi Commodity Exchange of India Ltd (MCX) for the period between January 01, 2009 to December 20, 2018. Though, the gold futures data is available much before in the MCX, just to avoid the effect of 2008 financial crisis (may distort the results: nonlinearities and breaks in the series), I deliberately chose the data for this study from 2009 onwards. While selecting among the gold contracts (gold generic, gold guinea, petal and gold mini) which are actively traded in the MCX platform, I chose the generic gold futures contract data for this study. Obvious reasons for selecting gold futures contract data from MCX over other competing exchanges in India emerges from the fact that it accounts for about 85 percent and 99 percent of market share in Commodity Futures contracts and bullion futures traded in India. The rationale of choosing generic gold futures contract emanates from the fact that it is the most popular gold futures (MAUc1) contract in the MCX platform. This contract is one of the high traded volume gold futures contract in MCX platform. There are six gold contracts are available in the MCX platform. The contract start day is 16 day (if 16 th day is holiday then the following working day) of the contract launch month with last trading day on 5th day (if 5th day is holiday then preceding working day) of contract expiry month (February, April, June, August, October and December) and these contracts are available for trading as per the contract launch calendar.   According to the MCX contract specification a lot size of 1 kg gold with a quotation value of 10 gm gold is traded from Monday through Friday with session time in between 10 am to 11.30/11.55 pm. The MCX gold futures market is a limit order market, where daily price limit of 3 percent is set initially. If the daily price limit is breached, the relaxation would be allowed up to 6 percent without any cooling off period (See further detail MCX Contract Specification of Gold).

Gold futures trading started in multiple exchanges in India in 2003 and trades on these future exchanges are concentrated in near month contracts. However, most of the trading does not result in delivery and speculative trading drives the market for gold futures (Nath and Dalve 2014). Keeping this idea in mind, I collected the near month gold contract price continuation series and MCX gold spot market price from the Thomson Reuters and Bloomberg data bases respectively. Further, stock index, exchange trade fund index and macroeconomic data series utilised in this study are sourced from the Bloomberg data base. The data set sample for the study accounting all the variables spans the period January1, 2009 to December 20, 2018. To avoid the extreme thin trading effect and maturity effect which may cloud the study inference, I have removed those observation from the data set. Finally, I used a dat set having 2303 number of observation for this study.

4.2 Variables used

In a theoretical paradigm, forward prices and futures prices for delivery on the same day in the future may not be same. However, empirical evidence suggests that forward and futures contracts prices are observed to be almost indifferent (hodrick and Srivastava, 1987 and Baum and Barkoulas, 1996). Against this backdrop, I also followed in this study the future rates are a substitute for the forward rate of gold to study the time varying risk premium hypotheses.

Gold Futures price (f_t): It refers to the daily closing price of MCX generic gold futures contract (MAUc1) value of 10 gm gold that is traded from Monday through Friday with session time in between 10 am to 11.30/11.55 pm. This is obtained from the Thomson Reuters EIKON data base.

Gold ETF prices: p_{q}, p_{u} and p_{r} are the daily closing prices of Quantum gold ETFs, UTI gold ETFs and Reliance gold ETFs traded in either Bombay or nationals stock exchanges of India. These gold ETF prices are obtained from the Bloomberg terminal.

Realised spot return variance $(rvar_t)$*:* Following (Anderson et al., 2001; Christiansen, 2011) in the currency market study, I have also deployed the realized daily realised variance $(rvar_t)$ as a predictor for realised risk premium. However, unlike Anderson et al., 2001; Christiansen, 2011, I have followed the following computation methodology to compute $(r\ var_t)$

$$rvar_t = (r_j - \bar{r})^2$$

Hereby, rj is the log return of the spot gold on day j and r¯ is the average log return during the last n trading days.

Realised spot return skewness $(rskw_t)$*:* Using the same reasoning, we calculate the realised skewness $(rskw_t)$ as follows

$$rskw_t = \frac{(r_j - \bar{r})^3}{\sigma_t}$$

Realised spot return variance $(rkur_t)$*:* In the equation above, σt denotes the standard deviation of the currency returns during the last n trading days. The realised (excess) kurtosis Kurtt is calculated using the following formula:

$$rkur_t = \frac{(r_j - \bar{r})^4}{\sigma_t} - 3$$

Note that $rkur_t$actually specifies the excess kurtosis, by subtracting 3 (the kurtosis of the normal distribution) from the formula for the kurtosis. Thus, the variable can be interpreted as measuring the deviation of the kurtosis from that of a normal distribution

Future Basis (bs_t): I construct ‘bs_t’, which is the difference between futures price and spot price of the underlying asset. Basis risk arises when the futures price and spot price of an underlying asset does not converge at maturity T (Hull, 2014). The basis may be positive, negative or zero. When the basis of an underlying asset the market is in contango or is in backwardation—there is a supply shortage. Thus, the basis is the difference between the daily closed gold futures contract price and closed spot price of 10 grams of gold which is formulated as follows:

$$bs_t = f_t - s_t$$

The basis is standardised by dividing the standard deviation of the daily gold spot price for the study period. Thus, the standardised basis takes the following form:

$$sbs_t = \frac{f_{t-}s_t}{\sigma_t}$$

Equity Risk Premium ($\boldsymbol{mrp_t}$): Following Nguyen et al., (2017), I have also used Indian equity risk premium (mrp_t) as a predictor for the realised gold risk premium in the Indian market. This is measured as the difference between expected daily return from BSE Sensex (Rm,t) and the daily 10-year government of India bond rate ($r_{b,t}$). The choice of BSE Sensex over BSE 500 or NSE 500 arises due to the fact that investment managers generally benchmark India betas against the BSE Sensex. Further, this index is highly correlated with the NIFTY 50 and thus I used this as an equity market representation for India. The rate on 10-year government bond is considered as a better choice for risk free rate over competing instruments due to its smaller beta and lower liquidity risk premium. This variable is formulated as follows:

$$mrp_t = R_{m,t} - r_{b,t}$$

Similarly, US equity Risk Premium ($\boldsymbol{usmrp_t}$): I have also used US equity risk premium (mrp_t) as a predictor for gold futures risk premium in the Indian market. The rate on 10-year US government daily bond rate ($r_{usb,t}$) and S&P 500 returns ($R_{s\&p,t}$) are used in estimating this variable. This variable is formulated as follows:

$$USmrp_t = R_{s\&p,t} - r_{usb,t}$$

Following empirical literature where authors claim that macroeconomic variables are the predictor of risk premium in gold futures, I initially select 15[5] macro variables for this study. After several experiments and following literature, I finally chose five covariates such as future basis, global crude oil futures, , US dollar index gold to silver price ratio and Goldman Sach's India financial confidence index for building gold futures conditional models that would explain the conditional risk premium in gold futures. Though I did not find any empirical support for engaging last two macro variable. However, investor, portfolio managers pay attention to gold to silver price ratio as a strategic trading proxy and Goldman Sach's financial confidence index as a composite India macroeconomic proxy, thus I included these variables in predicting the conditional risk premium in gold futures market in India. The measurement techniques applied in computing these variables are given hereunder:

Global Crude oil futures Proxy: Following the literature (Pukhthuanthong and roll., 2011; Baur, 2013) I further include the log return of the West Texas Intermediate (WTI) crude oil futures as proxy for global macroeconomic variable to predict gold risk premium. However, I

[5] Following these studies (Capie et al., 2005; Tully and Lucey, 2007, Baur, 2013; Reberedo, 2013; Nguyen et al., 2017; Simen, 2017), I also model the risk premium including domestic and international macroeconomic variables. Initially, I chose about 15 macroeconomic variables (money supply [M1/M2], inflation index [index of industrial production/ wholesale price index], month wise value gold import, quarterly gold reserve with reserve bank of India, gold to silver price ratio, sentiment indicator [India volatility index], rupee dollar exchange rate [INR/USD], global crude futures [WTI crude futures], US dollar index, Goldman Sachs India financial confidence Index, price to earning ratio of BSE 30 companies, dividend yield ratio of BSE 30 companies, global market risk premium (S&P 500 market risk premium), interbank offer rate and foreign exchange reserve) to model the gold futures conditional risk premium.

use the standardised WTI crude futures return (dwtit) in the modelling framework for predicting the conditional risk premium:

$$dwti_t = \frac{rwti_t - \overline{rwti_t}}{\sigma_{rwti_t}}$$

US dollar index ($\boldsymbol{dix_t}$): There is no dearth of literature that engages crude oil price and US dollar index as macroeconomic predictor for gold premium (Tully and Lucey, 2007, Reberedo, 2013, Nguyen et al., 2017). Thus, I engage standardised US dollar index ($ddix_t$) as well as INR/USD as a proxy for exchange rate. The ‘ddixt’ is computed as follows:

$$\mathrm{d}dix_t = \frac{dix_t - \overline{dix_t}}{\sigma_{dix_t}}$$

The $dinr/usd_t\ exchange\ ate$ is computed as follows:

$$dinr/usd_t = \frac{inr/usd_t - \overline{inr/usd_t}}{\sigma_{inr/usd_t}}$$

Gold to silver price ratio ($dgslv_t$): The gold to silver ratio could indicate the state of the Indian economy and the investors’ appetite for safe-haven assets. This refers to the ratio between the daily spot price of gold and silver. The standardised value of $dgslv_t$ is computed as follows:

$$dgslvr_t = \frac{gslvr_t - \overline{dgslvr_t}}{\sigma_{dgslvr_t}}$$

Goldman Sachs India financial condition index($dfci_t$): I didn’t get any support for engaging a financial confidence index in the risk premium analysis, however to capture the composite macroeconomic perspective I have brought this variable to the framework of risk premium analysis. Thus, Goldman Sachs India financial condition index in its standardised form is used ($dfci_t$) as a predictor for the realised gold risk premium in this study. The standardised value of $dfci_t$ is computed as follows:

$$dfci_t = \frac{fci_t - \overline{fci_t}}{\sigma_{fci_t}}$$

4.3 Methodology

The methodology used in this study comprise three broad segments (i) DCC GARCH framework (Engle, 2002) is deployed to test the presence and behaviour of conditional time varying risk premium in gold futures market, (ii) vector autoregulation (Sims, 1980); VECM Granger block exogeneity Wald test (time domain causality test) Breitung and Candelon's (2006) frequency domain causality test ; frameworks are engaged to test the causal movement of conditional risk premium with the conditional variances and covariances and (iii) portfolio risk diversification in the presence of gold futures and its hedging effectiveness are examined combinedly using portfolio optimal weight selection method of Kroner and NG (1998) minimum hedge ratio method of Kroner and Sultan (1999), hedge effectiveness measurement method of Arouri et al.,2011; Harris and Shen, 2006; Cotter and Hanly, 2006.

4.3.1 Multivariate GARCH model

Risk premia refers to the compensation investors expects to receive for bearing risk in an investment asset. Risk premium literature dominates the asset pricing literature since many decades. However, the literature on the presence, behavior and determinants of risk premium has remained a puzzle in the asset pricing empirical literature. The fact remains is that neither the risk premia nor their drivers are directly observed. Practitioners and academic researchers find diverse ways out to estimate risk premia in the asset market. There has been growing body of literature that explores the diverse methodology to extract risk premium using the information contained in the asset prices. To test the presence and behaviour of time varying conditional risk premium in gold futures market under the framework of commodity price theories a set of estimation strategies deployed in this study are delineated hereunder. To examine the determinants of the conditional risk premium in the generic gold futures market in India, I closely followed the multivariate GARCH framework used by Chong and Miffre (2007). However, I have modified this methodology incorporating a few macroeconomic covariates. This modification is done owing to two major reasons (i) the defined methodology does not captures the conditional risk premium dynamics in the Indian context and (ii) literature suggests risk premium in the commodity market depends on the macroeconomic variables. Bearing that in mind, I modelled the risk premium including domestic and international macroeconomic variables. While estimating the model, I have tried to maintain the parsimony and other econometric issues associated with the time series regression. A brief discussion of these methodologies are given below:

Portfolio theory suggests that inclusion of an asset is desired in a portfolio, when the asset provides higher return with lower(negative) standard deviation and lower (negative) correlation with other assets in the portfolio. Gold is often used as a strategic tool for risk diversification in a portfolio of traditional asset classes such as equity. In this segment, I have made an attempt to examine whether, gold futures contract offers such a strategic portfolio optimisation opportunity. To analyse the factors that may influence the optimal allocation in equity and gold futures markets in India, a bivariate Dynamic Conditional Correlation Generalised Autoregressive Conditional Heteroskedastic first order [DCC-GARCH(1,1)] model is deployed. This model estimates the conditional expected returns and the conditional variance-covariance matrix simultaneously. I have made a deliberate choice for the DCC-GARCH (1,1) model over the Diagonal VECH model, Constant Conditional Correlation model, Varying Conditional Correlation model. However, MGARCH models are dynamic multivariate regression models in which the conditional variances and covariances of the errors follow an autoregressive-moving-average structure. The DCC MGARCH model uses a nonlinear combination of univariate GARCH models with time-varying cross-equation weights to model the conditional covariance matrix of the errors. MGARCH models differ in the parsimony and flexibility of their specifications for a time-varying conditional covariance matrix of the disturbances, denoted by $H_t(Tsay, 2002)$. Using DCC-GARCH, the following mean variance and dynamic conditional correlation equations are estimated.

$$r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t + u_{f,t} \ldots\ldots\ldots (1)$$

$$h^2_{g,t} = c_g + \gamma_g h^2_{g,t-1} + \delta_g u^2_{g,t-1} \ldots\ldots\ldots (2)$$

$$r_{s,t} = \beta_0 + \beta_j X_{t-1} + \omega_k Z_t + u_{s,t} \ldots\ldots\ldots (3)$$

$$h^2_{s,t} = c_s + \gamma_s h^2_{s,t-1} + \delta_s u^2_{s,t-1} \ldots\ldots\ldots (4)$$

$$h_{sg,t} = c_{s,g} + \gamma_{sg} h_{sg,t-1} + \delta_{sg} u_{s,t-1} u_{g,t-1} \ldots\ldots\ldots (5)$$

$$\rho_{gs,t} = \frac{h_{gs,t}}{\sqrt{h^2_{g,t} * h^2_{s,t}}} \ldots\ldots\ldots. (6)$$

In the conditional correlation family of MGARCH models, the diagonal elements of H_t are modeled as univariate GARCH models, whereas the off-diagonal elements are modelled as nonlinear functions of the diagonal terms. In the DCC MGARCH model, the conditional correlation is represented by eq.[6]. Where the diagonal elements $h_{ij,t}$ and $h_{ij,t}$ follow univariate GARCH processes and $\rho_{ij,t}$ follows the dynamic process specified in Engle (2002) and discussed below. Because the $\rho_{gs,t}$ varies with time, this model is known as the DCC GARCH model.

$Where, r_{m,t}, r_{b,t}$ and $r_{g,t}$ are the excess returns on the S&P BSE SENSEX index (here onwards equity), the 10-year Government of India Treasury bond and gold future, respectively. X_{t-1} is a vector of information variables that capture the variations through time in the prices of risk present in equity and gold futures markets. Z_t is a structural covariate such as gold future basis. $u_{s,t}$ and $u_{g,t}$ are residuals on the equity and the gold futures, $h^2_{s,t}$ and $h^2_{g,t}$ are conditional variance of equity and gold futures return respectively and $h_{Sg,t}$ is a conditional covariance. The parameters to estimate for risk premia in gold futures are $\alpha_1, \alpha_2\ and\ \vartheta_1$ as per eq. [1]. Following the empirical literature (Chong and Miffre, 2007), I also account for the opportunity cost of investing in stocks, where equity risk premium is computed as excess returns over the risk-free rate for the equity. While for the gold futures, raw returns are computed assuming that there is no initial investment in futures markets.

I try to answer the following research questions in the Indian market: (i) whether there is presence of conditional risk premia in the gold futures market and if so, whether gold futures market is in contango or backwardation? (ii) whether the risk premium in gold futures (gold ETFs) outweighs the equity premium? (iii) how is the behaviour of the conditional correlation between returns of the gold futures (gold ETFs) and excess equity returns? (iv) whether gold futures (ETFs) market still provides an opportunity for portfolio diversification for the traditional asset class like equities? (v) whether gold as an asset possess the properties of hedge for the index equity? (vi) whether gold futures (gold ETFs) market still provides an opportunity of safe haven for the traditional asset class like equities? (vii) whether gold futures market relatively provides better hedge effectiveness as compared to gold ETFs? (viii) whether macroeconomic factors determine gold futures risk premium? (ix) whether gold futures and gold ETFs hedging benefit? And (x) whether risk premium in equity and gold futures comove over time and frequency?

First five questions are suitably examined under Multivariate GARCH (MGARCH) framework. Last two questions are suitably examined using first stage MGARCH model estimates in a Vector Error Correction, frequency domain, time domain causality wavelet coherency and phase difference analysis framework. Though there are wide arrays of MGARCH family of models, I deploy the DCC-GARCH model. It is very similar to the univariate GARCH (1,1) model except that its covariance also evolves over time. Literature also supports that the multivariate models provide more precise parameter compared to univariate GARCH models estimates because the model uses information from the entire variance-covariance matrix of the errors. Apart from the above, the rationale of choosing DCC GARCH model emanates from the fact that DCC MGARCH model is more flexible than the conditional correlation MGARCH model (CCC MGARCH) and more parsimonious than the Diagonal VECH MGARCH model (see Tsay, 2002) As argued by Bauwens and Laurent (2005) and Rossi and Spazzini (2010), among many others, the MGARCH models combined with Gaussian innovations could be inadequate once conditional financial returns exhibit fat tails and are often skewed. Against this backdrop, thus I engaged the DCC GARCH model with the student t distribution. However, this model is not also free from limitations. But it is widely used to examine the variances covariance structure and conditional movement in the multivariate framework.

In the light of the empirical literature, I examine first two research questions directly adopting the multivariate GARCH framework. The sign, significance and magnitude of the coefficients associated (eq….) would determine the presence and quantum of conditional risk premia in gold futures market. There are three possibilities that the mean equation attached to gold futures in the DCC GARCH framework may turns out to be either zero, positive or negative. If gold futures mean equation value turns out to be zero ($\boldsymbol{c}r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t$ =0), which would confirm the absence of risk premium in the gold futures market. If gold futures mean equation value turns out to be zero $\boldsymbol{c}r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t$>0), which would confirm the presence of risk premium in the gold futures market and lend support to the backwardation theory of Keynes (1930). If gold futures mean equation value turns out to be zero ($\boldsymbol{c}r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t 0$*), which would confirm that the gold futures market follows the behaviour of a contango market.*

To address the second research question, a paired t test difference in mean between the equity risk premium and gold futures (gold ETFs) risk premium derived from the DCC GARCH output would be attempted. If paired t test result turns out to be positive and significant, which would conclude that investors enjoyed significant differential risk premium over the gold futures market during the study period.

While addressing the third research question, I estimate eq. (7) regressing the observed conditional correlation series on a constant and a time trend so as to understand the time varying correlation behaviour of equity and gold futures market.

$$\rho_{sf,t} = \alpha + \delta_t T + \varepsilon_t \dots \dots \dots (7)$$

Where, δ_t is the coefficient of time trend (T), α is intercept and ε_t is the stochastic disturbance term is the stochastics disturbance term. If, I find δ_t coefficient is positive (negative) and statistically significant in eq. [7] which would suggest that correlation between equities and gold futures (gold ETFs) markets follows upward (downward) trend overtime. The significant upward (downward or flat) trend in conditional correlation overtime would suggest that the gold futures (gold ETFs) fails (succeeds) to provide much of hedging opportunity to the investors overtime, who hold equities and gold in their risky portfolio.

To, address fourth research question, whether gold future (gold ETfs) as an asset possess the properties of hedge, I examined the eq.[8]. Though empirical literature also suggest that an asset is a hedge if it is uncorrelated or negatively correlated with another asset or portfolio on average (Kaul and Sapp, 2006; Baur and Lucey, 2010; Baur and McDermott, 2010). However, I followed the definitional approach of Chong and Miffre (2007) in defining hedge properties of gold futures. Contextualising in the present study context, gold futures would be offering hedging opportunity, if the conditional correlation of the returns of the gold futures (gold ETFs) and excess returns of the equity index is uncorrelated or negatively correlated with the variances of the excess returns of the equity index. The eq.[8] is calibrated as follows:

$$\rho_{sf,t} = \alpha + \delta_t T + \pi_s h_{s,t} + \pi_g h_{g,t} + \varepsilon_t \dots\dots\dots (8)$$

Where π_s *and* π_g are the coefficients attached to the excess returns of variance of the equity index and π_g is the returns of variance of the gold futures (gold ETFs)? If I find π_s coefficient is positive (negative or zero) and statistically significant, which would suggest that gold futures and equity return would increase (decrease, flat) during the periods of low (high, flat) equity market volatility assuming other things constant. It is conjectured that π_s coefficient would be negative or zero and statistically significant, which would provide opportunity to the investors to diversify their risk investing in the gold futures market at the time of high equity market volatility. This would provide that gold futures as an asset possesses the properties of hedge.

To address the fifth research question, whether gold futures (gold ETFs) possesses the properties of a safe haven asset? I examine eq.[9]. Some of the empirical literature accounts that an asset is a safe haven, if it is uncorrelated or negatively correlated with the with another asset or portfolio on average in times of extreme market movement (Kaul and Sapp, 2006; Baur and Lucey, 2010; Baur and McDermott, 2010). However, I modified the definitional approach of Chong and Miffre (2007) in defining safe haven properties of gold. Contextualising in the present study context, gold futures (gold ETFs) would be offering safe haven opportunity, if the conditional correlation of the returns of gold futures (gold ETFs) return and excess returns of equity is uncorrelated or negatively correlated with the variances of the excess returns of the equity index during the period of extreme market turbulence. However, one may conjecture that the inverse relationship between $\boldsymbol{\rho_{gs}}$ and π_s is already captured in eq. [8] but that only captures the average relation over time. But the crucial distinction between asset is a hedge and safe haven emanates from the fact that dependence is required to hold under extreme market turbulence, whereas for a hedge, it must do so on average. Thus, to address this issue whether gold futures (gold ETFs) possesses the properties of safe haven in conjunction with the equity index eq. [9, 10 & 11] are calibrated as follows:

$$\rho_{gs,t} = \alpha + \delta_t T + \pi_s h_{s,t} + \pi_g h_{g,t} + \gamma_n IDh_{s,t,normal} + \varphi_s IDh_{s,t,stress} + \varepsilon_t \dots\dots\dots (9)$$

Where, $IDh_{s,t,normal}$[6] and $IIDh_{s,t,stress}$[7] are the interaction dummy variables that are proxied for the period of extreme market turbulence. If I find γ_n $is\ significantly\ zero$ and π_s, and φ_s are either significantly zero (negative) and the magnitude of φ_s is significantly negative and low compared to $is\ significantly\ negative\ and\ low\ compared\ to$ the magnitude of π_s would necessarily and sufficiently justify the safe haven role of the gold futures (gold ETFs) for the equity index investor at the extreme market stress period in India. If the direction and magnitude of these dummy coefficients are proved to be otherwise as stated above, then it would refute the safe haven role of the gold for the equity index investor at the extreme market stress period in India.

During model estimation, it is realized that though the explanatory variables are free from multicollinearity but exposed to heteroscedasticity and serial correlations. Thus, to compute the heteroskedasticity and autocorrelation consistent (HAC) standard errors, I deployed the regression model with Newey-West standard errors (See Wooldridge, Introductory Econometrics, 3d ed, Ch. 12). Keeping in mind the quarterly periodicity of some of the variables, I chose a lag length of 5 to estimate the Newey-West standard errors. As the

[6] ($IDh_{s,t,normal}$): it is an interaction dummy variable which indicates that equity market under no stress. If the conditional variance of equity index return on day 't' falls under the lower 20-quintile (no stress) range of conditional equity variance of the day 't' then $IDh_{s,t,normal}$ takes $original\ conditionl\ equity\ variance\ value\ for\ the\ day\ t$ otherwise 0.

[7] ($IDh_{s,t,stress}$): it is an interaction dummy variable which indicates that equity market under high stress. If the conditional variance of equity index return on day 't' falls under the upper 20-quintile (high stress) range of conditional equity variance of the day 't' then $IDh_{s,t,stress}$ takes $original\ conditionl\ equity\ variance\ value\ for\ the\ day\ t$ otherwise 0.

regression model with Newey-West standard errors in a time series context are robust to both arbitrary autocorrelation and arbitrary heteroskedasticity, thus it became an obvious choice over the OLS.

To address the sixth question, this section succinctly delineates the way in which two assets portfolios are constructed using conditional variances and covariance estimate obtained from the DCC GARCH models. To examine the risk reduction performance, three portfolio indicators such as Minimum Variance Hedge Effectiveness Index (HEI), Value at Risk (VaR) and Conditional Value at Risk (CVaR) effectiveness matrices are deployed. To be specific, I gauge hedge effectiveness of the risk reducing portfolio using DCC GARCH estimates against the unhedged portfolio. To this end, I consider a hedged portfolio composed of gold futures and Indian equity market index proxied by equity index (BSE SENSEX 30) in which a risk averse investor warrants to protect himself from the equity index price movements exposure by investing in gold futures. The objective here is to determine whether minimum variance gold futures and equity mixed auxiliary asset based hedging portfolio influences a reduction in risk while keeping the same expected returns. Using the conditional variances measure from the DCC GARCH across the models, I construct the optimal portfolio weights of stock to gold futures (gold ETFs) [$w_{gs,t}$] referring to Kroner and NG (1998) with the following equation and constraints presented below: `

$$w_{sg,t} = \frac{h_{s,t}^2 - h_{sg,t}}{h_{s,t}^2 - 2h_{sg,t} + h_{g,t}^2} \dots \dots \dots (10)$$

Where $w_{sg,t}$ denotes weight of the gold futures asset in a 1$ portfolio of a two-asset holding at time period t. (1-$w_{sg,t}$) is the proportion of wealth that an investor put in the equity market index in the 1$ portfolio. $The\ terms\ h_{s,t}^2$, $h_{g,t}^2$ and $h_{sg,t}$are the conditional variance of equity, conditional variance of gold futures and conditional covariance og equity index and cold futures obtained from the DCC GARCH model. Assuming short selling is not allowed in the equity and futures market, the following restrictions are imposed on the optimal portfolio weights:

$$w_{sg,t} = \begin{cases} 0, & if\ w_{sg,t} < 0 \\ w_{sg,t}, & if\ 0 < w_{sg,t} <= 1 \\ 1, & if\ w_{sg,t}, > 1 \end{cases} \dots \dots \dots (11)$$

Now the objective is to optimally hedge the risk associated with the equity index investment. In order to minimise the risk in the hedged portfolio, the investor is required to calibrate an appropriate trading strategy in both gold futures and equity market. Following Kroner and Sultan (1999) I construct long and short trading strategies for the investor. The optimise hedge ratio ($\psi_{sg,t}$), 1$ worth of long position in equity index must be hedged by a short position of $h_{sg,t}$ amount in the gold futures. The optimal hedge ratio can thus be expressed as:

$$\psi_{sg,t} = \frac{h_{sg,t}}{h_{g,t}^2} \dots \dots \dots (12)$$

Hedge effectiveness is examined using two different methods. First, following Arouri et al. (2011), I constructed variance hedging effectiveness index (HEI_{Var}) to examine the realized hedging errors. This method accommodates both upside and downside risk, attaches equal weight to positive and negative returns. Higher is the HEI value of a portfolio grater is the hedging effectiveness and vice-versa. The HEI index is expressed as follows:

$$HEI_{Var} = \frac{V_u - V_h}{V_u} \times 100 \dots \dots \dots (13)$$

Where, V_u is the variance of the unhedged equity index portfolio (BSE SENSEX) and V_h is the variance of the hedged auxiliary asset-based portfolio (BSE SENSEX and Gold Futures) computed based on earlier optimal weights.

The inherent limitation of the HEI_{Var} is that it captures only the second moment of the return distribution and fails to recognise the positive and negative return distribution processes. The uncertainty about the higher return distribution (skewness and kurtosis) of the minimum variance portfolio may have distorted effect on the quantile of cumulative distribution function. Thus, from an investor perspective it is worthwhile to deploy a hedging effectiveness measure that can capture the tail risk of the hedged portfolio as well. Following the illuminating works (Harris and Shen, 2006; Cotter and Hanly, 2006), I compute here 95% confidence VaR(Value at Risk) hedge effectiveness index, which captures the effect of hedging on negative tail returns. Thus, the VaR of the portfolio for the long positions at α confidence level calibrated as follows:

$$VaR_P = \hat{\mu} + q_P(\alpha)\hat{\sigma}_P{}'$$

Where $q_P(\alpha)$ designates the left quantile at α% of the CDF of portfolio returns, while $\hat{\mu}$ and $\hat{\sigma}_P$ denote the mean and standard deviation estimates of the gold futures in the auxiliary portfolio. The VaR hedge effectiveness index can be written as follows:

$$HEI_{VaR} = \frac{VaR_u - VaR_h}{VaR_u} \times 100 \ldots\ldots\ldots (14)$$

Where VaR_u and VaR_h indicate to the VaR of the BSE SENSEX stock index and the VaR of the portfolio with the selected commodities, respectively.

The VaR metrics measurement is not free from limitations, which does not capture the expected loss size in the event when expected loss exceeds the VaR of the portfolio. The VaR is not a coherent measure risk measure of a portfolio returns, when they are drawn from a multivariate elliptical distribution. Thus, Conditional Value at Risk (CVaR) as an alternative robust measure for VaR is used. The CVaR would measures the mean expected loss, condition upon the fact when VaR of a portfolio that exceeds the weighted average VaR of the assets that is engages. Alexander and Baptista (2004) showed that, in some cases, the use of CVaR as a measure to control risk is more effective than use of VaR. expression of CVaR is given as:

$$CVaR_P = \frac{1}{\alpha}\int_{1-\alpha}^{1} VaR(x)dx = -\frac{\sigma_P}{\alpha}\int_{1-\alpha}^{1} q_p^x dx.$$

In the process of CVaR calculation, we used the probability of occurrence, q=5% to examine the position for different types of hedgers. Accordingly, the performance metric utilized to assess the hedging effectiveness is the percentage reduction in CVaR is as follows:

$$HEI_{CVaR} = \frac{CVaR_u - CVaR_h}{CVaR_u} \times 100 \ldots\ldots\ldots (15)$$

Where $CVaR_u$ and $CVaR_h$ indicate to the CVaR of the BSE SENSEX and the CVaR of the gold futures asset in the auxiliary portfolio.

Seventh question is directed to examine the determinants of gold futures risk premium in Indian This is I examine this in a multivariate regression framework following the equation 15 and 16.

$$r_{g,t} = a_{1,i} + \sum_{i}^{o} b_{1i} * r_{g,i} + u_t \ldots (16)$$

$$r_{g,t} = a_{1,i} + \sum_{i}^{o} b_{1i} * r_{g,i} + \sum_{j=1}^{p} c_{1i} * r_{s,i} + u_t \ldots (17)$$

Base model (eq.15) is estimated with five gold futures specific variables[8] [sbt_t (b_{11}), $rvar_t$ (b_{12}), $\rho_{sg,t}$ (b_{13}), $rskw_t$ (b_{14}), $rkur_t$ (b_{15})]. I estimate the eq.[17] including some combination of macroeconomic variables[9] such as mrp_t (c_{11}) , $M3_t$ (c_{12}), $dfci_t$ (c_{13}), $dgvslr_t$ (c_{14}), $ddix_t$(c_{15}), inr/usd_t (c_{16}), $dwti_t$(c_{17}) and $usmrp_t$ (c_{18}). I estimate eq. [16 & 17] with Newey-West standard errors regression (See Wooldridge, Introductory Econometrics, 3d ed, Ch. 12) to achieve the heteroskedasticity and autocorrelation consistent (HAC) standard errors. Keeping in mind the quarterly periodicity of some of the variables, I chose a lag length of 5 to

[8] The construction methodologies of these variables are explained in the section 3.2.
[9] The construction methodologies of these variables are explained in the section 3.2.

estimate the Newey-West standard errors. As the regression model with Newey-West standard errors in a time series context are robust to both arbitrary autocorrelation and arbitrary heteroskedasticity, thus it became an obvious choice over the OLS. The sign and significance of the parameters attached to each of the variable in conformity with the theory would confirm whether these variables are significant determinants of gold futures risk premium in India.

*While addressing the question number eight and 9 I simplify by answering three specific questions in this segment. W*hether there is dynamic nexus between risk premia in gold futures (gold ETFs) and equity market in India? If that nexus exists, (ii) whether it is short lived or long lived or both? (iii) whether this nexus varies across time domain and frequency domain? As theory states that the dependency structure of the risk premium on the conditional second moment depends on the nature of the assets and the stochastic structure of the economy. Based on the previous findings, I conjecture that as the equity market is relatively risky the risk premium innovations of this market would dynamically cause changes in the gold futures (gold ETfs) risk premium. To prove this conjecture, I estimate a bi-variate Vector Error correction model (VECM[10]) between gold futures risk premium and equity risk premium. I estimate VECM over the VAR model since the variables are cointegrated[11]. The specification of the VECM model is as follows:

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[10] VECM model helps to understand the relationship between economic variables by capturing the linear interdependency among the variables (Sims, 1980). I deploy a VAR model to investigate the dynamic nexus between conditional risk premium in gold futures and conditional correlation between gold futures and equity index.

[11] Johansen (1988) provides two statistics to test for the null hypothesis of no cointegration: the Trace statistic and the Maximum eigenvalue statistic. They are given by:

Trace statistic = $-T\sum_{i=k+1}^{N} ln\,(1-\lambda_i)$

Maximum eigenvalue statistic = $-Tln(1-\lambda_{k+1})$

where $\lambda_i (i = 1, \ldots.., N)$ are the related eigenvalues. The trace test is a joint test where the null is that the number of cointegrating vectors is less than or equal to r. The maximum eigenvalue test conducts separate tests on each eigenvalue and has as its null hypothesis that the number of cointegrating vectors is r. The Johansen technique tests the hypothesis that there are no cointegrating vectors. If the test statistic is greater than the critical value from Johansen's tables, reject the null hypothesis that there are r cointegrating vectors in favor of the alternative that there are $r+1$ (for trace) or more than r (for maximum eigenvalue). The first test involves a null hypothesis stating that π is of zero rank, against alternative that there are r cointegrating vectors. If π has zero rank, then there is no long-run relationship between the elements of Y_{t-1} (there are no cointegrating vectors). The second is for at most one cointegrating vector $(r \leq 1)$ and so on. If the hypothesis of no cointegrating vectors $r = 0$ is not rejected, it would be concluded that there are no cointegrating vectors and the testing would be completed. However, if the hypothesis $r = 0$ is rejected, the null that there is one cointegrating vector, $r = 1$, would be

$$\Delta r_{g,t} = \alpha_1 + \sum_{i=1}^{m} a_{1i} * \Delta r_{g,t-i} + \sum_{i=1}^{m} b_{1i} * \Delta r_{s,t-i} + u_t \ldots (18)$$

$$\Delta r_{s,t} = \alpha_1 + \sum_{i=1}^{m} a_{1i} * r_{g,t-i}\Delta + \sum_{i=1}^{m} b_{1i} * \Delta r_{s,t-i} + u_t \ldots (19)$$

Where Δr_g and Δr_s vectors represent the daily measure of risk premium in gold futures (gold ETFs) and equity market at time at time 't-i' respectively. 'i' represents the minimum lag length. a_{1i}anda_{2i} are the coefficients of lagged value of Δr_g vector, and b_{1i} and b_{2i}, the coefficients of lagged value of vector Δr_s. $u_t$andv_t are the error terms of equation (18) and (19), respectively. This model examines whether risk premium in the gold futures and equity markets are dynamically linked together. To choose the optimal lag length *m*, I employ Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). if the two criteria show different lag lengths, I would choose the smaller one to retain the maximum number of degrees of freedom.

Despite its usefulness, the VECM model suffers from certain key limitations. First, the involvement of a large number of parameters in the model makes it difficult to interpret. Second, the sign of the coefficients of lagged variables changes across different lags. That makes it difficult to ascertain the effect of a given change in a variable upon the future values of the variables in the system. To overcome these weaknesses, I use the VECM model along with VAR-Granger causality test (Granger, 1969 and Sims, 1980) and impulse response functions. The Granger-causality test enables us to know the direction of causality (unidirectional or bidirectional causality) between risk premium in gold futures and equity market. The impulse response function (IRF) traces the impact of a unit shock applied on one of the endogenous variables on the current and future values of other endogenous variables. In this study, the IRF traces out the response of risk premium in gold futures (gold ETfs) market to one positive shock applied upon the residuals of risk premium in equity market and

tested and so on. So, the value of r is continually increased until the null is no longer rejected. If there are two series, there are two statistics for $r = 0$ and $r \leq 1$.

conversely. IRF helps to capture the sign, magnitude, and persistence of responses of risk premium in gold futures (gold ETFs) measure to shocks in risk premium equity and vice versa.

IFR test only explains the causality for the overall period. There may be change in cause and effect relationship between these variables across the time domain. To address this issue, I compute time domain granger causality (Further, the VECM Granger exogeneity) test. Now, I present in brief the time domain frequency analysis in the presence of cointegrating relationships between the variables. The study decomposes the causal relationship into frequency components using Breitung and Candelon's (2006) approach. The frequency domain causality analysis is to be performed in the following modified model:

$$\begin{bmatrix}\Delta r_{g,t}\\ \Delta r_{s,t}\end{bmatrix} = \tilde{\Theta(L)}\begin{bmatrix}\Delta r_{g,t-1}\\ \Delta r_{s,t-1}\end{bmatrix} + e_t \dots\dots\dots (20)$$

Where $\tilde{\Theta(L)} = \Theta_1 - I + \Theta_2 L + \cdots \Theta_p L^p$. The hypothesis that $\Delta r_{s,t}$ does not cause in the Granger sense $\Delta r_{g,t}$ at frequency w can be proved with the following measure.

$$M_{\Delta r_{s,t} \to \Delta r_{g,t}}(w) = log\left[1 + \frac{\left|\Psi_{12}(e^{-iw})\right|^2}{|\Psi_{11}(e^{-iw})|^2}\right] \dots\dots\dots (21)$$

This procedure is valid when all the variables are integrated of the same order. Detail frequency domain analysis procedure is presented in the Appendix II.

5. Results and Discussions

I organise my results and discussions under four major segments, (i) preliminary data analysis, (ii) detect and tests the hypothesis regarding the presence of conditional risk premium in the gold futures market over the study period, (iii) examine the time varying conditional correlations between gold futures and equity returns (iv) examine factors determining the time varying risk premium in the presence of macroeconomic factors (v) tests hypothesis whether investors enjoyed significant differential risk premium investing in gold futures market over equity market over the study period.

4.1 Preliminary analysis

Table 1 (Panel VI) reports the average daily and annualised mean, standard deviation, skewness and kurtosis and Jarque-Bera test of normality for the equity and gold futures return in percentage terms over the study period. The average daily (annual) percentage return on gold futures, quantum gold ETF, UTI gold ETF, Reliance Gold ETF are observed to 0.036% (9.5%), 0.29% (7.6%), 0.32% (8.32%), 0.32% (8.27%) compared to the equity of 0.052% (13.93%) in nominal terms over the study period respectively. While at the same time the average risk reward ratio is observed to be relatively higher for the gold futures compared to its peer gold ETFs but lower for the equity. However, annual risk reward ratio is observed to be less than one for both gold and equity markets but this ratio is observed to be relatively higher for the former than the later market. Further, it is also clear from this table that the return distribution of gold futures departs from normality, with strong evidence of positive skewness and excess kurtosis (Gorton and Rouwenhorst, 2006). Table 1 (Panel IV) also presents unconditional correlations between daily percentage gold futures and equity returns, which suggest that gold and equity return moves in an inverse direction with a correlation value of -0.139. This result here apparently evidences that gold can act as a hedging tool in the presence of broad range of equities in portfolio of risky assets at least having equity in it. Descriptive statistics here largely supports the literature (Chong and Miffre, 2007) that the gold futures return series exhibits positive skewness and negative correlations with equity, which are often sought by the risk averse investors for portfolio optimisation[12].

Before analysing the DCC GARCH results it is worthwhile to analyse the descriptive statistics of the gold futures returns, gold ETFs returns and the excess returns of the equity index relationship by quantiles of the later. This analysis would mainly indicate how gold futures and equity index average return varies across the periods of bullish, bearish and flattish equity market stats in India. The descriptive statistics in Table 1 show that the daily gold futures and gold ETFs return always outperform (underperforms) equity index returns in first two lower quintiles (upper two quintiles). It is also observed that gold futures and gold ETFs are observed to be relatively less volatile compared to equity index returns in most of the quintile ranges. In this sense, gold is a more efficient asset relative to stock during this period. However, the reward to risk ratio for the gold futures (equity index) remains positive (negative) in the lower two quintile ranges, which is observed to be inverse in the upper two quintile ranges. This result here apparently hints that the gold provides hedge and safe haven opportunity to the equity investor. However, in a normal market states investment is equity is apparently preferred over the gold futures and gold ETFs, which is evident from the risk reward ratio associated with the third quintile distribution (results are not reported here). It is worthwhile to note here that gold future as a risk hedging instrument offers the benefit to the investor compared to gold ETFs.

Table 1: Descriptive Statistics of daily percentage of asset returns conditional on quintiles ranges

Variable	Obs	Mean	Std. Dev.	Min	Max	Reward to Risk	Correlation with SENSEX	Annualised return
		Panel: BSE SENSEX <= 20 return quintiles category						
mrp	461	-0.061	1.224	-7.528	-0.744	-0.050	1.000	-14.2%
rf	461	0.045	1.274	-6.402	5.664	0.036	-0.108	12.1%
Lrquant	461	0.033	1.213	-6.632	4.238	0.027	-0.138	8.6%
Lreuti	461	0.034	1.230	-6.628	4.380	0.027	-0.097	8.8%
Lreril	461	0.014	1.214	-6.590	4.365	0.012	-0.134	3.7%
		Panel V: BSE SENSEX 80-100 quintiles Category						

[12] The descriptive statistics, correlation and stationarity test statistics for the explanatory variables are not presented here but they are provided in the appendix Table 1A, 1B and 1 C.

mrp	459	0.051	1.211	0.830	15.984	0.042	1.000	13.6%
Rf	459	-0.046	1.047	-5.475	3.297	-0.044	-0.129	-11.0%
Lrquant	459	0.023	1.124	-4.493	4.749	0.021	-0.005	6.0%
Lreuti	459	0.025	1.118	-4.501	4.751	0.022	-0.001	6.4%
Lreril	459	0.024	1.128	-4.493	4.721	0.021	0.014	6.2%
		Panel VI: Full Sample						
mrp	2303	0.052	1.127	-7.528	15.984	0.046	1.000	13.9%
Rf	2303	0.036	1.028	-9.469	5.664	0.035	-0.139	9.5%
Lrquant	2303	0.029	1.018	-8.027	4.749	0.029	-0.054	7.6%
Lreuti	2303	0.032	1.018	-8.028	4.751	0.031	-0.045	8.3%
Lreril	2303	0.032	1.015	-7.964	4.721	0.031	-0.050	8.3%

This table captures the descriptive statistics and correlation matrix of the assets under the study for full sample period and sub sample statistics for the upper 20% quintile and bottom 20% quintile statistics. The variables for which these statistics computed are i.e., equity market risk premium (mrp), risk free rate (rf), log returns associated with the quantum ETF (lrqunt) ,UTI ETF, and Reliance ETF (lreuti). Apart from the above daily reward risk ratio and annualised returns of the assets under investigations are also capured.

4.2 Detection of conditional risk premium in gold futures market

Following Chong an Mirffe (2007), I use multivariate GARCH mean equation estimated results to detect the presence of risk premium in gold futures and equity market in India. I deployed DVech, CCC, CVC and DCC GARCH models to detect the presence of such conditional time varying risk premium. However, based on the model selection criterion (AIC and SBC and Log Likelihood) DCC GARCH (1,1) with t distribution is relatively observed to be the optimal model. Thus, I have presented here only the DCC GARCH estimates for the detection of time varying risk premium in gold futures market in India. I have estimated four DCC GARCH models with combination of equity and gold futures, 3 gold ETFs including gold futures basis as a structural covariate in each model. DCC GARCH Model I consider equity risk premium and gold futures as dependant variables and one period lagged gold futures and equity risk premium and basis as a structural covariate comprises independent variables. While DCC GARCH Model II, III replaces level and one period lag gold futures returns with the Quantum Gold ETF, UTI Gold ETF and Reliance Gold ETF in dependent and independent sides of the equation. The estimates are reported in Table 2A and 2B. The DCC estimates irrespective of the covariates used across the models satisfies conditions of a DCC GARCH (1,1) model with t distribution, which discussed in the section 4.3.

Modelling conditional correlation and conditional volatility is required to be carried out in a well-specified modelling framework. To ensure that this condition is met, I modelled the data with a variety of multivariate GARCH models (DVech, CCC, TVC and DCC) both multivariate normal and Student t distributions. But in entirety the estimates across the models are observed to be very similar. While examining the log likelihood values and Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) for all such multivariate models, that DCC GARCH model is seen to have the highest log likelihood and least AIC and SIC values. However due to space brevity, in the following section I succinctly capture the results of the four DCC GARCH model estimates with multivariate Student t distribution which is observed to be preferred to other competing multivariate GARCH models under consideration.

DCC GARCH estimates with students t distribution are reported in Table 2A and 2B. The Wald χ^2 test estimate is observed to be highly significant across the models with and without macro covariates, which confirms the overall model fit. Further, estimates of the DCC GARCH models are statistically significant and non-negative in all cases. Note that the sum of the parameter estimates δ_g and γ_g $(\delta_g + \gamma_g)$ is close to but less than unity, as is the sum of δ_s and γ_s $(\delta_s + \gamma_s)$, suggesting strong persistence in variance both in the gold futures and equity market respectively. The highly significant parameter of the multivariate student t distribution confirms the adequacy of this distribution. That means the gold futures and equity market under consideration, the GARCH specification does capture the time-variation in return variances and covariances. The log likelihood value for the Model-I is observed to be the highest compared to other models.

As stated earlier that the sign, significance and magnitude of the coefficients associated with the eq. [1 to 4] would determine and quantify the presence of conditional risk premia in gold futures market. Table 2 reports the DCC GARCH mean equation estimates along with the average gold futures risk premia and equity risk premium for these models over the study period. While examining the sign and significance of the coefficients attached to explanatory variables in conditional mean in Model I [eq.1] all the parameters are observed to be positive and statistically significant at accepted level. Then, I proceed to compute and quantify the time varying gold futures risk premium using the estimated coefficients for the lagged gold futures return, lagged market risk premium and standardised futures basis. Upon computing the gold futures risk premium over the study period, a single mean t-test is conducted to detect and examine the statistical significance of the average daily risk premium. The t test results reveal that gold futures market significantly offered 0.0238% of daily mean risk premia. The annualised[13] mean risk premium is observed to be 6.27% for the base model [eq. 1]. Thus, the result here confirms that the gold futures mean equation value is significantly greater than zero ($r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t$>0). The result here reveals a striking evidence of the presence of risk premium in the Indian gold futures market, which lend supports to the Keynes's theory of backwardation. This results also supports that speculators are net long and require a risk premium for underwriting the price risk of net short hedgers. Further, I examine the time varying gold ETFs risk premium using Model [II, III & IV] conditional mean equation [eq.1]. However, computing the average daily risk premium/discount using the fist stage DCC GARCH conditional mean equation coefficients, it is observed that $r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t$>0. Further, the single mean t-test on gold ETFs risk premia across the series also confirm the presence of positive risk premium. The annualised[14] mean risk premia offered by gold ETFs

[13] The mean annualised risk premium is computed using the formula [(1+rp)^252-1], where 'rp' is the daily percentage risk premium.
[14] The mean annualised risk premium is computed using the formula [(1+rp)^252-1], where 'rp' is the daily percentage risk premium.

are found to be about 2%, which remain invariant across the ETFs. Thus, the result here also confirms that the gold ETFs conditional mean equation value is significantly greater than zero ($r_{g,t} = \alpha_0 + \alpha_j X_{t-1} + \vartheta_m Z_t$>0). Similarly, I computed the daily (annual) conditional equity risk premium which is observed to be about 14% over the study period.

Table 2A: Estimates of the conditional risk premium in gold futures and equity market

Coefficients	**Gold Futures- SENSEX 30**	**Quantum Gold ETF- SENSEX 30**	**UTI Gold ETF- SENSEX 30**	**RIL Gold ETF- SENSEX 30**
	Panel I: Gold Future/Gold ETFs Conditional Mean Equation			
α_1	0.358***	-0.059***	-0.065***	-0.061***
	(0.018)	(0.019)	(0.019)	(0.019)
α_2	0.025**	-0.061***	-0.063***	-0.060***
	(0.011)	(0.015)	(0.015)	(0.015)
ϑ_1	0.761***	-0.367***	-0.360***	-0.366***
	(0.017)	(0.020)	(0.020)	(0.020)
α_0	0.010	0.012	0.013	0.012
	(0.011)	(0.015)	(0.015)	(0.015)
Annualised Risk Premium	6.2%	1.8%	1.9%	1.9%
	Panel II: Equity Conditional Mean Equation Estimates			
β_1	-0.079***	-0.051**	-0.006*	-0.081*
	(0.024)	(0.021)	(0.021)	(0.041)
β_2	0.068***	0.054***	0.055***	0.055***
	(0.020)	(0.020)	(0.020)	(0.020)
ω_1	-0.070***	-0.029	-0.029**	-0.030
	(0.024)	(0.022)	(0.012)	(0.012)
β_0	0.061***	0.067***	0.069***	0.068***
	(0.018)	(0.018)	(0.018)	(0.018)
Annualised Risk Premium	13.9%	13.4%	13.7%	13.7%

Notes: *, ** and *** indicate the 10%, 5% and 1% level of significance.
This table reports four structural covariates multivariate DCC GARCH (1,1) mean equation estimates of gold futures conditional risk premium and conditional equity risk premiums. The variables for which these models are build in association with the equity index are the gold futures, quantum ETF (lrqunt) ,UTI ETF, and Reliance ETF (lreuti). Apart from the above daily reward risk ratio and annualised risk premium of the assets under investigations are also captured.

It is also observed that the equity market clearly outweighs gold futures and gold ETFs in terms of offering risk premium to the investor in India. Deploying a paired t test, I examine whether the risk premium offered by equity over gold futures is positive and significantly different over the study period. The result reveals that equity market has significantly offered a higher premium over the gold futures market, which is in line of the existing stock of empirical literature (Chong and Miffre, 2007). In nutshell, it is detected that gold futures and gold ETFs offers a significant amount of risk premium of 6.5 % and 2% to the investors over the study period respectively. While supporting the Keyne's theory of backwardation (1930), the study here confirms that in the Indian gold futures market, hedgers transfers the risks to the speculators which they accept it for receiving a premium from the hedgers *[Supports Hypothesis 1.1 Ha]*. Further, equity market offers significantly higher conational risk premium compared to the gold futures market (*Supports Hypothesis 1.2 Ha*). This finding is consistent with the earlier empirical literature associated with risk aversion (Arrow, 1971), consumption smoothing (Friedman,1956; Modigliani and Brumberg, 1954) and asset pricing models (Sharpe, 1964; Lintner, 1965; Mossin,1966; Merton, 1973[15]; Jagannathan and Wang, 1996).

4.3: Behaviour of conditional correlation and its nexus with conditional volatilities

Now I move to examine the behaviour of conditional correlation between excess equity returns and gold futures returns and gold ETFs returns. Table 2B Panel V reveals that the conditional correlation between excess equity and gold futures returns are observed to be -11% and statistically significant at 1% level. But the annual conditional correlation between equity gold ETFs are varying around 5%. However, it is interesting to note that the conditional correlation found here is to be lower than the mean unconditional correlation of -13.9 percent presented in Table 1. Further, I present the time varying conditional correlation between gold futures (gold ETFs) and equity plots for all the four models. The plot here suggests that the conditional

[15] Gold has a long-distinguished role in the financial markets used as an ideal candidate to be a factor in international extensions to asset pricing models (i.e. used in Merton (1990) intertemporal capital asset pricing model)

correlation though seems mean reverting but it is observed to be spiking highly around the major risky market events.

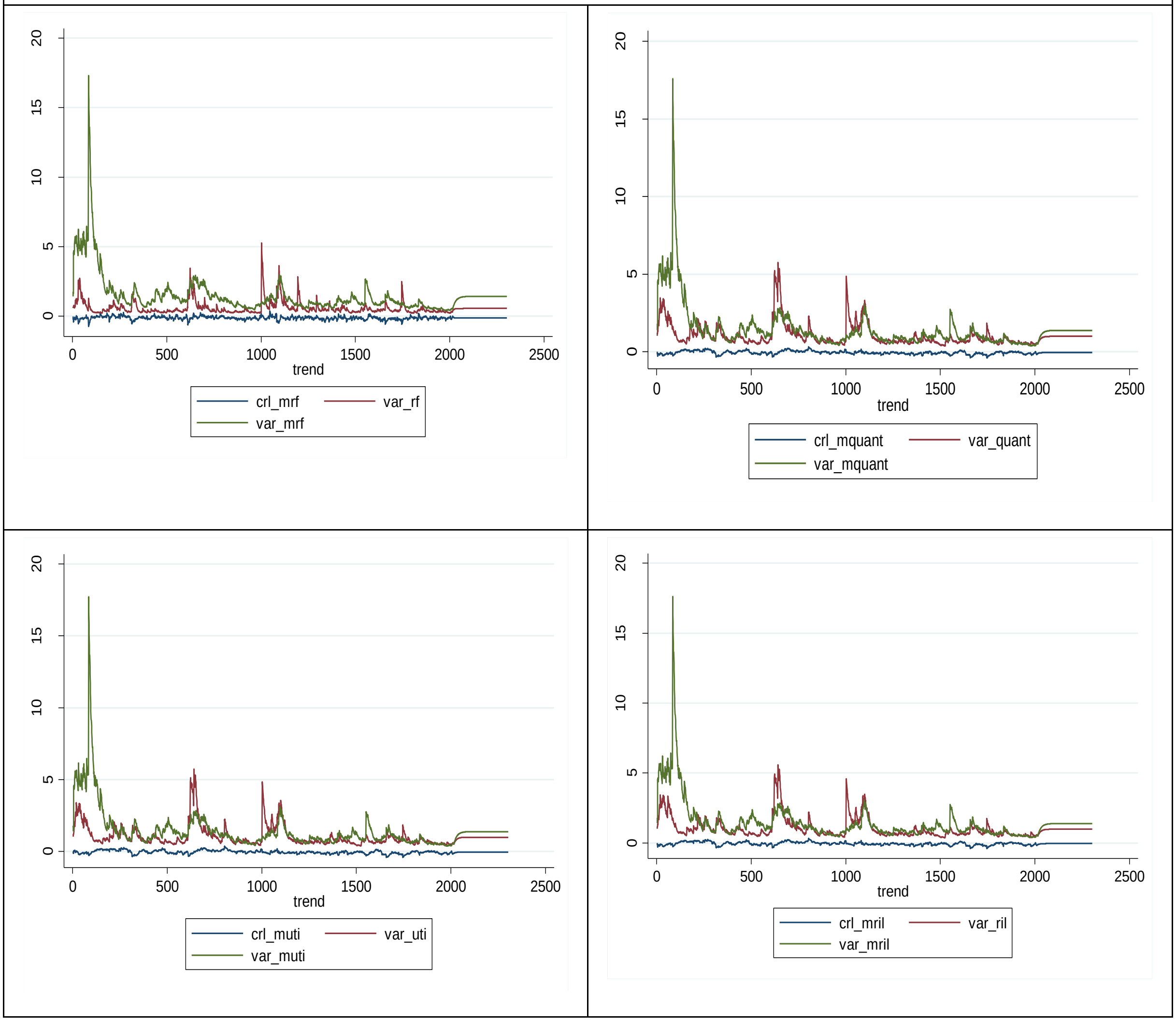
Thus, this result here strikingly evidences that gold futures serves as a strategic tool for portfolio managers to hedge against the risky equity. In the presence of gold futures, the portfolio managers may construct a portfolio attaching optimal weights to stocks and gold futures to hedge away risk and optimise return, which I have also attempted in one of the segments of this study.

Table 2B: Estimates of the conditional variance and conditional correlation of time varying risk premium

Coefficients	**Gold Futures-Equity**	**Quantum Gold ETF- Equity**	**UTI Gold ETF-Equity**	**RIL Gold ETF-Equity**
	Panel III: Gold Futures/ETFs Conditional Variance Estimates			
δ_g	0.086***	0.065***	0.060***	0.060***
	(0.017)	(0.012)	(0.011)	(0.011)
γ_g	0.871***	0.906***	0.913***	0.916***
	(0.024)	(0.017)	(0.015)	(0.015)
c_g	0.020***	0.022***	0.021***	0.018***
	(0.006)	(0.006)	(0.006)	(0.005)
$\delta_g + \gamma_g$	**0.95700**	**0.97100**	**0.97300**	**0.97600**
Ljung-Box *Q (18)*	18.47	17.86	17.55	17.92
Ljung-Box *Q^2 (18)*	20.76	21.55	20.64	20.87
	Panel IV: Equity Conditional Variance Estimates			
δ_s	0.050***	0.051***	0.051***	0.051***
	(0.009)	(0.009)	(0.009)	(0.009)
γ_s	0.942***	0.939***	0.939***	0.939***
	(0.010)	(0.011)	(0.011)	(0.010)
c_s	0.013***	0.013***	0.013***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)
$\delta_s + \gamma_s$	**0.99200**	**0.99000**	**0.99000**	**0.99000**
Ljung-Box *Q (18)*	15.27	15.22	14.83	15.35
Ljung-Box *Q^2 (18)*	17.76	17.55	16.97	17.82
	Panel V: Conditional Correlation between gold futures ETFs and Equity			
ρ_{gs}	-0.110***	-0.057	-0.054	-0.054
	(0.032)	(0.042)	(0.043)	(0.043)
λ_1	0.064***	0.031***	0.033***	0.032***
	(0.020)	(0.007)	(0.007)	(0.008)
λ_2	0.781***	0.932***	0.931***	0.931***
	(0.078)	(0.013)	(0.012)	(0.013)
ρ_c	5.753***	6.443***	6.289***	6.286***
	(0.462)	(0.567)	(0.545)	(0.545)
Wald chi2(6)	**2007.76*** **	**374.43*** **	**367.74*** **	**385.41*** **
Prob > chi2	0.0000	0.000	0.000	0.000
Log likelihood	**-5510.745**	**-6117.075**	**-6116.83**	**-6086.164**

Notes: *, ** and *** indicate the 10%, 5% and 1% level of significance.
This table reports four structural covariates multivariate DCC GARCH (1,1) conditional variance equation estimates of gold futures conditional risk premium and conditional equity risk premiums. The variables for which these models are build in association with the equity index are the gold futures, quantum ETF (lrqunt) ,UTI ETF, and Reliance ETF (lreuti). Apart from the above daily reward risk ratio and annualised risk premium of the assets under investigations are also captured.

Figure1: Dynamic *nexus between conditional correlation and conditional volatilities*



While modelling the relation between conditional correlations between gold futures returns (gold ETFs) and the excess equity index returns against the time trend and conditional volatilities of the gold futures (gold ETFs) and excess equity index returns a two-step modelling framework is followed. First, I extract the conditional correlation and conditional variances series by fitting each DCC GARCH models, which is estimated in the previous section. Second, I estimate three sets of regression models with Neway Standard Errors[16], where conditional correlation is the dependant variable. The first set of models are estimated with the logarithmic trend to examine the time varying behaviour of the conditional correlation over the study period following eq. [6]. Second set of models are estimated to examine the effect of conditional variances of the gold futures (gold ETFs) and equity markets along with the time trend following eq. [7]. Third set of models examines the effect of time trend and conditional variances in the presence of two interaction dummies that captures the period of equity market stress and normal period otherwise following eq. [8]. Table 3 and Table 4 reports these model estimates. The result here warrants three important comments.

Table 3: Estimates conditional correlation behaviour over time.

Coeffiients	**Panel I: Model with Trend only**			
	Model 1	**Model 2**	**Model 3**	**Model 4**
δ_t	-0.010***	-0.014***	-0.027***	-0.018***
	(0.003)	(0.003)	(0.003)	(0.003)
α	-0.075***	0.041**	0.136***	0.067***
	(0.022)	(0.020)	(0.020)	(0.022)
R-squared				
F(1, 2300)	9.98***	25.82***	96.26***	33.02***
Coefficients	**Panel II: Model with Trend and variances**			
	Model 1	**Model 2**	**Model 3**	**Model 4**
δ_t	-0.030***	-0.032***	-0.048***	-0.036***
	(0.004)	(0.003)	(0.004)	(0.004)
π_g	-0.034***	-0.005	-0.006*	-0.007**
	(0.009)	(0.003)	(0.003)	(0.003)
π_s	-0.019***	-0.018***	-0.021***	-0.018***
	(0.004)	(0.001)	(0.002)	(0.002)
α	0.106***	0.188***	0.311***	0.223***

[16] Due to the presence of heteroskedasticity and serial correlation among the variables, I estimate four regression model deploying Neway Standard Errors.

	(0.033)	(0.026)	(0.027)	(0.029)
R-squared				
F(3, 2298)	22.15***	54.91***	67.26***	50.06***
	Panel III: Model with Trend and variance and Dummies			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Ltrend	-0.029***	-0.032***	-0.048***	-0.036***
	0.004	0.004	0.004	0.004
π_g	-0.039***	-0.008**	-0.009**	-0.010***
	0.010	0.003	0.003	0.003
π_s	-0.023**	-0.017**	-0.017**	-0.015**
	0.009	0.007	0.008	0.007
γ_n	0.002	-0.002	-0.005	-0.004
	0.007	0.007	0.007	0.007
φ_s	-0.062***	-0.048***	-0.049***	-0.048***
	0.011	0.009	0.010	0.010
_cons	0.113***	0.197***	0.320***	0.232***
	0.032	0.026	0.027	0.028
F(3, 2298)	35.23***	62.83***	71.22***	59.22***

Notes: *, ** and *** indicate the 10%, 5% and 1% level of significance.
This table captures the estimates that deals with how conditional correlation changes over time under three different scenario i.e. in the presence of trend only, in the presence of trend and gold and equity market conditional variance dummies and in the presence of trend gold and equity market conditional variance dummies in extreme market conditions.

First, the negative sign and significance attached to the trend (δ_t) coefficient [Panel I, Table 3] confirms that the conditional correlation between gold futures (gold ETFs) and equity market is seen to have been declining over the years. That means though both the markets are inversely comoving but the degree of movement is seen to have been declining over the period. Thus, the result here confirms the power of diversification benefits of gold futures for the portfolio of equity index. That means long equities and gold futures as strategic asset allocation has remained a continuing story for the investor and portfolio managers in the Indian market. This finding here is in support of the empirical literature (Jaffe, 1989; Ciner, 2001).

Now, using information provided by the DCC GARCH model, one can distinguish between the hedge and safe heaven properties of gold futures in relation to equity index-based portfolio.

I estimate eq.[7] with a goal to examine whether gold futures [gold ETFs] provide an opportunity for portfolio risk diversification for the equity index investor in India (gold plays hedge against equity index portfolio or not). The results are reported in Panel II of Table 3. The conditional correlation of gold futures (gold ETFs) returns and excess equity returns are observed to be inversely associated with the conditional equity variance across the models. The average equity variance coefficient [π_s] across the models is -0.019%. Ceteris paribus, 1% rise in equity index risk causes to decline conditional correlation between gold futures (gold ETFs) and excess equity returns by 0.019% on an average. This is of course good news at the time of high equity market volatility, when long positions in gold futures and equity offers precisely the diversification benefit to the investors and portfolio managers, who utterly need it. Further, figure 1 which captures the direction of co-movement of the conditional correlation and conditional variances of the equity and gold futures (gold ETFs) also depicts that at the time of high equity market volatilities conditional correlation plunges and vice versa. This result here corroborates the earlier findings that gold futures contract is observed to be a strategic asset for the equity portfolio investor/ portfolio manager, who can effectively hedge away equity portfolio risk investing in gold futures at the time of market turbulence. This finding here is in support of the empirical literature (Bodie and Rosansky, 1980; Carter et al., 1982; Bodie, 1983; Jaffe, 1989; Shishko, 1977; Jensen et al., 2000; Ciner, 2001; Erb and Harvey, 2006; Chong and Miffre, 2007; Baur and Lucey, 2010, Baur and McDermott, 2010; Erb and Harvey, 2013; Reboredo, 2013; Hood and Malik, 2013; Nguyen et al. 2017). Thus, the findings of the study here supports the hypothesis: ………..

This result is also corroborating by the graphical analysis that at the time of market turbulence, conditional correlation between the returns of gold futures (gold ETFs) and equity index excess returns plunges and the conditional market volatilities of these asset classes rise simultaneously

(Figure 3). This finding here apparently in support the safe heaven role of the gold futures (gold ETFs) especially for the equity index. However, one may conjecture that the inverse relationship between $\boldsymbol{\rho_{gs}}$ and π_s in eq.7 captures only the average relation over time. But the crucial distinction between asset is a hedge and safe haven emanates from the fact that dependence is required to hold under extreme market turbulence, whereas for a hedge, it must do so on average. Thus, to address this issue whether gold futures possesses the properties of safe haven in conjunction with the equity index, I estimate eq. [9] including market stress period and normal period dummies. The estimates of the eq. [8] are reported in the panel III of Table 3.

The result here also suggests that the relationship between conditional correlation of the gold futures (gold ETFs) and excess returns of the index equity and conditional variances of the excess returns of the equity index in eq. [8] are found to be negative at 5% level of significance across the models. However, the important variables of interest to prove the safe heaven property of the gold futures are attached coefficients $\varphi_s, \pi_s\ and\ \gamma_n$ and. It is observed that both the coefficients $\varphi_s\ and\ \pi_s$ are observed to be negative and statistically significant at 1 % level. But the magnitude of φ_s coefficient (interaction dummy coefficients of the equity market volatility under the period of market stress) is observed to be extremely negative (2.5 times) compared to the π_s (average volatility of the excess returns of the equity index over the time). That means, ceteris paribus, under the period of equity market stress (period of average market condition), 1% increase in equity market returns volatility decrease the conditional correlation between gold futures and equity by 0.062 % (0.023%). However, at the same point in time the γ_n coefficient that measures the period of equity market tranquillity is found to be statistically not significant across the models as expected. It is also important to note the results associated with the gold ETFs are also reveling the similar results but the gold futures are observed to be the distinctively recognised as an asset for safe haven for the equity investor. Thus, the results here confirm that gold offers the safe heaven opportunity to the equity index investor in India. That means allocating a greater proportion of portfolio weights to gold futures during extreme market stress period, equity index investors in Indian market can benefit more from the decrease in correlation and increasingly hedging away risk. This finding here corroborates the descriptive statistics presented in the section 4.1. This finding here justifies the economic rationale that at the time of high market stress asset managers would take long in gold futures and short in equity, this market condition may put more downward spiralling pressure on the equities and thereby inflating the market volatilities.

In nutshell, it can be inferred that the conditional correlation between gold futures returns and equityexcess returns against the conditional volatilities of equity excess return significantly move inversely over the period, indicating that gold futures market continues to play safe heaven role in India. That means at the time of high market stress, gold provides portfolio diversification opportunities to equity investor in India. The observed negative relation between conditional correlation and equity market variance suggests the economic rationale of flight to quality at the time of market stress. This finding here is consistent with the academic literature and institutional investors practice, who short their shares in order to stop the loss in the equity portfolio and take long position in the gold futures market during the period of extreme equity market stress (Capie et al., 2005; Chong and Miffre, 2007; Baur and Lucey,2010, Baur and McDermott,2010; Erb and Harvey, 2013; Reboredo, 2013; Hood and Malik, 2013; Nguyen et al. 2017). Thus, the study here confirms the Hypothesis……………

4.4 Optimal portfolio design and hedging effectiveness measures in the presence of gold futures

This section succinctly evaluates overall in sample portfolio performance in terms of different risk measures. To be specific, I gauge hedge effectiveness of the risk reducing portfolio using DCC GARCH estimates against the unhedged portfolio. To this end, I consider a hedged portfolio composed of gold futures and Indian equity market index proxied by BSE SENSEX in which risk averse investor warrants to protect himself from the equity index price movements exposure by investing in gold futures. The objective here is to determine whether minimum variance gold futures equity composed hedging portfolio influences a reduction in risk while keeping the same expected returns. Further, how minimum variance hedging portfolio influences a reduction in portfolio VaR and CVaR. The hedge effectiveness is measured by three indicators $HEI_{Var,}$ HEI_{VaR} and HEI_{CVaR}. Table 7 reports the full sample estimates of minimum variance hedge and hedge effectiveness measures using inputs from first stage DCC GARCH results.

Following Kroner and NG (1998), [eq.10 & 11] I evaluate the optimal portfolio weights of stock to gold ($w_{gs,t}$), which would hedge away the risk in the equity portfolio. The findings are in line with the expectation that gold often serves as safe haven for the investor in the Indian market. The coefficient attaches to gold shows that the optimal weights for result her reveals that the optimal average weights for equity and gold assets are observed to be 70% and 30% respectively.

Following Kroner and Sultan (1999) [eq.12], I estimate the optimal hedge ratio ($\psi_{sg\ ,t}$) using DCC GARCH inputs. The finding is in line with the assertion that the average optimal hedge ratio is low and it remained within 25% in any of the DCC GARCH models under consideration. The result here warrants three comments for the short hedgers. The low short hedge ratio indicates that in India, equity index investment risk can be hedged away by taking about 23% short position in the gold futures market.

Now, I moved to estimate how effective is the diversification and hedging associated with the gold futures using three indicators i.e. HEI_{Var}, HEI_{VaR} and HEI_{CVaR} following eq.[13, 14 and 15]. Irrespective of the DCC GARCH model inputs used in estimating HEI_{Var} across the models, the results here affirm that portfolio with gold futures diversify away about 50% risk in the equity index portfolio. That means, hedging strategies including equity index and gold futures effectively tend to reduce almost about half of the portfolio risk in the hedged portfolio compared to unhedged one in the Indian market.

Table 4: Estimates of the optimal portfolio weights and hedge effectiveness

Parameters	Model 1	Model 2	Model 3	Model4
1-$w_{sg,t}$	63.30%	89.00%	88.30%	87.76%
$w_{sg,t}$	36.70%	11.00%	11.70%	12.24%
HEI_{Var}	55.43%	20.80%	21.83%	22.81%
$HEI_{VaR_{95\%}}$	36.29%	11.30%	12.29%	12.71%
$HEI_{VaR_{99\%}}$	26.16%	13.40%	14.52%	15.32%
$HEI_{CVaR_{95\%}}$	30.88%	11.75%	12.47%	12.95%
$HEI_{CVaR_{95\%}}$	28.98%	13.02%	13.24%	14.13%
$\psi_{sg\ ,t}$	-12.68%	-5.24%	-6.66%	-6.29%

However, empirical literature contends that the HEI_{Var} as a minimum variance hedge effectiveness measure suffers from diverse limitations, which substantially reduces standard deviation of portfolio returns, increases tail risks (Harris and Shen, 2006). To avoid such unambiguous results, I estimate VaR and CVaR to confirm whether HEI_{Var} can still be considered as a suitable measure of hedge effectiveness in the minimum variance portfolio. The HEI_{VaR} and HEI_{CVaR} hedge effectiveness measures are estimated for 95% confidence level and the results are reported in Table 7. The findings here demonstrate that the HEI_{VaR} and

HEI_{CVaR} estimates are mostly in conformity with the HEI_{Var} results, when it comes to the selection of minimum variance portfolio. However, HEI_{Var} estimates are seen to have higher values compared to HEI_{VaR} and HEI_{CVaR} estimates across the models, which might have happened due to the increased portfolio skewness and kurtosis. This finding is in conformity with the literature (Harris and Shen, 2006). Further, HEI_{CVaR} estimates q=5% are observed to be lower compared to HEI_{VaR} estimates across the models, which suggests in conformity with the literature that HEI_{VaR} perhaps does not capture the expected loss size in the event when expected loss exceeds the VaR of the portfolio (Alexander and Baptista, 2004). The result here confirms that CVaR as a measure to control risk is more effective than use of VaR. Thus, portfolio designed via Kroner and Ng(1998) demonstrate relatively lower reduction in risk in conditional value at risk (CVaR) portfolio compared to the minimum variance (Var) portfolio.

Table 5: Risk and return estimates of the hedged and unhedged portfolio

Parameters	SENSEX based Portfolio	Portfolios with SENSEX and gold based assets			
	SENSEX 100%	63.3% SENSEX + 36.7% Gold Futures	89% SENSEX+ 11% Quantum GOLD ETF	88.3% SENSEX+ 11.7% UTI GOLD ETF	87.76% SENSEX + 12.24% RIL GOLD ETF
Daily Mean variance	1.41%	0.63%	1.16%	1.10%	1.09%
Daily mean return	0.05%	0.05%	0.05%	0.05%	0.05%
Annual mean return	13.93%	12.27%	13.22%	13.26%	13.22%
Annual STDEV	18.84%	12.58%	16.77%	16.66%	16.56%
Annual Sharpe ratio	0.74	0.98	0.79	0.80	0.80
This table captures the daily and annual return, risk and risk adjusted returns for the portfolio with SENSEX, portfolios with SENSEX and gold futures and portfolio with the SENSEX and gold ETFs.					

Now, I examine whether the gold futures (gold ETFs) minimum variance hedged portfolio offers maximised risk adjusted returns compared to the unhedged portfolio. It is observed that irrespective of the gold assets whether gold futures or gold ETFs constructed with the DCC GARCH model inputs offer relatively higher risk adjusted returns. However, the Sharpe ratio on gold futures is the highest compared to any other asset class under this study. It is the exclusive equity portfolio (unhedged portfolio) remained relatively risky and risk adjusted return offer is observed to be the least.

In nutshell, the HEI_{Var} , HEI_{VaR} and HEI_{CVaR} results are also in conformity with the conditional correlation and market volatilities findings captured in section 4.4 that the hedge effectiveness and safe heaven properties of the portfolio, when gold futures is a constituent along with the equity index in a portfolio especially during the period of equity market turmoil. This result is in conformity with the empirical literature that the usefulness of gold futures in the portfolio risk management, and the portfolio composed with gold experiences, Var, VaR and CVaR reductions. These findings are in conformity with the some of the previous studies aligned with India and world (Reboredo, 2013; Arouri et.al., 2015; Gulseven and Ekici, 2016; Chkili, 2016; Nguyen and Prokopczuk).

4.5 Factors determine conditional risk premium in gold futures

Now, I turned to examine the gold futures risk premium determinants in India. I have estimated five models with and without the macro specific variables along with the gold futures variables. Base model I (eq.16) is estimated with Newey-West standard errors regression using five gold futures specific explanatory variables $[sbt_t\ (b_{11}), rvar_t\ (b_{12}), \rho_{sg,t}\ (b_{13}), rskw_t\ (b_{14}), rkur_t$ $(b_{15})]$ to explain the gold futures risk premium. The Table 6 reports the estimates of the gold futures risk determinants[17].

[17] While examining the effect of conditional variances on the gold futures risk premium, the sign of the coefficient is observed to be positive but not statistically significant at accepted level (results are not reported here keeping the academic brevity in mind). Thus, the result here suggests that the conditional variances without the presence of covariances fails to perhaps predict the conditional risk premium in the gold futures market. This result here justifies that the deployment of the MGARCH model to captures covariance risk in the modelling framework. Jointly modelling the effect of conditional variances and covariances of the gold and stock series, it is observed that the covariances are found to be significantly determining the change in future gold risk premium. However, following the literature, I included the realised gold futures return variance (square of the gold futures return).

While examining the sign and magnitude of the coefficients, it is revealed that the most important predictor of the time varying risk premium in the gold futures market is turned out to be the basis. The result here suggests that basis positively affects the risk premium at 1% level of significance. The magnitude of the basis coefficient observed to be varying from 0.791, which suggests that contemporaneously there is positive effect of basis on the risk premium in the gold futures market. Keeping other things constant 1% percentage increase in basis decreases the risk premium by 0.791%. It is also worthwhile to note that the coefficient attached to basis is is relatively higher than the spot gold return, which justifies the importance of basis risk is in deciding the risk premium in the gold futures market. However, the positive sign attached to the basis coefficient suggests that the hedgers are perhaps willing to compensate the speculators bearing the risk and providing insurance to hedgers that they need. This result here in line with the literature on commodity futures market (Konjhodzic and Narmo, 2017) and also in Indian currency market (Kumar and Truck, 2014).

The next best predictor of the time varying risk premium in the gold futures market is turned out to be the conditional correlation. The coefficient on conditional correlation is observed to be negative and statistically significant at 1% level of significance, which suggests that higher is the correlation risk divergence between the equity and gold futures market higher is the risk premium in gold futures market. That means, the correlation risk between equity and gold futures returns is priced into the gold futures.

It is also observed that realised variance and skewness measured out of the spot gold return seem to play an important role in the determination of the gold futures risk premium. However, the sign of the coefficient for the realised variance turns out to be positive suggesting that there realised risk premium varies directly with the spot gold price realised volatility. Similar findings are reported in the commodity market (Khonjodizic, 2017), currency futures market (Jiang and Chiang, 2000) and equity market (Guo and Whitelaw, 2006). The coefficient on realised skewness is statistically significant and positive with an average of 0.108% per day across models.

This result here lend supports to the fact that skewness matters to the pricing of gold futures risk premium and that investors demand higher compensation for exposure to gold futures at times with lower levels of skewness[18]. Empirical literature also claims that positive skewness has a valuable impact on the utility investors derive from their investments (Barberis and Huang, 2008). Exploring skewness is a profitable signal in markets other than equities (e.g., Chang et al., 2013) and equity derivatives (Boyer and Vorkink, 2014). The result here lend support to the theories on skewness preferences (Mitton and Vorkink, 2007; Barberis and Huang, 2008). Since commodity futures markets are not subject to short-sale constraints and are dominated by speculators and hedgers, with retail investors rarely participating, our findings are more in line with the cumulative prospect theory framework of Barberis and Huang (2008). An additional mechanism through which skewness could affect commodity prices relates to selective hedging, or more specifically, to hedging under skewness preferences (Stulz, 1996; Gilbert et al., 2006 and Lien and Wang, 2015). Selective hedging is a practice in which hedgers' view of future price movements influences their optimal hedge ratio.

However, the coefficient on realised kurtosis though is observed to be positive but not statistically significant, which suggests that the realised skewness measured out of the gold spot price fails to determine the gold futures risk premium. Further, it would have been

[18] In these frameworks, skewness matters because of investors' preference for positive skewness (lottery-type payoffs), which causes positively skewed equities to become overpriced and earn lower expected returns than equities with negative skewness.

interesting to capture the maturity effect of these lagged variables and structural covariates on the gold futures risk premium but, I have only considered the near month futures data to examine the aforesaid phenomenon, which may be worth exploring in future.

Table6: Estimates of the gold futures risk premium determinants

rf	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
sbt_t (b_{11})	0.791***	0.791***	0.791***	0.786***	0.779***
	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)
$rvar_t$ (b_{12})	0.009**	0.008**	0.008**	0.006*	0.008**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$\rho_{sa.t}$ (b_{13})	-0.223**	-0.222*	-0.222**	-0.221**	-0.219**
	(0.055)	(0.057)	(0.056)	(0.056)	(0.056)
$rskw_t$ (b_{14})	0.109***	0.109***	0.109***	0.107***	0.107***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$rkur_t$ (b_{15})	0.001	0.001	0.001	0.001**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
mrp_t (c_{11})	-	-	-	-0.061***	-0.046***
	-	-	-	(0.011)	(0.011)
$M3_t$ (c_{12})	-	-	-	-0.101***	-
	-	-	-	(0.039)	-
dfci (c_{13})	-	0.033**	-	-	-
	-	(0.013)	-	-	-
$dgvslr_t$ (c_{14})	-	-	-	-0.012***	-
	-	-	-	0.005	-
$ddix_t (c_{15})$	-	-	-0.036***	-	-
	-	-	(0.013)	-	-
$dinr/usd_t$ (c_{16})	-	-	-	-	-0.282***
	-	-	-	-	(0.083)
$dwti_t (c_{17})$	0.0004*	0.00034*	0.00037*	0.0004*	0.0004*
	(0.00025)	(0.00024)	(0.00023)	(0.00023)	(0.00026)
$usmrp_t$ (c_{18})	-	-	-	-	-0.053***
	-	-	-	-	(0.012)
Cons	0.009	0.012	0.009	1.636***	1.156***
	(0.015)	(0.015)	(0.015)	(0.619)	(0.337)
$F(5, 2296)$	831.79	695.83	696.46	608.99	640.84
R-squared	0.6435	0.6444	0.6446	0.6591	0.6724

The table reports the estimates of the coefficients, standard errors t values and level of significance for each of the explanatory variables of the determinants of the risk premium for five variants of models. While considering the determinants from the gold market specific variables, I have chosen basis ($basis_t$), spot return(r_t), realised variance ($rvar_t$) realised Skewness ($rskw_t$)and realised kurtosis ($rkur_t$) . Along with this idiosyncratic variables, I have also incorporated macro specific variables such as equity market risk premium (mrp_t), Goldman Sachs India financial condition index ($fci_{t,}$) US dollar Index (dix_t), WTI crude oil futures (wti_t) and US Risk premium (usmrp) are reported.

Now, I turned to examine how does conditional gold risk premium is explained by the structural macroeconomic factors in the presence of gold futures basis and conditional variances. I estimate four variants of model using eq.[17]. The models takes on the base model variables of eq.[16] along with some combination of the macroeconomic control variables. These models are estimated with Newey-West standard errors regression using five gold futures specific explanatory variables $[sbt_t\ (b_{11}), rvar_t\ (b_{12}), \rho_{sg,t}\ (b_{13}), rskw_t\ (b_{14}), rkur_t\ (b_{15})]$ and some combination[19] of the macroeconomic control variables (mrp_t (c_{11}) , $M3_t$ (c_{12}), $dfci_t$ (c_{13}), $dgvslr_t$ (c_{14}), $ddix_t(c_{15})$, inr/usd_t (c_{16}), $dwti_t(c_{17})$ and $usmrp_t$ (c_{18})] to explain the gold futures risk premium. To avoid the multicollinearity issues among the control variables I have included these macroeconomic variables under separate models. Thus, I proceed to examine in detail the effect of each of these macro factors on the gold futures risk premium using some of the input variables obtained from the first stage DCC GARCH model.

The coefficient on the crude oil proxy ($dwti_t$) is observed to have positive and statistically significant indicating that the change in crude oil futures return is seen to have been affecting the gold futures risk premium over the study period. It can be inferred from this result that the prices of crude oil partly account for inflation basket in India and the gold futures price tends to appreciate with rising inflation and crude oil prices. Thus, the result here supports the view that higher inflation and crude oil future price risks has eventually translated into the higher gold future premium over the study periods in India. However, comparing the magnitude of the '$dwti_t$' coefficient across the models seems to have the least bearing on the gold risk premium among the significant determinants [Model II to Model V].

[19] We have used them in some combinations to avoid the problem of multicollinearity.

I also find a positive and statistically significant coefficient on financial confidence index (c_{13}) (Model II) indicating that increase in consumer financial confidence has a positive and significant bearing on the gold risk premium. This finding is in line with my expectation. As the financial confidence is high in the market hedgers in the gold market especially consumers (gold jewellery manufactures, industrial houses and jeweller exporters) would hedge against the price increase and in tun never mind to pay positive premium to the speculators in the market. This results here also corroborates our earlier finding that the gold market is a premium market in India and there is supply shortage and thus the consumers who dema0nd gold would never mind to pay a premium gold future to hedge against the price rise.

I also observe that the coefficient attached to US dollar Index ($ddix_t$) and INR/USD exchange rate (inr/usd_t) is negative and statistically significant at 1% level in explaining the gold futures risk premium, which is in line with my expectation [Model III]. The result here indicate that either $ddix_t$ or inr/usd_t is an inverse predictor of gold futures risk premium (value of both the asset move in tandem). Ceteris paribus, 1% increase in the effective external value of the US dollar index led to 0.036% decline in gold risk premium over the study periods in India. However, there are of course exceptions to this relationship as there are periods when gold and dollar move together as both are considered as safe havens. Further the dollar index is not the exclusive driving for gold price movement and rather gold price movement is linked to a wide variety of domestic and international macro factors.

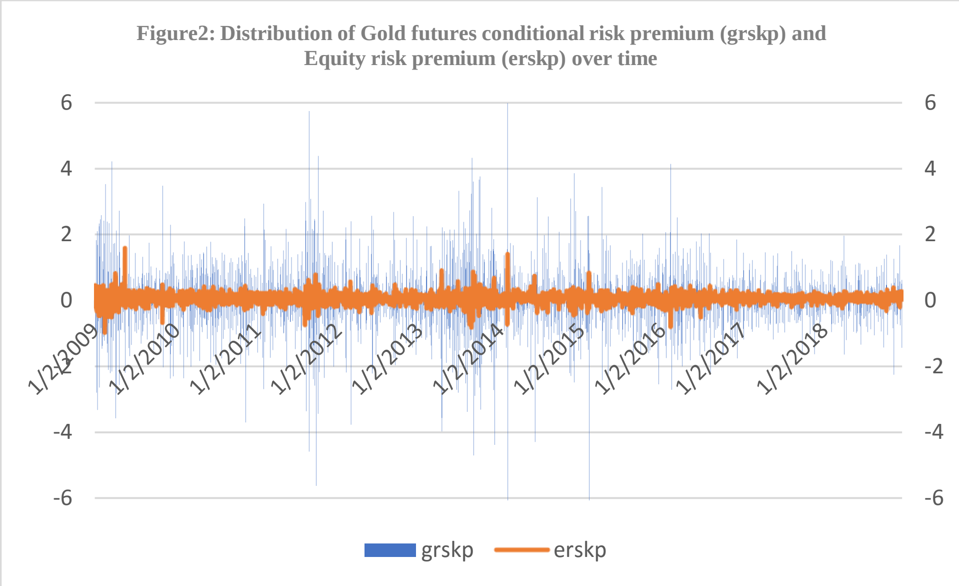
I examine the effect of gold to silver price ratio on the gold futures risk premium using equation estimates in Model IV. The study here reports invaluable insight into the role of gold silver price ratio in determining the gold futures risk premium. The result here affirms a statistically significant negative contemporaneous effect of gold to silver price ratio on the gold futures risk premium over the study period. Thus, it can be inferred that the demand for hedging using short futures against price decline appears to be higher for the producers (jewellery manufacturers) compared to the and speculators who are net long in futures position) resulting in net positive risk premiums for the speculators.

Broadly, it is the gold futures basis is found to be the most important covariates to explain the gold futures risk premium. Further, among the structural macroeconomic covariates, it is the dollar index ($ddix_t$) followed by financial confidence index ($dfci_t$) is seen to have been the most prominent factors determining the gold risk premium in the Indian market. It is the crude oil futures ($dwti_t$) is seen to have been the least impact on the gold futures risk premium among the covariates irrespective of the models under consideration. Finally it is interesting to note that the risk premium in gold futures is inversely explained by the equity risk premium India and USA. The result here affirms that the investors/speculators are in search of risk premium in both the markets.

4.6. Dynamic nexus between risk premium in equity, gold futures and ETFs

Now I move to examine, the dynamic nexus between conditional risk premium in gold futures (gold ETFs) market and equity risk premium. I apply here five specific econometric tools (Johannsen cointegration test, vector error correction method, time domain Granger block exogeneity test, frequency domain causality test and wavelet coherency and phase difference analysis) to examine the dynamic nexus between conditional risk premia in gold futures and equity over the study period. First of all, I test stationarity test of the variables considered in the study through Phillips & Perron (1988) (PP) test, Kwiatkowski et al. (1992) KPSS test. The results support that all variables are stationary in the level form i.e., they are integrated of order zero, I (0). The results are reported in Appendix (Table:A1)

Figure2: Cointegration relation between conditional risk premia gold futures and equity over time



First, to examine the long run dynamic association between risk premium in gold futures return and excess equity return, I deploy Johannsen cointegration test on the derived conditional risk premia for both the markets series obtained from the first stage DCC GARCH model following eq. [1] and eq. [3] respectively. Figure 2 plots the cointegrating relationship between these variables over time and it appears that the long-run relationship between two variables is highly likely.

To confirm the log run cointegrating relationship, the Johansen trace and maximum eigenvalue cointegration tests are performed. The results presented in Table 7 evidences that there exists one cointegration relationship between risk premium in gold futures and equity index. This result here confirms the long run dynamic relationship between the conditional risk premium in gold futures and equity markets. Similar results are also observed for the Johansen Cointegration test estimates for the equity and gold ETFs (results are not reported keeping academic brevity in mind).

Table 7: Johansen Cointegration test estimates for gold futures risk premium and equity risk premium

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.176740	865.4526	15.49471	0.0001
At most 1 *	0.167464	419.8906	3.841466	0.0000
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.176740	445.5620	14.26460	0.0001
At most 1 *	0.167464	419.8906	3.841466	0.0000
Note: Trace test and Max-eigenvalue test indicates 2 cointegrating eq(s) at 0.05 level of significance, * denotes rejection of hypothesis at 0.05 level and ** MacKinnon-Haug-Michelis (1999) p-value.				

Table 8: Bi-variate VECM estimates of risk premium between equity and gold futures and ETFs

Parameters	Model I		Model II		Model III		Model IV	
	Gold Futures -Equity		Quantum Gold ETF -Equity		UTI Gold ETF -Equity		RIL Gold ETF -Equity	
	$\Delta r_{g,t}$	$\Delta r_{s,t}$	$\Delta r_{g,t}$	$\Delta r_{s,t}$	$\Delta r_{g,t}$	$\Delta r_{s,t}$	$\Delta r_{g,t}$	$\Delta r_{s,t}$
CointEq1	-0.195***	-0.557***	-0.017*	-0.207***	-0.020**	-0.222***	-0.036***	-0.280***
	0.029	0.032	0.010	0.010	0.010	0.011	0.013	0.014
$\Delta r_{g,t}(-1)$	-0.703***	0.444***	-0.875***	0.141***	-0.871***	0.156***	-0.862***	0.200***
	0.032	0.035	0.022	0.024	0.022	0.024	0.023	0.025
$\Delta r_{g,t}(-2)$	-0.583***	0.321***	-0.748***	0.105***	-0.755***	0.120***	-0.739***	0.158***
	0.034	0.037	0.028	0.030	0.028	0.030	0.029	0.031
$\Delta r_{g,t}(-3)$	-0.386***	0.204***	-0.541***	0.028	-0.537***	0.041	-0.528***	0.064*
	0.033	0.036	0.030	0.032	0.030	0.032	0.030	0.033
$\Delta r_{g,t}(-4)$	-0.218***	0.134***	-0.295***	0.057*	-0.293***	0.065**	-0.289***	0.090***
	0.029	0.031	0.027	0.029	0.027	0.029	0.027	0.030
$\Delta r_{g,t}(-5)$	-0.099***	0.109***	-0.153***	0.0291	-0.151***	0.044**	-0.1495***	0.056**
	0.021	0.023	0.021	0.022	0.021	0.022	0.021	0.022
$\Delta r_{s,t}$(-1)	0.245***	-0.088**	-0.004	0.064	-0.001	0.062	0.032	0.054
	0.0401	0.043	0.042	0.045	0.042	0.045	0.042	0.045
$\Delta r_{s,t}$(-2)	0.218***	-0.078**	0.014***	0.047	0.015	0.045	0.051	0.039
	0.036	0.039	0.037	0.040	0.037	0.040	0.037	0.040
$\Delta r_{s,t}$(-3)	0.181***	-0.052	0.027	0.047	0.026	0.046	0.051	0.041
$\Delta r_{s,t}$(-4)	0.031	0.034	0.032	0.035	0.032	0.035	0.032	0.035
	0.126***	-0.048*	0.025	0.019	0.024	0.017	0.038	0.014
	0.026	0.028	0.026	0.029	0.027	0.029	0.026	0.029
$\Delta r_{s,t}(-5)$	0.098***	-0.058***	-0.002	-0.023	-0.001	-0.024	0.006	-0.024
	0.019	0.021	0.019	0.021	0.019	0.021	0.019	0.021
C	0.000	0.002	0.000	0.001	0.000	0.001	0.000	0.001
	0.023	0.025	0.023	0.024	0.023	0.024	0.023	0.024
Adj. R-squared	0.450	0.458	0.453	0.477	0.453	0.477	0.457	0.477
F-statistic	171	177	174	191	174	191	177	191
Log likelihood	-3468	-3654	-3440	-3613	-3437	-3613	-3431	-3614
Akaike AIC	3.030	3.192	3.006	3.156	3.003	3.157	2.998	3.157
Schwarz SC	3.060	3.222	3.036	3.186	3.033	3.187	3.028	3.187
Notes: *, ** and *** indicate the 10%, 5% and 1% level of significance.								

Having understood the presence of long run relationship between the conditional risk premia in gold futures (gold ETfs) and equity markets, I now turned to estimate the VECM model to understand the short-term dynamics between these variables. The VECM restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run dynamics. The cointegration term is known as the error-correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

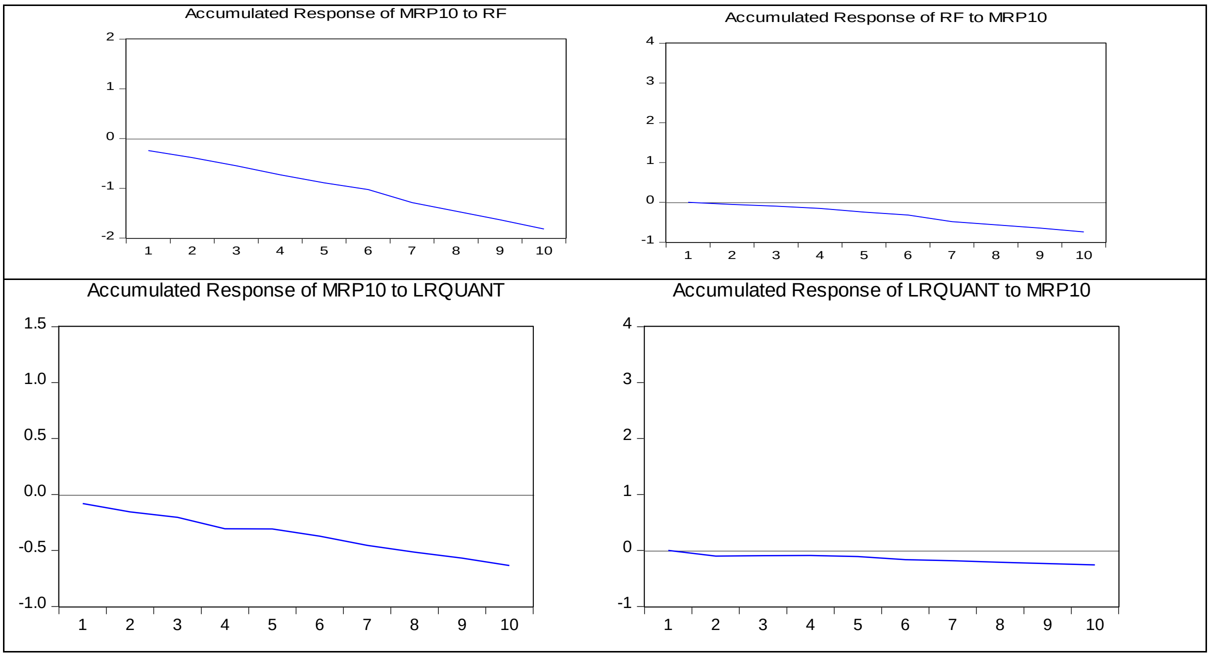
I report the results of eq. [18 &19] in Table 8. The results warrant three important comments. First, the cointegration terms are statistically significant and negative for conditional risk premium in gold futures [gold ETFs] and equity markets suggesting that the deviations in the relationship between both the variables is corrected gradually through short run adjustments with each other. Second, it is observed that keeping other things constant the conditional covariance between gold futures returns and excess equity index returns is driven majorly by lagged conditional risk premium of gold futures[gold ETFs]. The past periods conditional risk premium of gold futures market significantly and negatively impacts conditional risk premium of equity market suggesting that risk premium in gold futures leads the conditional covariance of gold futures and equity index market in an inverse direction. This result here also corroborates our findings in the descriptive statistics earlier that the standard deviations of the gold futures are relatively high irrespective of the quintile ranges. Second, the past conditional risk premium in equity fail to demonstrate much significant impact on risk premium in gold futures except a few lags. Third, the change in current period conditional risk premium in gold futures is having a dynamic linkage with most of its own lagged terms but which is not much observed in case of the conditional risk premium in equity. This result here supports the view that past period information of conditional risk premium in gold can be used as predictor for the state of the conditional risk premium in equity in India. The post estimation VECM specification test confirms that the estimated model pass most of the tests (Appendix Table 3A and 3B).

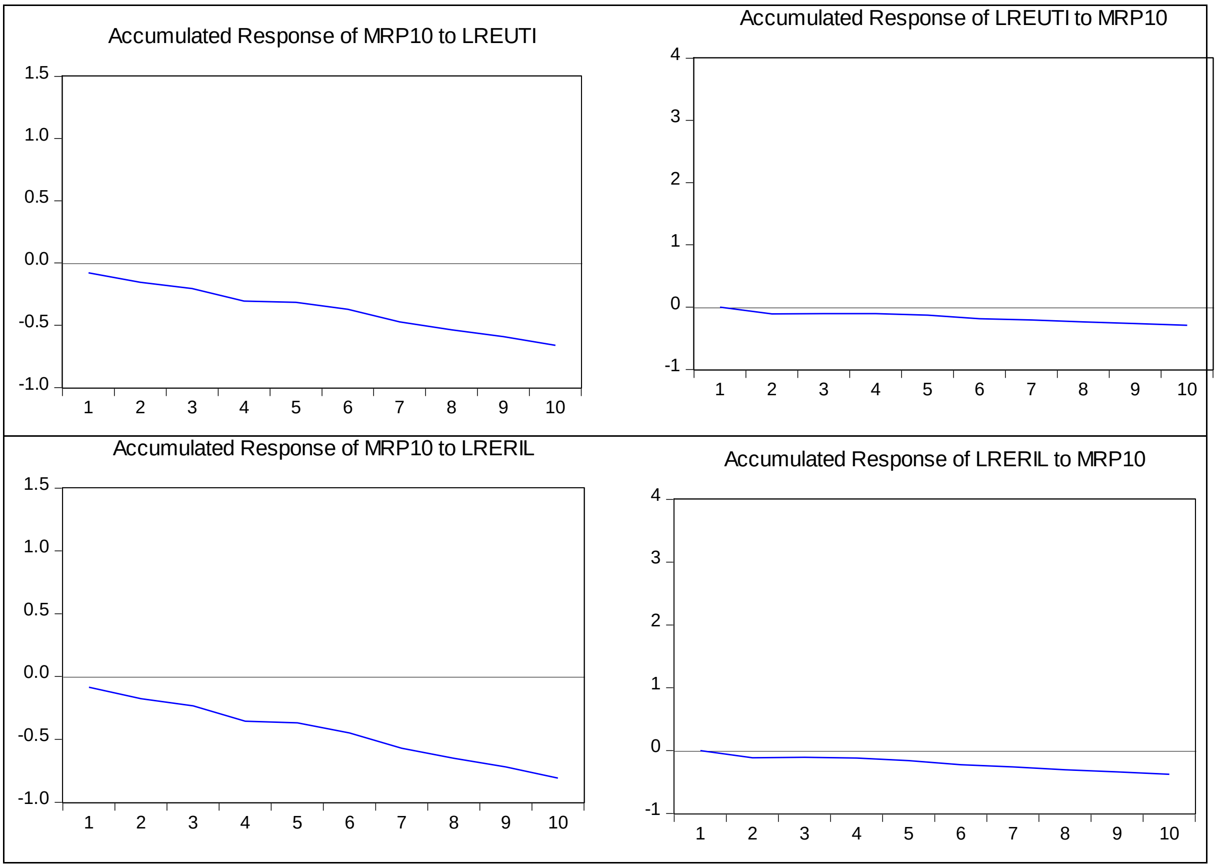
As stated earlier, despite its usefulness, the VAR/VECM model suffers from certain key limitations. Especially as the sign of the coefficients of lagged variables changes across different lags, it becomes difficult to ascertain the effect of a given change in a variable upon the future values of the variables in the system. To overcome these weaknesses, I also use the

VEC Granger causality test (otherwise termed as Time domain Granger Causality test) and impulse response functions (irf) to confirm the relationship between risk premium in gold futures and equity market in India. The estimates of the impulse response function and granger causality tests are captures in Figure 3 and Table 8 respectively.

The ‘irf’ is meant to elucidate the impact of unit standard deviation innovation to one of the variables on current and future values of other endogenous variables. I use accumulated standard Cholesky decomposition method for estimating ‘irf’ keeping in mind the existence of a high correlation between the interest variables. I primarily aim at tracing the dynamic interaction of risk premium of gold (gold ETfs]. for every unit standard deviation innovation in the risk premium of equity and vice versa. Irf analysis shows that the response of gold futures risk premium (gold ETFs) to one standard deviation shock from equity risk premium is observed to be persistently negative and conversely. Even it is admitted that there is bidirectional causality between the variables, still examining the quantum of shocks, apparently it can be argued that the equity risk premium is more sensitive to the shocks of risk premium in gold futures (gold ETFs) than conversely. This result here also corroborates the earlier VECM results.

Figure 3: Accumulated Response to Cholesky one S.D innovations





However, to confirm the bidirectional short term causality gold futures risk premium and equity risk premium, I estimate time domain and frequency domain Granger causality tests. Table 9 reports the χ^2statistics and p-values of pairwise time domain Granger causality tests between endogenous VECM variables. The results here confirm that there is bidirectional causality running from risk premium in gold futures to risk premium in equity market. This finding here demonstrates that the change in risk premium in gold futures significantly Granger causes change in risk premium in equity market and vice versa. It is also observed that the change in risk premium in gold ETFs significantly Granger causes change in risk premium in equity market but not conversely. Further, it is also observed that there exists bidirectional causal relationship between gold futures and gold ETFs risk premia. This results on the one hand hint that the change in risk premium in gold futures (gold ETFs) has a bearing in the ordering trading activity and triggering riskiness in both gold futures (gold ETFs) and equity markets. On the other the change in risk premium in equity has a bearing in the ordering trading activity and triggering riskiness in both gold futures (gold ETFs) but not in the gold ETFs.

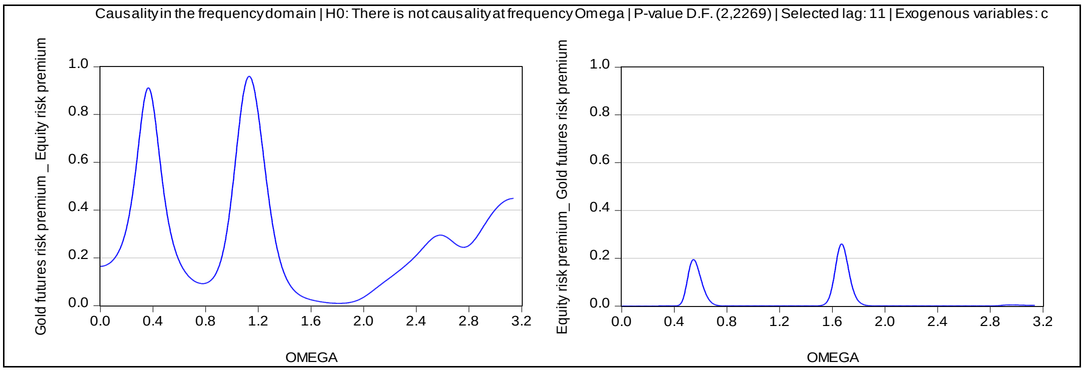
Table 9: Time domain Granger-causality / Block exogeneity Wald Test estimates

(H_0 : Equity risk premium Granger Causes Gold Futures and Gold ETFs risk premium			
Relationship	**Chi-Square**	**Df**	Prob.
MRP10 Granger Causes RF	46.6871	5	0
RF Granger causes MRP10	175.7559	5	0
MRP10 Granger Causes Quantum Gold ETF	3.39363	5	0.6395
Quantum Gold ETF Granger causes MRP10	47.8065	5	0
MRP10 Granger Causes Quantum Gold ETF	2.759	5.000	0.737
UTI Gold ETF Granger causes MRP10	55.902	5.000	0.000
MRP10 Granger Causes UTI Gold ETF	4.510414	5	0.4785
Reliance Gold ETF Granger causes MRP10	81.4337	5	0
Reliance Gold ETF Granger Causes ETF			
(H_0 : Gold futures risk premium does not Granger causes gold ETFs premium)			
Dependant variable: Equity risk premium			
D(LRQUANT) Granger causes RF	111.9358	5	0
D(RF) Granger causes Quant	229.8528	5	0
D(LREUTI) Granger causes RF	109.9085	5	0
D(RF) Granger causes UTI gold	251.051	5	0
D(LRERIL) Granger causes Rf	107.096	5	0
D(RF) Granger causes RIL gold	237.4657	5	0
(H_0 : Gold ETF premium of one does not Granger causes gold ETFs premium of other)			
D(LREUTI) Granger causes quant	27.57155	5	0
D(LRQUANT) Granger causes uti gold	56.73793	5	0
D(LRERIL) Granger causes quant gold	6.419423	5	0.2675
D(LRQUANT) Granger causes RIl gold	20.31234	5	0.0011
D(LRERIL) Granger causes UTI gold	20.3103	5	0.0011
D(LREUTI) Granger causes RIL gold	20.83719	5	0.0009
Note: This table presents Wald $\chi 2$ statistics of pair wise time domain Granger-causality Block exogeneity Wald tests between conditional risk premium in gold futures market and conditional correlation of equity and gold futures market. *** and ** indicate 1% and 5% level of significance respectively.			

Having established that the bidirectional causality in time domain, I now estimate the causality between risk premium in gold futures (gold ETFs) and equity markets in frequency domain. The estimates are plotted in Figure 4. The frequency domain causality analysis examines the causal and reverse causal relations between the variables at different frequencies. As the series are cointegrate with I(1), I estimate the frequency domain causality for the cointegrating relationships as suggested in the literature. Figure 4 corresponds to the hypothesis that the change in equity risk premia does not cause the change in gold futures risk premium at frequency omega(w), it can be seen that the change in equity risk premium cause the change in conditional risk premium at only a few sporadic frequencies such as at low frequency 0.8

[corresponds to the period between March 3 2010 to May 10, 2010[20]) and at medium frequencies 1.2 (corresponds to the period between May 5, 2011 to March 15 2012[21]] at 5% level of significance and this result is partially supports with the Granger causality test in the time domain analysis which states that the risk premium in equity market cause the risk premium in gold futures market. On the other hand, it can be seen that the change in risk premium in gold futures market causes the change risk premium in the equity market almost across the frequencies. Thus, precisely, the frequency domain approach reveals that the risk premium in gold futures market granger-causes the risk premium in equity market irrespective of the frequencies which suggests that a short run and long run risk premium causality running from the gold futures market to the equity market in India. But the reverse causality of risk premium from equity to gold futures market is observed in a few sporadic frequencies when global and domestic markets are under stress[22].

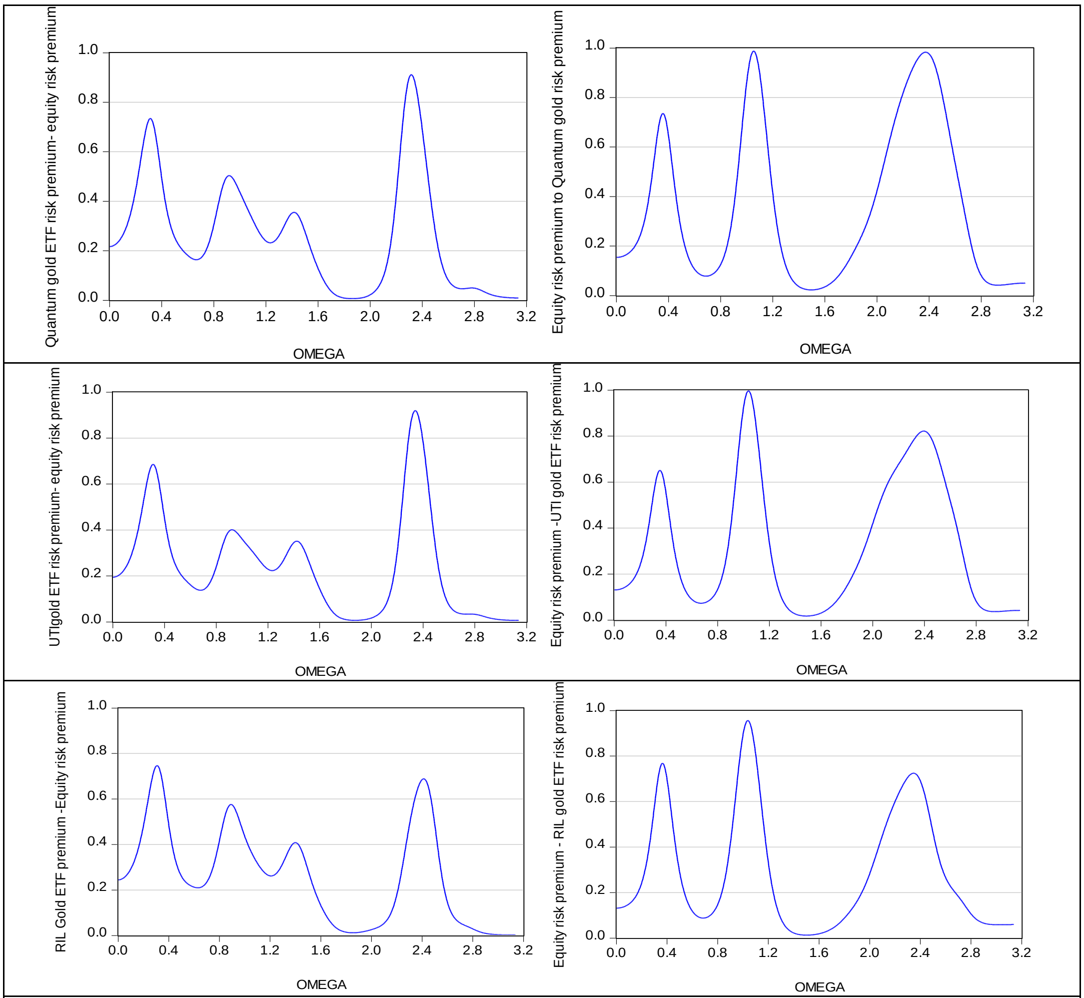
Figure: 4 Frequency domain Granger-causality between risk premium in gold futures and equity markets.



[20] This corresponds the period around UK election, Greek debt crisis and the "Flash **Crash"** on May 6, 2010, where Dow Jones index lost almost 9% (a trillion dollar stock market crash) of its value in a sequence of events.

[21] This period correspond to the period around series of events such as Japan's Tsunami and Nuclear Disaster, European debt crisis, Black Monday of August 8, 2011 (US and global stock markets crashed following the Standard and Poor's credit rating downgrade of the United States sovereign debt from AAA to to AA+),

[22] The reasons of this high sporadic bidirectional coherency during the market stress period between risk premium in gold ETFs and equity risk premium could be attributed to wide array of global and domestic factors (i) emerging market weakness, effect of quantitative easing, Brexit, slowdown in China, Chinese market crash, yuan devaluation, dollar appreciation, rupee depreciation, political regime changes in US and India, enduring global trade war, effect of US quantitative easing, disappointing earnings, crack down on black money, NPAs of Indian banks, crude oil supply shortage and price risk, introduction of long term capital gain tax. These factors brought several crashes in the global and domestic equity market, which made the equity market more vulnerable during this period. During this period, equity market in India has experienced several crashes in India (6 Jan 2015 sensex fell by 854 points, 24 August 2015 sensex fell by 854 points, 9 November 2016 crashed by 1689 points). Even stock market in India continued to fall during 2016 and sensex fell about 1700 points year on year.



Note: Granger bidirectional causal relationship between conditional risk premium to conditional correlation. Y axis measures the Granger coefficient of coherence and X axis measures the frequency (Omega). The line parallel to the frequency axis (X axis) with Granger coefficient of coherence, which represents critical value for the null hypothesis in terms of probability values at the different levels of level of significance.

However, the causal and reverse causal relationship are also observed between the pairs of gold ETF risk premium and equity risk premium in a few sporadic frequencies but especially it is observed when market is under stress. The result here also corroborates partially that causal relationship between gold ETFs and equity premium are disconnected in most of the frequency domain. This result here suggests that the gold ETFs are the hybrid instruments they are aligned to both the equity and gold futures market.

6. Summary of Findings, Conclusion and implications

This study broadly examines (i) the presence of conditional risk premia in the gold futures (gold ETFs) markets, (ii) size of risk premium in gold futures compared to the gold ETFs and equity, (iii) behaviour of the conditional correlation between returns of the gold futures (gold ETFs) and excess equity returns, (iv) gold portfolio diversification opportunities for equity index investors (v) gold is an asset for hedge against risky index equity (vi) gold futures (gold ETFs) offers safe haven opportunities for the equity index investor (vii) gold futures hedge effectiveness as compared to gold ETFs (viii) gold futures and gold ETFs hedging benefit, (ix) factors determine gold futures risk premium and (x) dynamic nexus between risk premium gold futures (gold ETFs) and equity risk premium.

First, we find that historically investor earned about 6% risk premium in gold futures and about 2% in gold ETF markets in India. It is the equity market which offers about 14% of risk premium during the period and further in terms of risk premium offerings equity market offers more than risk premium either in gold futures and gold ETF markets. Though the quantum of the equity risk premium seems bit inflated but it is true that the Indian equity market is under the influence of bull run during the study period, which justifies the quantum of estimated equity risk premium. Second, the findings on the nature of market it is observed that both gold futures and gold ETFs markets are in backwardation, which supports the Keynes (1930) theory of Normal Backwardation. The sign and size of the gold futures (gold ETFs) risk premia may be guide for the future but it requires further exploration across different time horizons. Thus, this study is an indicative and investor should be cautioned enough devising the trading strategies while extrapolating the size and sign of the gold risk premium from the past into futures. Third, the empirical findings on the conditional risk premium of gold futures (gold ETFs) markets confirms that their returns are time varying with the equity index in India.

Fourth, empirical finding suggests that conditional correlation between the gold futures (gold ETfs) and equity returns persistently declining over time. Thus, the result here confirms the power of diversification benefits of gold futures for the portfolio of equity index. That means long equities and gold futures as strategic asset allocation has remained a continuing story for the investor and portfolio managers in the Indian market. Fifth, the inverse co-movement of the conditional correlation and conditional variances of the equity and gold futures (gold ETFs) also depicts that at the time of high equity market volatilities conditional correlation plunges and vice versa. This result here corroborates the earlier findings that gold futures contract is observed to be a strategic asset for the equity portfolio investor/ portfolio manager, who can effectively hedge away equity portfolio risk investing in gold futures at the time of market turbulence. This finding here is in support of the empirical literature (Bodie and Rosansky, 1980; Carter et al.,1982; Bodie, 1983; Jaffe,1989; Shishko,1977; Jensen et al., 2000; Ciner, 2001; Erb and Harvey, 2006; Chong and Miffre, 2007; Baur and Lucey,2010, Baur and

McDermott,2010; Erb and Harvey, 2013; Reboredo, 2013; Hood and Malik, 2013; Nguyen et al. 2017). Thus, the findings of the study here supports the hypothesis:

Sixth, observed negative relation between conditional correlation and equity market variance suggests the economic rationale of flight to quality at the time of market stress. Further the negative sign and size of the equity market volatility interaction dummy during equity market stress period suggests that gold futures and gold ETFs offers safe heaven opportunity and risk diversification to the equity index investor in India. This finding here is consistent with the academic literature and institutional investors practice, who short their shares in order to stop the loss in the equity portfolio and take long position in the gold futures market during the period of extreme equity market stress (Capie et al., 2005; Baur and Lucey,2010, Baur and McDermott,2010; Erb and Harvey, 2013; Reboredo, 2013; Hood and Malik, 2013; Nguyen et al. 2017). Thus, the study here confirms the Hypothesis

Seventh, findings of hedge effectiveness measured via HEI_{Var} , HEI_{VaR} and HEI_{CVaR} are in conformity with the conditional correlation and market volatilities findings captured in section 4.4. That means the hedge effectiveness and safe heaven properties of the portfolio is found to be effective when gold futures (gold ETFs) is (are) a constituent along with the equity index in a portfolio especially during the period of equity market turmoil. This result is in conformity with the empirical literature that the usefulness of gold futures in the portfolio risk management, and the portfolio composed with gold experiences, Var, VaR and CVaR reductions. These findings are in conformity with the some of the previous studies aligned with India and world (Reboredo, 2013; Arouri et.al., 2015; Gulseven and Ekici, 2016; Chkili, 2016; Nguyen and Prokopczuk).

Eighth, the empirical findings here confirm that is the gold futures offers the higher risk adjusted return measured in terms of Sharpe ratio compared to gold ETFs, which confirms the superior role of gold futures over and above the gold ETFs for portfolio diversification in Indian market for the equity index investor.

Ninth, it is realised futures basis, realised risk premium and realised skewness have appositive bearing on the gold futures risk premium. It is the conditional correlation between the gold futures return and excess equity returns have inverse bearing in determining the gold futures risk premium. However, it is the gold futures basis found to be the most prominent determinants of the gold futures risk premium in Indian market, which is in line with the commodity futures empirical literature (Khonjodizic, 2017). Further, positive and significant coefficient on gold price realised volatility as an determinants of gold futures risk premium are in similar line with the empirical thinking reported in the commodity market (Khonjodizic, 2017), currency futures market (Jiang and Chiang, 2000) and equity market (Guo and Whitelaw, 2006). The coefficient on realised skewness is statistically significant and positive with an average of 0.108% per day across models. This result here lend indicates that realised gold price skewness matters to the pricing of gold futures risk premium and that investors demand higher compensation for exposure to gold futures at times with lower levels of skewness. Empirical literature also claims that positive skewness has a valuable impact on the utility investors derive from their investments, which lend supports to the theories on skewness preferences (Mitton and Vorkink, 2007; Barberis and Huang, 2008). Since commodity futures markets are not subject to short-sale constraints and are dominated by speculators and hedgers, with retail investors rarely participating, our findings are more in line with the cumulative prospect theory framework of Barberis and Huang (2008). This result has also implication on hedgers who practices selective hedging with a view of future price movements influences their optimal hedge ratio. Further it is also observed that among the structural macroeconomic covariates dfci and dwti have positive bearing and all others covariates are observed to have negative bearing on the gold futures risk premium.

To analyze the issue of dynamic nexus between gold futures risk premium and equity risk premium in depth, study deploying VECM, time domain and frequency domain analysis. The time and frequency domain analysis decompose the causal relationship into time and frequency components using VECM Granger Exogeneity test and Breitung and Candelon's (2006) frequency domain approach. To the best of my knowledge, this is first ever study in this direction with the present frequency domain approach application to any gold futures market. Converging 'irf' analysis, time domain causality and frequency domain causality the study reveals that the risk premium in gold futures market granger-causes the risk premium in equity market irrespective of the frequencies and over time. This confirms the believe that a short run and long run risk premium causality running from the gold futures market to the equity market in India but the reverse causality of risk premium from equity market to gold futures market is true only when global and domestic equity markets seems to be under stress.

The outcome of this study has academic, managerial and regulatory policy implications. From the academic point of view, this study answers one of the the most enduring questions in the domain of financial economics with regards to the validity of the normal backwardation theory in Indian gold futures market for the first time to the best of my knowledge while lending support to empirical literature (Dusak, 1973; Ehrhardt et al., 1987; Kolb, 1992; Miffre, 2007; Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). From the managerial point of view portfolio with gold futures and gold ETFs offers portfolio diversification and safe haven opportunities to the index equity investors. The portfolio managers and institutional investors are required to mix the gold futures preferably over the gold ETFs into the equity index portfolio for risk diversification, optimal risk adjusted return and hedge effectiveness. Further this study also offers a few stochastics variables such as financial confidence index and gold silver ratio as trading indicators for the investors in gold futures market. Further the detection of positive skewness as one of the predictor variables in the gold futures market may possibly investor building trading strategies to exploit the risk premium in the gold futures market. These findings of the study also have important policy implications from the regulator and policy formulations point of view in India. Thus, it is recommended that the dependence on gold futures as a hedging tool for equity investors should be reduced by incorporating more hedging instruments like gold ETFs and gold options in India. Commodity trading exchanges should take greater interest in forwarding and launching such hedging instruments in Indian so as to avoid market inefficiencies.

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Appendix I

Table 1A: Descriptive statistics of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max	VIF	1/VIF
rpm	2303	0.01	1.37	-8.38	9.51		
Rf	2303	0.04	1.03	-9.47	5.66		
Rs	2303	0.04	0.90	-8.66	4.40	2.2	0.45
basis	2303	0.00	1.02	-8.98	7.54	1.27	0.79
variance	2303	0.97	1.65	0.00	22.24	3.48	0.29

skewness	2303	0.01	5.21	-104.8	56.5	2.04	0.49
kurtosis	2303	0.66	17.15	-3.00	491.4	3.64	0.27
dmrp	2303	0.00	1.00	-6.39	13.42	1.04	0.96
dfci	2303	0.00	1.00	-1.47	2.59	2.35	0.43
ddix	2303	0.00	1.00	-1.79	1.95	2.35	0.43
dwti	2303	0.02	2.25	-12.91	12.56	1.01	0.97

Table 1 B : Correlation across the variables used in the risk premium examination

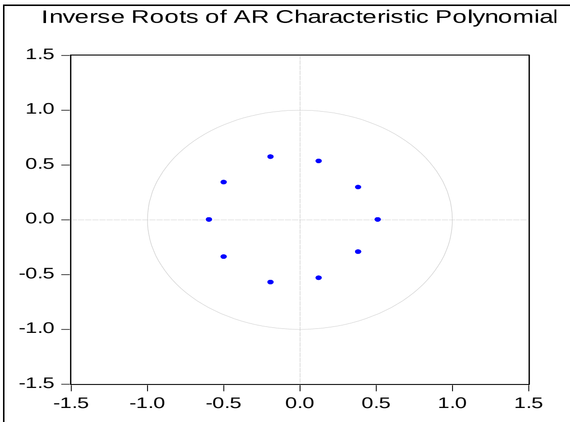
	rs	sdbasis	rfsq	crl_mrf	skewness	kurtosis	lm2	ddix	dfci	dgslvr	dwti	lfxr_d	mrp	Usmrp
Rs	1													
sdbasis	-0.513	1												
rfsq	-0.0332	-0.1012	1											
crl_mrf	-0.0565	0.0257	-0.0086	1										
skewness	0.6896	-0.2836	-0.1612	-0.0333	1									
kurtosis	-0.114	0.0146	0.3824	0.0233	-0.2163	1								
lm2	-0.0366	0.0002	-0.063	-0.1476	0.0071	0.0107	1							
ddix	-0.0353	-0.0006	-0.0642	-0.1818	0.0092	0.0047	0.7716	1						
dfci	0.0354	-0.0016	0.0877	0.1038	-0.0122	-0.0045	-0.8573	-0.7575	1					
dgslvr	-0.0394	0.0096	-0.0227	-0.1017	0.0104	0.0014	0.6064	0.7658	-0.7492	1				
dwti	0.0141	0.0726	-0.0284	-0.014	0.0206	-0.0381	-0.0267	-0.0218	0.0255	-0.0123	1			
lfxr_d	-0.0449	-0.0014	-0.0214	-0.1723	0.0058	0.0066	0.927	0.8148	-0.8587	0.7614	-0.0263	1		
mrp10	-0.124	-0.0302	-0.0595	-0.0089	-0.0827	-0.0099	-0.0209	-0.0111	-0.0127	0.0196	0.118	0.0025	1	
usmrp	-0.0658	-0.1095	-0.0971	0.0254	-0.0132	-0.0388	-0.0109	-0.0238	0.0033	-0.0034	0.321	-0.0028	0.3168	1
Note: This table represent the correlation matrix of the independent variables														

Table 1 C Unit root tests statistics of the variables under the study

Variables	ADF		KPSS	
	Intercept without trend	Intercept with trend	Intercept without trend	Intercept with trend
Rpm	-7.675***	-7.666***	0.071	0.065
r_t	-47.560***	-47.610***	0.338	0.065
$basis_t$	-27.940***	-27.930***	0.065	0.045
$rvar_t$	-47.320***	-47.310***	o.0049	0.005
$rskw_t$	-49.213***	49.200***	0.062	0.041
$rkur_t$	-48.270***	-48.260***	0.042	0.028
mrp_t	-45.369***	-45.370***	0.149	0.088
$dfci_t$	-34.915***	-34.909***	0.083	0.048

$ddix_t$	-49.028***	-49.022***	0.083	0.063
wti_t	-49.484***	-49.507***	0.226	0.071
usmrp	-32.028***	-33.022***	0.283	0.233
Note: This table captures the unit root statistics associated with the independent variables. *** and ** indicate level of significance at 1% and 5% level respectively				

Table 8A: Vector Error correction specification test



Root	Modulus
1.000000	1.000000
-0.585141 - 0.310201i	0.662280
-0.585141 + 0.310201i	0.662280
-0.105999 - 0.645361i	0.654009
-0.105999 + 0.645361i	0.654009
0.486153 - 0.403886i	0.632035
0.486153 + 0.403886i	0.632035
-0.229260 - 0.505185i	0.554772
-0.229260 + 0.505185i	0.554772
0.381113 - 0.390986i	0.546001
0.381113 + 0.390986i	0.546001
-0.456081	0.456081
VEC specification imposes 1 unit root(s).	

Table 8B: Vector Error correction specification test

Test name and lag order	Null Hypothesis	Test statistics	p value
VAR Residual Serial Correlation LM Tests [lag 5]	H0: No autocorrelation at lag order	8.16	0.086
VAR Residual Normality Tests-Joint J–B test [lag 5]	H0: residuals are multivariate normal	22485139	0
VAR Residual Heteroskedasticity Tests [lag5]	H0: residuals are homoscedastic	5.5491	0.31
Multivariate ARCH–LM TEST with 2 lags [lag5]	H0: N0 ARCH effect	9.32	0.19