An Empirical Analysis of Inflation Hedging Potential of Commodity Futures: A Regime Switching Approach

Ritika Jaiswal
Rashmi Uchil
National Institute of Technology Karnataka (NITK), Surathkal, Mangalore

Abstract

This study analyses inflation hedging potential of individual commodity futures viz. crude oil, gold, silver, copper and zinc for the sample period from April 2005 to April 2015. On the basis of information selection criterion, linearVector Error Correction Model (VECM) and nonlinearMarkov-Switching Vector Error Correction Model (MS-VECM)are employed to analyse the time-varyingmovement of long-run inflation hedging properties of commodity futures. Theerror correction mechanism of VECM gives evidence of full inflation hedging ability of gold and silver futures. On the contrary, results of VECM give very weak evidence of the inflation hedging potential of crude oil. The MS-VECM estimation confirms the partial hedging potential of copper and it is appropriately represented by both the regimes. Conversely, the Johansen cointegration test suggests the lack of long-run relationship between zinc and inflation index. Hence, it is concluded that precious metals possess better inflation hedging potential than energy and industrial metals. Based on these findings, it is suggested that futures on gold, silver and copper can be effectively used as a hedge against inflation and inflation hedging potential of these commodities does not depend on the time horizon of investment.

Keywords: Cointegration, Commodity futures, Hedge, Inflation, Markov-switching, Vector error correction model.

1. Introduction

Two extreme sides of inflation, in terms of hyperinflation and deflation always create havoc for the economy. To maintain inflation at an acceptable rate becomes the cornerstone of a policy framework for an economy, which is suffering from the long-run erosive effect of unstable inflation on assets' return and overall growth of the economy (Pettinger, 2014).It is apparent from the deflationary situation in European countries and the US in the aftermath of financial crisis. Conversely, India recorded an average inflation rate of 8.44 percent from 2012 until 2015. In November 2013, it reached a recent highof 11.60 percent.In addition, the ruinous case of hyperinflation in Russia during 1992 and 1994, in Zimbabwe during 1999-2009, and in Venezuela in 2015 are few cases that confirm that price stability should be the primary goal of monetary policy-makers (Pilling and England, 2016; Hanke, 2015).

Price stability increases the employment rate, economic growth and the stability of financial markets. High inflation rate disrupts the operations of financial institutions and their integration with the rest of the world market (Pettinger, 2014). Inflation creates uncertainty in future prices, interest rates and the exchange rate, resulting in reduced economic activity of a nation. Stable and sufficiently low inflation do not influence the economic decisions of households and firms, which result in the more efficient allocation of resources. Inflation erodes the real value of an investment and purchasing power over time (Gerolamo, 2015). Conversely, inflation helps the investors to decide the rate of return on their investment they need to make in order to protect their purchasing power and investment returns over the long-run.Hence, several efficacious economic policies such as fiscal policies, monetary policies, supply-side reform policies and labour market reforms are being considered by the government and the central bank to achieve the goal of price stability(Trichet, 2004; Mathai, 2012). In addition, investors should invest in a product which moves with inflation and isimmune to inflation risk(Spierdijk and Umar, 2014).

A vast literature is available to analyse the inflation hedging ability of various asset classes such as stocks, bonds and real estate. However, investment in hard assets such as metals, energy and agricultural commodities is considered a decent approach to hedge against inflation, as they tend to maintain their values in times of inflation (Worthington and Pahlavani, 2007).

Commodity prices, shares and currencies show wide fluctuation and sometimes brutal variations that entail risks arising from unforeseen price changes. The high inflation rate is driven by the rising cost of raw materials and basic commodities and ultimately leads to higher prices for the basic goods such as food and clothing. It is evident from oil crisis and energy crisis in 1973 and 1979 respectively, which caused a stagnant growth and price inflation during the 1970s (Zhou, 2014). Similarly, the 2007-08 subprime crisis was marked by a commodity boom and a high inflation rate. In addition, continuous fall in the prices of crude oil from their 2014 peak, had a positive impact on the retail inflation and domestic growth rate in India (Kumar, 2015).

From a theoretical perspective, the investors, producers and consumers buy a commodity due to increase in expected inflation. They either want to protect their purchasing power due to decline in the value of money or buy a commodity to be onthesafer side, due to the expectation of a rise in the prices of commodities. This activity increases the demand for commodities and yields an increase in price also. Investors with prior knowledge of increase in expected inflation rate can make profits by taking their respective positions in the spot and future markets of the commodities (Beckmann and Czudaj, 2013). Thus, commodities can be used as a hedge against inflation as the movements of commodity prices give a direction to the expected future inflation.The above mentioned arguments indicate that there is a need to analyse the inflation hedging potential of commodity futures in order to identify the role played by commodities in driving the inflation rates.

Investing in commodity futures is one of the alternative ways to invest in commodities and to participate in the commodity market. Commodity futures represent a bet on commodity prices (Gorton and Rouwenhorst, 2006). The commodity futures contract can be used by producers and consumers to protect from price risk as the expected spot prices are reflected in commodity futures prices. The prime motivation of this study is the conventional perception of treating commodity futures as a hedge against inflation. Conventional wisdom indicates that commodity futures can be a natural hedge against inflation due to its ability to accommodate expected commodity price changes (Bhardwaj et al., 2011). The rationale of using commodity futures as an inflation hedge is its ability to incorporate future trends in commodity prices and to foresee the expected deviation in inflation (Gorton and Rouwenhorst, 2006). However, sensitivity in returns of commodity futures to the changes in the inflation rate does not remain constant over time and varies from one commodity futures to another (Erb and Harvey, 2006). These lines of thought motivated usto explore the feasible implications of conventional wisdom related to commodity futures acting as an inflation hedge in the Indian scenario.

The prime contribution of the study to the theoretical world is the analysis of inflation hedging potential of crude oil, gold, silver, copper and zinc futures in the Indian scenario by the application of nonlinear MS-VECM. To the best of authors' knowledge, this is the first paper which has used the regime-switching framework of MS-VECM to investigate the regime-specific equilibrium relationship between individual commodity futures and inflation. The empirical results of the study give evidence of the application of linear VECM for gold, silver and crude oil and nonlinear MS-VECM for copper futures. The estimated results signify the full inflation hedging potential of gold and silver futures. On the contrary, MS-VECM confirms partial inflation hedging potential of copper futures. In addition, like gold and silver futures, investment decision in copper does not depend on the time horizon of investment.

The remaining part of the paper is organized as follows: Section 2 discusses the literature review. Section 3 elaborates the theoretical background of the study while Sections 4 and 5 brief about methodology and dataset used. Section 6 contains the empirical results and discussion, followed by conclusion in Section 7.

2 Literature Review

The following literature provides an insight into the inflation hedging potential of various asset classes such as stocks, bonds, gold and real estate. Mahdavi and Zhou (1997) used conventional VECM to measure the performance of gold and commodity prices as a leading indicator of the inflation rate. Their out-of-sample forecasts of the prices of gold signify that error correction model of the Consumer Price Index (CPI) and commodity prices significantly outperform a CPI model. However, the marginal contribution of an error correction model was statistically insignificant. The inflation hedging property of gold has diminished over time, which undermines the role of gold as a leading indicator of inflation.Levin et al. (2006) used VECM to analyse the long-run and short-run determinants of gold prices from January 1976 to August 2005. They found that there is a long-term relationship between US price level and price of gold. However, there was a presence of slow reversion towards long-run equilibrium from any deviation caused by shocks in short-run. Their conclusions are in line with the outcomes of Laurent (1994), Harmston (1998), Adrangi et al. (2003) and Ghosh et al. (2004) which confirmed the reliability of gold as an inflation hedge both in long-run and short-run in the US, UK, France, Germany and Japan. Worthington and Pahlavani (2007) analysed the structural changes in both gold market and consumer prices by using Zivot and Andrews(1992) unit root test to find out the most significant structural breaks impacting the long-run relationship between these two variables. Their modified cointegration method using these breaks suggested a strong cointegration relationship between gold and inflation, which confirms gold as an efficient inflation hedge. Bekaert & Wang (2010) investigated the inflation hedging capability of standard securitiesand assets using inflation beta derived from an ordinary least squares regression. They found that standard securities such as nominal government bonds and equities are the poor hedge against inflation. Other standard assets such as treasury bills, foreign bonds, real estate and gold improved the relationship, even asforeign bonds and gold perform better than other assets. However, it is difficult for these assets also to hedge the inflation risk.Tiwari (2011) used cointegration analysis with an allowance of structural breaks and seasonal adjustment to investigate the inflation hedging ability of gold from April 1990 to June 2010 in the Indian context. He suggested that gold can be used by investors as an effective tool for hedging inflation.

Wang et al. (2011), Beckmann and Czudaj (2013) and Van Hoang et al. (2016) have examined the long-run and short-run inflation hedging potential of gold by using nonlinear approach.In addition, Bredin et al. (2015) used nonlinear wavelet analysis to examine the hedge and safe haven properties of gold for investors with short and long-run horizons.The findings of Wang et al. (2011) suggested that gold returns cannot be used as a hedge against inflation in both the US and Japan during low momentum regimes, while in the case of high momentum regimes, gold shows its inflation hedging potential only in the US. Beckmann & Czudaj (2013) analysed the inflation hedging ability of gold for four economies, the US, the UK, the Euro area and Japan for a sample period ranging from January 1970 to December 2011 using MS-VECM. They found that gold is a partial hedge against inflation in the long-run and this ability is stronger for the US and the UK compared to Japan and the Euro area. In addition, inflation hedging ability of gold depends on the time horizon of investment. Van Hoang et al. (2016) analysed the inflation hedging potential of gold which is denominated in the local monthly prices of China, India, Japan, France, UK and US. They have used Nonlinear Autoregressive Distributed Lags (NARDL) model for the study period from 1955 to 2015. Their results confirmed that gold is not a hedge against inflation in the long-run for any of the countries. However, gold is an inflation hedge in the short-run only for the UK, the US and India. In addition, they found that there is a lack of long-run equilibrium relationship between gold prices and the CPI in China, India and France.

The above studies have mainly concentrated on investigating the inflation hedging property of gold. Very few studies have been conducted on the inflation hedging property of commodity futures. Bodie (1983), Kaplan and Lummer (1997), Becker and Finnerty (2000) and Menzel and Heidorn (2007) found that commodity futures are valuable portfolio components as they perform better during the high inflationary period. Gorton and Rouwenhorst (2006) used the Sharpe ratio to investigate the simple properties of commodity futures as an asset class. They conducted the study on equally-weighted index of commodity futures and found that commodity futures are positively correlated with inflation, unexpected inflation and changes in expected inflation. Erb and Harvey (2006) used ordinary least squares to investigate the inflation hedging capability of commodity futures. They suggested that all commodity futures are not a good inflation hedge. However,the portfolio of commodity futureswith selected weights of futures can serve as an inflation hedge, while their returns depend on the rebalancing of the portfolio.

Spierdijk and Umar (2014) and Zhou (2014) considered the nonlinear relationship between commodity futures and inflation. Spiedijk and Umar (2014) assessed the hedging properties of commodity futures from 1970 to 2011 using Vector Autoregressive Model (VAR) across three dimensions: market, investment horizon and time. They used the rolling window and sub-sample analysis to incorporate structural changes in the inflation rate and commodity futures prices. They found thesignificant abilityof energy, industrial metals and live cattle to hedge US inflation, especially for an investment horizon of one year. Long-run inflation hedging property of Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI)-total return Index against the US seasonally adjusted CPIwas conducted by Zhou (2014). He adopted MS-VECM for the sample period from January 1983 to December 2012. He found that sub-indices of energy, industrial metals and precious metals were the best inflation hedge. However, the hedging capacity exhibited substantial variation over time.

In the Indian context, Joshi (2013),Thota and Bandi (2015) and Sharma (2015) investigated inflation hedging potential of commodity futures. Joshi (2013) used the standard statistical method to investigate the potential of pepper, steel, mustard seed and wheat futures to hedge the portfolio of equities against the risk of inflation. They found that all these commodity futures provide a hedge against fall in the equity prices in an inflationary environment. Similarly, Thota and Bandi (2015) used the normal regression model to analyse the inflation hedging potential of base metals and agricultural commodities traded in National Commodity & Derivatives Exchange (NCDEX) for the study period from January 2004 to December 2014. They found that most of the commodity futures under agricultural sector can be used as a hedge against inflation. In addition, Sharma (2015) analysed the performance of a conventional portfolio with and without the inclusion of inflation tracking portfolios. They found that conventional portfolio gives higher Sharpe ratios during the high inflationary period due to the present of inflation tracking portfolio. Hence, their results confirm the inflation hedging potential of commodity futures with the exception of agricultural commodities.

Through literature review, it is found that studies related to measuring the time-varying exposure of individual commodity futures to inflation using the nonlinear framework are very limited. For instance, Zhou (2014) used MS-VECM to analyse the inflation hedging potential of commodity futures index. However, he didnot consider the individual commodity futures. Similarly, there is a lack of studies to analyse the inflation hedging potential of commodity futures using the nonlinear approach in the Indian context. For instance, Joshi (2013), Thota and Bandi (2015), and Sharma (2015) have conducted studies in this stream for the Indian context. However, they used a simple linear regression model. Hence, this study analyses the inflation hedging potential of individual commodity futures using the nonlinear framework in the Indian context.

The present study contributes to the existing literature by analysing the inflation hedging potential of individual commodity futures by using linear VECM and nonlinear MS-VECM framework. It investigates the changing nature of inflation hedging properties of individual commodity futures among the different states of the economy in the Indian context.

3. Theoretical Framework

In the existing literature, inflation hedging has been defined in different ways. Informally, an asset can be qualified asan inflation hedge if it can immune the investors' return from the general increase in the price level. Many inflation hedging measures have beenproposed in literature and all these measures evaluate the inflation hedging potential of various assets from different aspects such as the Fisher hypothesis (Theory of Interest) converted into an empirical test by Fama & Schwert(1977), Pearson correlation used by Hoevenaars et al.,(2008), cointegration approach used by Ely and Robinson (1997), Mahdavi and Zhou (1997) and Anari and Kolari (2001), hedge ratio and cost of hedging used by Bodie (1976) and hedging demand and inflation tracking portfolio by Bodie (1976) and Schotman & Schweitzer (2000).

From a theoretical perspective, it is necessary to check the long-run equilibrium relationship between commodity futures price and inflation since the variables deviate from their equilibrium relationship due to short-run price volatility (Ghosh et al., 2004). The validity of any commodity as an inflation hedge is justified only if prices adjust to any variation from long-run equilibrium relationship. In addition, from an econometric point of view, the cointegration approachis needed when the series is integrated of order one which leads to distinguished long-term and short-term analysis of inflation hedging potential. If an asset is cointegrated with inflation then it can be considered at least a partial hedge against inflation for institutional investors with a long-term investment horizon, whereas short-term dynamics allow the evaluation of hedging properties of this asset at shorter horizons. Hence, the cointegration technique seems to be the most suitable technique to verify the inflation hedging potential of commodity futures. Many studies adopted the conventional cointegration technique to investigate the inflation hedging potential of different asset classes such as Ely and Robinson (1997) used VECM to identify the long-run and short-run dynamics between output, money, stock prices and goods prices. According to them, stock prices are considered to be a good hedge against inflation if, in response to a real or monetary shock in inflation, stock prices adjust their values relative to the goods prices. Anari and Kolari (2001) applied VEC model and impulse response function to assess the impact of an inflationary shock on stock prices over time. They found that if the permanent effect of inflationary shock on expected stock return is equal to unity, then the stock can be considered as a complete long-run hedge against inflation.

However, commodity prices and inflation usually undergo many structural changes and show significant variation in time series. The sudden and unexpected changes in the movements of commodity prices cause the presence of different regimes in the economy, such as the bull phase during sub-prime crisis, the bear phase during the European crisis and the recent economic slowdown in China. The application of the conventional linear model for these scenarios will not provide the proper analysis of inflation hedging potential of commodity futures as these regimes depict different equilibrium relationship between commodities and inflation (Beckmann and Czudaj, 2013). Thus, from a theoretical perspective, it is essential to adopt the time-varying cointegration approach to estimate the inflation hedging potential of commodity futures under different regimes of the economy. In these cases, MS-VECM is more suitable than any other time-varying model since it is based on the state-dependent time series model where unobservable state follows the exogenous stochastic process rather than deterministic process.

4. Methodology

This study adopts a linear VECM and nonlinear MS-VECM to analysethe inflation hedging property of individual commodity futurescontract in different regimes and their pace of adjustment towards the long-run equilibrium. The Markov-Switching (MS) model is originally designed by Hamilton (1989), which is further extended by Krolzig (1997, 1998), who provided the overview of Markov-switching vector auto regression model. The concept of MS-VECM is based on the state-dependent time series model, which allows for a shift of some estimated parameters between the stochastic, unobservable regimes. These unobservable regimes are generated using a stationary, irreducible ergodic Markov chain.Maximum likelihood estimation of MS-VECM includes the additional process of adjustments of divergence in the long-run equilibrium relationship in each regime.

MS-VECM is the generalization of the basic VECM with finite order of *p* and *r* cointegrating vector. Thus, the VECM for a k-dimensional time series vector is $Y_t=(Y_{1t},\ldots,Y_{kt})$, t = 1, ... , T, with p^{th} order of autoregression and *r* cointegrating vector is shown in Equation (1):

$$\Delta Y_t = \upsilon + \sum_{i=1}^{p} P_i \, \Delta Y_{t-1} + \sum_{j=1}^{r} C_j V_{t-1} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t \sim \text{IID}\,(0, \Sigma)$$

Where IID refers to Independent and Identically Distributed, υ is the intercept term, P_i shows the short-run dynamics of the model, C_j measures the speed of error correction and V_t contains the residuals from the error correction equation.

This study generalized the VECM (p,r) by using MS-VECM of M-regimes, p^{th} order autoregression with *r* cointegrating vector. This model allows the regime shift in the intercept term, the autoregressive parameter, error correction speed coefficient and variance-covariance matrix of residuals as shown in Equation (2).

$$\Delta Y_t = \upsilon\,(S_t) + \sum_{i=1}^{p} P_i(S_t)\; \Delta Y_{t-1} + \sum_{j=1}^{r} C_j\; (S_t) V_{t-1} + \varepsilon_t$$

$$\varepsilon_t \,|\, S_t \sim NID\,(0, \Sigma(S_t)), \qquad t = 1,\ldots\ldots, T \qquad (2)$$

Where, NID refers to Normally and Independently Distributed, ΔY_t shows the time t column vector of observation, S_t = 1, 2,….M represents the regime in time t, $\upsilon(S_t)$ shows the vector of regime-dependent intercept terms. $P_i(S_t)$is a row vector of p^{th} order autoregressive parameters in regime S_t, denotes the state-dependent short run dynamics of the model. $C_j(S_t)$ measures the speed of error correction in regime (S_t) and V_t is the column vector representing the residuals from the error correction equation.

The coefficient of the long-run error correction term should be negative and statistically different from zero in order to provide regime-specific equilibrium correction and unconditional cointegration. The regime generating process is guided by Markov chain with a finite number of regimes, $S_t \in \{1,………,M\}$ and constant transition probabilities. Transition probability of switching from regime i to regime j at time t+1 is independent of the history of the process, is depicted in Equation (3).

$$P_{ij} = P_r(S_{t+1} = j \mid S_t = i),\ P_{ij} > 0,$$

$$\sum_{j=1}^{M} P_{ij} = 1\ \forall \quad i,j \in (1, \ldots\ldots, M) \tag{3}$$

State variable S_t follows the transition matrix represented in Equation (4), which is decided by an irreducible ergodicM state Markov process:

$$P = \begin{pmatrix} P_{11} & P_{12} \ldots\ldots & P_{1M} \\ P_{21} & P_{22} \ldots\ldots & P_{2M} \\ \vdots & \vdots & \vdots \\ P_{i1} & P_{i2} \ldots\ldots & P_{im} \end{pmatrix} \tag{4}$$

Where $P_{im} = 1 - P_{i1} - \ldots - P_{i,m-1}$ for $i = 1, \ldots, M$.

The smoothed probability estimated in the MS model represents the conditional probability which uses all the information in the sample up to future date T and as a result, it represents the ex-post measure. In MS model, smoothed probability is estimated at each point in time and based on this smoothed probability, each observation is classified to a regime. The classification rule signifies the assignment of each observation in the regime with the highest probability. In case of two regimes, classification rule specify the classification of observations to the first regime if $P_r(S_t = 1 \mid Y_t) > 0.5$ and to the second if $P_r(S_t = 1 \mid Y_t) < 0.5$. The average duration of the first regime and second regime can be computed by Equation (5) and (6).

(5)Average Duration of Regime 1 = $1/(1- P_{11})$

(6)Average Duration of Regime 2 = $1/(1- P_{22})$

The MS-VECM model is estimated with the Grocer toolbox forScilab (Dubois and Michaux, 2013).The parametersof MS-VECM model are estimated by maximum log likelihood function via Expected Maximum (EM) algorithm.

5. Data and Summary Statistics

This study is conducted on crude oil, gold, silver, copper and zinc futures traded on Multi Commodity Exchange (MCX), which covers 83 percent of the commodity market in India. The Indian commodity exchange MCX has been chosen for study as it is not only the largest commodity exchange in India, but also the world's third largest commodity futures exchange in terms of the number of contracts traded in 2012. According to Annual Volume Survey of Futures Industry Association (FIA), MCX is the largest silver and gold exchange, second largest copper and natural gas exchange and third largest crude oil exchange in terms of a number of commodity futures contracts traded for each commodity. The current study uses monthly futures contract prices of five commodities, gold, silver, crude oil, copper and zinc from April 2005 to April 2015 as these commodity futures are the top five commodity contracts traded in MCX in terms of their average daily value. However, availability of data with a higher frequency can give a better analysis of linearity and nonlinearity in the movements of commodity futures and their inflation hedging potential. In addition, 2003-04 isconsidered asignificant year for the development of commodity futures market in India due to the establishment of many nationwide multi commodity exchanges (Gupta, 2011). However, the prices of commodities considered for the study are taken from April 2005, due to the inconsistency on the availability of data for all the months from 2003 to 2005. Although, the study period is short to give firm conclusion, during this period, commodity market has experienced many ups and downs such as industrialization of China (which has given the boost to the global economy), sub-prime crisis in the US, the European crisis and recent economic slowdown in China. Hence, the period is rich enough to give a better regime-specific analysis of inflation hedging potential of commodity futures.

Future prices of commodities considered for the study are retrieved from the website of MCX. These commodities are the constituents of sub-indices MCXMETALS and MCXENERGY of composite index MCXCOMDEX. The commodity-specific Wholesale Price Index(WPI) is selected as inflation index and its value is retrieved from the Database of Indian Economy of RBI. WPIis considered for the study instead of the CPI as a measure of inflation since the commodities under study are not the part of CPI in India.

The nearby futures contracts are used to construct the future price series as these are the most actively traded contract. The rollover of the series from first nearby contract to next nearby contract is performed during rolling periods based on the rolling mechanism adopted by MCX. Before the start of the rolling period, future price series takes the price of the first nearby contract and after the end of the rolling period, the series takes the price of the second nearby contract. During the rolling period, series incorporates the next nearby future price series in a predetermined manner of rolling 20 percent of each day.

Summary statistics on returns of gold, silver, crude, copper, zinc and commodity-specific WPI are given in Table 1. Continuously compounded logarithmic returns are used, which are estimated by taking the first difference of natural logarithm of futures prices of commodities and commodity-specific WPI. Among the five commodities, gold has the highest average monthly return of 1.22 percent with the lowest standard deviation of 5.18 percent, while zinc has the lowest average negative monthly return of -0.018 percent with a standard deviation of 8.199 percent. However, crude oil shows the highest volatility of 8.86 percent with an average monthly return of 0.45 percent. The average monthly inflation rate 1.25 percent with the standard deviation of 3.55 percent for WPI index of gold is highest among the five commodity-specific inflation rates. Whereas, WPI of zinc has the lowest average monthly inflation rate of 0.37 percent with a standard deviation of 3.47 percent.

6. Results and Discussion

Based on a broader overview of Markov-switching vector autoregression given by Krolzig(1997), the analysis is performed in two stages. In the first stage, the Johansen cointegration test is used to identify the cointegration relationship and a number of cointegrating vectors between the variables. In the second stage, estimation of VECM and MS-VECM are performed for each model and the best model is chosen by systematically considering the information criterion: Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQ).

Table1: Summary statistics

	Gold	Silver	Crude	Copper	Zinc	WPI-Gold	WPI-Silver	WPI-Crude	WPI-Copper	WPI-Zinc
Mean	1.21	1.04	0.451	0.849	-0.018	1.25	1.05	0.591	0.451	0.376
Median	1.19	1.08	1.89	1.102	0.198	0.963	0.697	0.271	0.00	0.00
Maximum	16.19	28.58	20.63	29.61	20.09	12.09	25.62	25.16	11.53	20.99
Minimum	-13.20	-22.67	-36.99	-37.86	-33.84	-8.83	-14.37	-31.26	-4.13	-22.29
SD1	5.18	8.85	8.86	8.13	8.19	3.55	5.89	8.83	1.95	3.47
Skewness	0.103	0.111	-0.857	-0.726	-0.669	0.242	0.657	-0.476	2.61	-0.617
Kurtosis	3.43	3.59	5.11	7.52	4.79	4.26	5.85	5.21	14.79	29.46
Jarque-Bera	1.14	2.01	36.97	112.50	22.56	9.05	49.29	28.82	831.24	3157.85
Probability	0.5657	0.3661	0.00	0.00	0.00	0.01083	0.00	0.00	0.00	0.00
Observation	120	120	120	120	120	120	120	120	120	120

Notes: SD[1] refers to the standard deviation.

6.1 Unit root test and cointegration analysis

In this section, the unit root test is performed to check if commodities and inflation are integrated of order one. Then, Johansen cointegration test is performed on level data to test whether commodities and inflation series are cointegrated.

The Augmented Dickey Fuller (ADF) test is applied to check the stationarity of time series data. In order to take into account the possibility of a structural break, the Zivot and Andrews (1992) unit root test is used. This test allows for a single break both in the intercept and trend. The results of the unit root test are provided in Table2. For the ADF test, the null hypothesis of unit root is accepted at onepercent level of significance for level time series of all the five commodities and commodity-specific WPI.The null hypothesis of unit root is rejected when the first difference of time series is considered. Similarly, for the Zivot and Andrews test, the null hypothesis of a unit root with a structural break in both the intercept and trend is accepted at the onepercent level for all the time series in their level form. In addition, based on AIC, SIC and HQ information criterionthe autoregressive order of one is selected for all the pairs of commodity and commodity-specific WPI.

Next, the Johansen cointegration test is performed to test the existence of a cointegrated vector for models as presented in Table 3. In the first model of crude and WPI, Johansen's trace statistics confirm the existence of one cointegrating vector at fivepercent level. In the model of gold and WPI, Johansen test statistics indicate the existenceof one cointegrating vector. Similarly,in the third model of silver and WPI and fourth model of copper and WPI, Johansen test of trace statistic and max-eigen value imply one cointegrating vector at the onepercent level. The estimated values of the normalized cointegrating vector for all models are presented in Table 4.In the fifth model of zinc and WPI, Johansen trace test and max-eigen value test confirm the zero cointegrating vector between zinc future price series and inflation.This result suggests the lack of long-run association between zinc and inflation and concludes that zinc futures cannot be used to hedge inflation. In all vectors, except for zinc and WPI, the coefficients are in the expected side, where each cointegration vector entails a positive relationship in the long-run between commodity and WPI. However, gold and silver coefficients are equal to unity in magnitude which depicts proportional relationship of inflation with gold and silver. On the contrary, the copper coefficient is less than unity in magnitude suggesting partial hedging capability of copper future series. The crude oil coefficient is greater than unity, which suggests that crude oil is not able to fully hedge inflation as there is a lack of proportional relationship essential forthe long-run association.

Table 2: Unit root test statistics

	Level Series		First Difference	
	ADF Test	Zivot Andrews Test	ADF Test	Zivot Andrews Test
Gold	-1.678631*	-4.831544*	-13.14161	-13.64990
Silver	-1.623493*	-4.952168*	-11.30789	-9.506214
Crude	-3.171932*	-4.885994*	-7.857013	-8.288129
Copper	-2.523413*	-3.836267*	-8.424634	-9.729757
Zinc	-1.679933*	-5.374482*	-11.34118	-12.36556
WPI-Gold	-0.530756*	-4.629628*	-10.37028	-10.94916
WPI-Silver	-1.179044*	-4.974868*	-8.093387	-8.685411
WPI-Crude	-0.571434*	-3.789352*	-10.94485	-11.32122
WPI-Copper	-2.621863*	-3.0099328*	-4.620237	-5.818255
WPI-Zinc	-3.306422*	-4.197269*	-14.05784	-15.23390

*Statistically significant at 1% level of significance.

Table 3: Johansen cointegration test

Models	r(No. of cointegration)	Trace Statistics	Probability	Max-Eigen Statistics	Probability
Crude-WPI	0	16.06819	0.0410	13.82211	0.0586
	1	0.018698	0.1340	2.246076	0.1340
Gold-WPI	0	26.59969	0.0007	25.23156	0.0006
	1	1.368135	0.2421	1.368135	0.2421
Silver-WPI	0	52.06879	0.0000	49.71148	0.0000
	1	2.357313	0.1247	2.357313	0.1247
Copper-WPI	0	25.62334	0.0050	20.72728	0.0070
	1	4.896058	0.4184	4.896058	0.4184
Zinc-WPI	0	13.55735	0.0959	12.42965	0.0955
	1	1.127708	0.2883	1.127708	0.2883

Table 4: Cointegrating vectors from Johansen estimation

Variables	Vector # 1	Vector # 2
Log(Crude)	-1.7671759	1.7544326
Log(WPI)	1	-3.5389788
Log(Gold)	-1.0096462	4.3114964
Log(WPI)	1	-2.2483232
Log(Silver)	-1.0027849	1.1569745
Log(WPI)	1	0.8340556
Log(Copper)	-0.0342800	1
Log(WPI)	1	-1.3159629

6.2 Estimation of VECM and MS-VECM

After establishing a cointegrating relationship between variables of different models, next, linear VECM and different variants of MS-VECM are estimated. The tests based on information criterion are used to determine the number of regimes for each model.

6.2.1 Inflation and Crude

Table 5 shows the comparison of linear VECM and different specification of nonlinear MS-VECM based on information criterion (AIC, SIC, HQ) and log-likelihood values. According to AIC, the best model specification is MSIAH(3)VECM(1,1) with three regimes, heteroscedastic errors and an autoregressive order of one, SIC favours linear VECM(1,1) while HQ favoursMSIAH(2)VECM(1,1) with two regimes, heteroscedastic error and an autoregressive order of one.SIC supports more parsimonious model and protects from over-parameterisation by imposing stiffer penalty term associated with a number of parameters than AIC and HQ. Hence, preference is given to SIC test results as the selection is made among a

Table 5: Information criterion of VECM and MS-VECM of Crude and WPI

Lag=1	Estimation Period	No. of Obs.	AIC	SIC	HQ	Log-likelihood
VECM(1,1)	2005m7-2015m4	118	-526.75	-488.64	-511.39	274.37
MSIA(2)VECM(1,1)	2005m7-2015m4	118	-525.22	-459.41	-459.41	281.61
MSIAH(2) VECM(1,1)	2005m7-2015m4	118	-563.25	-480.12	-529.74	305.62
MSIA(3)VECM(1,1)	2005m7-2015m4	118	-554.13	-446.75	-510.84	308.06
MSIAH(3)VECM(1,1)	2005m7-2015m4	118	-574.42	-439.33	-519.96	326.21

parsimonious linear model and a less parsimonious nonlinear model. Thus, from an econometric point of view, linear VECM is selected for estimating the inflation hedging potential of crude oil and concluded that there is weak evidence in favour of two regimes and three regimes.

VECM estimation of crude oil and WPI is presented in Table 6. The speed of convergence towards the long-run relationship is determined by the coefficient of the error correction mechanism.The error correction coefficient is the product of cointegrating vector and speed coefficient. Cointegrating vector shows the long-run equilibrium relationship between variables and speed coefficient representing the speed ofcorrection of disequilibrium caused by deviation in the short-run.The negative sign of the long-run error correction coefficient (-0.219) and its t-statistics (-3.74) incrude oil futures price shows the convergence of crude futures price towards inflation. However,a positive sign of the error correction coefficient (0.037) inthe equation of inflation shows the divergence of WPI from crude futures price, though it is not significant. In order to hedge inflation risk, it is essential that the high crude futures price today results in high inflation tomorrow. Convergence of WPI towards crude futures price is essential for this reverse causality to be at work. The short-run dynamics are shown by changes in lagged value of crude oil and WPI. There is a significant and positive dependence of changes in crude oil return over its lagged return. However, there is an insignificantly negative relationship between lagged inflation index and changes in crude. Conversely, there is a positive and significant relationship between changes in WPI and changes in lagged crude oil prices, which signifies that increase in crude future prices results in an increase in WPI.It gives the positive indication of inflation hedging potential of crude oil in short-run. However, long-run dynamics showinefficiency of convergence of WPI towards crude futures price, which is a weak evidence of inflation hedging potential of crude oil futures.

Table 6: Results of the Linear VECM estimated for the model of Crude and WPI

Parameters		Δ Crude	Δ WPI
Intercept		1.16[3.75]*	0.349[1.12]
Δ Crude(-1)		0.409[3.85]*	0.481[4.52]*
Δ WPI(-1)		-0.083[-0.815]	-0.232[-2.27]**
Error Correction		-0.219[-3.74]*	0.037[-1.10]
Standard Errors		0.0819923	0.0820570
Correlation	Δ Crude	1.00000	0.513555
	Δ WPI	0.513555	1.000000

Values in the square bracket exhibit the't' statistics and * shows the significance level at 1%, ** at 5% and *** at 10%.

Table 7: Information criterion of VECM and MS-VECM of Gold and WPI

Lag=1	Estimation Period	No. of Obs.	AIC	SIC	HQ	Log-likelihood
VECM(1,1)	2005m7-2015m4	118	-914.82	-876.72	-899.46	468.41
MSIA(2)VECM(1,1)	2005m7-2015m4	118	-869.58	-803.77	-843.05	453.79
MSIAH(2) VECM(1,1)	2005m7-2015m4	118	-938.04	-854.91	-904.53	493.02
MSIA(3)VECM(1,1)	2005m7-2015m4	118	-906.85	-799.47	-863.56	484.42
MSIAH(3)VECM(1,1)	2005m7-2015m4	118	-964.61	-829.52	-910.15	521.30

6.2.2 Inflation and Gold

The details of information criterion and log-likelihood values of the linear VECM and different specification of nonlinear MS-VECM are presented in Table 7. As per AIC and HQ information criterion, the nonlinear model with three regimes is better than the linear model and the best model specification is MSIAH (3) VECM (1, 1). However, SIC supports the linear VECM (1, 1) as it has minimum SIC value compared tovariants of MS-VECM with two regimes and three regimes.From an econometric perspective, preference is given to SIC test results and the linear VECM is selected for estimating the inflation hedging potential of gold futuresand conclude that there is weak evidence in favour of two regimes and three regimes.

The estimation results of the linear VECM are presented in Table 8. There is an evidence of equilibrium adjustment in inflation index as the error correction coefficient (-0.254) has the negative sign and is statistically significant with t-statistics 3.56. This convergence of inflation towards gold future price gives an indication that inflation reacts to the changes in the prices of gold futures. It confirms that gold future price movements give direction to the inflationary expectation and can be used as a hedge against inflation. Short-run dynamics are shown by a positive and significant relationship between change in inflationand the lagged changes in the gold prices. It indicates the inflation hedging potential of gold futures in short-run. However, there is an insignificant and negative relationship between lagged WPI and change in gold prices. Thus, based on results of short-run dynamics, cointegrating vector and long-run equilibrium adjustment, it can be concluded that gold is able to provide a full hedge against inflation.

6.2.3 Inflation and Silver

The information criterion and log likelihood values of the VECM and MS-VECM for the model of inflation and silver are shown in Table9. Information criterion AIC and HQ suggest the MSIAH (3)VECM(1,1) as the best model specification among the linear and nonlinear models.However, SIC supports the linear VECM (1, 1)

Table 8: Results of the linear VECM estimated for the model of Gold and WPI

Parameters		Δ Gold	Δ WPI
Intercept		0.022[0.039]	-1.07[-3.52]*
Δ Gold(-1)		-0.128[-0.978]	0.267[3.81]*
Δ WPI(-1)		-0.123[-0.847]	-0.163[-2.09]**
Error Correction		-0.0016[-0.012]	-0.254[3.56]*
Standard Errors		0.0519077	0.0278990
Correlation	Δ Gold	1.0000	0.384578
	Δ WPI	0.384578	1.00000

Values in the square bracket exhibit the't' statistics and * shows the significance level at 1%, ** at 5% and *** at 10% .

Table 9: Information criterion of VECM and MS-VECM of Silver and WPI

Lag=1	Estimation Period	No. of Obs.	AIC	SIC	HQ	Log-likelihood
VECM(1,1)	2005m7-2015m4	118	-705.92	-667.82	-690.56	363.96
MSIA(2)VECM(1,1)	2005m7-2015m4	118	-647.38	-581.56	-620.85	342.69
MSIAH(2) VECM(1,1)	2005m7-2015m4	118	-740.60	-657.47	-707.09	394.30
MSIA(3)VECM(1,1)	2005m7-2015m4	118	-683.73	-576.35	-640.45	372.86
MSIAH(3)VECM(1,1)	2005m7-2015m4	118	-762.67	-627.58	-708.22	420.33

as the most fitted model compared to the nonlinear models. Thus, the results of SIC information criterion provide a weak evidence in favour of two regimes and three regimes and give direction to uselinear VECM (1,1) for estimating inflation hedging potential of silver futures.

Table 10 shows estimation results of VECM (1,1) for silver and WPI. The significant and negative coefficient (-0.376) of the error correction term oninflation index depicts the convergence of inflation towards silver future prices. This convergence suggests that movement of silver futures priceis a reflection of inflationary expectations and can be used as a hedge against inflation. Short-run dynamics depict insignificant and negative correlation between lagged WPI and changes in silver futures prices. However, the WPI hasa significant and positive relationship with lagged silver futures prices, which justifies the inflation hedging potential of silver futures in short-run. Thus, cointegrating vector and both long-run and short-run dynamics indicatethe full inflation hedging potential of silver futures.

6.2.4 Inflation and Copper

Table 11 shows a comparison of linear VECM and different specification of nonlinear MS-VECM based on information criterion and log-likelihood values. In the model of inflation and copper, all the information criterion and log likelihood values support the nonlinear model over linear model. However, AIC and HQ support the MSIAH (3) VECM (1, 1) while SIC suggestsfor MSIAH (2) VECM (1, 1). Based on SIC, the nonlinear MSIAH(2)VECM(1,1) is selected with two regimes, heteroscedastic error and an autoregressive order of onefor estimating the inflation hedging potential of copper futures.

Smoothened probabilities of being in the first regime and the second regime are estimated by MS model and depicted in Figure 1. The first regime persists during 2005m7 to 2006m3, 2007m7 to 2007m10, 2008m5 to 2008m8, 2010m3 to 2010m11, 2011m3 to 2013m5 and 2013m9 to 2014m12. All these periods show the period

Table 10: Results of the linear VECM estimated for the model of Silver and WPI

Parameters		Δ Silver	Δ WPI
Intercept		0.515[0.566]	-1.78[-4.08]*
Δ Silver(-1)		0.045[0.287]	0.192[2.53]**
Δ WPI(-1)		-0.018[-0.114]	-0.026[-0.343]
Error Correction		-0.106[-0.554]	-0.376[-4.09]*
Standard Errors		0.0901157	0.0431783
Correlation	Δ Silver	1.000000	0.466516
	Δ WPI	0.466516	1.000000

Values in the square bracket exhibit the't' statistics and * shows the significance level at 1%, ** at 5% and *** at 10% .

Table 11: Information criterion of VECM and MS-VECM of Copper and WPI

Lag=1	Estimation Period	No. of Obs.	AIC	SIC	HQ	Log-likelihood
VECM(1,1)	2005m7-2015m4	118	-897.16	-859.06	-881.80	459.58
MSIA(2)VECM(1,1)	2005m7-2015m4	118	-735.18	-669.37	-708.65	386.59
MSIAH(2) VECM(1,1)	2005m7-2015m4	118	-1009.25	-926.12	-975.74	528.62
MSIA(3)VECM(1,1)	2005m7-2015m4	118	-853.74	-746.37	-810.46	457.87
MSIAH(3)VECM(1,1)	2005m7-2015m4	118	-1056.90	-921.81	-1002.44	567.45

Table 12: Results of the nonlinear MSIAH (2) VECM (1, 1) estimated for the model of Copper and WPI

Parameters	Regime 1		Regime 2	
	Δ Copper	Δ WPI	Δ Copper	Δ WPI
Intercept	0.835[4.26]*	0.170[7.38]*	2.29[2.41]**	1.41[13.85]*
Δ Copper(-1)	-0.175[-1.59]	0.018[1.38]	0.413[2.47]**	0.072[2.74]*
Δ WPI(-1)	-1.009[-2.60]**	0.053[0.961]	-0.554[-0.764]	-0.112[-1.00]
Error Correction	0.006[-4.18]*	-0.034[-7.34]*	0.016[-2.39]**	-0.282[13.79]*
Variance-Covariance Matrix				
Δ Copper	0.00196[3.65]*	0.000039[1.14]	0.009874[4.31]*	-0.0000851[-0.35]
Δ WPI	0.000039[1.14]	0.0M00033[4.79]*	-0.000085[-0.35]	0.0002385[4.23]*

Transition Matrix			Persistence of Regimes		
	Regime 1	Regime 2	Observations	Ergodic Probability	Duration
Regime 1	.8349742	0.2859034	74.81	0.6340317	6.059659
Regime 2	0.1650258	0.7140966	43.18	0.3659683	3.497685

Values in the square bracket exhibit the't' statistics and * shows the significance level at 1%, ** at 5% and *** at 10%.

of low volatility or normal times, i.e. the absence of any major shocks. Conversely, the second regime presents in periods of high volatility such as a period of sub-prime crisis from 2008m7 to 2010m2. The ergodic probability and transition matrix suggest a predominance of the first regime rather than the second regime. The first regime persists for 63.40 percent of the months and lasts for 6.059 months on an average while the second regime remains for 36.59 percent of the months lasting for 3.49 months on an average.

Long-run equilibrium relationship is explained by the error correction term of copper and WPI for each regime as presented in Table 12. The first and second regimes show the significant adjustment in the WPI index towards long-run equilibrium for any variations in the prices of copper during short-run and it is appropriately represented by both the regimes. This result gives the positive indication of the inflation hedging potential of copper futures. Short-run dynamics are depicted by the changes in lagged value of copper and WPI. There is a negative and significant relationship between the change in copper and change in lagged value of WPI in the first regime. The second regime shows the significant dependence of change in WPI over changes in lagged value of copper. Hence, the short-run dynamics show the positive indication of inflation hedging potential of copper for second regime rather than the first regime in short-run. Based on results of the cointegrating vector, short-run dynamics and long-run adjustment coefficient for both the regimes, it is concluded that copper futures can provide the partial hedge against inflation.

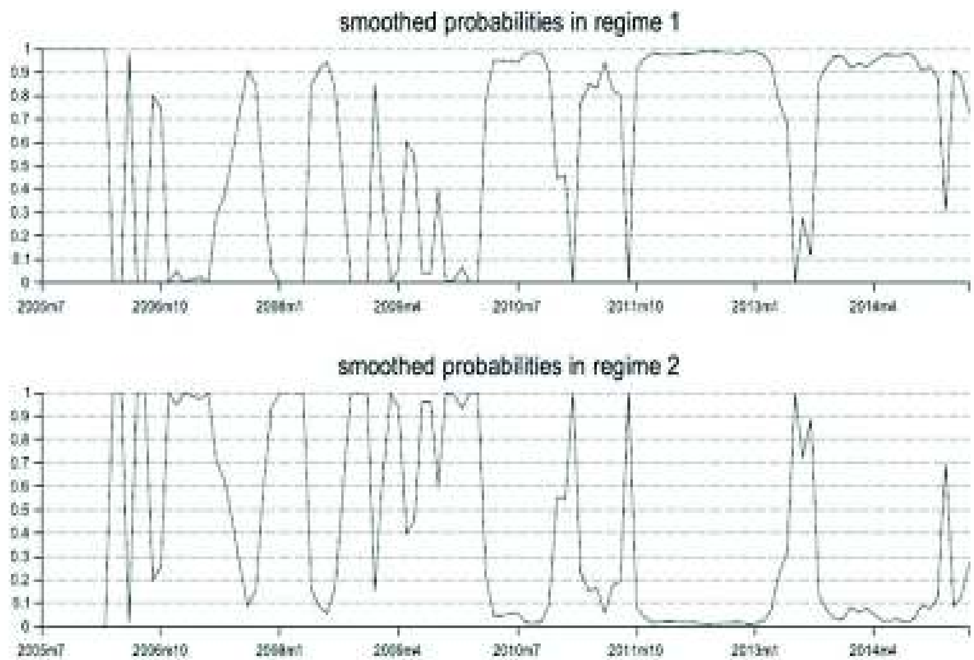

Figure1: Smoothed probability of regimes for the model of Copper and WPI

7. Conclusion

This paper empirically examines the inflation hedging potential of crude oil, gold, silver, copper and zinc futures under the nonlinear framework. The Johansen cointegration test suggests the lack of long-run association between zinc future and inflation and it is concluded that zinc futures cannot be used as a hedge against inflation. In addition, results give evidence in support of full inflation hedging potential of gold and silver futures and partial hedging capability of copper futures. On the contrary, empirical findings for crude oil give the weak evidence in support of its inflation hedging potential. Notably, investment decision in copper does not depend on the time horizon of investment as the inflation hedging potential of copper is common in both the regimes. Moreover, smoothened probability of regime classification characterises the first regime as a period of low volatility or normal period and the second regimeas a period of high volatility affected much by major shocks like the sub-prime crisis. Based on the results, it is concluded that futures of precious metals possess better inflation hedging potential than energy and industrial metals.

From an investors' perspective, they can effectively use gold, silver and copper as a hedge against inflation and the inflation hedging potential of these commodities does not dependon time horizon of investment. Based on these findings, it can be suggested that futures prices of gold, silver and copper can be used to forecast inflationrate.

In India, commodity futures market is working under several institutional constraints. The current study highlights one of the important benefits of investment in commodity futures in terms of their inflation hedging potential. The findings of this study are crucial for global and domestic investors who want to protect their investment returns from inflation risk, which is considered a crucial risk factor. In addition, the results of full inflation hedging potential of gold and silver futures provide aninitial pathway to the policy-makers to design a regulatory framework which will increase awareness among the investors and probably help in enhancing the investment demand for these commodities in India. Moreover, the findings of the studywill pave the direction to the policy-makers in designing such policies that will strengthen the derivative trading in India. It may increase the intensity of commodity derivative trading by growing awareness among the investors about the commodity futures as an alternative asset class. This study can be extended further by including the other commodity futures and different asset classes such as stocks, bonds and real estate in this nonlinear framework to have more elaborate and comparative analysis of inflation hedging potential of different asset classes.

References

Anari, A., & Kolari, J. (2001).Stock prices and inflation. *Journal of Financial Research,* 24(4), 587-602.

Adrangi, B., Chatrath, A. & Raffiee, K. (2003). Economic activity, inflation, and hedging:the case of gold and silver investments. *The Journal of Wealth Management,* 6(2), 60-77.

Bekaert, G., & Wang, X. (2010). Inflation risk and the inflation risk premium. *Economic Policy,* 25(64), 755-806.

Beckmann, J., & Czudaj, R. (2013).Gold as an inflation hedge in a time-varying coefficient framework. *The North American Journal of Economics and Finance,* 24, 208-222.

Bodie, Z. (1976). Common stocks as a hedge against inflation. *The Journal of Finance*, 31(2), 459-470.

Bodie, Z. (1983). Commodity futures as a hedge against inflation, *The Journal of Portfolio Management,* 9(3),12-17.

Bredin, D., Conlon, T., & Potì, V. (2015). Does gold glitter in the long-run? Gold as a hedge and safe haven across time and investment horizon. *International Review of Financial Analysis*, 41, 320-328.

Becker, K. G. & Finnerty, J. E. (2000).Indexed commodity futures and the risk and return of institutional portfolios.OFOR Working PaperNumber 94-02. Available at SSRN.

Bhardwaj, G., Hamilton D. J. & Ameriks, J. (2011).Hedging Inflation: The Role of Expectations.*Vanguard Research.* Retrieved October, 2015, from: https://personal. vanguard.com /pdf/ icruih.pdf

Dubois É. & Michaux E. (2013).Grocer 1.6: an econometric toolbox for Scilab, Retrieved March, 2015, from http:/ /dubois.ensae.net/grocer.html.

Demidova-Menzel, N. & Heidorn, T. (2007). Commodities in asset management. *Frankfurt, School of Finance & Management.*

Ely, D. P., & Robinson, K. J. (1997). Are stocks a hedge against inflation? International evidence using a long-run approach. *Journal of International Money and Finance,* 16(1), 141-167.

Erb, C. B., & Harvey, C. R. (2006).The strategic and tactical value of commodity futures. *Financial Analysts Journal,* 62(2),69-97.

Fisher, I. (1930). The Theory of Interest. New York: MacMillan.

Fama, E. F., & Schwert, G. W. (1977). Asset returns and inflation. *Journal of financial economics,* 5(2), 115-146.

Gorton, G., & Rouwenhorst, K. G. (2006).Facts and fantasies about commodity futures. *Financial Analysts Journal,* 62(2), 47-68.

Ghosh, D., Levin, E. J., Macmillan, P., & Wright, R. E. (2004).Gold as an inflation hedge? *Studies in Economics and Finance,* 22(1), 1-25.

Gerolamo, D. (2015). Inflation and its effect on investment. Retrieved from http://econc10.bu.edu/Ec341_money/ Papers/Gerolamo_paper.htm (January, 2016)

Gupta, R. (2011). Commodity Derivative Market in India: The Past, Present and Future. *Analytique,* 7(2), 4-9.

Hamilton, J. D. (1989). A new approach to the economic analysis of non-stationary time series and the business cycle. *Econometrica: Journal of the Econometric Society,* 357-384.

Hoevenaars, R. P., Molenaar, R. D., Schotman, P. C., &Steenkamp, T. B. (2008). Strategic asset allocation with liabilities: Beyond stocks and bonds. *Journal of Economic Dynamics and Control,* 32(9), 2939-2970.

Hanke, H. S. (2015). Venezuela: World's Highest Inflation Rate, Cato At Liberty, Retrieved from https:// www.cato.org/blog/venezuela-worlds-highest-inflation-rate (December, 2016).

Harmston, S. (1998). Gold as a Store of Value. Centre for Public Policy Studies, The World Gold Council Research Study, No.22. Retrieved September, 2015, from http:/ /www.spdrgoldshares.com/media/GLD/file/ research_ study_22.pdf

Joshi, A. (2013). Inflation risk hedging strategy for equities using commodity Futures. *International Journal of Trade, Economics and Finance,* 3(2),78-81.

Krolzig, H. M, (1998). Econometric Modelling of Markov-Switching Vector Autoregressionusing MSVAR for OX. *Institute of Economics and Statistics and Nuffield College,* Oxford.

Krolzig, H. M.,(1997).Markov-Switching Vector Auto-regression: Modelling, Statistical Inference and Application to Business Cycle Analysis. *Lectures Notes in Economics and Mathematical Systems,* Springer.

Kaplan, P. D. & Lummer, S. (1997). GSCI collateralized futures as a hedging and diversification tool for institutional portfolios: an update. *Journal of Investing,* 7(4),11-17.

Kumar, A. (2015). How falling oil prices impact India's economy. Retrieved from http://zeenews.india.com/ exclusive/how-falling-oil-prices-impact-indias-economy_ 1531868.html (November, 2015).

Levin, E. J., Montagnoli, A.& Wright, R. E. (2006).Short-run and Long-run Determinants of the Price of Gold. *Unpublished Manuscript.World Gold Council, Research Study* No. 32, University of Strathclyde Glasgow, Glasgow, Scotland.

Laurent, R. D. (1994). Is there a role for gold in monetary policy? *Economic Perspectives,* (Mar), 2-14.

Mahdavi, S., & Zhou, S. (1997). Gold and commodity prices as leading indicators of inflation: tests of long-run relationship and predictive performance. *Journal of Economics and Business,* 49(5), 475-489.

Mathai, K. (2012). Monetary Policy: Stabilizing Prices and Output. Finance & development, International Monetary Fund. Retrieved from http://www.imf.org /external/pubs/ft/fandd/basics/monpol.htm (November, 2015).

Pilling, D., & England, A. (2016). Zimbabwe swaps hyperinflation for deflation with use of US dollar. *Financial Times.* Retrieved from https://www.ft.com/content/9eb1c2d8-c341-11e5-b3b1-7b2481276e45 (January, 2016).

Pettinger, T.(2014). Inflation: advantages and disadvantages. *Economics Help,* Retrieved from http://www.economicshelp.org/blog/315/inflation/inflation-advantages-and-disadvantages/ (December, 2016).

Spierdijk, L., & Umar, Z. (2014). Are commodity futures a good hedge against inflation? *Journal of Investment Strategies,* 3(2), 35-57.

Schotman, P. C., & Schweitzer, M. (2000). Horizon sensitivity of the inflation hedge of stocks. *Journal of Empirical Finance,* 7(3), 301-315.

Sharma, A. (2015) "Performance of Indian commodity futures markets an analysis "Shodhganga : a reservoir of Indian theses @ Inflibnet, Retrieved from http://hdl.handle.net/10603/76604 (January 2016).

Trichet, J.C. (2004). Supply side economics and monetary policy. *European Central Bank.* Retrievedfrom ttps://www.ecb.europa.eu/press/key/date/2004/html/sp0406221.en. Html (December,2016)

Tiwari, A., K. (2011). Gold Investment as an Inflationary Hedge: Cointegration Evidence from India with Allowance for Structural Breaks and Seasonal Adjustment. *Journal of Asian Business Management,* 3,165-176.

Thota, N. & Bandi, K. (2015). Are the Indian Commodity Futures a Good Hedge against Inflation. *Asian Journal of Research in Business Economics and Management,* 5(6), 106-115.

Worthington, A. C., & Pahlavani, M.(2007). Gold investment as an Inflationary Hedge: Cointegration Evidence with Allowance for Endogenous Structural Breaks. *Applied Financial Economics Letters,* 3(4), 259-262.

Zhou, Z. (2014). Commodity Futures as a Hedge against Inflation: An Application of Markov-Switching Cointegration and Error-Correction Modelling. Unpublished paper, Department of Finance, Bocconi University, Milan (Italy).

Van Hoang, T. H., Lahiani, A.,& Heller, D. (2016). Is gold a hedge against inflation? New evidence from a nonlinear ARDL approach. *Economic Modelling,* 54, 54-66.

Wang, K. M., Lee, Y. M. & Thi, T. B. N. (2011). Time and place where gold acts as an inflation hedge: An application of long-run and short-run threshold model. *Economic Modelling,* 28(3), 806-819.

Zivot, E. & Andrews, D. W. (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root. *Journal of Business & Economic Statistics,* 10(0),3.

Ritika Jaiswal is a Research Scholar at School of Management in National Institute of Technology Karnataka (NITK), Surathkal, Mangalore. Her research interest is in the area of financial economics, derivative trading, commodity market, capital market, asset pricing and risk management. She can be contacted at ritikastone@gmail.com.

Rashmi Uchil is an Assistant Professor at School of Management in National Institute of Technology Karnataka (NITK), Surathkal, Mangalore. Her research interest is in the area of organizational culture, organizational identification, mergers and acquisitions and international finance.