When and Why to Invest in Gold: An Empirical Analysis of Gold Market for Portfolio Management

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Abstract

Gold finds common use as a store of value, medium of exchange and instrument of investment. It is widely believed that rarity, hedging and safe-haven properties of gold largely drive investor sentiments. The time series uses monthly data, dating back to 1990, accounting in aggregate for a period after the abolishment of gold standards. The paper concludes with definitive reasoning of when and why investments in gold can be made- analysing Gold's level prices and returns in relation to Stock Market Indices, Inflation Expectation and Consumer Sentiments.

Gold was shown as an effective hedge against stocks, however, its role as a store of value in an inflationary environment was disputed. Similarly, it was hypothesised that gold may not be popularly conceived as a safe haven to rising inflation expectations. A negative correlation was found between gold and consumer sentiments. A time scale analysis was carried out between Gold, Consumer Sentiments and inflation expectations to provide further insight. Furthermore, suggestions for future studies were pointed out and policy implications were considered.

Keywords: *Stock Index, Gold Prices, Inflation Expectation, Stationarity, Wavelet Coherence, Granger non-causality test, Cointegration, Investor sentiments, Modern Portfolio Theory*

1. Introduction

Gold is viewed as a quintessential addition to any portfolio and remains a popular choice of investment. It is time tested and widely believed to be the definitive asset to fall back upon in times of crisis, currency failure, bleak financial outlook and inflation concerns. Unlike stocks and bonds, Gold does not provide any fundamental return in form of dividend or coupons, yet, its use cases are varied -ranging from production of jewellery, coins and electronics to management of exchange rate and volatility by Central Banks through reserving gold.

Thus, due to Gold's liquidity, fungibility and responsiveness to price changes, it is particularly significant from the viewpoints of portfolio managers, academicians, investors and traders.

Given commodities' inherent inverse relation to currency's purchasing power, it is intuitive belief that precious metals, especially Gold, provide a natural hedge against currency impact caused by inflation. Resultantly, for the purposes of the study, the importance shifts from only discovering Gold's relationship with stock markets and traditionally risky assets to studying its responses against inflation expectations and consumer sentiments. Its relationship with Equity becomes especially important in context of Modern Portfolio Theory where the goal is of risk minimisation by reducing variance of the overall portfolio.

This position, as propounded by the Modern Portfolio Theory can be summed up through the following representation:

Let proportion of the funds (W) be invested in Commodities i.e., Gold in our case **(**Expected returns from commodities being (Rc)**.** The rest of the funds are invested in Equities with expected returns being (Re). The expected returns from the portfolio can now be computed as:

$$R_p = W * R_e + (1–W)*R_e \quad .....(1)$$

The variance of the portfolio can now be computed as:

$$\sigma^2_{portfolio} = W^2 * \sigma^2_{gold} + (1\text{-}W)^2 * \sigma^2_{equities} + 2 * W * (1\text{-}W)* \text{Correlation Coefficient} * \sigma_{gold} * \sigma_{equity} \quad .....(2)$$

And by conjunction,

$$\text{Beta of Gold=Correlation Coefficient}*\sigma_{gold} * \sigma_{equity} \quad .....(3)$$

Hence, variance of the portfolio is directly proportional to the correlation between both asset class. Portfolios of less than perfectly correlated assets always offer better risk-return opportunities and the lower the correlation between the assets, the greater the gain in efficiency.

At the same time, one must come to a definite conclusion regarding when the investment can be made. Due to its relatively modest returns as compared to the stock market- Gold might not always represents an attractive investment proposition. Investments in Gold maybe made keeping in mind its popularity as a safe haven against inflation and worsening financial outlook and sentiments.

Consequently, for the purposes of asset and security selection, the following questions prove to be fundamental:

(a) What is the dynamic relationship between Gold and Stock market prices? Do they have conjunct movement?

(b) Can Gold retain its value even in an inflationary environment — Do investors flock to Gold during high inflation periods?

(c) What is the relation between gold prices and Consumer sentiment?

2. Review of Literature

Cointegration and causal relationships between stock markets returns and gold returns have, since long, being under study. In Smith's (2001) study, gold prices and four stock market indices were tested for Granger Causality – finding unilateral causality for US stock market returns to returns on gold price. Similar views backing the above finding was reciprocated in the Indian context (using NSE) in Tripathy and Tripathy (2016) **-** the study established cointegration between Gold and Stock market prices indicating a long-run equilibrium and conjunct movement of Gold and Stock prices. The CUSUM test also confirmed that long run relationship is present in between Gold and Stock market price and exhibited the stability of co-efficient, thus concluding that stock market returns can be effectively used as a predictor for gold prices. In the Turkish context, Gurel (2020) studied the hedging ability of Gold, real estate and stock markets against inflation- finding that Gold and real estate might lose hedging abilities in short run, while stock markets exhibit no such phenomenon.

For the purposes of discovering Gold's Beta, studies have been conducted by Chua (1990) - confirming that Gold has a low beta. The same study also pronounced that gold price movements displayed no significant correlation with stock prices, highlighting its role as a portfolio diversifier. This result was later collaborated by Faff, Rober and Chan (1998)- which emphasized on the stable beta of Gold against the relatively unstable beta of Gold stocks.

Over the years, the idea of "safe haven" has been defined in a multitude of ways - while some authors have defined it as a sanctuary against volatility in financial markets, inflation expectations and value of US dollar, many have linked it to political tensions. Baur and Lucey (2010) established Gold as a safe haven and hedge against stocks (US, UK and German markets). Similarly, Sumner (2010) found no real spill over to gold prices from Stock or bond prices which highlighted the role of Gold as a significant diversifying force.

Gold's allocation in a portfolio was studied by Jaffe (1990). In isolation, Gold displayed significant volatility, yet 10% allocation to Gold in a portfolio was found to be optimal. Hillier (2006) tackled the topic in his paper- examining roles of all precious metals – Gold, silver and platinum- finding significant diversification benefits.

For the instances of finding relationship between consumer sentiments and Gold prices, studies have been conducted by Balcilar, Bonato, Demirer and Gupta (2016)- measuring the sentiment effect on Gold's volatility in short run. Results were obtained showing that extreme fear or excitement contributed to positive or negative jumps in returns. For the purposes of measuring consumer sentiment - FEAR or Financial Attitudes Revealed by Search Index developed by Da (2015) was used which employed internet searches featuring "economic keywords". Further studies have been conducted by Huang (2015)**.** While many, even recently (Emrich and McGroarty (2013) updated Jaffe's work using 1981-2011 data), have tackled the problem of using Gold as a tool for diversification, the novelty of this paper lies in its simplicity.

Through use of cointegration and causality, this paper has arrived at a different conclusion than the ones reach before by Tripathi and Tripathi (2016). Similarly, this paper addresses a gap in research of behavioural aspects of Gold by tackling the relationship between UMCSENT-University of Michigan Consumer Sentiments and Gold prices. It also serves to disprove the myth of Gold acting as a store of value in an inflationary environment by showing loss in purchasing over extended time span. Customer's behavioural tendencies revealed that a mere increase in expectation of inflation did not cause them to resort to gold- disputing the notion that gold may not be commonly believed to protect against inflation.

3. Objectives of the Study

The paper strives to ascertain the dynamic relationship between Gold and Stock market prices, inflation expectations and consumer sentiments. Its objectives can be summed up below:

(a) Establishing Gold's beta through linear regression to test previous findings of Gold as a zero-beta asset

(b) Testing whether gold prices and stock markets prices have a long run equilibrium through cointegration test. Finding evidence of cointegration can mean lock-step movement of prices, thus, diminishing hedging properties in the long run. Short run dynamics was tested through Granger Causality test between the two variables at first difference.

(c) Inspecting CPIA (Consumer Price Index, Average of all U.S Cities) adjusted prices of Gold and stock market to test their qualities as store of value.

(d) Scrutinizing whether a rise in inflation expectations can lead to rise in gold returns. This is based on the conjecture that rising inflation expectations can lead to investors switching over to Gold due to its perceived nature as a safe haven. This demand shock can cause a rise in gold returns. Thus, a theoretical directly proportional relationship of inflation expectations and returns forms the basis of this hypothesis. A wavelet coherence approach was followed to determine lag-lead relationship between the two variables.

(e) The above finding is substantiated with testing the relationship between Investor sentiments and gold prices. A significant negative relationship might imply that Gold can be used for betting against fear or worsening financial outlook.

4. Hypotheses of the Study

This paper aspires to study the relationship among variables through use of following hypothesis

Hypothesis 1:

$\mathbf{H}_0$: *The regressor variable significantly affects target variable*

$\mathbf{H}_1$: *The regressor variable does not significantly affects target variable*

Hypothesis 2:

$\mathbf{H}_0$: *There is no short-run causal relationship or long-run cointegrating relationship between the selected variables.*

$\mathbf{H}_1$: *There is short run causal relationship or long-run cointegrating relationship between the selected variables.*

Hypothesis 3:

$\mathbf{H}_0$: *There is coherency between the variables*

$\mathbf{H}_1$: *There is no coherency between the variables*

5. Research Methodology

The study employs the monthly prices of Gold and S&P 500 over a period of 30+ years from 1990 to 2020.

5.1. Variables

The variables used and their respective frequencies were as follows:

Variable	Frequency	Source
Gold	*Monthly, daily*	*Federal Reserve, Bank of St. Louis*
S&P 500	*Daily*	*Federal Reserve, Bank of St. Louis*
Consumer Sentiment (UMCSENT)	*Monthly*	*University of Michigan*
5 Year Forward Inflation Expectation Rate	*Daily*	*Federal Reserve, Bank of St. Louis*

5.2. Returns for a Particular Period

$$Returns = log \frac{(Current\ Returns)}{(Previous\ Returns)}$$

For the purposes of the studies, log-transforms of returns have been taken.

5.3. Unit Root Test

For the purposes of eliminating spurious results from the procedure Granger causality-which assumes covariance stationarity and linear modelling- stationarity was tested using Augmented Dickey Fuller Test and substantiated with Pips-Perron tests.

For the purposes of cointegration test, non-stationarity was proven. Given our nationality of time series, such a finding was in line with expectations.

5.3.1. Augmented Dickey Fuller Test-ADF

Given the large sample size of our data, ADF test proved particularly suitable for the purposes of this study. In ADF, the null and alternate hypothesis is as follows

H_0= Unit Root Present

H_1=No Unit Root Present

Presence of unit root is indicative of non-stationarity of data

The formulation of model is given as below:

$$\Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_{p-1} \Delta y_{t-p+1} + \in_t \quad \text{... ....(4)}$$

Here, α is a constant, β the coefficient on a time trend and p the lag order of the autoregressive process - p can be calculated using AIC, BIC or HQ tests.

The unit root test is carried out under a null hypothesis = 0 against an alternate hypothesis of <0. The more negative the results are, the more confidently can the null hypothesis be rejected. If the observed value is more negative than the Tau-critical value, the absence of unit root and the stationarity of data is confirmed.

5.3.2. Phillips Perron Test-PP

Pips-Perron test's greatest advantage over ADF lies in that its non-parametric-unlike ADF, it can be applied on heteroscedastic data since it corrects time series for autocorrelation and heteroscedastic data.

Its formulation can be written as:

$$y_t = c+\delta t+\alpha y_{t-1} + e^3_t \quad .....(5)$$

Through application of several tests of stationarity, one can come to a robust conclusion about stationarity of the data.

5.4. Linear Regression

Linear regression represents the simplest of polynomial equations. In its modelling, the relation between the dependent variable Y and the explanatory variable X is established to ensure a line of best fit.

A simple linear regression can be modelled as:

$y = mx+c$

Further, the slope of the equation line m can further be defined as

$$b_{yx} = \frac{\sum XY - n\overline{XY}}{\sum X^2 - \widehat{X}^2} \quad ...(6)$$

5.5. Karl Pearson's Correlation Analysis

Karl Parsons's correlation analysis is indicative the extent to which two or more variables fluctuate together. It is a measure of degree of linear relationship between two variables

In its modelling, it can be described as:

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\sqrt{n\sum y_i^2 - (\sum y_i)^2}} \quad ....(7)$$

N = Sample Size $\mathbf{x}_{i,}$ $\mathbf{y}_i$ = Sample Points

5.6. Johansen's Cointegration Test

Cointegration test[16] is used for establishment of long run linkages between time series. This is accomplished using an error term. Two cointegrated series will always have stationarity of error term, by which, one might conclude that these two variables cannot deviate from equilibrium in long term. For the purposes of the study, given the large sample size and the possibility of more than one cointegrating relationships - Johansen's Cointegration test was decided upon.

Johansen's test takes the form of two main tests - the Lambda Max or Maximum Eigenvalue Test and the Trace Test.

5.7. CPIA / Inflation Adjusted Price

For the purposes of adjusting for the effects of inflation, gold prices were divided by CPIA -Consumer Price Index Average of all U.S cities. This was done in order to study the changes in purchasing power of the investment. Removal of rise in price due to inflation also indicated the real return of the investments.

5.8. Granger Causality Test

Bivariate granger causality[17] is generally used in the context of linear regression and assumes stationarity of variables. It evaluates whether either of the variable's past values can be used for predicting the other variable.

Its mathematical formulation (for causation of X on Y and vice versa) can be as follows:

Restricted Regression:

$$X_t = \beta_0 * \sum X_{t-1} + U_1 \quad .... (8)$$

Un-restricted Regression

$$Y_t = \alpha_1 * \sum Y_{(t-k)} + U_3 \quad .... (9)$$

Restricted Regression

$$X_t = \beta_0 * \sum X_{(t-k)} + \beta_1 * \sum Y_{(t-k)} + U_3 \quad .... (10)$$

Un-Restricted Regression

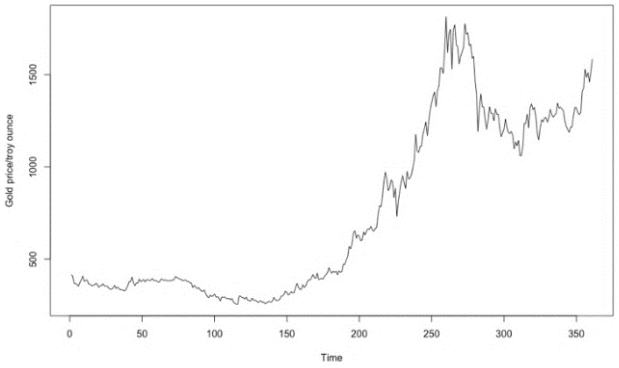
$$Y_t = \alpha_0 * \sum X_{(t-k)} + \alpha_1 * \sum Y_{(t-k)} + U_2 \quad \ldots (11)$$

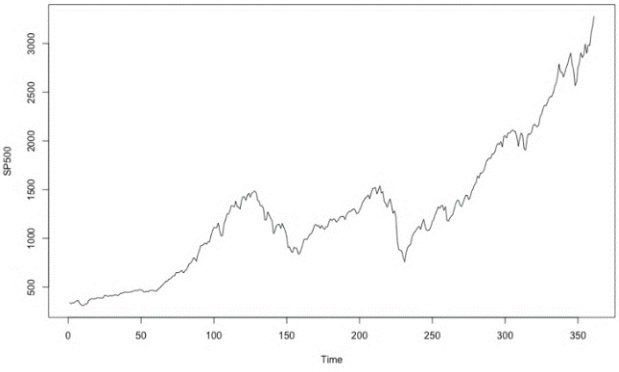
6. Results And Discussion

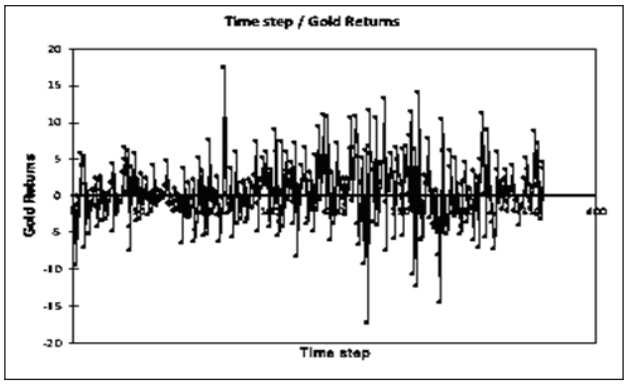
The descriptive statistics of Gold and S & P 500 prices are provided below:

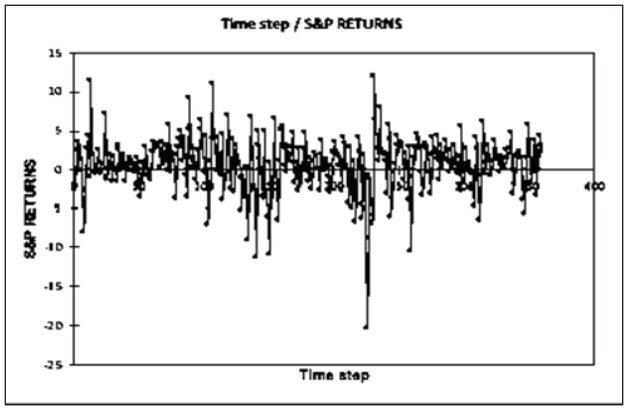
Table-1: Descriptive Statistics and plot of variables

Statistic	Gold prices/Troy Ounce	S & P500
Minimum	*254.8*	*307.12*
Maximum	*1813.5*	*3278.2*
Range	*1558.7*	*2971.08*
1st Quartile	*353.15*	*833.09*
Median	*427.5*	*1194.9*
3rd Quartile	*1216.5*	*1480.4*
Standard Deviation	*470.161*	*678.845*
Skewness	*0.598*	*0.787*
Kurtosis	*-1.193*	*0.16*









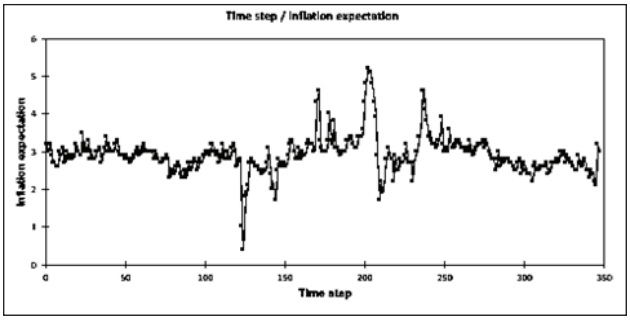


Table-2 presents standard OLS estimates for gold returns regressed on S&P 500 returns (used as a market proxy. The variable was shown to be statistically insignificant at 1, 5 and 10% confidence level. Thus, such a finding may provide prima facie evidence that S&P 500 returns may not be able to able to influence gold returns.

Table-2: Linear Regression Line Between Gold Returns And S & P 500

Model Parameters (Gold Returns)

Source	Pr. Value
Intercept	0.048
S&P500 Returns	0.009

Gold Returns=0.47558-0.0061*S&P500 Returns

The paper calculates the 30-year period **β (Beta of Gold)**

in relation to the S&P 500 serving as the market proxy. The coefficient of S&P 500 was rejected by the virtue of P <= 0.05, denoting its lack of significance in affecting gold returns.

Table-3 presents the Dickey Fuller test and PP test[18] for testing stationarity of time series. On observing the output, it exceeds than the critical value in 5% confidence level. Thus, null hypothesis of unit root presence cannot be rejected. One can conclude that Gold or S&P prices display characteristics of a random-walk series or a time series process. This allows us to test for a linear stationary combination of the following two non-stationary time series through the Cointegration test.

Table-3: Stationarity Test on Gold and S&P 500 Prices

Test	Gold Prices	S&P 500
ADF	Non-Stationary	Non-Stationary
PP	Non-Stationary	Non-Stationary

Both PP and ADF tests complement each other- reporting non stationarity in cases of gold prices and S&P 500 index. Such a result is expected from a random walk time series exhibiting Brownian motion.

Following the finding, lambda max test (max eigenvalue test) and the trace test was performed for finding co-integration. The order of Vector Auto Regression was calculated from Aikake Information criterion. The test showed that both lambda test and trace test found lack of any cointegrating vector between Gold and Stock prices. Such a finding may have an important implication that neither of the assets display same stochastic trend-or a similar long run behaviour. This lack of a long run cointegration might mean that either of the assets can be effectively used to reduce the variance of the overall portfolio.

Table-4: Johansen's Cointegration Test

Test Statistic	Number of Cointegrating Relationship
Lambda Max test	0
Trace Test	0

Table-5 presents the Dickey Fuller test for testing stationarity of gold returns, S&P 500 returns and Inflation Expectation. On analysing the output, the observed value is less than the critical value in 5% confidence level. Thus, null hypothesis of unit root is rejected. One can conclude that gold, S&P returns, or inflation do not display characteristics of a random-walk series, instead, they are stationary and exhibits property of returning to mean.

Table-5: Stationarity Test on Gold and S&P 500 Returns

Test	Gold Prices	S&P 500
ADF	Stationary	Stationary
PP	Stationary	Stationary

The causal relationships between gold returns and S&P 500 was examined to answer a critical question- can either one of the variables cause one another? - the results revealed no causality existing between gold returns and S&P returns. This can be interpreted as a simple conjecture that S&P500 and Gold did not exhibit lockstep movement in short run. This further substantiates our previous hypothesis which posits that gold can be effectively used as a hedge against the stock market. Table 6 is representing the Granger causality test between S&P returns versus gold returns. Optimum lag length was calculated from the AIC method. In both cases, no instances of causal relationship were observed. Through lack of causal relationships, one can effectively conclude that either of the metrics cannot be used for reliably predicting the other, which strengthens our previous finding from OLS estimates.

Table-6: Granger Causality Test

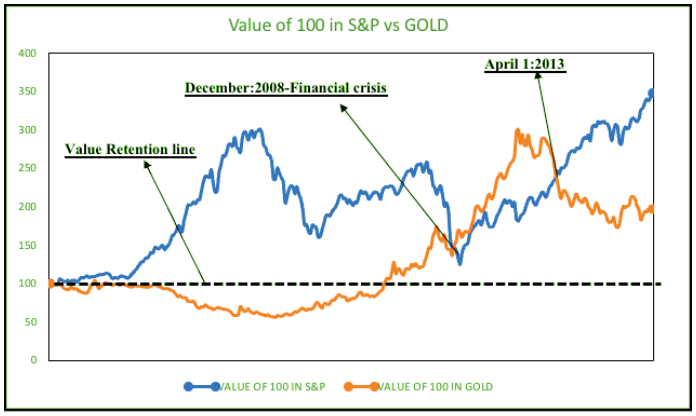
Dependent Variable: Gold Returns	
Type of Causality	*No Causal Relationships Found*
Dependent Variable: S&P 500 returns	
Type of Causality	*No Causal Relationships Found*

From lack of cointegration and causal relationships, one can come to a definitive conclusion regarding Gold's hedging potential against Stock Market indices.

However, the portfolio manager must not be entrapped by the common notions that gold can act as effective safe haven against inflation too.

Historically, the inflation-adjusted prices of gold were not linear nor certain to appreciate. For extended periods of time, the real-purchasing power of the investment in It was shown that gold might not always protect the investor's interest in an inflationary period. When adjusted for inflation, the number of months where purchasing power of gold was negative exceeded months where its purchasing power was positive. Thus, although gold served to hedge against longer time frames, the case was not always true during shorter periods. The study compares both the CPIA-inflation adjusted prices of S&P 500 and Gold to examine their efficacy as stores of value in an inflationary environment and hedges against inflation.

Table-7: Purchasing Power of Gold and S&P 500 (Adjusted for CPIA)



	Months of Negative Purchasing Power	Months of Positive Purchasing Power
Gold	163	146
S&P 500	4	305

Notably, against existing biases heralding Gold as the ultimate store of value, the S&P 500 proved to be far better at that purpose than its metal counterpart. Over 309 months- investment in S&P 500 lost purchasing power in only 4 months. Gold, counterintuitively, lost purchasing power for 163 months, thus failing to retain its real value.

However, yet again, the hedging and safe haven properties of Gold against equities was displayed by carefully examining the period where Gold's purchasing power exceeded that of S&P 500. Out of the 56 months when such a phenomenon occurred, 54 of them related to the 2008-2013 financial crisis. This can be taken as a prima facie indication of Gold's reliability and popularity as a safe-haven asset against stock market fluctuations.

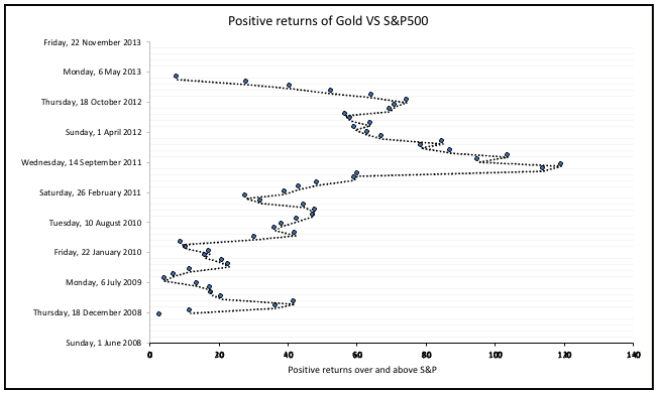


Figure-8: Months where Gold's Purchasing Power Exceeded S&P 500

Table-9 represents granger causality test between inflation expectations and gold returns. If Gold is popularly considered as a safe-haven asset against inflations, it can be hypothesised that rise in inflation expectations will inductively lead to gold prices and gold returns rising as a result of demand shocks.

Table-9: Granger Causality between Inflation Expectation and Granger Causality

	F Value	P value
Test Statistic	-1.09191	0.3134
H_0 = *Gold prices is not granger caused by inflation expectation*		
H_1 = *Gold prices is granger caused by inflation expectation*		
As P value exceeds 5%, one cannot reject the null hypothesis		

Rise in inflation expectations was shown not to affect gold prices. Thus, through non causality of gold returns by inflation expectation, one can indicate that consumers do not resort to gold at mere expectations of worsening inflation.

This narrative was further elucidated upon by Wavelet Coherence analysis.

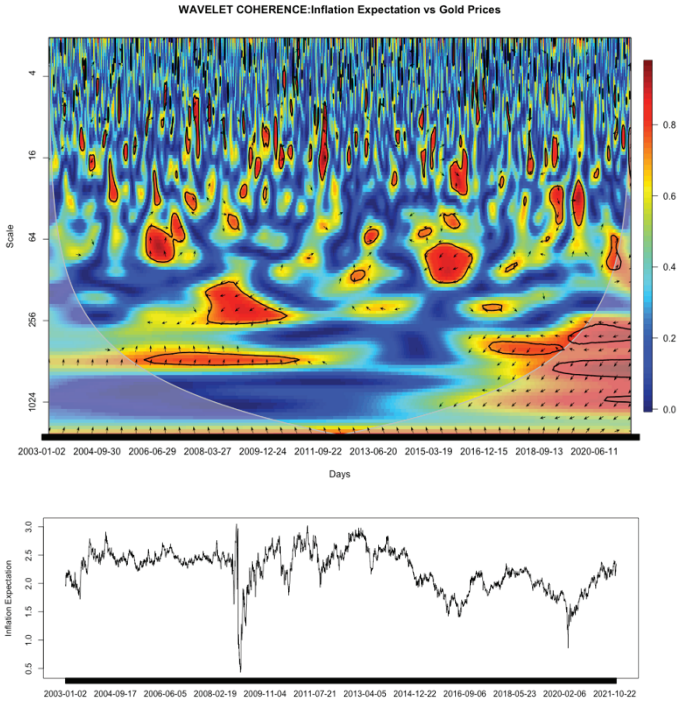


Figure-9: Wavelet Coherence, Gold Returns and Forward Inflation Expectations

To provide suitable number of observations for usable analysis, gold returns and 5 years forward inflation expectations were utilised on a daily frequency from 2003 to 2021. Difference in coherency was represented

using a gradient of colours ranging from Red (high coherency) to blue (low coherency). Unlike a time-amplitude relationship studied by general statistical methods, Wavelet Coherence studied the time-frequency relationship. Left facing arrow represented anti-phase movement or negative correlation whilst right facing arrows represented positive correlation. Periods of high coherency throughout the study period was observed in periods exceeding 128 days. During the financial crisis (2008:2011), Inflation expectations and gold returns showed negative correlation, with inflation expectation leading gold returns. This might indicate that during times of crisis, gold returns rise despite falling inflation expectations- supporting the hypothesis that Gold should be used as a hedge against fears of worsening financial outlook. Similar finding was reiterated during the Covid Crisis where Inflation expectations fell by 7.6%, yet gold returns rose. Positive correlation (positive coherence) of inflation expectations and gold returns was only observed on very long-time frames exceeding 300 days during the period of 2003 to 2011. The findings suggested that negative coherency between gold and inflation expectations might be associated with periods of decreasing inflation, signifying the importance of accounting dynamically for positive and negative changes in expected inflation.

Lack of positive Coherence and causal relationship is indicative of absence of hedging potential against inflation expectations on shorter time frame.

Table-10 is representative of the relation between UMCSENT and Gold prices. For the purposes of the study, a Karl Pearson's correlation analysis was performed. P-values indicated strong evidence towards rejections of null hypothesis at 1,5 and 10% confidence interval. Significantly, a negative correlation was exhibited. Thus, when retail investors are afraid of worsening conditions in the economy, they seek to invest in gold. It's safe haven properties against certainty in the economy are suggested. One can make a bold claim bold claim that Gold can be used to bet on fear of the customers.

Table-10: Relation between Consumer Sentiments and Gold Prices

Correlation Matrix (Pearson)		
Variables	**UMCSENT**	**Gold prices**
UMCSENT	1	**-0.347*** **
Gold prices	**-0.347*** **	1

Again, a wavelet coherence approach is taken using monthly data

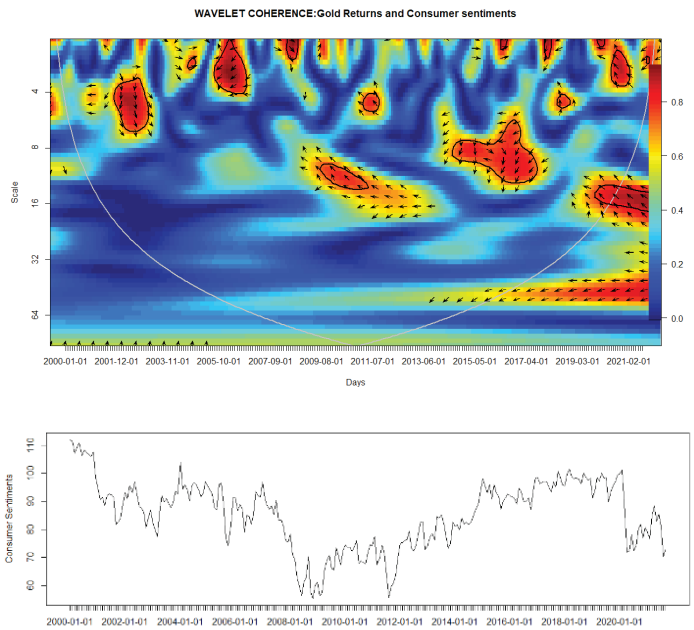


Figure-10: Wavelet Coherence, Gold Returns and Consumer Sentiments

Both in short and longer frequency periods, negative coherence was found. Barring the period between 2002 to 2003, all other periods of coherence were negative. In the housing crisis of 2007 to 2013, it was found at for shorter time periods between 1 to 8 months, Consumer sentiments was the leading variable and exhibited negative coherence. Gold returns was the leading variable and displayed negative coherence with Consumer sentiments in longer time frequencies. Similar behavioural patterns were found in the Covid period too. Thus, a strong and robust negative relationship was established.

7. Limitation of the Study

Given limited set of information, certain assumptions were made which might reduce real work applicability of the study. Further studies might expand upon the current paper through removal of these certain restrictive assumptions.

Notably, gold was compared against the entirety of the S&P500 index. An ideally diversified might consist of only 10 stocks, and at max,40 stocks. Thus, gold's relation with these 40 stocks might differ. Similarly, its relationship with other variables of importance- Crude Oil prices, bound prices etc was not studied. Furthermore, the study period is long and contiguous, a better approach maybe dividing the study into distinct periods- after testing for structural breaks. For example, in time of despair (Wars, global unrest)- the outliers might distort the overall result obtained. The

study focuses on only the US market. While almost all developed stock markets are interconnected, a different relation might be obtained for high gold consumption countries. In such countries, India for an instance, a fall in consumer sentiments and worsening of financial outlook might cause the consumers to defer the purchase of gold. sentiments and gold prices.

8. Scope for Further Study

Further studies should tackle multiple countries at once. Inflation was calculated using CPIA-Consumer all prices average of US cities. This might not be indicative of inflation in the business/producer sector nor is it perfectly representing the global scenario. Further studies can obtain an average of CPI and WPI inflation from other countries in addition to US data.

Sharpe and Treynor ratios can be added to the project to identify Risk-adjusted-returns. While Cointegration and Granger Tests can symbolise statistical significance, volatility modelling can definitively prove hedging and safe-haven properties. For this purpose, a DCC- GARCH /BEKK GARCH might be better suited.

9. Conclusion

The paper is novel in its approach due to its emphasis on gold as a vehicle of investment and in its emphasis on the U.S stock exchange. While the short-run and long-run causal relationships have been studied previously, its implication on a theoretical investment portfolio have not been expounded upon. Through its use of Wavelet Coherence, Cointegration, Correlation and Granger Causality Tests, this study examines the long run Gold/ S&P500, Gold/Inflation and Gold/Consumer Sentiment Relationship. The paper presented the following hypothesis:

Variable	Is Gold A Hedge?
Stock Market Index	*Yes*
Inflation	*No*
Consumer Expectations – Optimism/ Pessimism in Financial Outlook	*Yes*

Gold served as a hedge against stock indices- its efficacy was substantiated using multiple metrics. Stocks and Gold prices were shown to be independent from each other. Similarly, gold returns and stock returns displayed no causal relationships-indicating lack of linkages.

Yet, it was found that one should not blindly invest in gold and expect linear and certain returns from it in an inflationary period. Gold may not always beat inflation, in fact, it displayed greater tendencies to lose purchasing power. Gold is shown to not act as safe haven against inflation in the shorter time frames.

For the purposes of long-term investment, S&P500 proved to be a better store of value. Rise in inflation expectations was shown not to affect gold prices and returns. Thus, through non causality of gold prices by inflation expectation, it was indicated that consumers do not resort to gold at mere expectations of worsening inflation. Through wavelet coherence approach, it was shown that positive interrelationships did not exist between gold and inflation expectations in shorter time frame. Instead, Negative coherence was found with Inflation expectations leading gold returns.

However, when sentiments of market participants were low, gold shone as a medium of investment. Thus, in times of crisis, like the housing market crash of 2008, it is suggested to move away from equity and become bullish on gold. The strategy of buy and hold might not be most optimal given pervious reasoning. Hence, an investor can invest in stocks and switch to gold only in times of downturn or worsening sentiments regarding the health of the economy. Consumer sentiments and Gold Prices displayed statistically significant negative correlation coefficient. From the wavelet coherence heat map, it was observed that Gold displayed negative coherence in all time frequencies across the study period, except in 2003 when sentiments momentarily rose. An attributable cause of this phenomenon might be the stockpiling of gold due to imminent Iraq War.

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