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## DETERMINING FACTORS FOR GOLD AS INFLATION HEDGE: AN EMPIRICAL STUDY BASED ON US DATA

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### Abstract

In investing community *gold* is considered to be inflation or economic risk hedge. It has been seen that when there is high inflation *gold* performs better than the capital markets. Similarly, if there is risk in economic activity due to some local or global issues *gold* has better performance. In this study we have tried to answer the question that arose during last few months that when Consumer Price Index (CPI) was increasing in all developed economies *gold* was not responding to as expected. Therefore, we tried to find the relevant variables to which gold was responding. The data used for this study has been taken from the United States of America (USA) markets. In this study we have taken data of Gold returns against CPI and other expected inflation indicators, which was tested for stationarity, multicollinearity, heteroscedasticity and other data parameters. Time series Auto Regressive Distributed Lag (ARDL) model was used to check the relationship of Gold performance with CPI and other expected inflation variables. It was found, based on the monthly data (2011 to end of 2021), that the variable of expected inflation was statistically significant for the Gold performance but not CPI. This study could be beneficial for the investment community.

**Key words:** GLD, CPI, 10 Year US Bond Yield, Treasury Inflation Protected Securities (TIPS)

### Introduction

As we know that commodities and especially gold is considered as inflation hedge and also risk averse investment. Whenever we have inflation or risk in the economic activity we tend to see gold performance better than equity market's performance. One of the reasons off course is expectations that interest rates are going to go higher which will increase financial cost for businesses which translates to the decrease in earnings going forward. This also increases cost for consumer loans and ultimately buying power and demand of consumer. Inflation and buying power is studied by Easterly et al, (2001). Since the start of 2021 we have seen all over the world that CPI in general is higher than

what was originally thought to be but gold is not performing according to the expectations that the price should go higher with the inflation. One of the main reasons could be that, based on United States information, the Federal Reserve is expecting that the inflation seems to be transitory. Now the question is, if the Consumer Price Index (CPI) is consistently higher then why not gold is behaving according to the expectations of the inflation hedge property. In our understanding CPI is always a backward looking indicator but we need to have some variable(s) like the 'expected inflation' and not the CPI to see the inflation's impact on the gold. To do that we need to see variables which can be proxy for the expected inflation and then check the relationship for inflation hedge. One aspect of gold is inflation hedge and the other is that gold is also considered risk averse investment. Whenever there is some instability in the global economy or some instabilities due to political environment even then gold performs better than the risky investments. In this study we tried to avoid time period for any political instability. First of all we need to see why there exists inflation and then we will be able to see whether this is going to be transitory as Federal Reserve stated, or more than transitory? Only then we will be able to understand the real relationships. One of the factors is that we have not seen this kind of inflation during the previous couple of decades at least for developed economies.

For this, historically, bond market is considered to be the best and broadest indicator which could give us some guidance about the interest rates going forward and indirectly the expectation of inflation. In this study we have picked monthly data for US from start of 2011 and till the end of 2021. Gold (GLD) Exchange Traded Funds (ETF) of Standard and Poor Depository Receipts (SPDR) is selected for this study to be the proxy for gold price. We also selected 10 year US treasury yield, Consumer Price Index for US (CPI), US Treasury Inflation Protected Security (TIPS) 10 yr yield. We also picked the difference between 10 yr yield and the TIPS 10 yr yield as the proxy for Expected Inflation going forward. In all these variables we also used returns for these variables to see the change on monthly basis. This is done to see the impact of CPI and change in other variables on the gold price change.

### **Literature Review**

Since long it has already been discussed about the inflation hedge properties of gold in detail, some authors have selected different macroeconomic variables and others have seen the impact of political instabilities on the gold and silver prices, such as the study by Ariovich (1983). Mahdavi and Zhou (1997), contrary to most of the other studies where mostly inflation impact on Gold is studied, in the Mahdavi and Zhou's study Gold and commodity prices were used as an indicator for inflation and they found that emphasis on gold price (inflation) as a guide to monetary policy seems misplaced.

Simon (1984) in his theoretical perspective of political risk to Gold has studied the South African political instabilities and its impact on the gold price. Beckmann and Czudaj (2013) in their study found based on time varying Coefficient framework that gold price is regime dependent meaning that gold's inflation hedge properties depend on time horizon. If we have time horizon which is turbulent then results are different than the normal times.

Qian et al (2019) studied different factors like federal funds rate, CPI, exchange rates, oil prices etc., and found out that other than CPI all other factors have negative impact on gold price. Batten et al. (2014) also studied the impact of different variables on gold price and just like Beckmann and Czudaj (2013) found that there is relationship but the impact of this relationship is different with different time frames. Bampinas and Panagiotidis (2015) also studied CPI impact on Gold prices for US and UK

markets and found that based on CPI data the inflation hedging ability of gold is better in US when it is compared with UK inflation data. They also found that silver does not hedge US inflation (CPI). Sephton and Mann (2018) studied impact of oil shock on the gold pricing, they found that the impact is dependent on the size of the shock. Soucek (2013) studied relationship and co-movement among equity, energy and gold futures and found that there is bi-directional link between equity and energy futures and it is positively related. He also found that even though there is correlation between gold and equity futures that is weak and negative during financial uncertainty.

Van Hoang et al. (2016) studied overall perspective of Gold as an inflation hedge, based on ARDL approach, they studied US, UK, China, India and France economies. According to their findings, in the long run gold is not inflation hedge for all these countries. On the other hand in the short run it is inflation hedge in US, UK and India. Authors also mentioned that this could be traditional aspects of gold in different regions of the world. Sharma (2016) studied 54 countries to see the impact of CPI on gold. Based on flexible generalized least square estimator technique the author found limited evidence that CPI can predict the gold price but on the whole he found that there is reasonable evidence that CPI predicts gold price returns.

### **Methodology**

The methodology followed in this study is quantitative in nature for which monthly data is collected from the start of 2011 to the end of 2021 accessed through FRED site or other investing sites for US markets. We picked US because first of all this is the largest economy in the world and second factor is that we do not need to address the exchange rate issue for US because even gold price is dollar denominated as compared to other economies. This research studies the influence of inflation (CPI) and other inflation related variables like 10 year US Bond Yield (Y), percentage change in 10 year bond yield (YC), 10 year Treasury Inflation protected Securities change (TYC) and Expected Inflation Change (EIC) by bond market on the gold price change (GC). Expected Inflation (EI) can be found based on bond market which is calculated by subtracting 10 year TIPS value from 10 year yield value, which gives value of expected inflation going forward and then monthly % change is calculated for the data. Based on all this information the equation for these variables becomes:

$$GC_t = \alpha_0 + \beta_1 Y_t + \beta_2 CPI_t + \beta_3 YC_t + \beta_4 TYC_t + \beta_5 EIC_t + e_t$$

Where:

Y = 10 year US Treasury Yield

CPI = Consumer Price Index for US

YC = 10 year US Treasury Yield % Change

TYC = 10 year US Treasury Inflation Protected Security Yield % Change

EIC = Expected Inflation % Change

EI = 10 year US Treasury Yield – TIPS Yield

Because we need to test the impact of inflation related factors on the gold price change, this means gold price change is dependent variable and all the others are the independent variables. The main issue was to see why gold price is not moving with CPI due to the gold's representation as inflation hedge as advocated by previous researchers, and see if not CPI what other variables impact this price change during the time horizon picked for this research.

First step to run the modeling is to test the stationarity of different variables which was tested with

Augmented Dickey Fuller (ADF) and found that some are stationary at level (0) and other at level (1). This test is run for probability values of less than 5%.

Generalized equation for ADF is as follows:

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t$$

The individual equations for different variables would become like this:

$$d(GC_t) = \alpha_0 + \beta t + \gamma GC_{t-1} + d(GC_t(-1)) + \varepsilon_t$$

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t$$

$$d(CPI_t) = \alpha_0 + \beta t + \gamma CPI_{t-1} + d(CPI_t(-1)) + \varepsilon_t$$

$$d(YC_t) = \alpha_0 + \beta t + \gamma YC_{t-1} + d(YC_t(-1)) + \varepsilon_t$$

$$d(TYC_t) = \alpha_0 + \beta t + \gamma TYC_{t-1} + d(TYC_t(-1)) + \varepsilon_t$$

$$d(EIC_t) = \alpha_0 + \beta t + \gamma EIC_{t-1} + d(EIC_t(-1)) + \varepsilon_t$$

As we found that some of the variables are stationary at level and other at first difference due to this reason we need to apply Auto Regressive Distributed Lag (ARDL) approach for modeling as well as the analysis of the results. This research also ran descriptive statistics, correlation matrix, ARDL bound test and finally Error Correlation model (ECM) and both models are given as follows:

$$\Delta GC_{2t} = \alpha_0 + \sum \delta_1 \Delta GC_{t-1} + \sum \delta_2 \Delta Y_{t-1} + \sum \delta_3 \Delta CPI_{t-1} + \sum \delta_4 \Delta YC_{t-1} + \sum \delta_5 \Delta TYC_{t-1} + \sum \delta_6 \Delta EIC_{t-1} + \varphi_1 GC_{t-1} + \varphi_2 Y_{t-1} + \varphi_3 CPI_{t-1} + \varphi_4 YC_{t-1} + \varphi_5 TYC_{t-1} + \varphi_6 EIC_{t-1} + \varepsilon_t$$

$$\Delta GC_t = \alpha_0 + \sum \delta_1 \Delta GC_{t-1} + \sum \varphi_2 \Delta Y_{t-1} + \sum \omega_3 \Delta CPI_{t-1} + \sum \theta_4 \Delta YC_{t-1} + \sum \gamma_5 \Delta TYC_{t-1} + \sum \pi_6 \Delta EIC_{t-1} + \delta ECM_t + v_t$$

ECM model can also be rearranged in this format:

$$\delta ECM_t = \Delta GC_t - \alpha_0 - \sum \delta_1 \Delta GC_{t-1} - \sum \varphi_2 \Delta Y_{t-1} - \sum \omega_3 \Delta CPI_{t-1} - \sum \theta_4 \Delta YC_{t-1} - \sum \gamma_5 \Delta TYC_{t-1} - \sum \pi_6 \Delta EIC_{t-1} - v_t$$

## Results

Based on this study here is the descriptive statistics for different variables. From Table 1, it can be seen that average 10 year treasury yield change for this time frame is around 2 or 2.105 to be exact and correspondingly the mean CPI is around 2.5. Mean numbers are corresponding to the Federal Reserve goals for this time period. When YC and TYC is compared it seems like due to some deflationary pressures in the economy during this time period mean of inflation adjusted the yield changes more effectively compared to regular 10 yr Yield change. For CPI during this time period the minimum number is around 1% and maximum is around 7% which correspond to current inflation numbers coming out of the US economy.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
GPC	0.320	4.715	-11.062	12.275
Y	2.105	0.642	0.620	3.580
YC	-0.180	9.314	-42.162	28.061
TYC	-9.626	205.759	-2195.238	332.189
EIC	0.267	6.477	-38.927	18.686
CPI	2.527	0.841	0.980	7.100

After running Augmented Dickey-Fuller Test (ADF) to analyze the stationarity for different variables, one major issue when dealing with different variables is the presence of multicollinearity. Based on ADF test it was found that in these variables some are stationary at level and others are stationary at first difference. For multicollinearity, this can be tested either with Correlation behavior among different variables or be tested with Variance Inflation Factor (VIF). To be on safe side multicollinearity was tested with both of these methods and no issue was found. Results of both methods are shown in Table 2 and 3. Based on the criteria of correlation matrix we do not observe any value more than 0.85. Based on VIF all values are also on the lower side.

Table 2: Correlation Matrix

Variables	GPC	Y	YC	TYC	EIC	CPI
GPC	1.000					
Y	-0.013	1.000				
YC	-0.319	0.0717	1.000			
TYC	0.202	-0.000	0.084	1.000		
EIC	0.086	-0.127	0.556	0.087	1.000	
CPI	0.114	-0.064	-0.032	-0.001	-0.007	1.000

It can be seen that for VIF, this test was even run for different lags and their differences also. To run this analysis, first of all Maxlag command was used in Stata to find out the maximum lags we can use for this analysis. After running this, Schwarz Bayesian Information Criterion (SBIC) was used to select the max lags used in this research. After selecting the lags ARDL was run in EC

Table 3: Variance Inflation Factor (VIF)

Variables	VIF	1/VIF
EIC		
L1	2.78	0.360
D1	2.68	0.378
YC	1.70	0.588
CPI		
D1	1.25	0.802
L1	1.24	0.805
GPC		
L1	1.17	0.857
TYC	1.16	0.862
Y	1.05	0.950
Mean VIF	1.62	

format and regression was restored to run the VIF test on these variables. Based on first VIF results there was some lags where multicollinearity was present therefore some of the variables were downgraded to run without lags to avoid multicollinearity. This was done with hit and trial method. The ARDL bound test was also run to find out if the long-run correlation among the variables existed. After running the Autoregressive Distributed Lag (ARDL) run with error correction model (ECM),

Pesaran/Shin/Smith ARDL Bound Test was run to test the long run relationship. Based on the F-statistics and critical values it showed the existence of long-run relationship. The results are shown in Table 4.

Table 4: ARDL Bound Test

Model	F-statistics	Max Lags	Level of Significance	Bound test values	critical
GPC/(Y,YC,TYC,EIC,CPI)	41.013	1		I(0)	I(1)
			1%	3.41	4.68
			5%	2.62	3.79
			10%	2.26	3.25

One of the characteristics in ARDL ECM model is that this gives us results for both short run and long run coefficients. Both of these results are shown in table 5 and 6. As expected it is noted that both in short and long run change of 10 year yield is statistically significant in both cases. One more thing is clear that Yield is not but the change in Yield is significant. When we compare CPI with the expected inflation change (EIC) it is clear for both short and long run relationship that CPI is not significant but expected inflation is.

Table 5: Short Run Coefficients

Variables	Coefficient	Std. Error	t-Statistics	Prob.
D(YC)	-0.3339636	0.050829	-6.57	0.000
D(Y)	0.5234282	0.603312	0.87	0.388
D(TYC)	0.0020393	0.005251	0.39	0.698
D(EIC)	0.3437604	0.072365	4.75	0.000
D(CPI)	0.7667195	0.531485	1.44	0.152
Coint Eq/ ECM(-1)	-1.285455	0.084340	-15.24	0.000
R-squared	0.69844892		Adj R-squared	0.67651793

It is also clear based on Adj R-squared value that variation based on chosen variables explains 67.65% variation in Gold prices. It is also known that ECM(-1) coefficient must be negative, which is in this case. This is because when we have ECM(-1) negative that shows that model is converging to the equilibrium. If this value is more negative that shows how quickly it is converging but it could be in oscillatory manner.

Table 6: Long Run Coefficients

Variables	Coefficients	Std. Error	t-Statistics	Prob.
YC	-0.2598018	0.0382405	-6.79	0.000
Y	0.4071929	0.4704802	0.87	0.389
TYC	0.0015864	0.0040996	0.39	0.700
EIC	0.2982211	0.0691200	4.31	0.000
CPI	0.2639762	0.4158792	0.63	0.527

## **Discussion**

The main finding of this research is that gold price shows relation with 10 yr yield and also the expected inflation which is calculated by taking difference between 10 year yield and 10 year TIPs. CPI does not show any statistical relationship towards gold pricing. This can be explained by the fact that CPI is always based on the lagging data and what yields are showing is the inflation projections going forward. Even though it is seen that CPI values are going high during 2021 but it is not translating in the gold price. It has also been noted by Beckmann and Czudaj, R. (2013) and Batten et al, (2014) that relationship of gold price with different variables changes with different time horizons. It can be deduced from the earlier as well as this research that there could be some time horizons in which lagging and expected inflation could be in the same direction. During that time frame CPI could also be statistically significant as the expected inflation is. In the time period selected for this research, it is only shown that whenever we will have some variable for expected inflation for future then both short and long run relationship will be statistically significant for gold price. Based on this it can be deduced that gold is an asset which can be used as expected inflation hedge.

For policy purposes it can be deduced that Federal Reserve may have option to increase the Federal Funds rate based on CPI data which could be very abrupt change in the current Federal Monetary Policy. But if we see the data based on projected inflation then Federal Reserve needs to be very careful in increasing these rates. Basically Federal Reserve needs to increase the rate and see its impact and then decide to increase it again. Based on this finding investors may use this information to hedge their portfolios accordingly, hence its implication for the investing industry could be enormous.

## **Conclusions**

This study was conducted after seeing higher CPI inflation which was not affecting the Gold Price especially in 2021. That was the reason it was tried to see what could be the other variables affecting the gold price if not CPI. Conceptually it makes sense to see what could be the impact of ‘expectation of inflation’ at least for the near future on the gold price. Historically the bond yields are very good predictor for expected inflation. For this research, we subtracted ‘bond yield’ from ‘inflation protected bond yield’ which becomes even more relevant for expected inflation. May be this is the reason the Federal Reserve announced based on their analysis that inflation is transitory. The results from this analysis also support the Federal Reserve’s original stance as far as inflation is concerned. Going forward, this stance could change based on different time horizon. Even though, the Federal Reserve has the option to increase the rates in a big step fashion but it needs to be very careful when increasing the policy rates, and probably they need to take small to medium steps to do so and monitor it carefully. These results are based on US data, but could be expanded to all developed world, where low inflation has been in place for long time.

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