The Impact of Inflation Measures on Asset Returns: Evidence from India

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Abstract

The study investigates the impact of inflation measures in India like the Wholesale Price Index (WPI) and Consumer Price Index (CPI) on different assets returns like equity, bond, and gold for the period from June 2013 to April 2020. This period is defined as an inflation switching regime. The unit root test, Granger causality, multiple regression, quantile regression, and VAR model, along with the Impulse response function, were employed to examine the effect of inflation. Based on regression, we find that equity act as a marginal hedge against the wholesale price index, and bond provides a hedge against the consumer price index. However, none of the asset's i.e., equity, bond, or gold act as a hedge against the unexpected inflation component. Further, based on Vector Autoregression (VAR) analysis, we find that past values of asset returns have no significant effect on inflation. The study also found that the hedging potential of any asset is a function of inflation switching time period.

Keywords: Asset Returns, Inflation, Stock Market, Gold, Bond

JEL Classification: G10, E31, G11

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1. Introduction

The claim that inflation affects the stock market is a well-documented fact in the literature (Fisher, 1930; Jaffe and Mandelker, 1976; Fama and Schwert 1977; Fama 1981; Sharpe, 2002). Inflation is the increase in prices of goods and services over a period of time. An increase in prices leads to a decrease in the purchasing power of money, and the value of financial assets erodes over time. According to the Fisher hypothesis (1930), the expected nominal return on an asset should equal to the real return earned plus the expected inflation. Most of the empirical studies in the literature support the positive relationship between inflation and stock market (Boudoukh and Richardson, 1993; Alagidede and Panagiotidis, 2012; Otieno et. al., 2019). However, there are also studies that contradict the fisher hypothesis (Linter, 1975; Bodie, 1976; Fama and Schwert, 1977; Fama, 1981). In case of India, Chatrath et al. (1996) showed a partial hedge for stock returns against the expected inflation.

Two major sources to measure the inflation in India are Wholesale price index (WPI) and the Consumer price index (CPI). Consumer price index (CPI) is a measure that computes inflation from a consumer's perspective. The wholesale price index (WPI) is an indicator of price changes in the wholesale market or from the producer's perspective. In April 2014, the Indian government shifted from WPI to CPI to measure inflation and make policy decisions for the economy. Further, in February 2015, Inflation targeting (IT) is introduced in India. By inflation targeting, the central bank (RBI) sets a specific interest rate as a sustainable goal to manage inflation. It then tries to achieve IT through various measures such as interest rate, reserve requirement, and by changing the money supply. Inflation targeting announcement reduces the volatility in inflation expectation (Yigit, 2010).

Investment in the financial market is a long-term affair, and any structural or policy change in inflation will impact financial markets. Various empirical literature found inflation to hamper asset returns, reducing the purchasing power of individuals (Yeap and Lean, 2017, Christou et al., 2018). Maintaining the purchasing power of assets is of great importance for long term investors (Attié and Roache, 2009). Existing literature on the test of generalized fisher hypothesis is mixed with studies in support and against it. Fluctuation in inflation and unexpected inflation can be expected to affect the asset returns through future cash flows, discount rates, or the growth channel. Inflation targeting economies have lower inflation and enhance the transparency of monetary policy, and interest rate is less volatile (Crowe, 2010). Gold price increases with inflation, and it can be viewed as a hedge against inflation (Ghosh et al., 2004). Iqbal (2017) investigated whether Gold can hedge investment risk and act as a safe haven asset against inflation by finding the correlation with stock and commodity prices. In this paper we investigate how inflation and unexpected inflation affect the different asset class in an emerging economy like India.

The main aim of a rational investor is to maximize return with the lowest risk. However, inflation seems to be a hurdle and impede these objectives (Christou et al., 2018). When interest rates are high in an economy, inflation also makes a high hurdle rate for stock market investment. However, lower

rates and inflation during the IT regime, the hurdle rates also drop. Investors like assets having a negative correlation as they enhance diversification property. Assets with imperfect correlations are a fundamental assumption used in portfolio optimization and form the basis for the construction of diversified investment portfolios (Markowitz 1952; Sharpe 1964). If there is any adverse effect caused by purchasing power due to inflation, the same can be compensated by other assets.

In this paper, we investigate the dynamic relationship between monthly returns of various asset class, to the actual and unexpected portion of CPI and WPI inflation rate during the inflation switching regime. The study seeks to quantify the extent to how assets, such as Nifty 50, Gold ETF (Exchange-traded fund), and Bond will perform during the inflation switching regime. Since the Indian economy experiences high volatile inflation due to supply-side constraints such as monsoons, crop failure, infrastructure, etc., there is an active debate as to which type of asset protects investors purchasing power and is a perfect hedge against inflation and unexpected inflation in India.

The rest of the paper proceeds as follows. Section 2 reviews some of the existing literature. Section 3 describes the data and econometric methodology used in the study. Section 4 analyses and discusses the results. Section 5 presents the concluding remarks.

2. Literature Review

The relationship between asset prices and inflation has fascinated researchers over the past decades. The generalized Fisher hypothesis (1930) assumes independence between the expected real return and inflation. According to the Fisher Hypothesis, the stock market should act as a hedge against inflation. A hedge is an uncorrelated asset or an asset that has an inverse relationship with a given asset during the economic depression (Baur and Lucey, 2010). Fama and Schwert (1977) examined the relationship between asset returns and the expected and unexpected inflation rate from January 1953 to July 1971. The study tested how assets like Stocks, Bonds, and Gold are effective in hedging against expected and unexpected inflation. According to Fama (1981), an increase in inflation reduces real economic activity, negatively affecting future corporate profits and depressing the current stock prices. Several studies support the negative relationship between the stock market and inflation (Linter, 1975; Jaffe and Madelker, 1976; Fama 1982; Wahlroos and Berglund, 1986). Some studies also show a positive relationship between inflation and stock markets (Spyrou, 2004; Al-Khazali and Pyun, 2004). Several reasons have been put forth for this negative relationship: debtor-creditor hypothesis, taxation-relationship, negative relationship between inflation and real economic activity, etc.

The returns on Gold are generally independent of the return on other assets. The volatility of the global stock indices and other asset returns like gold, silver follow the random walk behavior (Shaik et al. 2019, 2020) and the connectedness of the financial assets are observed to be stronger during periods of uncertainty (Salisu et al. 2022; Shaik et al. 2023).One of the early studies by Chua and Woodward (1982), found gold returns are positively related to both expected and unexpected inflation

rates for the US, but the relationship was not consistent for Canada, Germany, U.K., Japan, and Switzerland. Many previous studies support the notion of using Gold to hedge against inflation (Jaffe, 1989; Reboredo, 2013). Wang et al. (2011) show that the gold prices and consumer price index (CPI) series are cointegrated, and there seems to be a long-term trend. Dee et al. (2013) examined whether Gold is a hedge or a safe haven against stock and inflation for the Chinese stock market from October 2002 to April 2012. The study found that Gold could not hedge stock or inflation during the short term, but it did for long term investors. According to Le Long et al. (2013), Gold provides a complete hedge against both the ex-post and ex-ante inflation, and its return is positively related to unexpected inflation. A recent study by Shahbaz et al. (2014) examined whether an investment in Gold is a hedge against Pakistan's inflation during the period of 1997 to 2011. The results indicate that investment in Gold is a hedge against inflation for both the short-run and long-run. Gold is the only metal that co-integrates with Germany's consumer price index (Rubbaniy et al., 2011). Bilal et al. (2013) examined nexus between gold prices and stock prices using data of Karachi and Bombay stock markets. Their results indicated no cointegration between gold prices and the stock market. The causality analysis revealed a neutral effect between gold prices and stock prices for both stock markets.

For the Indian markets there are numerous studies that looked at the relationship between different asset returns and inflation. Durai and Bhaduri (2009) investigated the nexus between equity returns and inflation for India's post-liberalized period. The study examined both expected and unexpected inflation for equity returns and found both are negatively correlated to equity returns. Kumari (2011) looked at the weekly and quarterly returns for equity markets and inflation from 1991 to 2009 for India. The study used Granger causality along with ordinary least squares, and provide evidence of no significant relationship between stock return and inflation. Tiwari (2011) examined the cointegration between Gold and inflation for the Indian market. Using cointegration analysis, the study found a long-term relationship between Gold and inflation from 1990 to 2009. Bhandari and Bandi (2018) examined the relationship between inflation and stock returns for India using spectral and time-frequency methods for the period 1994 to 2014. The study revealed that stock returns are no longer an efficient hedge against inflation. A recent study by Tiwari et al. (2018) analyzed the dynamics between inflation and stock returns for UK, US, India, and South Africa. The study found that the relationship between stock returns and inflation varies across time periods, and there is no evidence of stock returns acting as a hedge against inflation for both the developed and developing markets.

Economies adopting the Inflation-targeting have a low and stable inflation level compared to other regimes (Rose, 2007). A series of papers by Mishkin (1990, 1991) investigate whether the slope of the term structure has any predictive content in forecasting the future inflation rate. Inflation hedging properties of various assets are heterogenous (Salisu et al., 2020). Robiyanto (2018) scrutinized Gold and Bond's potency to act as safe haven assets for the Indonesia and Malaysia markets for the period June 2008 to September 2016. Using quantile regression, the study indicated Gold did not act as a safe haven for the Indonesian economy but did act as a safe haven for the

Malaysian economy. The study also found that government bonds and Malaysia corporate bonds did not act as a safe haven asset. In contrast, the corporate bonds of Indonesia were able to act as a safe haven asset. Shiller and Beltratti (1990) report negative co-movement between Bond and the stock market. Shorter maturity bonds are less likely to be sensitive to inflation, and longer maturity bonds demand a risk premium. Inflation in emerging countries is higher and more highly volatile than developed economies, which provides an excellent background to study the link between bond markets and inflation for an emerging country like India.

We make two contributions to the existing literature. Firstly, most of the previous studies have examined a single asset inflation relationship. We extend the literature by examining the effect of inflation on various assets. Second, the changes in WPI to CPI and, later, Inflation targeting provides an interesting setup to analyze the relationship during this inflation switching regime. None of the previous studies incorporate this crucial structural change while examining the effect of inflation on the different asset classes. We investigate the nexus between the Stock prices, the Bond market, Gold ETF, and inflation for the Indian stock market during the inflation-switching regime.

3. Data

The study uses monthly returns of Nifty 50, HDFC Gold ETF, and 3-Year bond yield. Monthly CPI and WPI measures are used to check for the impact of inflation on equity, gold, and bond markets. The period of this study covers data from June 2013 through April 2020. The reason for selecting this period is that India moved from WPI to CPI in 2014, there was a significant event when inflation targeting was adopted in 2016. The sample size chosen for the study provides an adequate number of observations to apply time series methods. The index data for different asset classes such as Equity, Gold, and Bond are obtained from Bloomberg. The data for inflation is obtained from investing.com and Bloomberg. The rationale behind using both actual inflation and unexpected inflation approach is that the unexpected component contains new information, which is not reflected in the stock prices. By actual inflation, we mean the inflation number that is reported on the inflation announcement date. In this paper, unexpected inflation would mean overestimation or underestimation. When the forecasted inflation is more than actual inflation it would mean overestimation and when the forecast is less than actual inflation it would mean underestimation.

There are many gold exchange-traded funds (ETFs) that trade in India, and the study only uses only HDFC gold ETF. The reason for selecting the HDFC gold ETF is because it is the market leader. The benchmark and underlying index for all the gold ETFs are the physical gold price, which makes the correlation between all the ETFs close to one. Hence, it would be better to study one and generalize it to India's gold ETF market.

Table 1, shows the descriptive statistics of the monthly asset returns of Nifty, 3-year Bond yield, and HDFC Gold ETF along with the actual and unexpected wholesale price index (WPIA, WPIU) and actual and unexpected consumer price index (CPIA, CPIU) of India for the period from 2013 to

2020. We find that the average monthly return is negative for a 3-year bond yield, WPIU, and CPIU. The standard deviation is high for unexpected wholesale and consumer price indices. We find that the monthly returns of Nifty, Unexpected WPI, and Unexpected CPI are negatively skewed. The monthly returns of Nifty, Bond, Actual and unexpected wholesale price index, and unexpected consumer price index have high kurtosis.

Table 1. Descriptive statistics

	Nifty Index	Bond	Gold ETF	WPI Actual	WPI Unexpected	CPI Actual	CPI Unexpected
Number of Observations.	81	81	81	81	81	81	81
Mean	0.008	-0.005	0.008	0.061	-1.971	0.005	-0.520
Standard Deviation	0.050	0.038	0.041	0.945	8.275	0.149	11.325
Minimum	-0.232	-0.125	-0.103	-4.545	-66.000	-0.300	-75.000
25%	-0.016	-0.023	-0.017	-0.181	-1.716	-0.090	-1.586
50%	0.011	-0.007	0.009	-0.044	-0.741	0.014	-0.688
75%	0.035	0.013	0.035	0.156	0.125	0.068	0.133
Maximum	0.146	0.168	0.114	4.282	10.571	0.532	42.000
Skewness	-1.130	0.771	0.247	0.509	-6.081	0.777	-2.705
Kurtosis	6.215	5.373	0.362	13.051	45.838	1.970	26.417

Note: Here WPIA stands for Actual Wholesale Price Index. WPIU stands for Unexpected Wholesale Price Index.
CPIA stands for Actual Consumer Price Index. CPIU stands for Unexpected Consume Price Index.

Table 2 shows the correlation of different asset classes, namely Nifty 50, HDFC Gold ETF, and 3-Year Bond yield with actual and unexpected inflation for WPI and CPI. The correlation matrix also shows that the assets do not move in the same way.

Table 2. Correlation between Inflation and different monthly asset returns

	Nifty Index	Bond	Gold ETF	WPI Actual	WPI Unexpected	CPI Actual	CPI Unexpected
Nifty Index	*1*						
Bond	*-0.07*	*1*					
Gold ETF	*-0.27*	*0.05*	*1*				
WPI Actual	*0.04*	*0.06*	*0.13*	*1*			
WPI Unexpected	*0.01*	*0.11*	*-0.07*	*0.14*	*1*		
CPI Actual	*0.03*	*0.17*	*-0.03*	*0.35*	*0.16*	*1*	
CPI Unexpected	*-0.06*	*0.02*	*0.07*	*0.05*	*0.38*	*0.25*	*1*

Note: WPI stands for Wholesale Price Index, CPI stands for Consumer Price Index.

4. Methodology

To examine the relationship between asset returns and inflation, different time series econometrics methods are used, such as unit root test, Granger causality test, and regression analysis. To check for the stationarity of the series, two-unit root tests are performed, namely, Dickey and Fuller (1979) and KPSS (Kwaitkowski et al., 1992). The study uses Granger (1969) causality test to examine the causal link between different asset returns and inflation. Multiple linear regressions and quantile regressions are also performed to examine the relationship between multiple assets returns and inflation. For robustness, the study also performs Vector autoregression along with Impulse response function.

4.1. Unit Root Tests:

The stationarity test that is widely popular over the years is the unit root test. The unit root test helps determine the time series property and establish the order of integration, i.e., if the series is stationary or not. We employ Augmented Dickey and Fuller (1979) and Kwiatkowski et al. (1992) on all variables at levels and at first difference. For the ADF test, the null hypothesis is the presence of a unit root. In case of KPSS unit root test, the null hypothesis is the presence of "stationarity," which is represented by I (0), the alternative hypothesis is the existence of a unit root, which is represented by I (1), i.e., the series is integrated of order one.

4.2. Granger Causality Test:

To test for any causal association between the different asset returns and inflation, the standard Granger test is applied. Granger causality is applied at the first differences to measure the short-term association between the Nifty 50 index, HDFC gold ETF, 3-year bond yield, and inflation. According to the Granger (1969), if the past values of 'Y' variable help to forecast the value of another variable 'X', then Y is said to Granger cause X and vice versa. The Granger test is based on the following equations:

$$Y_t = \beta_0 + \sum_k^p \beta_k Y_{t-k} + \sum_l^q \alpha_l X_{t-l} + \mu_t \quad (1)$$

$$X_t = \beta'_0 + \sum_k^p \beta'_k X_{t-k} + \sum_l^q \alpha'_l Y_{t-l} + \mu'_t \quad (2)$$

where $\beta_0, \beta_k, \alpha_l (\beta'_0, \beta'_k, \alpha'_l)$ are the regression parameters and $\mu_t (\mu'_t)$ is regression residuals. The null hypothesis to be tested is $\alpha_l = \alpha'_l = 0$ for all l's and the alternative hypothesis is $\alpha_l \neq 0 \; and \; \alpha'_l \neq 0$ for at least some l's. The l's refers to the order of integration. The first step to check the granger causality is stationarity of the variables to be tested and then test for cointegration between them.

4.3. Multiple Linear Regression:

The study also performs multiple regression equations:

$$R_{i,t} = \beta_0 + \beta_1 Inflation_{Actual,t} + \beta_2 Inflation_{Unexpected,t} + \varepsilon_t \quad (3)$$

$R_{i,t}$: is the return on Asset i on day t. β_0, β_1 and β_2 are the parameters, and ε_t: is the error term and $\varepsilon_t \sim N(0, \sigma^2)$.

4.4. Quantile Regression:

A small change in the inflation level for both WPI and CPI will be less of a surprise because the unexpected component will be small. Hence, a large unexpected change in inflation will have a larger impact on asset returns than small inflation changes. This would suggest that the relationship between inflation and asset returns is not linear. A high level of inflation and larger unexpected component has a greater impact on asset prices than low inflation. One can explore such a relationship between asset returns and inflation using quantile regressions. The following equation describes the quantile regression:

$$y_i = x'_i \beta_q + e_i \quad (4)$$

where, β_q is a vector of unknown parameters associated with the Q^{th} quantile.

4.5. Vector Autoregression (VAR) and Impulse Response Function (IRF):

Vector Autoregressive (VAR) Models were popularized by Sims (1980). The term AR (autoregressive) is due to the appearance of the lagged values of the dependent variable on the right-hand side of the equation. Vector represents the notion that we are dealing with two or more variables. VAR is a system of equation where each variable depends not only on its past values but also on the past values of other variables. A basic p-lag VAR system takes the following form:

$$Y_t = \alpha_1 + \delta_1 t + \emptyset_{11} Y_{t-1} + \ ... + \emptyset_{1p} Y_{t-p} + \beta_{11} X_{t-1} + \ ... + \beta_{1q} X_{t-q} + \varepsilon_{1t} \quad (5)$$

$$X_t = \alpha_2 + \delta_2 t + \emptyset_{21} Y_{t-1} + \ ... + \emptyset_{2p} Y_{t-p} + \beta_{21} X_{t-1} + \ ... + \beta_{2q} X_{t-q} + \varepsilon_{2t} \quad (6)$$

Where, Y_t and X_t are transformed variable vectors, $\emptyset_{i's}$ and $\beta_{i's}$ are coefficients to be estimated and ε_t are the stochastic error terms, called impulses or innovations or shocks. The error term is randomly and normally distributed with zero mean and constant variance. Johansen (1988, 1991), developed VAR models to test the cointegration between 2 variables. Cointegration analysis helps in finding the long-run relationship between two variables (Ely and Robinson, 1997; Al-Nassar and Bhatti, 2019). Further we apply the impulse response function to examine the causal link between different asset returns and the inflation rate

5. Empirical Analysis

In this section, we report and analyze the findings of the empirical tests of the relationship between the different asset returns and inflation.

5.1. Unit root tests

Looking at Table 3, Nifty 50, Bond, and Gold are non-stationary at levels unlike WPIA, WPIU, CPIA, and CPIU. The first differenced series for all the variables is stationary at 5% significance level. The series was transformed by taking the first differences of each variable's value to attain stationarity in the first moment.

5.2. Granger Causality Test

The stationarity of the series is an essential precondition to applying Granger causality. The granger causality test checks for unidirectional, bidirectional, or no causality between the different asset returns and the inflation. The test statistics for granger causality are presented in Table 4 for the Wholesale Price Index (WPI) and Table 5 for CPI. The null hypothesis that WPIA (actual inflation) and WPIU (unexpected inflation) does not cause affect various asset returns cannot be rejected. However, there is unidirectional effect between WPI and Bond.

Table 5 gives results for granger causality for Consumer Price Index (CPI), Bond, Gold, and Stock markets. The causal link between CPI and other asset class is weak, with only a unidirectional flow in case of Gold for CPIA. Out of 12 cases, evidence of an independent relationship between the two variables is found in 11 cases, which means not to reject the null hypothesis. The granger causality suggests that WPI strongly affects the asset returns compared to the CPI. One possible explanation for the weak granger causality could be because inflation targeting was adopted when the CPI was used as a measure of inflation to take policy decisions. Inflation targeting brings greater transparency and understanding of the RBI monetary policy. During the IT regime, there are fewer surprises in two major macroeconomic indicators, such as inflation, interest rate, and markets becoming more efficient (Singh and Padmakumari, 2020). So, it could be possible that the information is already reflected in asset prices, and there is a weak causal link leading to less predictive power for CPI.

Table 3. Results of Unit Root Test Statistics

	ADF (Level)	P-Value	KPSS (Level)	P-Value	ADF (First Difference)	P-Value	KPSS (First Difference)	P-Value
Nifty 50	-1.848	0.357	0.691	0.014**	-9.008	0.00***	0.216	0.100***
Bond	0.189	0.972	0.580	0.024**	-5.797	0.00***	0.272	0.100***
Gold	2.662	0.999	0.465	0.049**	-9.705	0.00***	0.266	0.100***
WPIA	-3.425	0.010**	0.093	0.100*	-9.227	0.00***	0.233	0.100***
WPIU	-5.577	0.001***	0.081	0.100*	-9.027	0.00***	0.192	0.100***
CPIA	-2.915	0.044***	0.488	0.044**	-3.985	0.00***	0.201	0.100***
CPIU	-4.013	0.001***	0.104	0.100*	-9.041	0.00***	0.121	0.100***

Note: *, **, and *** represent 10 %, 5 %, and 1% significance levels, respectively.

Table 4. Granger Causality Test Results for WPI

S. No.	Null Hypothesis	P-Value	Inference (H_0)
1	Nifty does not Granger cause WPIA	0.094	Accept
2	Nifty does not Granger cause WPIU	0.125	Accept
3	Bond does not Granger cause WPIA	0.051	Accept
4	Bond does not Granger cause WPIU	0.004	*Reject*
5	Gold does not Granger cause WPIA	0.052	Accept
6	Gold does not Granger cause WPIU	0.409	Accept
7	WPIA does not Granger cause Nifty	0.019	*Reject*
8	WPIA does not Granger cause Bond	0.084	Accept
9	WPIA does not Granger cause Gold	0.050	*Reject*
10	WPIU does not Granger cause Nifty	0.000	*Reject*
11	WPIU does not Granger cause Bond	0.000	*Reject*
12	WPIU does not Granger cause Gold	0.025	*Reject*

Note: Here WPIA stands for Actual Wholesale Price Index. WPIU stands for Unexpected Wholesale Price Index. CPIA stands for Actual Consumer Price Index. CPIU stands for Unexpected Consume Price Index

Table 5. Granger Causality Test Results for CPI

S. No.	Null Hypothesis	P-Value	Inference (H_0)
1	Nifty does not Granger cause CPIA	0.3227	Accept
2	Nifty does not Granger cause CPIU	0.3315	Accept
3	Bond does not Granger cause CPIA	0.0815	Accept
4	Bond does not Granger cause CPIU	0.5066	Accept
5	Gold does not Granger cause CPIA	0.3430	Accept
6	Gold does not Granger cause CPIU	0.2791	Accept
7	CPIA does not Granger cause Nifty	0.2296	Accept
8	CPIA does not Granger cause Bond	0.0831	Accept
9	CPIA does not Granger cause Gold	0.0221	*Reject*
10	CPIU does not Granger cause Nifty	0.1306	Accept
11	CPIU does not Granger cause Bond	0.8697	Accept
12	CPIU does not Granger cause Gold	0.3192	Accept

Note: Here, WPIA stands for the Actual Wholesale Price Index. WPIU stands for the Unexpected Wholesale Price Index. CPIA stands for the Actual Consumer Price Index. CPIU stands for the Unexpected Consumer Price Index.

5.3. Multiple Regression Analysis

The multiple regression models examined the effect of actual and unexpected inflation on different asset returns. The actual inflation rate and the unexpected inflation are treated as the independent variable, and the monthly asset returns for equity, Gold, and Bond are treated as dependent variables. In Table 6, we find that WPI does not support the hypothesis that WPI is a significant explanatory variable for asset returns. The P-value is more than .05, for all the regression

models and all the coefficient show insignificant relationship (Tables 6). None of the assets provides hedge against WPI as all the coefficients are very close to zero. The findings for WPI do not support the fisher hypothesis that any increase in the inflation rate leads to a proportional change in the asset return of 3-year Bond, gold ETF, and equity markets. The R-squared, which measures the success of the regression in estimating the dependent variable within the sample, indicates that the WPI inflation can explain only .2% of equity markets, 1.5% of the bond market, and 2.7% of gold market movements.

Table 6 also represents the regression result for equity, gold and bond market regressed on actual CPI and unexpected CPI. Equity and bond support the fisher hypothesis and provide marginal hedge against the CPIA while gold act as a negative hedge. The relationship between CPI and asset returns is not significant as the P-value is more than .05 for all the asset classes. The hedge against the unexpected CPI inflation is very low for all the asset classes. The R-squared indicate that the CPI inflation can explain only .8% of equity markets, 3% of bond market movements and .9% of the gold market.

5.4. Quantile Regression Analysis

Table 7 reports the findings for quantile regression at various quantiles of .25, .5, and .75. The impact of WPI on different asset returns is insignificant for all the quantile except for Gold (tau=.25 and tau =.5) as shown in Table 7, Panel A. The hedge for all the asset classes against WPI is close to zero at all the quantiles except for gold (tau =.5). The effect of CPI on different asset returns is insignificant at all the quantiles except for Bond at tau of .75 as shown in Table 7, Panel B Gold provides mixed results on the hedging potential against CPI. Interestingly, none of the asset acts as hedge against unexpected CPI.

Table 6. Result of Multiple Linear Regression performed on both WPI and CPI on asset returns

		Equity			Bond			Gold		
Variables	**No. of Observations**	**Coefficient**	**S.E.**	**t-stat (p-val)**	**Coefficient**	**S.E.**	**t-stat (p-val)**	**Coefficient**	**S.E.**	**t-stat (p-Val)**
Constant		0.0078	0.006	1.395 (0.167)	-0.0047	0.004	-1.109 (0.271)	0.0075	0.005	1.651 (0.103)
WPIA	81	0.0022	0.006	0.374 (0.709)	0.0021	0.005	0.466 (0.642)	0.0063	0.005	1.299 (0.198)
WPIU		0.0000	0.001	0.116 (0.908)	0.0005	0.001	0.905 (0.369)	-0.0005	0.001	-0.891 (0.375)
R^2			0.002			0.015			0.027	
Constant		0.0072	0.006	1.283 (0.203)	-0.0054	0.004	-1.269 (0.208)	0.0083	0.005	1.803 (0.075) *
CPIA	81	0.0182	0.039	0.469 (0.640)	0.0452	0.030	1.528 (0.130)	-0.0172	0.032	-0.539 (0.592)
CPIU		-0.0004	0.001	-0.771 (0.479)	0.0000	0.000	-0.168 (0.867)	0.0003	0.000	0.780 (0.438)
R^2			0.008			0.030			0.009	

Note: *, **, and *** represent 10 %, 5 %, and 1% significance levels, respectively. WPIA, WPIU stands for Actual Wholesale Price Index, Unexpected Wholesale Price Index respectively. CPIA, CPIU stands for Actual Consumer Price Index, Unexpected Consumer Price Index respectively.

Table 7. Result of Quantile Regression Analysis

Panel A: Quantile Regression for WPI

		Equity			Bond			Gold		
Quantile	**Variables**	**Coefficient**	**S.E.**	**t-stat (p-Val)**	**Coefficient**	**S.E.**	**t-stat (p-Val)**	**Coefficient**	**S.E.**	**t-stat (p-Val)**
	Constant	-0.017	0.00	-2.533 (0.013) **	-0.022	0.00	-5.027 (0.000) ***	-0.019	0.00	-3.262 (0.002) ***
Tau=0.25	WPIA	0.005	0.00	0.629 (0.531)	-0.000	0.00	-0.151 (0.881)	0.005	0.00	0.838 (0.405)
	WPIU	-0.001	0.00	-0.084 (0.934)	0.000	0.00	1.666 (0.100)	-0.001	0.00	-2.413 (0.018) **
	Constant	0.014	0.00	2.245 (0.028) ***	-0.006	0.00	-1.612 (0.111) *	0.004	0.00	0.820 (0.415)
Tau=0.5	WPIA	0.000	0.00	0.107 (0.915)	-0.001	0.00	-0.355 (0.723)	0.010	0.00	1.813 (0.074) *
	WPIU	0.000	0.00	0.510 (0.612)	0.000	0.00	0.548 (0.585)	0.000	0.00	-1.813 (0.240)
	Constant	0.035	0.00	5.614 (0.000) ***	0.013	0.01	2.861 (0.005) ***	0.027	0.00	4.987 (0.000) ***
Tau=0.75	WPIA	0.003	0.00	0.678 (0.500)	0.000	0.01	0.115 (0.909)	0.007	0.00	1.632 (0.107)
	WPIU	0.000	0.00	0.057 (0.955)	0.000	0.00	0.484 (0.630)	0.000	0.00	-0.768 (0.445)

Note: *, **, and *** represent 10 %, 5 %, and 1% significance levels, respectively. WPIA, WPIU stands for Actual Wholesale Price Index, Unexpected Wholesale Price Index respectively.

Panel B: Quantile Regression for CPI

		Equity			Bond			Gold		
Quantile	**Variables**	**Coefficient**	**S.E.**	**t-stat (p-Val)**	**Coefficient**	**S.E.**	**t-stat (p-Val)**	**Coefficient**	**S.E.**	**t-stat (p-Val)**
	Constant	-0.019	0.00	-2.715 (0.008) ***	-0.022	0.00	-5.252 (0.000) ***	-0.019	0.00	-3.194 (0.002) ***
Tau=0.25	CPIA	0.013	0.05	0.230 (0.819)	0.027	0.02	0.949 (0.346)	-0.015	0.03	-0.412 (0.682)
	CPIU	0.000	0.00	-0.598 (0.552)	0.000	0.00	0.280 (0.780)	0.000	0.00	0.005 (0.996)
	Constant	0.011	0.00	1.841 (0.069) **	-0.007	0.00	-1.746 (0.085) *	0.010	0.00	1.660 (0.101)
Tau=0.5	CPIA	-0.009	0.04	-0.219 (0.827)	0.035	0.03	1.183 (0.240)	0.000	0.04	-0.003 (0.998)
	CPIU	0.000	0.00	-0.730 (0.468)	0.000	0.00	0.195 (0.846)	0.000	0.00	0.655 (0.514)
	Constant	0.036	0.00	5.722 (0.000) ***	0.011	0.00	2.538 (0.013) **	0.036	0.00	5.552 (0.000) ***
Tau=0.75	CPIA	-0.016	0.04	-0.388 (0.699)	0.053	0.02	1.872 (0.065) *	-0.008	0.05	-0.171 (0.865)
	CPIU	0.000	0.00	-0.105 (0.917)	0.000	0.00	0.336 (0.738)	0.000	0.00	1.209 (0.230)

Note: *, **, and *** represent 10 %, 5 %, and 1% significance levels, respectively. CPIA, CPIU stands for Actual Consumer Price Index, Unexpected Consumer Price Index respectively.

The asset shows marginal positive returns for WPI compared to the CPI. The results for multiple linear regression are consistent with Kumari (2011) that the relationship between inflation and the stock market is insignificant. The study uses the same methodology used by Kumari (2011) to check for the relationship between inflation and asset returns. For robustness check, we also perform quantile regression, and the results indicate an insignificant relationship between inflation and different asset returns during the WPI and the CPI regime. Hence, we can infer that none of the asset provides a perfect hedge for both actual and unexpected inflation during both regimes.

5.5. VAR Model and Impulse Response Function

In this study, VAR analysis is done along with the impulse response function to examine the causal link between different asset returns and the inflation rate. The series needs to be stationary, and the choice of optimal lag length is important for VAR methodology. Selecting a higher-order lag than the actual lag increases the mean square error, and selecting a lower lag than the true lag leads

to an increase in autocorrelated error. The appropriate number of lags for VAR is selected by using Akaike information criterion (AIC). Table 8, reports the result of VAR for different asset returns and WPI. Table 9, reports the VAR result for different asset returns and CPI. Looking at table 8, we find statistically insignificant inflation coefficients for different asset returns. Previous month WPI strongly affects current WPI and previous month unexpected WPI strongly affects the current month returns (Table 8). Table 9 shows statistically insignificant inflation coefficients for Nifty and Bond, but statistically significant coefficients for Gold for CPIA (lag 2). We also find that previous month CPI strongly affects current CPI (Table 9). We find evidence of insignificant relationship between unexpected CPI and asset returns.

The impulse response function (IRF) tries to assess the dependent variable's response due to the shock that occurs only in the independent variable. It is a pairwise shock from one variable to another to examine the causality between each pair. IRF (Impulse Response Function) helps in tracing out the time path of the effect of one-unit shock on each of the variables in the VAR model. Figure A shows the IRF for the variables Nifty 50, Bond, Gold, and WPI. The thick line represents the shock response, whereas the dotted line represents the standard error band. If the standard error excludes the value zero, the effect is significant. Y-axis is represented by standard deviation, and the X-axis represents lag periods. Before analyzing the IRF, it's important to understand the shock and the response variable. For example, X→Y, means the impact of response X on Y over the lag period. X→X, is pretty much an autocorrelation plot for the X variable. If the standard error lines do not exclude zero, the results are insignificant.

None of the asset provides hedge for CPI and WPI over the long run. For the WPIA there is negative affect initially on Nifty and Bond, however the effect diminishes over the long run. Gold provides positive returns against WPIA but the returns fall over the next few months. We find very little effect of inflation on asset returns during the CPI compared to the WPI according the impulse response function (Figure A and Figure B). The standard error bands include zero for all the IRF results; hence the relationship between different asset returns and inflation is insignificant for both WPI and CPI.

Table 8. A: VAR (4) model for Nifty, Bond, Gold, and WPI

	Results for equation Nifty				**Results for equation WPIA**				**Results for equation WPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	0.011	0.006	0.046**	Const	-0.019	0.091	0.833	Const	-1.136	0.997	0.255
Lag 1 (Nifty)	-0.079	0.119	0.507	Lag 1 (Nifty)	0.730	1.901	0.701	Lag 1 (Nifty)	-0.904	20.738	0.965
Lag 1 (WPIA)	0.008	0.007	0.237	Lag 1 (WPIA)	0.741	0.113	0.000***	Lag 1 (WPIA)	0.446	1.230	0.717
Lag 1 (WPIU)	0.001	0.001	0.340	Lag 1 (WPIU)	-0.002	0.010	0.874	Lag 1 (WPIU)	-0.054	0.114	0.636
Lag 2 (Nifty)	-0.155	0.144	0.280	Lag 2 (Nifty)	0.216	2.286	0.925	Lag 2 (Nifty)	9.740	24.931	0.696
Lag 2 (WPIA)	-0.016	0.007	0.028**	Lag 2 (WPIA)	-0.335	0.112	0.003***	Lag 2 (WPIA)	-0.642	1.225	0.600
Lag 2 (WPIU)	0.000	0.001	0.529	Lag 2 (WPIU)	-0.003	0.011	0.760	Lag 2 (WPIU)	0.022	0.115	0.848
	Results for equation Nifty				**Results for equation WPIA**				**Results for equation WPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	-0.006	0.004	0.079*	Const	0.008	0.089	0.926	Const	-0.552	0.932	0.554
Lag 1 (Bond)	0.149	0.103	0.146	Lag 1 (Bond)	4.722	2.491	0.058*	Lag 1 (Bond)	73.040	26.040	0.005***
Lag 1 (WPIA)	-0.006	0.004	0.101	Lag 1 (WPIA)	0.548	0.095	0.000**	Lag 1 (WPIA)	0.040	0.989	0.968
Lag 1 (WPIU)	0.000	0.000	0.350	Lag 1 (WPIU)	-0.001	0.011	0.939	Lag 1 (WPIU)	-0.079	0.111	0.475
	Results for equation Nifty				**Results for equation WPIA**				**Results for equation WPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	0.005	0.004	0.258	Const	0.001	0.090	0.987	Const	-1.033	0.990	0.297
Lag 1 (Gold)	-0.216	0.114	0.058*	Lag 1 (Gold)	-1.564	2.386	0.512	Lag 1 (Gold)	-0.672	26.118	0.979
Lag 1 (WPIA)	0.008	0.005	0.166	Lag 1 (WPIA)	0.751	0.113	0.000***	Lag 1 (WPIA)	0.444	1.241	0.721
Lag 1 (WPIU)	-0.001	0.001	0.241	Lag 1 (WPIU)	-0.002	0.011	0.854	Lag 1 (WPIU)	-0.054	0.115	0.638
Lag 2 (Gold)	0.085	0.109	0.434	Lag 2 (Gold)	-1.007	2.280	0.659	Lag 2 (Gold)	-3.006	24.964	0.904
Lag 2 (WPIA)	-0.001	0.005	0.907	Lag 2 (WPIA)	-0.324	0.114	0.004***	Lag 2 (WPIA)	-0.591	1.246	0.636
Lag 2 (WPIU)	-0.001	0.001	0.075*	Lag 2 (WPIU)	-0.004	0.010	0.727	Lag 2 (WPIU)	0.020	0.115	0.864

Note: *, **, *** represents significance at 1%, 5% and 10% respectively. Here, 'prob', 't-stat', 'std.error', stands for 'P-value', 'T-statistic' and 'Standard Error'. WPIA, WPIU stands for Actual Wholesale Price Index, Unexpected Wholesale Price Index respectively.

Table 8. B: VAR (4) model for Nifty, Bond, Gold, and CPI

	Results for equation Nifty				**Results for equation CPIA**				**Results for equation CPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	0.008	0.006	0.168	Const	-0.001	0.016	0.937	Const	-1.381	1.310	0.292
Lag 1(Nifty)	-0.079	0.119	0.510	Lag 1(Nifty)	0.302	0.341	0.376	Lag 1(Nifty)	7.984	27.578	0.772
Lag 1(CPIA)	-0.020	0.039	0.611	Lag 1(CPIA)	0.353	0.111	0.002***	Lag 1(CPIA)	1.198	9.024	0.894
Lag 1(CPIU)	-0.001	0.001	0.198	Lag 1(CPIU)	-0.001	0.001	0.434	Lag 1(CPIU)	-0.035	0.119	0.768
	Results for equation Bond				**Results for equation CPIA**				**Results for equation CPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	-0.007	0.004	0.053*	Const	0.002	0.016	0.918	Const	-1.250	1.307	0.339
Lag 1(Bond)	0.127	0.104	0.220	Lag 1(Bond)	0.351	0.452	0.437	Lag 1(Bond)	22.993	36.455	0.528
Lag 1(CPIA)	0.041	0.026	0.111	Lag 1(CPIA)	0.349	0.112	0.002***	Lag 1(CPIA)	0.568	9.074	0.950
Lag 1(CPIU)	0.000	0.000	0.799	Lag 1(CPIU)	-0.001	0.001	0.384	Lag 1(CPIU)	-0.038	0.118	0.746
	Results for equation Gold				**Results for equation CPIA**				**Results for equation CPIU**		
	Coefficient	std. error	Prob		Coefficient	std. error	Prob		Coefficient	std. error	Prob
Const	0.005	0.004	0.235	Const	-0.002	0.016	0.914	Const	-1.782	1.387	0.199
Lag 1(Gold)	-0.174	0.114	0.129	Lag 1(Gold)	0.486	0.414	0.240	Lag 1(Gold)	41.194	35.479	0.246
Lag 1(CPIA)	-0.023	0.032	0.463	Lag 1(CPIA)	0.485	0.114	0.000***	Lag 1(CPIA)	0.978	9.797	0.921
Lag 1(CPIU)	0.000	0.000	0.327	Lag 1(CPIU)	-0.002	0.001	0.188	Lag 1(CPIU)	-0.055	0.122	0.653
Lag 2(Gold)	0.101	0.109	0.353	Lag 2(Gold)	0.410	0.396	0.301	Lag 2(Gold)	15.506	33.897	0.647
Lag 2(CPIA)	0.054	0.032	0.087*	Lag 2(CPIA)	-0.341	0.115	0.003***	Lag 2(CPIA)	2.551	9.840	0.795
Lag 2(CPIU)	0.000	0.000	0.303	Lag 2(CPIU)	0.001	0.001	0.500	Lag 2(CPIU)	-0.066	0.122	0.590

Note: *, **, *** represents significance at 1%, 5% and 10% respectively. Here, 'prob', 't-stat', 'std.error', stands for 'P-value', 'T-statistic' and 'Standard Error'. WPIA, WPIU stands for Actual Wholesale Price Index, Unexpected Wholesale Price Index respectively.

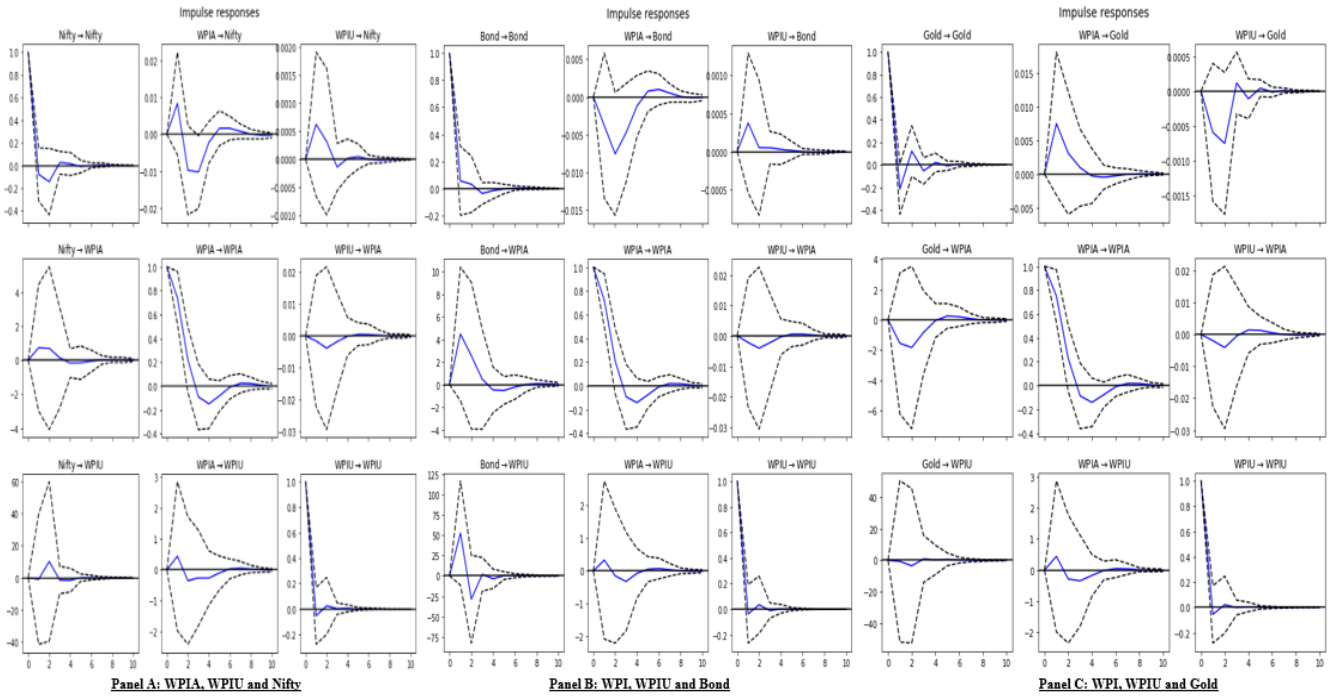

Figure A. Impulse Response Function for Asset Returns and WPI

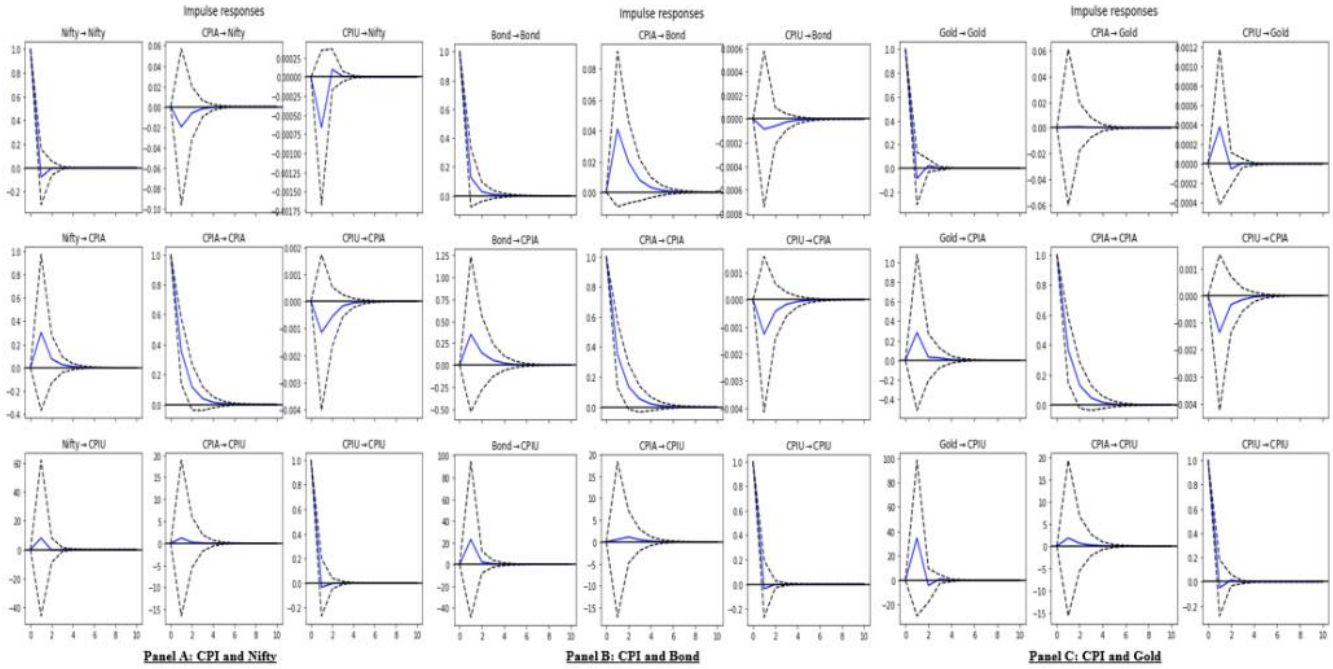

Figure B. Impulse Response Function for Asset Returns and CPI

6. Conclusion

In this paper we investigate how the actual and unexpected inflation measures like wholesale price index (WPI) and consumer price index (CPI) impact different asset returns for the period from June 2013 to April 2020. The assets examined were Nifty 50 index, HDFC gold ETF and 3 years bond. The analysis will help determine whether these different assets can be used to diversify the

inflation risk on average, which we call the "hedging" potential. The study performed various econometrics tests such as unit root tests, Granger causality, multiple and quantile regressions, and VAR to understand the impact of inflation on different asset returns during inflation switching regime.

Equity provides marginal hedge during the WPI regime and bond for the CPI. It indicates that the relationship between bond returns and interest rate or inflation volatility is negative. Uncertainty about interest rate during WPI leads to a decrease in bond returns. Interestingly, none of the assets provide a good hedge against both actual and unexpected consumer price index (CPI) and wholesale price index (WPI). The reason for different assets to act as a bad hedge against CPI compared to WPI could be because inflation targeting was adopted during the CPI regime. Inflation targeting brings greater transparency and stability in inflation, which might reduce the need for asset to act as a hedge. Hence, assets show insignificant results and lower hedging potential when CPI is used as a source of inflation. Further, we find that past values of asset returns do not have a significant effect on the current inflation measures based on vector autoregression (VAR) analysis and impulse response functions (IRF).

The findings have several implications for investors. India is a country that has experienced inflation throughout its history, which makes it more important to find asset that beats inflation. This paper provides useful information regarding the performance of different assets during the inflation switching regime for an emerging country.

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