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Empirical Analysis of Effects of Expected Inflation on Stock Returns

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Abstract

In this paper, we adopted asymmetric test specification model to investigate implications of expected inflation on stock returns in Pakistan. While to calculate expected inflation, two methods, Fama money demand model (1981) and ARMA model were employed on monthly data covering time span from August 1998 to June 2018. The results show a strong relationship between real stock returns (adjusted from inflation) and expected inflation while utmost an insignificant relationship between nominal stock returns and predicted inflation. An inverse relationship amidst stock returns and inflation is observed during only low inflation time period in contrast to high inflation time period (positive relationship). The impact of expected inflation on stock returns by dividing the sample period into sub periods provides insignificant relationship between stock returns and expected inflation which is obvious as stock returns behaves noisy in short time period.

Keywords: Expected Inflation, Stock Returns, Fama Money Demand Model, ARMA
JEL Codes: C58, E31, E44, G41, R53

1. Introduction

The relationship between stock returns and expected inflation plays vital role for investors to take investment decisions. Investors need to know about the behavior of stock returns when

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there is occurrence of some change in expected inflation to avoid inflation illusion, which leads to mispricing of assets, when expected inflation is high the price of stock is less than its fundamental value and vice versa (Ritter and Warr, 2002). Moreover, if there is positive relationship between stock returns and expected inflation it predicts that stock market can be hedged against inflation and vice versa. Additionally, in long run future prices are expected by taking in account current prices. While inflation reduces the ability of prices to predict future prices (Ball and Romer, 1993). Analysts estimate the future earnings by compensating inflation in it but they cannot compensate it completely as to include complete information is not possible (Basu et al., 2010; Chordia and Shivakumar, 2005).

Scheinkman and Xiong (2003) proposed heterogeneous belief hypothesis in this regard. When inflation is low, prices increases than their fundamental value and that is because of inflation illusion, and vice versa (Ritter and Warr, 2002). As a result, error-induced mispricing component occurs in stock prices (Cohen et al., 2005). Furthermore, Inflation decreases real economic activity which leads to the decrease in money demand which effects corporate profits negatively and so equity prices decreases which became the cause of negative relationship between inflation and stock prices which is "proxy effect" (Fama, 1981).

Meanwhile, the debate of relationship between stock returns and expected inflation is always questioned. Some literature suggests that the value of real investment should not be changed by inflation rate, there should not be influence of nominal variables on their real variables in long run (Tiwari et al., 2015). There is contradiction in results of many studies, some studies show that there is existence of negative relationship between stock returns and expected inflation and some shows positive relationship. This contradiction may be because of different methods used to test the relationship by different authors (Geske and Roll, 1983).

To examine the relationship among stock returns and inflation various methods are adopted by different authors. Spyros (2001) used cointegration test and Vector-Auto regressive (VAR) model to identify the relationship between stock returns and inflation. Also, a study investigated relationship between stock returns and inflation by employing correlation analysis Vector Autoregressive (VAR) model and Ordinary least square (OLS) (Crosby, 2001).

Besides Floros (2004) considered both the lead and lag periods of stock returns and inflation for which they adopted Pairwise Granger Causality Test, Ordinary least square (OLS) and Johansen Cointegration Test. Moreover, Geske and Roll (1983) and Lee et al., (2000) also adopted unit root test, ARIMA and OLS to estimate the effect of inflation on stock returns on inflation in United State and impact of German hyperinflation of stock returns respectively.

Data of expected inflation is generated by calculating it through both ARMA model and Fama's (1981) money demand inflation model and divided both series of expected inflation in two (high and low) groups through asymmetric test specification model.

Crosby (2001), Durai and Bhaduri (2009), Yeh and Chi (2009) found a negative relationship among stock returns and inflation. According to explanation, a higher rate of monetary expansion results from the drop-in economic activity due to higher inflationary expectations in the cases of low stock returns consistency with them.

A similar study conducted on US and ten pacific-rim countries and results shows that in all countries there is negative correlation between stock returns and inflation except Malaysia (Khil and Lee, 2000). Study of Aperigis and Eleftheriou (2002), Adrangi et al. (2001) and Sellin (2001) also showed a negative relationship between two variables which is in line with proxy hypothesis. Alternatively, Alagidede and Panagiotidis (2010) and Omay et al., (2015) found a positive relationship among stock returns and consumer prices.

Conversely, Spyros (2001) and Floros (2004) reported no relationship between stock returns and inflation. While Chen et al., (2013) found that inflation expectations do not predict mispricing of the stock market, instead heterogeneous beliefs have strong relationship with stock market mispricing. Whereas Ugur & Ramzan, (2005) reported no correlation between real stock returns and expected inflation and a negative relationship between stock returns and actual inflation.

Bhanja et al., (2012) stated stock returns cannot use for hedge other than frequency band between 16 to 32 months. Similarly, Boamah (2017) and Antonakakis et al., (2017) reported different results for long run and short run relationship among stock returns and inflation. Additionally, Farooq and Ahmed, (2018) found that the investment decisions of firms headquartered located in the high inflation countries are less sensitivity with the stock prices.

While in case of Pakistan, Ahmed and Mustafa (2012) used full information maximum likelihood and concluded that there is negative relationship between stock returns and inflation. While Attari and Safdar (2013) find out that macro variables have impact on inflation. A study used frequency causality and continuous wavelet transform method and concluded that in Pakistan stock market is a good hedge against inflation (Tiwari et al., 2015).

Aforementioned and most of other studies conducted in Pakistan were aimed to find out relationship among actual inflation and stock returns. While this study is an attempt to find out impact of expected inflation on real/nominal stock returns during both high and low inflation time period. The specific objectives of this study are to analyze the effect of expected inflation on stock returns in Pakistan and whether nature of correlation among forecasted inflation and stock returns vary during high and low inflation time span. Subsequently, to analyze the expected inflation in both nominal and real stock returns. To achieve aforementioned objectives, study divided the expected inflation into high and low inflation time period and tested the effect.

2. Methodology

There are different methods used to calculate expected inflation by different authors. Schmeling and Schrimpf (2011) used survey method to calculate expected inflation. Mankiw (2001), Stock and Watson (1999) used Phillips curve to estimate expected Inflation. While Fama (1981) used money demand model. Geske and Roll (1983) used adaptive expectation model to generate expected inflation series. While Kim and Ryoo (2011) adopted threshold vector error correction model.

Two well-established and fundamental forecast models ae enlisted to generate expected inflation in order to use in analyzing influence of expected inflation on stock returns. These models follow a rational traditional approach which identifies linkage between, money market, stock returns, product market and inflation.

To calculate expected inflation Fama (1981) used two models one is money demand based which calculates inflation in terms of real activity and money growth and other is based upon the beginning period of the treasury bill. Study used money demand model as the treasury bill-based method is proved poor to forecast expected inflation. Money demand model is

$$\Delta lnrm_t = \Delta lnNM_t - \Delta lnp_t = \alpha_0 + \alpha_1 \Delta lnAR_t + \alpha_2 \Delta lnTB_t + e_t \quad (1)$$

rm_t	=	Real Money Quantity
NM_t	=	Nominal Money Quantity
Δlnp_t	=	Actual Inflation for time period t
AR_t	=	Real Anticipated Activity
TB_t	=	Nominal Interest Rate on Treasury Bills

To measure "AR_t" industrial production is used. By assuming exogeniety of real activity and rearranging the equation Fama obtained following new equation (Fama, 1981):

$$\Delta lnp_t = -\alpha_0 - \alpha_1 \Delta lnAR_t - \alpha_2 \Delta lnTB_t + \alpha_3 \Delta lnNM_t + \mu_t \quad ; while\ \mu_t = -e_t$$

Then variable of interest rate is excluded as it was found the weakest variable. This is found insignificant when other variables are added.

$$\Delta lnp_t = \pi_t = \beta_0 + \beta_1 \Delta lnNM_t + \beta_2 \Delta lnAR_t + \beta_3 \Delta lnAR_{t+12} + \mu_t \quad (2)$$

AR_t and AR_{t+12} have the negative relationship with inflation and NM_t seem to have the positive relationship with inflation. When real activity decreases there is a fall in demand for real money and to compensate this price increase. To measure anticipated activity industrial production or real growth is used. AR_{t+12} is industrial production or real growth for the $t + 12$ month. We use Fama's money demand method and use actual growth rate instead of anticipated real activity as it has more satisfactory attributes to predict inflation.

Another method is used to calculate expected Inflation in order to compare results for Fama money demand model and ARMA model.

$$E_t(\pi)_{t+1} = \alpha_0 + \alpha_1 E_{t-1}(\pi_t) + \alpha_2 \epsilon_{t-1} + \in_t \quad (3)$$

ARMA and Fama model may have errors in forecasting the expected inflation. To filter those errors, we use Adaptive expectations model and that model would give us best-expected inflation to find their relationship with stock prices (Kolluri and Wahab, 2008). So, there are two steps just like two-stage least square model, first to develop a model to estimate expected Inflation and second is to calculate inflation.

$$E_t^*(\pi_{t+1}) - E_{t-1}^*(\pi_t) = \beta(\pi_{t-1}) - E_{t-1}^*(\pi_t)$$
$$E_t^*(\pi_{t+1}) = (1 - \beta)E_{t-1}^*(\pi_t) + \beta(\pi_{t-1}) \quad (4)$$

$E_t^*(\pi_{t+1})$ is forecasted true inflation at time period t but unobserved.

π_{t-1} is lagged one-period inflation
Let $E_t(\pi_{t+1}) = E_t^*(\pi_{t+1}) + e_t$
So $E_t^*(\pi_{t+1}) = E_t(\pi_{t+1}) - e_t$

$E_t(\pi_{t+1})$ = Estimated inflation through ARMA at time period t for the t+1 time period.

If the model is estimated in terms of adaptive expectations, then equation (4) will show unobserved but true inflation.

$$E_t^*(\pi_{t+1}) = \alpha_0 + \alpha_1 E_{t-1}^*(\pi_t) + \alpha_2(\pi_{t-1}) + \in_t \quad (5)$$
As $\alpha_1 = 1 - \beta$

Short-term expectations of inflation are influenced by previous or lagged inflation. To extend the model to make it adaptive expectations model, there is k-lags of independent variables are added.
By putting value of $E_t^*(\pi_{t+1})$ in (5) equation.

$$E_t(\pi_{t+1}) = \alpha_0 + \alpha_1 E_{t-1}(\pi_t) + \alpha_2(\pi_{t-1}) + \omega_t \quad (5)$$

While $\omega_t = \epsilon_t - \alpha_1 e_{t-1} + e_t$

Coefficients α_1 and α_2 are positive and significant statistically and adaptive expectations are designated here.

Now asymmetric test specification is used to analyze the correlation among predicted inflation and stock returns (Kolluri and Wahab, 2008).

$$R_{t,s} = \alpha + \beta_0 \delta E_{t-1}^*(\pi_t) + \beta_1(1-\delta)E_{t-1}^*(\pi_t) + \mu_t \quad (6)$$

While $\delta = 1\ if\ E_{t-1}^*(\pi)_t \geq inflation\ trend\ rate\ otherwise$ 0
$R_{t,s} =$ Monthly continuously compounded stock returns
$\delta =$ Dummy variable which is used to find out different responses of the stock market in return of expected inflation trend level in long run.

Equation (6) is the extended version of Fisher (1930) model according to which sum of the expected inflation rate and expected real return can be expressed as the nominal interest rate. This is used for many other assets (original model of Fisher and its following alteration to other categories of asset have always fixed symmetry assumption in reaction of asset returns to alternative inflation rate levels). If market proceeds the information which is available at the t-1 time period and it is efficient to set price for the present or current time period then nominal returns will compensate the expected inflation and assimilate the expected real return. More explaining,

$$E(R_t|\Psi_{t-1}) = E_{t-1}(r_t|\Psi_{t-1}) + E_{t-1}^*(\pi_t|\Psi_{t-1}) \quad (7)$$

R_t = assets nominal return
r_t = equilibrium of real expected return
Ψ_{t-1} = Information set

E^{*}_{t-1} = Best and unobservable expected inflation estimate formed upon set of information

Fisher's Hypothesis said that monetary and real sectors are independent of an economy. Predicted real returns can be computed with factors which are real including time preferences of investor, productivity of capital, and risk tastes then there is no relation among expected inflation and expected real return. This assumption allows testing the relationship between inflation and asset's return without the requirement of expected real return equilibrium model (Fama and Schwert, 1977).

To generate expected inflation, expected inflation and nominal stock return relationship testing have processed with some specifications as follows:

$$R_t = \alpha + \beta E^{*}_{t-1}(\pi_t|\Psi_{t-1}) + \mu_t \quad (8)$$

(8) equation estimated that the nominal asset return is the function of expected inflation, β is positive and it is unity, so it is showing that expected inflation and expected real return is independent furthermore nominal asset return and expected inflation are in one to one relationship. (Fama and Schwert, 1977). Equation (8) is used in literature in measuring the magnitude and direction of association between expected inflation and stock returns.

Let $E^{*}_{t-1}(\pi)_t = E_{t-1} - \omega_{t-1}$ now we substitute it in equation (8) and we will get:

$$R_{t,i} = \alpha + \beta[E_{t-1}(\pi_t) - \omega_{t-1}] + \mu_t \quad (9)$$

Or it can be $R_{t,i} = \alpha + \beta E_{t-1}(\pi_t) + (\mu_t - \beta\omega_{t-1})$

Now on the next step is to set up equation (12) for testing asymmetric stock return behavior depending upon fluctuations of forecasted inflation from the trending inflation level as follows:

$$R_t = \alpha + \beta_0 E_{t-1}(\pi_t) + (\mu_t - \beta_0\omega_{t-1}) \qquad if\ E_{t-1}(\pi_t) \geq Trend\ Inflation \quad (10)$$

$$R_t = \alpha + \beta_1 E_{t-1}(\pi_t) + (\mu_t^* - \beta_1 \omega_{t-1}^*) \qquad if\ E_{t-1}(\pi_t) < Trend\ Inflation \qquad (11)$$

Now by multiplying both equations (10) and (11) with δ and 1- δ consecutively and combining both equations

$$R_t = \alpha + \beta_0 \delta E_{t-1}(\pi)_t) + \beta_1(1-\delta)E_{t-1}(\pi)_t + \delta\eta_{0,t} + (1-\delta)\eta_{1,t} \qquad (12)$$

Here $\eta_{0,t} = (\mu_t - \beta_0 \omega_{t-1})$ and $\eta_{1,t} = (\mu_t^* - \beta_1 \omega_{t-1}^*)$

$$R_t = \alpha + \beta_0 \delta E_{t-1}(\pi)_t + \beta_1(1-\delta)E_{t-1}(\pi)_t + \xi_t \qquad (13)$$

While $\qquad \xi_t = (\mu_t - \beta_0 \omega_{t-1}) + (\mu_t^* - \beta_1 \omega_{t-1}^*)$

The relationship of stock returns with the expected inflation is analyzed for both the real returns and nominal returns. While real returns are calculated by taking the dissimilarity between nominal stock returns (compounded monthly) and monthly compounded predicted inflation (obtained from ARMA and Fama model).

In order to filter out errors of measurement a filter is used called adaptive expectation filter, this filters the errors in model and generated expected inflation estimates. Then filtered estimates are used in asymmetric test specification model to analyze the impact of expected inflation on stock returns. These are used in two settings, first is for in sample estimated forecasts and second is out of sample estimated forecasts.

Two in sample tests are conducted. First inflation forecasts are generated using data set only once. This results in one set of forecasts only for whole study period (1998m08-2018m06). This approach is called in sample/non iterative. This is most widespread approach in studies. Then used in-sample/iterative approach is used to forecast expected inflation. In every iteration a new set of variables is generated. This approach has the advantage to accommodate volatility of variable.

For out of sample forecasting; recursive window method is used by using one step ahead forecasting. In out of sample actual inflation is used to forecast expected inflation. On every estimation one actual value of inflation is picked and added while the earliest value for inflation is fixed.

For empirical analysis there are two steps. At first stage for the expected inflation equation (14) is estimated obtained from Fama (1981) and equation (15) is of ARMA model.

$$\Delta lnp_t = \pi_t = \beta_0 + \beta_1 \Delta lnNM_t + \beta_2 \Delta lnAR_t + \beta_3 \Delta lnAR_{t+12} + \mu_t \quad (14)$$

$\Delta lnp_t = \pi_t =$ Actual inflation
$NM_t =$ Nominal Money (M2)
$AR_t =$ Anticipated real activity (which can be measured by industrial production)

$$E_t(\pi)_{t+1} = \alpha_0 + \alpha_1 E_{t-1}(\pi_t) + \alpha_2 \epsilon_{t-1} + \in_t \quad (15)$$

Where $E_{t-1}(\pi_t)$ =expected inflation of time period t at the time t-1.
π_{t-1}= previous time period inflation of t-1.

Once the expected inflation is calculated from both Fama (1981) and ARMA. Study divided that expected inflation into two groups (high and low) through asymmetric test specification model which is calculated from both methods. Dummy variable in the equation divide them in groups by assigning "1" to high and "0" to low inflation group and vice versa.

In second stage study calculated real stock returns through expected inflation calculated in first step. After that study analyzed the relationship of expected inflation with real stock returns and then nominal stock returns in order to examine whether there is difference between behaviors of nominal and stock returns or not.
Following model is asymmetric test specification.

$$R_t = \alpha + \beta_0 \delta E_{t-1}(\pi_t) + \beta_1 (1-\delta) E_{t-1}(\pi)_t + \xi_t \quad (16)$$

$R_t =$ Nominal or real return on asset
$\delta =$ Multiplicative dummy variable if expected inflation is greater than or equal to trend inflation rate than 1, otherwise 0 (trend inflation will be calculated by taking mean of expected inflation)

$E_{t-1}(\pi)_t =$ Expected inflation of time period t predicted at the time period t-1.

Study used monthly data from August 1998 to June 2018.The variables which are used for the study are consumer price index (CPI), stock prices, industrial production and nominal money. The data sources are IFS for consumer price index, business recorder for stock prices. For stock prices KSE 100 index is used. The data of industrial production is not available directly that is why study used manufacturing production as proxy. The data source for manufacturing production index is IFS and for nominal money data source is State bank of Pakistan.

3. Results and Discussion

First, we go for time series properties, as we have used data of all variables in log difference form, therefore, we have found them stationary at level.

3.1 In-sample/non-iterative estimates

In order to examine the relationship between expected inflation and nominal/real stock return, it is required to estimate expected inflation. Expected inflation is used as independent variable in testing model while stock returns are dependent variable. Extended version of testing model includes the variables which are related to inflation and includes in Fama money demand model. Furthermore, in order to estimate extended version, it is also required to generate unexpected inflation and change in expected inflation. Change in expected inflation and unexpected inflation is generated from estimated expected inflation. Estimated expected inflation needs to be filtered out of errors.

As it is mentioned before, adaptive expectation filter is used in concurrence with estimated expected inflation is generated through both ARMA and Fama (F-model) models to estimate inflation in order to filter the errors out.

The results of Fama's model are presented in equation (17). In filtered inflation expectations calculated from Fama's model intercept is 0.0075 which is almost zero and value of expected inflation's coefficient is 0.965 which is near unity this shows that there is unbiasedness in estimated expected inflation.

Coefficient of expected inflation shows that there is almost one to one relationship between actual inflation and expected inflation.

Fama's model

$$\pi_t = 0.0075 + 0.96502\ E_t(\pi_{t+1}) + \epsilon_t \qquad (17)$$

(0.8914) (0.000)

R-square = 0.49 Dw = 1.98 Rmse = 0.55

ARMA model

$$\pi_t = 0.0628 + 0.9803\ E_t(\pi_{t+1}) + \ \epsilon_t \qquad (18)$$

(0.2223) (0.000)

R-square= 0.5049 Dw = 1.84 Rmse = 0.54

Where

$\pi_t =$ Actual inflation

$E_t(\pi_{t+1}) =$ Estimated Expected inflation

The results for ARMA model are represented in equation (18). These results are also showing that it is good forecasting.

Following table 1 is about descriptive summary of forecasted and actual inflation covering time period August 1998 to June 2018. First we calculated average of inflation and used it as a threshold to identify low and high inflation time period. We divided high and low inflation time period by making dummy variable for above average inflation and low average inflation time period. Table 1 is showing that there is not a big difference between predicted and actual inflation's proportion. For Fama's model predicted inflation's and expected inflation's proportion, standard deviation and mean is not so different. It is showed in table that there is minor difference between both results. Same goes for predicted inflation through ARMA model. Table is exhibiting that ARMA predicted inflation which is close to actual inflation.

Mean, standard deviation and proportion of predicted inflation for both models are not too different from actual inflation.

Table 1
Descriptive summary of forecasted and actual inflation (Time period: 1998m08: 2018m06)

Variable	N	Proportion	Standard Deviation (%)	Mean (%)
A. Fama Model				
Predicted Below	124	0.51	0.23	0.10
Predicted Above	115	0.48	0.61	0.52
Actual Below	132	0.55	0.30	0.034
Actual Above	107	0.44	0.74	0.57
Total	239	100		
B. ARMA Model				
Predicted Below	133	0.55	0.30	0.098
Predicted Above	106	0.44	0.56	0.45
Actual Below	132	0.55	0.30	0.034
Actual Above	107	0.44	0.74	0.57
Total	239	100		

Predicted Below = Forecasted inflation< Mean (trend) Inflation
Predicted Above = Forecasted inflation≥ Mean trend) Inflation
Actual Below = Actual Inflation< Mean (trend) Inflation
Actual Above = Actual Inflation≥ Mean (trend) Inflation
Proportion = occurrence of frequency in percentage
Standard Deviation = standard deviation of inflation rate
Mean = Mean of Inflation rate (actual or predicted)

Table 2 is presenting estimation results of asymmetric test specification model regression. Part (A) of 2 table includes the estimation results of asymmetric test specification model and a version of expansion for the nominal stock returns. Results for real stock returns are shown in part (B). In both parts four results for regressions are shown. In segment (A) equation (19) includes results for the regression using predicted inflation forecasted from Model of Fama. While Equation (20) is presenting results for the regression using expected inflation forecasted from ARMA model.

Equation (19) and (20) analyzed the relationship of forecasted inflation with nominal stock returns. They are showing that there is no significance relationship among stock returns and expected inflation.

Table 2
Regression results for in-sample/non-iterative estimates

A. For Nominal Stock returns

Fama:

$$NR_t = 2.1143 + 0.0465 HiNR_{t-1} - 0.0945 LoNR_{t-1} - 0.8375 HiE(\pi_t) - 1.4907 LoE(\pi_t) + \xi_t$$

(0.017)*** (0.63) (0.31) (0.39) (0.54)

Dw = 2.00, prob (F-statistic) = 0.02 (19)

ARMA:

$$NR_t = 2.2608 + 0.0910 HiNR_{t-1} - 0.085 LoNR_{t-1} - 0.764 HiE(\pi_t) - 1.322 LoE(\pi_t) + \xi_t$$

(0.004)*** (0.27) (0.34) (0.45) (0.47)

Dw= 2.05 prob (F-statistic) = 0.04 (20)

Fama:

$$NR_t = 2.7932 + 0.041 HiNR_{t-1} - 0.083 LoNR_{t-1} - 1.061 HiE(\pi_t) - 2.346 LoE(\pi_t) -$$

(0.018)*** (0.67) (0.36) (0.70) (0.06)*

$$0.094 HiUnE(\pi_t) - 1.163 LoUnE(\pi_t) + 2.527 Hi\Delta E(\pi_t) - 4.373 Lo\Delta E(\pi_t) - 0.126 Hi\Delta lnAR_{t+12}$$

(0.94) (0.46) (0.10)* (0.006)*** (0.24)

$$+0.086 Lo\Delta \ln AR_{t+12} - 0.513 HiNM_t + 0.182 LoNM_t + \xi_t$$

(0.24) (0.35) (0.70)

Dw= 2.05, prob (F-statistic) = 0.05 (21)

ARMA:

$$NR_t = 3.063 + 0.125 HiNR_{t-1} - 0.0677 LoNR_{t-1} - 1.920 HiE(\pi_t) - 3.671 LoE(\pi_t) -$$

(0.004)*** (0.15) (0.45) (0.14) (0.07)*

$$1.904 HiUnE(\pi_t) - 2.402 LoUnE(\pi_t) + 2.339 Hi\Delta E(\pi_t) - 3.076 Lo\Delta E(\pi_t) - 0.019 Hi\Delta lnAR_{t+12}$$

(0.15) (0.12) (0.081)* (0.02)** (0.89)

$$+0.037 Lo\Delta \ln AR_{t+12} - 0.280 HiNM_t + 0.002 L0NM_t + \xi_t$$

(0.58) (0.63) (0.99)

Dw= 2.07 prob (F-statistic) = 0.03 (22)

B. For Real Returns

Fama:

$$RR_t = 2.052 + 0.067 HiRR_{t-1} - 0.087 LoRR_{t-1} + 0.505 HiE(\pi_t) - 1.743 LoE(\pi_t) + \xi_t$$

(0.01)*** (0.49) (0.35) (0.83) (0.05)**

Dw= 2.02 prob (F-statistic) = 0.02 (23)

ARMA:

$$RR_t = 2.211 + 0.068 HiRR_{t-1} - 0.071 LoRR_{t-1} - 2.33 HiE(\pi_t) - 1.676 LoE(\pi_t) + \xi_t$$

(0.005)*** (0.49) (0.42) (0.21) (0.10)*

Dw= 2.03 prob (F-statistic) = 0.03 (24)

Fama:

$$RR_t = 2.7932 + 0.041 HiRR_{t-1} - 0.083 LoRR_{t-1} - 2.145 HiE(\pi_t) - 3.304 LoE(\pi_t)$$

(0.01)*** (0.67) (0.36) (0.44) (0.009)***

$$-0.094 HiUnE(\pi_t) - 1.163 LoUnE(\pi_t) + 2.610 Hi\Delta E(\pi_t) - 4.332 Lo\Delta E(\pi_t)$$

(0.94) (0.46) (0.09)** (0.006)***

$$-0.126 Hi\Delta lnAR_{t+12} + 0.086 Lo\Delta \ln AR_{t+12} - 0.513 HiNM_t + 0.182 LoNM_t + \xi_t$$

(0.24) (0.24) (0.35) (0.70)

Dw= 2.05, prob (F-statistic)= 0.05 (25)

ARMA:

$$RR_t = 3.050 + 0.100 HiRR_{t-1} - 0.063 LoRR_{t-1} + 2.83 HiE(\pi_t) - 4.709 LoE(\pi_t)$$

(0.005)*** (0.33) (0.48) (0.03)** (0.02)**

$$-1.72 HiUnE(\pi_t) - 2.28 LoUnE(\pi_t) + 2.416 Hi\Delta E(\pi_t) - 3.121 Lo\Delta E(\pi_t)$$

(0.20) (0.08)** (0.1)** (0.02)**

$$-0.022 Hi\Delta lnAR_{t+12} + 0.037 Lo\Delta \ln AR_{t+12} - 0.0294 HiNM_t + 0.002 LoNM_t + \xi_t$$

(0.87) (0.58) (0.61) (0.99)

Dw= 2.04 , prob (F-statistic)= 0.04 (26)

Note: Hi and Lo with all variables denote high and low inflation time period respectively. NR_t Denote nominal stock returns while RR_t denotes real stock returns. $UnE(\pi_t)$ I s unexpected inflation($\pi_t - E(\pi_t) = UnE(\pi_t)$). $\Delta E(\pi_t)$ is change in inflation expectations. $\Delta lnAR_{t+12}$ is industrial growth which is twelve months ahead. NM_t is growth rate of nominal money. NR_{t-1} and RR_{t-1} are lagged nominal and real stock returns. R-square is determination coefficient. While Rmse is root mean square error. NR_{t-1} and RR_{t-1} are lagged nominal and real stock returns. Inflation expectations are made at t-1 time period.
***, **, * Shows significance at 1%, 5% and 10% significance level respectively.

Equation (21) which is expended version of asymmetric testing model in which variables of Fama money demand are also added. In this Equation all variables found not to have significant relationship with nominal stock returns except "expected inflation" in low inflation time period and "change in expected inflation" during low and high expected inflation time period. During low expected inflation time period "change in expected inflation" has inverse relationship with nominal stock returns during period of low inflation by double proportion. These findings are accordant with results of Crsoby (2001). While during high inflation time period change in expected inflation has positive relation with nominal stock returns. Expected inflation has negative significant relationship with nominal stock returns at significance level of 10% during time period when inflation is less than its trend level. Results of (22) shows that expected inflation and change in expected inflation are inversely related to Nominal stock returns during low inflation time period. These findings are harmonious with Sellin (2001) and Adrangi *et al*., (2001).

Equation (23) is showing that stocks are delivering positive returns during low inflation time period. Equation (24) is also showing an inverse relationship between real stock returns and expected inflation during low inflation time period at 10% significance level.

Equation (25) has consistent regression results with equation (21). Moreover, there is positive relationship of real stock returns with change in expected inflation during high inflation time period at 10% significance level, while other variables are insignificant. Equation (26) has also consistent results with above regression results. Results presents that expected inflation, change in expected inflation and unexpected inflation has inverse relationship with real stock returns only during low inflation time period. An inverse relationship is also found between unexpected inflation and real stock returns during low inflation time period at significance level 10%.

Equation (21), (22), (25), (26) includes extra variables like industrial growth rate, nominal money growth rate, change in expected inflation and unexpected inflation.

3.2 In-sample/Iterative estimates

We estimated equation by using expected inflation data, which is generated iteratively, by moving forward with a month at a time by using data of ten years every time. First set of data includes first ten years (m06-1988__07-1998) of data. After generating first value we included new forecasted value then after generating second value we included this newly forecasted value and keep on repeating the procedure by adding new value until we get the whole data, then we got 239 recursive estimations from August 1998 to June 2018. Then we used these forecasted inflation observations to estimate asymmetric test specification model.

Table 3
Descriptive Analysis of in-sample/iterative estimates

Variable	N	Proportion	Standard Deviation (%)	Mean (%)
A. Fama Model				
Predicted Below	124	0.51	0.2331	0.0926
Predicted above	115	0.48	0.6118	0.5121
Actual Below	133	0.55	0.30	0.034
Actual Above	106	0.44	0.74	0.57
Total	239	100		
B. ARMA Model				
Predicted below	110	0.46	0.265	0.081
Predicted Above	129	0.53	0.553	0.478
Actual below	135	0.56	0.30	0.034
Actual Above	104	0.43	0.74	0.57
Total	239			

Predicted Below= Forecasted inflation< Mean (trend) Inflation
Predicted Above=Forecasted inflation≥ Mean trend) Inflation
Actual Below= Actual Inflation< Mean (trend) Inflation
Actual Above= Actual Inflation≥ Mean (trend) Inflation
Proportion= occurrence of frequency in percentage
Standard Deviation= standard deviation of inflation rate
Mean= Mean of Inflation rate (actual or predicted)

Table 3 is descriptive summary of expected inflation calculated from Fama's model and ARMA model which is calculated through in sample/iterative estimations. Table is showing that forecasted expected inflation is close to actual inflation.

Table 4:
In sample/Iterative estimates

(A). For Nominal stock returns

$$NR_t = \alpha + \beta_0 NR_{t-1} + \beta_1 HiE(\pi_t) + \beta_2 LoE(\pi_t) + \xi_t$$

Fama:

$$NR_t = 2.636 - 0.032NR_{t-1} - 2.520HiE(\pi_t) - 1.18LoE(\pi_t) + \xi_t$$

(0.01)*** (0.62) (0.26) (0.2)

Dw = 2.02, prob (F-statistic) = 0.051 (27)

ARMA:

$$NR_t = 2.498 - 0.028NR_{t-1} - 1.318HiE(\pi_t) - 1.283LoE(\pi_t) + \xi_t$$

(0.002)*** (0.67) (0.20) (0.55)

Dw = 2.02, prob (F-statistic) = 0. 062 (28)

(B): For real Stock returns

Fama:

$$RR_t = 2.636 - 0.032RR_{t-1} - 3.338HiE(\pi_t) - 2.16LoE(\pi_t) + \xi_t$$

(0.001)*** (0.62) (0.14) (0.02)**

Dw = 2.02, prob (F-statistic)= 0.04 (29)

ARMA:

$$RR_t = 2.498 - 0.028RR_{t-1} - 2.283HiE(\pi_t) - 2.318LoE(\pi_t) + \xi_t$$

(0.02)** (0.67) (0.28) (0.02)**

Dw = 2.02, prob (F-statistic)= 0. 04 (30)

Note: $HiE(\pi_t)$ and $LoE(\pi_t)$ are high and low expected inflation respectively. Rmse= root mean square error, while R-square= determination coefficient. NR_{t-1} =lagged nominal stock returns, RR_{t-1}= lagged real stock returns.
***,**,* shows significance level at 1%, 5% and 10%.

Results in table 4 is showing that nominal stock returns do not have significant relationship with expected inflation. While real stock returns have inverse relationship with expected inflation during low inflation time. When investors expect low inflation in future time period they discount dividends by adjusting low inflation which causes real stock returns to decrease. These results are consistent with Rapach (2002).

3.3. Out of sample/Iterative estimates

Estimates for asymmetric testing model using out of sample/Iterative forecasts are presented in table 5. Results are showing direct relationship of nominal stock returns with expected inflation during high inflation time period. Which is consistent with Lee *et al*., (2000) who investigated impact of hyperinflation on stock returns of Germany during 1920s and found positive relationship between variables.

Table 5
Out of sample/iterative estimates

A. For Nominal Stock returns

Fama:

$$NR_t = 2.064 - 0.0623NR_{t-1} + 0.885HiE(\pi_t) + 0.262LoE(\pi_t) + \xi_t$$

(0.01)*** (0.6) (0.03)** (0.9)

Dw = 2.04, prob (F-statistic) = 0. 07 (31)

ARMA:

$$NR_t = 2.160 - 0.027NR_{t-1} + 0.785HiE(\pi_t) + 1.299LoE(\pi_t) + \xi_t$$

(0.007)* (0.6) (0.03)** (0.5)

Dw = 2.00, prob (F-statistic) = 0.07 (32)

B. For Real Stock returns

Fama:

$$RR_t = 2.0439 - 0.019RR_{t-1} - 0.755HiE(\pi_t) - 1.88LoE(\pi_t) + \xi_t$$

(0.01)*** (0.77) (0.72) (0.06)*

Dw= 2.01, prob (F-statistic) = 0.031 (33)

ARMA:

$$RR_t = 2.134 - 0.018RR_{t-1} + 0.272HiE(\pi_t) - 1.78LoE(\pi_t) + \xi_t$$

(0.008)* (0.7) (0.9) (0.05)**

Dw= 2.01, prob (F-statistic) = 0.026 (34)

Note: $HiE(\pi_t)$ and $LoE(\pi_t)$ are high and low expected inflation, respectively. Rmse= root mean square error, while R-square= determination coefficient. NR_{t-1} =lagged nominal stock returns, RR_{t-1}= lagged real stock returns.
***,**,* shows significance level at 1%, 5% and 10%.

While part (b) is presenting an inverse relationship between real stock returns and expected inflation during low inflation time period. These results are consistent with Rapach (2002), Yeh and chi (2009) and Spyros (2001).

Asymmetric testing model was able to divide the regimes of low and high inflation. So, study could analyze the different behavior of stock returns during high and low inflation time period. There is a significant positive relationship found between stock returns and expected inflation when inflation is high and inverse relationship found when inflation is below than its trend level. The first finding is compatible with the Fisher's Hypothesis that when inflation is higher than its trend level it provides a good hedge against stock market. While the second finding shows that on average stock deliver good returns when inflation is lower than its trend level.

3.4. Results for sub periods

Table (6) is presenting descriptive analysis for sub periods shows that there is slight difference between frequency of actual and predictive inflation values. Standard deviation and mean are also close to actual inflation results.

Table 6

Descriptive summary of monthly forecasted and actual data by sub period

Variable	N	Proportion	Standard Deviation (%)	Mean (%)
			A. Fama Model	
Estimation Period: August 1998__December 2001				
Predicted Below	33	0.80	0.285	0.157
Predicted Above	8	0.19	0.306	0.146
Actual Below	33	0.80	0.292	0.120
Actual Above	8	0.19	0.350	0.168
Total	41	1		
Estimation Period: January 2002__December 2004				
Predicted Below	26	0.722	0.277	0.101
Predicted Above	10	0.277	0.359	0.214
Actual Below	22	0.611	0.322	0.043
Actual Above Total	14 36	0.388	0.527	0.393
Estimation Period: January 2005__December2007				
Predicted Below	18	0.50	0.232	0.144
Predicted Above	18	0.50	0.459	0.438
Actual Below	18	0.50	0.286	0.096
Actual Above Total	18 36	0.50	0.658	0.600
Estimation Period: January 2008__December 2010				
Predicted Below	2	0.05	0.11	0.02
Predicted Above	34	0.94	0.53	1.32
Actual Below	11	0.30	0.210	0.006
Actual Above Total	25 36	0.69	1.019	1.247
Estimation Period: January 2011__December 2013				
Predicted Below	9	0.25	0.164	0.072
Predicted Above	27	0.75	0.483	0.744
Actual Below	15	0.41	0.329	-0.041
Actual Above Total	21 36	0.58	0.700	0.755
Estimation Period: January 2014__June 2018				
Predicted Below	35	0.64	0.277	0.093
Predicted Above	19	0.35	0.601	0.344
Actual Below	31	0.57	0.359	-0.020
Actual Above Total	23 54	0.42	0.614	0.367
			B. ARMA Model	
Estimation Period: August 1998__December 2001				
Predicted Below	32	0.780	0.263	0.145
Predicted Above	9	0.219	0.355	0.183

Actual Below	33	0.80	0.292	0.120
Actual Above Total	8 41	0.19	0.350	0.168
Estimation Period: January 2002__December 2004				
Predicted Below	29	0.805	0.274	0.152
Predicted Above	7	0.194	0.354	0.168
Actual Below	22	0.611	0.322	0.043
Actual Above Total	14 36	0.388	0.527	0.393
Estimation Period: January 2005__December2007				
Predicted Below	18	0.5	0.275	0.184
Predicted Above	18	0.5	0.467	0.435
Actual Below	18	0.50	0.286	0.096
Actual Above Total	18 36	0.50	0.658	0.600
Estimation Period: January 2008__December 2010				
Predicted Below	5	0.138	0.291	0.087
Predicted Above	31	0.861	0.568	1.072
Actual Below	11	0.30	0.210	0.006
Actual Above Total	25 36	0.69	1.019	1.247
Estimation Period: January 2011__December 2013				
Predicted Below	10	0.27	0.272	0.026
Predicted Above	26	0.72	0.529	0.728
Actual Below	15	0.41	0.329	-0.041
Actual Above Total	21 36	0.58	0.700	0.755
Estimation Period: January 2014__June 2018				
Predicted Below	35	0.64	0.398	0.005
Predicted Above	19	0.35	0.480	0.232
Actual Below	33	0.61	0.359	-0.020
Actual Above Total	21 54	0.32	0.614	0.367

Predicted Below= Forecasted inflation< Mean (trend) Inflation
Predicted Above=Forecasted inflation≥ Mean trend) Inflation
Actual Below= Actual Inflation< Mean (trend) Inflation
Actual Above= Actual Inflation≥ Mean (trend) Inflation
Proportion= occurrence of frequency in percentage
Standard Deviation= standard deviation of inflation rate
Mean= Mean of Inflation rate (actual or predicted)

Table (7) is included results for expected inflation/stock returns relationship by sub periods. Part (A) is for relationship of expected inflation with nominal stock returns and Part (b) includes regression results for relationship between real stock returns and expected inflation by sub period.

Results in Table 7 are showing that there is insignificance association between stock returns and expected inflation, but this is not surprising as stock returns behave noisy during short time span.

Table 7
In sample/non-iterative estimations through asymmetric test specification model. Extended results by sub periods of study.

A. For Nominal Stock Returns

Estimation Period: August 1998__December 2001

Fama:

$$\mathrm{NR_t} = 1.050 - 0.502HiNR_{t-1} - 0.272LoNR_{t-1} - 2.245HiE(\pi_t) - 1.223LoE(\pi_t) + \xi_t$$

(0.66) (0.34) (0.13) (0.73) (0.05)**

Dw= 1.94, prob (F-statistic) = 0.05 (35)

ARMA:

$$\mathrm{NR_t} = 2.441 - 0.473HiNR_{t-1} - 0.264LoNR_{t-1} - 1.463HiE(\pi_t) - 6.173LoE(\pi_t) + \xi_t$$

(0.30) (0.36) (0.15) (0.80) (0.04)**

Dw= 2.0, prob (F-statistic) = 0.04 (36)

Estimation Period: January 2002__December 2004

Fama:

$$\mathrm{NR_t} = 3.365 + 0.587HiNR_{t-1} + 0.026LoNR_{t-1} + 0.937HiE(\pi_t) - 2.122LoE(\pi_t) + \xi_t$$

(0.07)* (0.26) (0.88) (0.80) (0.65)

Dw= 2.12, prob (F-statistic) = 0.08 (37)

ARMA:

$$\mathrm{NR_t} = 4.510 + 0.562HiNR_{t-1} + 0.002LoNR_{t-1} - 1.291HiE(\pi_t) - 5.281LoE(\pi_t) + \xi_t$$

(0.01)* (0.33) (0.98) (0.75) (0.26)

Dw= 1.99, prob (F-statistic) = 0.03 (38)

Estimation Period: January 2005__December 2007

Fama:

$$\mathrm{NR_t} = 0.928 - 0.226HiNR_{t-1} + 0.261LoNR_{t-1} + 0.230HiE(\pi_t) + 8.531LoE(\pi_t) + \xi_t$$

(0.71) (0.46) (0.26) (0.94) (0.20)

Dw= 1.99, prob (F-statistic) = 0.02 (39)

ARMA:

$$\mathrm{NR_t} = 2.827 - 0.269HiNR_{t-1} + 0.303LoNR_{t-1} - 1.812HiE(\pi_t) + 1.473LoE(\pi_t) + \xi_t$$

(0.29) (0.38) (0.19) (0.60) (0.80)

Dw= 2.10, prob (F-statistic) = 0.04 (40)

Estimation Period: January 2008__December 2010

Fama:

$$\mathrm{NR_t} = 1.513 + 0.158HiNR_{t-1} + 0.166LoNR_{t-1} + 1.73HiE(\pi_t) - 11.473LoE(\pi_t) + \xi_t$$

(0.72) (0.22) (0.20) (0.04)** (0.50)

Dw=1.99 , prob (F-statistic) = 0.03 (41)

ARMA:

$$\mathrm{NR_t} = -1.530 + 0.164HiNR_{t-1} + 2.977LoNR_{t-1} + 1.352HiE(\pi_t) - 12.165LoE(\pi_t) + \xi_t$$

(0.77) (0.20) (0.13) (0.02)** (0.20)

Dw= 1.92, prob (F-statistic) = 0.04 (42)

Estimation Period: January 2011__December 2013

Fama:

$$\mathrm{NR_t} = 3.828 - 0.195HiNR_{t-1} - 0.061LoNR_{t-1} - 1.814HiE(\pi_t) - 2.457LoE(\pi_t) + \xi_t$$

(0.17) (0.37) (0.84) (0.51) (0.75)

Dw= 1.92, prob (F-statistic) = 0.04 (43)

ARMA:

$$\mathrm{NR_t} = 1.5407 - 0.243HiNR_{t-1} + 0.135LoNR_{t-1} + 0.917HiE(\pi_t) - 1.586LoE(\pi_t) + \xi_t$$

(0.36) (0.26) (0.68) (0.61) (0.64)

Dw= 1.88, prob (F-statistic) = 0.03 (44)

Estimation Period: January 2014__June 2018

Fama:

$$\mathrm{NR_t} = 0.733 - 0.331HiNR_{t-1} - 0.026LoNR_{t-1} + 2.154HiE(\pi_t) - 0.274LoE(\pi_t) + \xi_t$$

(0.46) (0.29) (0.89) (0.10)* (0.92)

Dw= 1.86, prob (F-statistic) = 0.04 (45)

ARMA:

$$\mathrm{NR_t} = 0.9320 - 0.3879 - 0.080LoNR_{t-1} + 3.090HiE(\pi_t) + 0.326LoE(\pi_t) + \xi_t$$

(0.30) (0.27) (0.67) (0.09)* (0.64)

Dw= 1.88, prob (F-statistic) = 0.07 (46)

Note: Hi and Lo with all variables denote high and low inflation time period respectively. NR_t Denote nominal stock returns while RR_t denotes real stock returns. $UnE(\pi_t)$ is unexpected inflation($\pi_t - E(\pi_t) = UnE(\pi_t)$).
$\Delta E(\pi_t)$ is change in inflation expectations. $\Delta lnAR_{t+12}$ is industrial growth which is twelve months ahead. NM_t is growth rate of nominal money. NR_{t-1} and RR_{t-1} are lagged nominal and real stock returns. R-square is determination coefficient. While Rmse is root mean square error. NR_{t-1} and RR_{t-1} are lagged nominal and real stock returns. Inflation expectations are made at t-1 time period. ***, **, * Shows significance at 1%, 5% and 10% significance level respectively.

These results are consistent with the results of Kolluri & Wahab (2008) and Oxman (2012). Flow of new information in short time period or rumors are the cause of noisy behavior of stock returns in short run. People do have private information but over confidence of investor cause the under valuation of new information in the market.

Results show that overall there is existence of negative relationship between real stock returns and expected inflation during low inflation time period. Which are consistent with results of Ahmed and Mustafa (2012). While some results show a positive relationship during high inflation time period between stock returns and expected inflation which is consistent with Lee *et al.*, (2000) results which shows positive impact of hyperinflation of Germany on stock returns. But mostly results are showing insignificant relationship of stock returns with expected inflation during high inflation time period.

4. Conclusion

This study analyzed the effect of expected inflation on stock returns (real and nominal), and relationship of stock returns with different measures of inflation including changes in inflation and unexpected inflation through asymmetric specification model which is capable of dividing stock returns response during low and high inflation time period. To generate expected inflation two methods are used wich are Fama’s (1981) money demand model and ARMA model. Two models are adopted instead of one to check the vigorousness of results. These models are estimated two contexts first is in sample and second is out of sample estimates.

In sample/non iterative estimations shows that there is significant inverse relationship between real and nominal stock returns between real/nominal stock returns and expected inflation. In sample/iterative forecasted inflation estimations shows that there is no significance relationship among nominal stock returns and expected inflation during low inflation time period. While real stock returns have significant inverse relationship within sample/iterative forecasted inflation in the course of low inflation time period.

Out of sample/iterative estimations results show significant inverse relationship among real stock returns during low inflation time and expected inflation while it is showing positive relationship between nominal stock returns and expected inflation during high inflation period which is aligned with hypothesis presented by Fisher. Results for the estimations of stock returns/expected inflation model for sub period are presenting insignificant relationship between them which is because of noisy behavior of stock returns in short time span.

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Appendix

Table 1
Summary of Variables used for the Analysis

VARIABLES	DEFINITION OF VARIABLES	SOURCE
	Dependent Variable	
Infant Mortality	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year." (per 1,000 live births)	WDI 2016
	Independent Variable	
Remittances	Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Personal transfers thus include all current transfers between resident and nonresident individuals." (measured in current US$)	WDI 2016
	Other Independent Variables used as control variables	
GDP per capita	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products." (measured in constant 2010 US$)	WDI 2016
Physicians	Physicians include generalist and specialist medical practitioners. (per 1,000 people)	WDI 2016
Improved Water	Access to an improved water source refers to the percentage of the population using an improved drinking water source. (% of population with access)	WDI 2016
Urbanization	Urban population refers to people living in urban areas as defined by national statistical offices." (total urban population)	WDI 2016
Health Expenditure	Total health expenditure is the sum of public and private health expenditure. (% of GDP)	WDI 2016

Table 2
Summary Statistics

Variables	Observations	Mean	Ste. Dev	Min	Max
Infant Mortality	5662	62.97874	41.04466	3.4	212.5
Remittances	3651	4.881692	8.440601	8.705833	99.8218
GDP per capita	3872	7.441666	1.025932	4.748713	10.15552
Physicians	3765	1.26399	1.39983	.002	9.814
Urban Population	3675	14.48289	2.007398	9.388988	19.87774
Health Expenditures	4779	5.797004	2.433663	.3683202	30.8293
Improved Water	5238	77.26441	18.83237	13.2	100