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Relationship between Inflation and Interest Rate: Evidence from Pakistan

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Abstract

This study focuses on the study of the causal relation of inflation rate with that of nominal interest rate in Pakistan. This is also known as Fisher hypothesis, which is used to study the equilibrium relation for long run between the inflation rate and the nominal interest rate in the time series data from 1973-2010. In this study, the Stationarity and non-Stationarity of the data is checked empirically using both ADF and PP test of unit root. Co-integration techniques like Johansen and Engle-Granger (Residual Based) co-integration test are used to study the long run relationship between the nominal interest rate and inflation. It is found that there exist a long run equilibrium relationship between the nominal interest rate and the inflation of Pakistan for the period of 1973-2010.

Keywords: Inflation, nominal interest rate, unit root, Co-integration.

Introduction

One of the vast areas of the econometric is the time series econometric. It has verity of application in engineering, medical, signal processing, and agriculture and especially in economics. In econometrics, time series analysis has significant role because most of the variables are observed over the period of time. In time series analysis the collected series of observation can be arranged in continues time point or it can be observed at discreet set of point. But in most of the time series, the series are observed at equal interval of time.

The term inflation is used to indicate an increase in domestic prices of the commodities relatively more than increase in the prices of the commodities globally. It indicates the increase in the prices of goods and service over the time while nominal interest rate refers to those interest rates which are considered before taking inflation into consideration or before adjusting the interest rate for inflation and when nominal rates adjusted for the inflation are called real interest rate[1]. This relation commonly refers as the Fisher equation. Fisher equation can be defined as one-to-one relationship between the expected inflation and the nominal interest rate, assuming the real interest rate is stationary[2].

Fisher equation is also known as Fisher hypothesis which suggests that there exist a positive relationship between rate of interest and expected inflation. Fisher equation or hypothesis provides theoretical basis for studying the relationship between the interest rate and expected inflation. The implication of the Fisher equation affects the debtors and creditors and also important for the effectiveness of the monetary policy and efficiency in banking sectors. The Fisher hypothesis supports strongly the US economy in particular and for the industrial countries in general[3].

Suppose I is the nominal interest rate and r is the real interest rate and P is the inflation rate then Fisher equation can be defined as

$I = r + P$ *Or*

$r = I - P$

The Fisher equation states that a unit increase in P causes a unit increase in the nominal interest rate, this one to one relation between inflation and nominal interest rate is known as Fisher effect. Hassan, states that Fisher hypothesis as the theoretical framework for studying the relationship between the nominal interest rate and the rate of inflation for Pakistan. He tested the validity of the Fisher hypothesis using quarterly data from 1957 q_1 to 1991 q_2 by applying co-integration technique for Pakistan. The study concluded that there exists a long run relationship between the nominal interest rate and inflation for Pakistan[3].

Berument and Mehdi studied relationship between interest rate and inflation and test the Fisher hypothesis for 26 countries of world and concluded that there exists a positive relationship between the inflation rate and nominal interest rate. The study supports the Fisher hypothesis for more than half of the countries of the world under consideration[4].

Jayasinghe and Udayaseelan studied the Fisher equation by using co-integration technique of econometrics for Sri Lank. They considered the data set of the three frequencies i.e. monthly data from 1978 to 2008, quarterly from 1978 to 2008 and yearly from 1953-1977. They found that there are differences exist in the relationship of the nominal interest rate and expected inflation for the different data set collected

monthly, quarterly and yearly. The study finally concluded that there hardly exist a long run relationship in the nominal interest rate and inflation[5].

Alexander studied the relationship between the expected inflation and nominal interest rate for South Africa by using co-integration technique of econometrics and concluded that the Fisher Equation for South Africa for the period of 2000 to 2005, with objective of testing the relationship between the nominal interest rate and inflation i.e., Fisher hypothesis. The study concluded that the short run relationship did not verify empirically whereas in the long run relationship the data verify the Fisher Equation for South Africa[6].

Saeidi and Valian studied the relationship between currency rates, interest rate and inflation based on Fisher effect theory for the economy of Iran. They test the Fisher effect for the annual data for economy of Iran ranging from 1991-2009, by using econometric methods. They divide the annual interest rate into three parts, one year short term, 3-year midterm and 5-years long term and dividing the exchange rates into two groups' i.e., official currency rates and nonofficial currency rates. They studied relationship between official and nonofficial currency with all three types of interest rate i.e. long, midterm, and short term and then studied the relationship between inflation rate and interest rate and found a direct and positive relation i.e., validity of the Fisher effect for Iran economy[7].

Nicolas Million examined the Fisher hypothesis in application to US data. He used the data as monthly average of daily closing bids of 3 months treasury bills rate secondary market from 1951.1 to 1999.12 for the interest rate while the data of the inflation rate were computed from the monthly data of CPI of Urban. The empirical analysis showed a strong evidence for the threshold behavior in real interest rate. He concluded that Fisher effect appeared stronger in some periods of data and not in other periods. The Fisher effect was strong in a situation where there exist stochastic trend in the inflation and the nominal interest rate and in such situation he found strong correlation between the inflation and nominal interest rate. He also obtain the strong Fisher effect evidence when he considered the nonlinear feature of the relationship into account[8].

Macri J found in his research with the objective of studying the Fisher hypothesis for Australia. He studies the Fisher hypothesis for Australia using quarterly short term data from first quarter of 1979 to second quarter of 2005 i.e. 1979 Q1 to 2005 Q2 by using Johansen technique of cointegration. He used the consumer price index (CPI) for the computation of inflation and the 90 days bank Accepted Bill rates as nominal interest rate from the Reserve Bank of Australia. He observed the nominal interest rate is positively related with inflation and concluded that there exists a long run cointegration relationship between the nominal interest rate and inflation for Australia[9].

Helmut herwartz and Hans-EggertReimers investigated the cointegrationlink between the inflation and nominal interest rate for around monthly time series data of 43 years of 114 countries included Pakistan obtained from international financial statistics of the International Monetary Fund (IMF) for period of 1960:1 to 2004:6. They used cointegration test for testing the validity of Fisher hypothesis for different economies of world. They concluded that there exists a long run relationship between nominal interest rates and inflation for number of the countries of the world under consideration. They also concluded that few of the countries of the world where there were high inflation or high interest rate, the long run relationship not exists as mentioned by Fisher[10].

Sundqvistemil studied the empirical investigation of the international Fisher effect and test the long run validity of Fisher effect for quarterly data of nominal interest rate for six countries and quarterly exchange rates between the US dollars and five other currencies between years 1993-2000. He considered the data for Germany only for period of 1993-1998. The data was obtained from the International Monterey Funds. He studied the international Fisher effect in country pairs and concluded that Fisher effect hold for some of the country pairs like US-Japan and for some time period while it does not hold for others[11].

Phylaktis and Blake studied the Fisher effect for different countries of the World. They considerthree countries of the world having highly inflation including Argentina, Brazil and Mexico. They examined Fisher hypothesis using yearly data and observed the validity of the Fisher hypothesis i.e. there exists a long run equilibrium relationship among the nominal interest rate and inflation[12].

Paleologos. J and Georgantelis did a cointegration analysis of Fisher hypothesis for Greece. They studied the validity of Fisher hypothesis for economy of Greece from the period of 1980 Q-I to 1996 Q-II using Johnsons technique of cointegration. They concluded that there is no one to one movement in nominal interest rate and inflation rate in long run for Greece economy i.e. the data showed no validity of the Fisher hypothesis for Greece and found that there is no long run equilibrium relationship between the nominal interest rate and inflation[13].

Makku. L investigated the Fisher effect using unit root and cointegration. He studied Fisher hypothesis for monthly US data for period of 1953:1 to 1990:12. He studies the unit root in time series using ADF and studies a long run relationship between the nominal interest rate and the inflation foe the monthly data of the US and concluded that there Fisher effect showed the validity over the period of 1953:1 to 1079:12. Whereas the over the other time laps i.e. from 1979:11 to 1990:12 the data showed no validity of the Fisher hypothesis[14].

Beyer.A and Hug. A studied Fisher hypothesis after adjusting the structural breaks for 15 countries of OECD. They consider the different data set for different countries of OECD. Quarterly

data was used to study Fisher hypothesis by using cointegration techniques like ARDL and Johansen cointegration test. For different countries of OECD, data collected over the different period of time and make structural break adjustment. They used improved approach of unit root and observed unit root in nominal interest rate and inflation for all countries except the Netherland. Similarly they found the Fisher cointegration relationship but it does not support the evidence of the more of the countries of OECD in both pre and post break adjustment[15].

Westerlund studied Fisher effect for the 20 countries of OECD. The panel quarterly data form 1980 to 2004 collected and using co-integration techniques, the validity of Fisher hypothesis found in data[16].

The level of real interest rates is critical for standard evaluations of government debt sustainability. Ball, Elmendorf and Mankiw suggest the emergence of a virtuous cycle in which low real rates and rapid growth reduce fiscal debt burden. If the return on government debt is sufficiently below the output growth rate for a sufficiently long period, the government can roll over the debt and accumulated interest without raising taxes because output will likely grow faster than the debt will accumulate[17].

Material and Methods

In this research paper secondary data is considered for analysis. Data for 1973 to 2010 regarding the nominal interest rate and inflation acquired from the State Bank of Pakistan. Eviews and SPSS are used for econometric analysis of data.

Results and Discussion

Econometric analysis begins by checking the Stationarity and non-Stationarity of data graphically. For co-integration relationship, it's one of the assumptions that data must be integrated of either same order or different order. Unit root testing procedures like ADF and PP tests are then applied to discuss the Stationarity and non-Stationarity empirically. After this co-integration techniques are used to find out long run relationship between the nominal interest rate and inflation rate for Pakistan.

To test the Stationarity in yearly time series data for Pakistan from 1973-2010, both ADF and PP test are performed. The table-1, contains the output of the both test for the both variables i.e., nominal interest rate and inflation at levels. The output indicates that the variable nominal interest rate is non-stationary at both 1% and 5% significance level using both ADF and PP test whereas the variable inflation also is non-stationary as well.

After taking the first difference of nominal interest rate and inflation, both variables become stationary that can be verified from the table-2, which confirms that both variables are stationary using ADF and PP test. For the both variables i.e. inflation and nominal interest rate the null hypothesis of the unit root is not rejected at both 1% and 5% of significance level and concluded that both series are stationary or both series are integrated at order 1.

Table-1
Unit Root Test for Stationarity

Nominal Interest Rate					
Test	**Test statistics**	**1%**	**5%**	**Null Hypothesis**	**Status**
Augmented Ducky-Fuller	-3.255788 (0.0910)	-4.252879	-3.547490	Fail to Reject H_0	Non-stationary
Phillip-Perron	-2.462832 (0.3435)	-4.226815	-3.536601	Fail to Reject H_0	Non-stationary
Inflation					
Augmented Ducky-Fuller	-3.210628 (0.0980)	-4.226815	-3.536601	Fail to Reject H_0	Non-stationary
Phillip-Perron	-3.210628 (0.0980)	-4.226815	-3.536601	Fail to Reject H_0	Non-stationary

Table-2
Unit Root Stationarity after First Difference

Nominal Interest Rate					
Test	**Test statistics**	**1%**	**5%**	**Null Hypothesis**	**Status**
Augmented Ducky-Fuller	-4.315442 (0.0082)	-4.234972	-3.540328	Reject H_0	Stationary
Phillip-Perron	-4.201279 (0.0109)	-4.234972	-3.540328	Reject H_0	Stationary
Inflation					
Augmented Ducky-Fuller	-8.400166 (0.0000)	-4.234972	-3.540328	Reject H_0	Stationary
Phillip-Perron	-8.893679 (0.0000)	-4.234972	-3.540328	Reject H_0	Stationary

Test of cointegration: One of the conditions for testing co-integration for time based data is that time series must be non-stationary in nature and both series must be integrated at same order for Stationarity. As using PDF and PP test, it is verified from previous results that both series are non-Stationary and become stationary at first order difference.

Engle-Granger test for cointegration (Residual based): Since both series are stationary after 1st order difference at 1% and 5% of significance level, so to investigate equilibrium relationship for long run between nominal interest rate and inflation, run a regression of interest rate on inflation and then inflation on interest rate separately and save the residual for both regressions. The both residual series of regression equations are found stationary of same order difference by applying ADF and PP tests.

The following table-3, shows that residual series of regression of nominal interest rate on inflation (Residual 1) are non-stationary at 1 % and 5 % significancelevel.

Whereas the table-4 represents the Stationarity of the residual of regression of inflation on nominal interest rate and indicates that residual series are non-Stationarity at 1% and 5 % significance level using ADF and PP test of Stationarity.

After taking the first difference of the both residual series, again the Stationarity is being checked and it is found that both series of residual of the regressions are stationary at same order of integration i.e., (1, 1) at 1% and 5% significance level by using ADF and PP test of stationary. The following table shows the Stationarity of the residual after first difference.

After applying the Residual based test of co-integration i.e., Engle-Granger test for co-integration, it is concluded that the both residual series have unit root and after taking first difference of residual series of both regressions, they become stationary and show an equilibrium relation for long run between inflation and nominal interest rate for time series data of Pakistan[21].

Johansen Test of Co-integration: The Johansen test of co-integration used two different approaches for deciding the co-integrational relationship between nominal interest and inflation rate i.e., trace statistic and max-Eigen statistic. The following is the output of the Johansen co-integration test for time based data for Pakistan.

Table-3
Stationarity of the Residual of Regression of nominal interest rate on inflation

Residual 1					
Test	**Statistic**	**C.V 1%**	**C.V 5%**	**Null Hypothesis**	**Status**
Augmented Ducky-Fuller	-3.211007 (0.0979)	-4.226815	-3.536601	Fail to reject H_0	Non-stationary
Phillip-Perron	-3.211007 (0.0979)	-4.226815	-3.536601	Fail to reject H_0	Non-stationary

Table-4
Residual's Stationarity of Regression Equation of inflation on Nominal interest Rate

Residual2					
Test	**Test statistics**	**Critical Value at 1%**	**Critical Value at 5%**	**Null Hypothesis**	**Status**
Augmented Ducky-Fuller	-3.25771 (0.0906)	-4.252879	-3.548490	Fail to reject H_0	Non-stationary
Phillip-Perron	-2.464017 (.3430)	-4.226815	-3.536601	Fail to reject H_0	Non-stationary

Table-5
Stationarity of Both Residual Series of Regression after 1st Difference

Stationarity of Residual Series of Regression nominal interest rate on inflation after 1st Difference					
Test	**Test statistics**	**1%**	**5%**	**Null Hypothesis**	**Status**
Augmented Ducky-Fuller	-8.399584 (0.0000)	-4.234972	-3.540328	Reject H_0	Stationary
Phillip-Perron	-8.894523 (0.0000)	-4.234972	-3.540328	Reject H_0	Stationary
Stationarity of Residual Series of Regression inflation on nominal interest rate after 1st Difference					
Augmented Ducky-Fuller	-4.318898 (0.0081)	-4.234972	-3.540328	Reject H_0	Stationary
Phillip-Perron	-4.204862 (0.0108)	-4.2345972	-3.540328	Reject H_0	Stationary

Table-6
Johansen Co-integration Test

Johansen Co-integration Statistics						
Test Statistic	**H_0:**	**H_1:**	**Eigen Value**	**Computed Value of Test statistics**	**Critical Value 5%**	**Decision**
Trace-statistics	r = 0	r > 0	0.408155	25.67113 (0.0011)	15.49471	Reject H_0:
	r = 1	r > 1	0.171863	6.788743 (0.0092)	3.841466	
Max-Eigen statistics	r = 0	r > 0	0.408155	18.88239 (0.0087)	14.26460	Reject H_0:
	r = 1	r > 1	0.171863	6.788743 (0.0092)	3.841466	

It is clear from Table-6, that the computed value of the test statistic, both approaches of Johansen co-integration test, is more than the critical value at 5% level of significance so we reject our hypothesis. It is concluded that there exists a co-integration or equilibrium relationship for long run between nominal interest and inflation rate in Pakistan for period of 1973-2010.

Conclusion

The main objective of the study is to find out the causality between nominal interest rate and inflation and equilibrium relationship for long run between the said variables i.e., the study of the validity of the Fisher Hypothesis for Pakistan. It is found that both variables i.e. nominal interest rate and inflation rate for Pakistan form 1973-2010 show non-Stationarity and after taking first difference of their time series, The Stationarity in both time series is checked using empirical approaches of unit root. Both approached of unit root i.e. ADF and PP test were used to test the Stationarity in both nominal interest rate and inflation. Both variables are found non-stationary at 1 % and 5 % significance level and after 1st difference both were stationary at 1 % and 5% significance level. Using co-integration techniques likes Engle-Granger co-integration test (residual based) and Johansen co-integration test, it is obtained that there exists a relationship for long run or co-integration relationship in nominal interest rate and inflation rate at 5% significance level for period of 1973-2010.

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