

## How Inflation responds to Interest Rate: Time Series Analysis for Pakistan

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**Abstract:** *Inflation has been a menace for the world and is one of the most important factors in destabilizing the economy of Pakistan. The study examines the dynamic relationship among inflation and key macroeconomic variables (fiscal deficit, interest rate, and imports) for Pakistan. The study utilizes time series data from 1980-2021, with Johansson Co-integration Test and the (VECM) Vector Error Correction Model, to estimate the long-run and short-run relationships. This study is interested in understanding the relation of interest rate with prices which is also termed as Fischer effect in literature. So whether this effect prevails for Pakistani economy or not is the goal of this paper. The results show that in long-run, inflation has a significant positive relationship with interest rates, while showing an inverse relationship with fiscal deficits and imports. These results offer valuable insights into the role of monetary policy and prices in Pakistan. Through interest rate and imports the inflation can be controlled, while the study shows a weak relation of fiscal deficit with inflation in the study period.*

### Introduction

Inflation is a challenge confronting nearly all nations. Inflation refers to the rise in overall prices of goods and services, and it is categorized into three forms. Demand-pull inflation, Cost-push inflation, and anticipated inflation. Numerous factors influence inflation, including interest rates, fiscal deficits, and imports. The fiscal deficit is a significant issue confronting numerous nations. A fiscal deficit represents the disparity between government revenues and expenditures. When government expenditures surpass government revenues, the central bank or government incurs debt to bridge the deficit. Government expenditure encompasses investments in initiatives such as infrastructure, healthcare, education, and defense. The government acquires revenue through taxation, which can be classified as either direct or indirect. Non-tax revenue constitutes an alternative revenue stream, encompassing government assets and associated fees.

The government incurs debt from domestic banks and several external entities, including the IMF and World Bank. There exist two perspectives about the relationship of inflation and budget deficit. The initial perspective posits that when the government incurs debt, it amplifies the money supply in the market, thereby resulting in price increases. The alternative perspective posits that if a nation's demand for goods increases while their supply and production stay constant, the overall prices of those commodities will rise (Bhattacharyya, 2009). There are varying perspectives regarding the implementation of policies. There are primarily two factions: the first contends that fiscal deficit would stimulate and enhance economic growth, while the second argues that an escalation in fiscal deficit will result in heightened risks and generate inflationary pressures. The initial group determined that government expenditure of debt on projects, including infrastructure, industries,

and hospitals, would enhance the tax revenue for the government and promote privatization; taxes generated from these sectors would diminish the budget deficit and stimulate economic growth. The second group asserts that an increase in fiscal deficit exacerbates the country's burden, leading the government to service the debt with interest, which subsequently diminishes domestic investment and results in rising prices.

The classical school argues for minimal government action, asserting that the state should refrain from interfering in economic activities and should avoid incurring budget deficits. This perspective posits that a budget deficit increases general consumption by transferring tax liabilities to future generations, hence diminishing savings and resulting in a deficiency in private capital accumulation. The Keynesian school advocates for government expenditure, emphasizing the need of proactive fiscal policy and the potential for budget deficits to attain comprehensive economic stability. According to Ricardian equivalence, as articulated by Ricardo, consumption is contingent upon anticipated resources across generations, indicating that budget deficits effectively transfer tax liabilities to future generations (Fatima et al., 2012).

The interest rate is another factor that influences inflation. Low interest rates stimulate high investment levels, prompting individuals to borrow more capital for investment, thereby leading to increased growth. Conversely, when interest rates increase, individuals will borrow less money, resulting in a decrease in investment and economic growth.

Financial experts assert that interest rates positively influence inflation. Nonetheless, several studies yield diverse outcomes. Certain research indicates a positive or negative correlation between interest rates and inflation, while others conclude that the influence is negligible (Danladi et al., 2015). Globalization has facilitated opportunities for commerce and international trade. In an open economy, imports are associated with inflation. Dexter et al. (2005) asserts that imports impact inflation both directly and indirectly, regulating and influencing domestic prices.

Volkan Ulke and Uğur Ergün concluded that a relationship exists between imports and inflation in Turkey, both in the short run and the long term.

### **Research Problem**

There are various perspectives about the relationship between inflation and macroeconomic variables. Certain researchers propose that variables exert direct influence on other variables. Conversely, certain theorists propose an inverse relationship, while some economists assert that no correlation exists between the variables. This study aims to determine whether the relationship is positive, negative, or zero. The Aims of the research is to assess the impact of independent factors, including fiscal deficit, interest rate, and imports, on inflationary pressure in both the long run and short run.

### **Literature Review**

The correlation between inflation and other macroeconomic indicators is a prevalent subject for scholars, with numerous economists employing various methodologies to investigate this topic. Numerous studies have concentrated on fiscal deficit and interest rates. Furthermore, there is excessive emphasis on the causative relationship between these factors, namely how inflation influences inflation and vice versa (Miller 1983). Aghevli and Khan (1978) conclude that inflation is induced by an expanding budget deficit, primarily financed by the banking sector, resulting in excess liquidity and subsequent inflation. Miller (1983) also investigated that. Ezeabasili and Mojekwu (2011) employ a two-stage OLS model and conclude that their fiscal deficit exerts upward pressure on interest rates. Darrat (1988) did study in the U.S. estimate the relationship between inflation and budget deficit, applying the OLS technique. He analyzed time series data from 1960 to 1970 and determined that the relationship between inflation and budget deficit is considerable in comparison to other macroeconomic factors. Bilquees (1988) investigated the correlation among macroeconomic variables in Pakistan utilizing structuralist and monetarist theories, concluding that there is no association between these economic variables.

Chaudary and Ahmad (1995) investigated the correlation between inflation, fiscal deficit, and money supply utilizing data from 1973 to 1982 and 1973 to 1992. The researchers conducted a study on inflation, money supply, and fiscal deficit, employing the Ordinary Least Squares (OLS)

approach. The research finds that a positive correlation exists between inflation and budget deficit. Hondroyiannis and Papapetrou (1997) investigated the effects of inflation and budget deficit, discovering a direct correlation between the variables. Aisen and Hauner (2008) investigated the impact of fiscal deficit on inflation by analyzing data from 60 nations, revealing a direct correlation between the two variables. Saleem et al. (2013) examined the primary causes of inflation utilizing time series data from 1990 to 2011. The objective of the study was to establish a direct correlation between inflation and fiscal deficit; nevertheless, the conclusion indicates that there is no relationship between the variables. Ellahi (2017) examined the determinants of inflation in Pakistan from 1975 to 2015. The ARDL model indicates that, in the short term, the relationship is minor; nevertheless, in the long term, there is a direct correlation between imports and inflation, and an inverse correlation with GDP. Eddien and Ananzeh (2016) examined the relationship among budget deficit, interest rates, and inflation. The Johnson co-integration and Granger test were applied to time series data from 1992 to 2015 for Jordan. The results indicate a singular causation between inflation and budget deficit, as well as a short-term relationship between the variables. (Chimobi & Igwe, 2010) Utilized VECM and causality tests to ascertain the relationship, revealing bidirectional causation. Miller posited in 1983 that the budget deficit would induce inflationary pressures on the economy, resulting in upward pressure on prices. Shabbir and Ahmad (1994) investigated the impact of budget deficit on inflation, noting that general prices are influenced indirectly. (Saleh & Harvie, 2005) and (Darrat, 2000) reach same conclusions.

**Methodology**

**Variable Specification**

This study uses interest rate, fiscal deficit and imports as independent variables effecting inflation in Pakistan. The data has been taken from WDI from 1980-2021. Consumer price index has been used to represent inflation in Pakistan. While imports in million dollar has been taken from the data center. While fiscal deficit has been taken in percentage of GDP of Pakistan. Interest rate has always been used as a monetary policy tool to reign in growing inflation in the country. Hence the current study also uses this variable to detect any long and short run relation of interest rate with inflation.

**Econometric Technique**

This study uses Johansson Co-integration test to check whether there is any long run relation between inflation and its determinants. While for short run relationship VECM has been used. Which also shows the speed of adjustment in case of a shock in the independent variables. The variables were processed for stationarity through unit root test which identified the variables to be stationary in first difference. Which made it ideal to use the Johansson Co-integration test for finding long run relationship. The following equation was used to test the above techniques.

$$CPI_t = \beta_0 + \beta_1fd_t + \beta_2i_t + \beta_3 m_t + \varepsilon_t \dots\dots\dots (1)$$

While for VECM the following equation (2) is used to find the short run relation and speed of adjustment.

$$\Delta cpi_t = \beta_0 + \sum_{i=1}^{k-1} \beta_1 \Delta cpi_{t-1} + \sum_{i=1}^{k-1} \beta_2 \Delta fd_{t-1} + \sum_{i=1}^{k-1} \beta_3 \Delta i_{t-1} + \sum_{i=1}^{k-1} \beta_4 \Delta m_{t-1} + \beta_4 ect_{-1} + \varepsilon_t \dots\dots\dots (2)$$

Equation (2) above shows that the inflation depends on its previous lag value and the current and previous lag values of fiscal deficit, interest rate and imports.

The models were tested through different diagnostic tests which include; Ramsay reset test for model specification, Bruesch pagan test for heteroskedasticity, variance inflation factor for multicollinearity, and Durban Watson test for detecting autocorrelation in the data. Similarly, Jarque-Bera test for checking the normality of the data.

**Results and Discussion**

In this section the results are being discussed. First the unit root results are presented. The results of co-integration are presented after lag length selection. Then follows the VECM results for short run dynamics of the model. After that the diagnostic test results are presented.

**Table 1: Unit Root Results**

Null Hypothesis(H<sub>0</sub>): data has unit root

**At Level I(0)**

		LCPI	fd	Interest rate	imports
Const:	T value	-2.7570	-2.6526	-2.2237	1.4305
	<b>Prb value</b>	<b>0.0734</b>	<b>0.0911</b>	<b>0.2013</b>	<b>0.9988</b>
Const: with trend	t-Stat	-2.6948	-2.6639	-2.3666	-0.8658
	<b>Prb value</b>	<b>0.2440</b>	<b>0.2561</b>	<b>0.3907</b>	<b>0.9503</b>
No const: & trend	t-Stat	-0.7069	-0.6807	-0.6163	2.6829
	<b>Prb value</b>	<b>0.4044</b>	<b>0.4160</b>	<b>0.4442</b>	<b>0.9977</b>
		NO	NO	NO	NO
<b>At First Difference I(1)</b>					
		d(LCPI)	d(fd)	d(rate of interest)	d(imports)
Const:	t-Stat	-6.6117	-7.5317	-6.2500	-4.4374
	<b>Prb value</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0010</b>
Const: with trend	t-Stat	-6.5775	-7.4072	-6.1637	-4.6760
	<b>Prb value</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0029</b>
No const: & trend	t-Stat	-6.6967	-7.6275	-6.3340	-3.9199
	<b>Prb value</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0002</b>
		***	***	***	***

Stationarity is important for time series data, and if the data is stationary, we can proceed to the next step. Stationarity means when the mean, mode variance, and covariance remain the same with time. The null hypothesis for unit root is that the data is non-stationary, if the prob value is minimum than 0.05 we will reject (H<sub>0</sub>) hypothesis.

The Above unit root test table indicates that the variables are non-stationary at level I(0), and then at the first difference I(1) become stationary. We can use the Johanson test because the assumption of Johanson states that at the level the data must be non-stationary and then will be stationary at the first difference.

**Table 2: Optimal Lag Length**

Lag	LOG L	L-R	F-P-E	A-I-C	S-C	H-Q
0	-354.1610	n/a	1114.063	18.36723	18.53785	18.428445
1	-243.4438	193.0454 <sup>□</sup>	8.706827 <sup>□</sup>	13.50994 <sup>□</sup>	14.36305 <sup>□</sup>	13.81603 <sup>□</sup>
2	-229.7656	21.04337	10.08814	13.62901	15.16460	14.17997
3	-218.4307	15.11321	13.77227	13.86824	16.08633	14.66407

<sup>□</sup> Symbol Indicates lag length criteria for the model

For using VECM model the first step is to choose appropriate lag criteria in the study, in the lag length criteria the result shows 2 lag. In the study we will use 2 lags in the Shwarz criteria. Below table 3A and 3B show the co-integration test results which support long run Co-integration of the model. Both trace statistics and Eigen values are presented which confirm the relationship of the variables are co-integrated in the long run. After this the results for VECM are discussed.

**Table 3 A Johansson Co-integration Test**

(Trace stat:)

Co-integrating eq:	Eigen valu	Trace values	Prob.** Critical Value
None *	0.556987	58.35804	0.0038
At most 1	0.413594	25.79178	0.1351
At most 2	0.098676	4.442050	0.8648
At most 3	0.007136	0.286449	0.5925

**Table 3 B Johansson Co-integration Test**

Co-integrating eq:	Eigenvalue	Max-Eigen values	Prob.** Critical Value
None *	0.556987	32.56626	0.0105

At most 1 *	0.413594	21.34973	0.0466
At most 2	0.098676	4.155601	0.8426
At most 3	0.007136	0.286449	0.5925

Max-Eigen statistics shows 2 integrating equation(s) at 5% level, mean reject null hypothesis and conclude there is co-integration. The above table indicates the conclusions obtain from the Johansson co-integration test, for obtaining the long-run relation we used the Johansson co-integration test. Johansson co-integration used two types of statistics (1) trace statistics and (2) Max Eigen statistics. The null hypothesis for both statistics is; H0: There is no co-integration. If the trace value and Max Eigen value are more than their critical value it means reject H0, and accept there is co-integration. The above results of trace statistics and Max Eigen value show at least one co-integration equation, which mean reject null hypothesis and conclude that there is long- run relation between variables. The trace statistics show one co-integration equation. The maximum Eigenvalue results show 2 integration equations and we will reject the null hypothesis. Trace and Max Eigen show different results in our model. In this case, we will choose trace statistics results. The long run relationship of the model comes out to be positive for fiscal deficit and import while it is negative for interest rate. This result is in line with theory as well. Pakistan heavily depends on imports where the imports are twice as large as the exports. This way higher imports with higher tariffs lead to higher prices in the economy. Similarly, as structuralist point out in developing countries, one of the main cause of inflation in higher fiscal deficit. Though the relation for Pakistan in insignificant but it provides the direction that fiscal deficit leads to higher prices in the country. The same way if interest rate is high people tend to save more and reduce the demand for money thus decreasing the aggregate demand. Which pushes downward pressure on prices. That’s why there is negative relation of interest rate appears with inflation.

**Table 4 Cointegrating Equation**

Log-LH: -248.6997

Co-integrating coefficients with standard error

LCPI	Interest rate	f.deficit	Imports
1	0.075513 (0.04086)	-0.063830 (0.04684)	-0.016946 (0.00556)

**$Inf = 0.063 fd - 0.075 i + 0.016 m \dots\dots\dots (3)$**

When interest rate increases by one unit, inflation will decrease by 0.075 units, the result show inverse relation between interest rate and inflation in the long run, while a positive relation between inflation, fiscal deficit and imports. If the fiscal deficit increases by one unit the inflation will also rise by 0.0638 unit, and if imports increase by one unit inflation will rise by 0.016 unit.

**Table 5 Short Run Analysis**

DV: D(LCPI)

Method: Least Squares

Variable	Coefficient	t-Statistic	Prob.
D(fd)	0.043655	1.138422	0.2623
D(ir)	0.130096	3.951943	0.0003
D(import)	0.005737	0.558107	0.5801
ECT(-1)	-0.438232	-2.900590	0.0062

The Error Correction Term (ECT) represents the speed at which the system returns to equilibrium after an accident. The coefficient of **-0.438232** indicates that approximately **43.8%** of any variation from the long-run equilibrium point is corrected in each year. The negative sign is expected and confirms the presence of an adjustment mechanism back to the long-run equilibrium. The t-statistic and low p-value (0.0062) show that this term is statistically significant, meaning that if the system is disturbed, it will converge back toward equilibrium at a moderate rate, with nearly half of the disequilibrium corrected in each period.

This equation shows how inflation (LCPI) in the current period is influenced by changes in past inflation, interest rates, and imports. If inflation was higher in the past, it tends to lower the current inflation. A higher interest rate in the previous period increases inflation, while changes in imports have a small and insignificant impact on current inflation. The constant term represents a

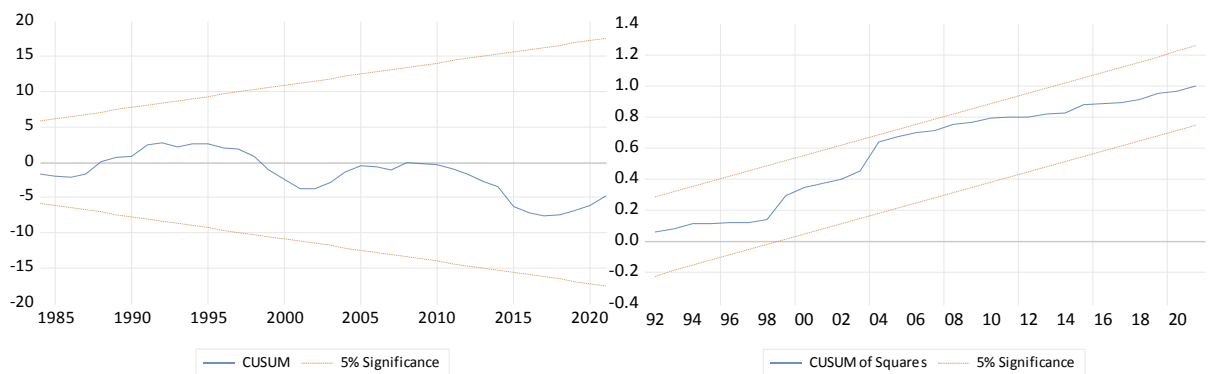
baseline level of inflation when all other factors are zero. In simple terms, past inflation and interest rates are the main factors driving short-term changes in inflation, with imports having a very minor effect.

**Diagnostic Testing Results**

**Table 6 multi-collinearity test: VIF**

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
fd	0.001409	14.75614	1.024444
Interest rate	0.000692	17.36994	1.201469
import	1.26E-05	7.202999	1.183717
C	0.102041	26.31172	NA

Test	statistics value	Probability	Remarks
NORMALITY Jarque bera	0.89945	0.63	Normally distributed
Heteroskedasticity Breusch-Pagan-Godfrey	F-statistic: 0.333976 Obs R-squared: 1.078945	0.8008 0.7822	No heteroskedasticity
S. correlation LM	F-stat: 0.937088 O R <sup>2</sup> : 2.195749	0.4037 0.3336	No Serial Correlation
Ramsey RESET Test	t-statistic: 0.321070 F-statistic: 0.103086	0.7500 0.7500	Correctly specified



**Vecm Results**

The Vecm results are presented in the equation (4) below

$$ECT_{t-1} = 1 lcp_i_{t-1} - 0.06 fd_{t-1} + 0.07 i_{t-1} - 0.01m_{t-1} - 1.58 \dots\dots\dots (4)$$

This equation signifies long run relationship among the variables of the model. While the short run VECM model is specified in the equation (5) below.

$$\Delta cpi_t = -0.38ect_{t-1} - 0.07\Delta cpi_{t-1} + 0.02\Delta fd_{t-1} + 0.04\Delta i_{t-1} - 0.002\Delta m_{t-1} - 0.00 \dots\dots\dots (5)$$

The above equation can be explained as; the previous time period’s deviation from long run equilibrium are corrected in the current time period at a speed of 38 percent. Similarly a percentage change in fiscal deficit is associated with 0.2 percent increase in inflation in the short run period. While interest rate effects the prices with 0.04 percent. The same way imports decrease the prices by 0.02 percent in the short run. The ceteris paribus is taken into account while the explanation of the coefficients in the short run.

**Conclusion**

The analysis indicates a significant positive correlation between interest rates and inflation, suggesting that elevated interest rates result in increased inflation, largely attributable to higher borrowing costs and diminished investment. Conversely, imports significantly decrease inflation, as an increase in imports alleviates inflationary pressure by supplying more affordable commodities. Nonetheless, fiscal deficits exert minimal influence on long-term inflation, suggesting that fiscal policies may be less effective in regulating inflation compared to other determinants, such as interest rates and trade dynamics. In the short term, interest rates significantly influence inflation,

highlighting the importance of monetary policy in managing inflation. Fiscal deficits and imports, however, exhibit negligible short-term effects on inflation, indicating that other immediate economic variables or transient shocks may exert greater influence on inflationary fluctuations. The error correction term, exhibiting a substantial negative value, signifies that deviations from long-run equilibrium are rectified swiftly, with a 43% recovery rate annually, as inflation adjusts to reestablish equilibrium with the model's independent variables.

The findings indicate that to regulate inflation in Pakistan, the central bank must meticulously oversee interest rates, given their significant impact on inflation. Accelerating interest rate increases may lead to heightened inflation. Moreover, augmenting imports might mitigate inflation, particularly as inflation in Pakistan frequently results from goods shortages. Policymakers ought to contemplate facilitating imports of essential goods to mitigate inflation. While fiscal deficits do not directly influence inflation in either the short or long term, it remains crucial for the government to maintain stable public finances and manage debt to preserve the general health of the economy.

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