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Understanding the Drivers of Inflation Volatility of Pakistan

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This paper focuses on the inflation problem about a worldwide issue. The aim of this study is to discuss the technique over the data collected for the last thirty-eight months. This study explores the significance of inflation and inflation volatility. The results were also compared with the estimates for effectiveness and volatility by the ARCH/GARCH technique. The entire model is statistically significant. There is a positive relationship between money supply and exchange rate with current inflation. The Granger test is applied to examine the causality connecting inflation and inflation volatility. The result shows that inflation will be increased in the future in Pakistan. Future studies can be extended by considering more factors to obtain more precision to control the inflation volatility in Pakistan.

Introduction

Inflation has many factors but the most important factors are past inflation, money supply, exports, and exchange rate. So, there is a dire need for econometric analysis. Inflation means an increase in the prices of goods and services in the economy over time. Inflation happens when the cost of goods and products increased over a particular timeframe (such as raw materials, wages, etc.) The rate at which prices are increased with the passage of time, due to that the monetary value of purchased things will fall. According to the business perspective, an economic Inflation rate is directly related to GDP, exports, imports, exchange rate, money supply, interest rate, tax revenue, etc.

Arespa and Gonzalez (2022) studied inflation and inflation volatility by considering the variables of exchange rate movements and macroeconomic variable helps to understand CPI as a subcategory. Musa (2021), studied the exchange rate volatility on inflation and considered the variable MS, Exchange rate, money supply, inflation, and consumer price index. These variables were used to reduce inflation in Nigeria. Ajide and Alimi (2021) studied the inflation and inflation volatility impact on terrorism. He used domestic activities over spam. He concluded that it helped to succeed in inflation volatility.

According to Omotosho and Doguwa (2013), inflation volatility defines the fluctuation in inflation. Most of the literature suggested inflation uncertainty is synonymous with inflation volatility (Shesadri, 2012). It is noted that inflation volatility in developed countries is considerably lower than in developed countries. There were many theories of inflation such as structural theory, Keynesian theory, and monetarist's inflation theory. According to Structuralizes theory, for less developed countries, inflation is prone. The reasons were structural rigidities such as institutional factors and economic and political factors in those countries, which was the reason for the delay of output. According to this theory, inflation is a supply side of the economy.

Now a day's inflation is a global and also a major issue for developing countries. In developing countries rise in inflation due to money supply, exchange rate, low-level production of goods, poor technology, fewer exports, etc. Inflation can also be explained by the destruction of purchasing power of people. So, Pakistan is a developing country and facing a curse like inflation. Inflation is increased due to the following factors such as when an increase in the MS, and the supply of goods, and the response for money. According to Fazlani et al. (2012) Inflation may be resulting from increased Aggregate demand that decreased Aggregate supply through these two causes and its effects on the level of the economy.

Demand-Pull Inflation: Demand-pull inflation increased due to the following factors such as money supply, government expenditures, exports, deficit financing, and GDP. "According to Keynesian economics the rise in employment increased the aggregate demand, as to produce more output company needs more people to be hired." Cost-push inflation is too much money chases

too few goods. Factors affecting cost-push inflation may be decreases in the Aggregate Supply, increase in the labor wage rate, wars, floods, strikes, and increase in imports. As there is a frequent increase in the price, increases the cost of the finished goods, which results in inflation. Inflation is a global issue and is worst in Africa like Nigeria, Zimbabwe, and Tanzania, etc. In Zimbabwe, the inflation rate was high due to the following factors such as MS, IR, real income, and ER, (Chhibber & Shaffik, 1991). In the case, of Egypt, the inflation rate was affected by the MS rate of growth, devaluation of the exchange rate, and interest rate and deficit of trade (Enu & Havi 2014). In the Nigerian economy inflation is the main issue and the policymakers decided how to solve it. Some of the empirical studies over the years have factored out the following determinants of inflation volatility. These factors were following such as currency depreciation, changes in CPI, exports, imports, and production price index among other factors were the causes of inflation volatility.

Rother (2004), discovers that fiscal deficits were the important factor that affects the volatility of inflation, and the "fiscal policies" discretionary volatility has a positive effect on inflation volatility. Openness reduced inflation volatility several studies explained the association between inflation and inflation volatility and the majority depend on time series analysis. Caporale and McKiernan (1997) used the methodology of GARCH to explain the positive relationship between high and variability of inflation by using the monthly data post-war. This study fully supports Friedman's theory. Javed et al. (2012) has also explained that the relation between inflation and inflation volatility is positive in the case of Pakistan by using the GARCH methodology. During the unprecedented condition, the inflation rate was higher in Pakistan. This work found that it has a big extension and that is expanding in two different ways. The first one is initial in which we used the variance of inflation or the conditional variance as the proxy of the volatility of inflation. In the inflation series data, conditional volatility is used to generate the process of GARCH in the inflation model. The second step Granger Causality test will also use to find the inflation, its volatility, and its direction (Asghar et al., 2011). Pakistan is a developing country. The problem of unemployment, deficiency of the literacy rate, and the financial sectors are weak like the other developing countries. MP becomes another challenge for developing countries in the presence of the above factors together with an increase in inflation. With respect to this reason, this study has analyzed the determinants of inflation, and its volatility in the case of Pakistan. The primary purpose of this research is to analyze the determinants of inflation volatility in Pakistan and utilized monthly data from May 2015 to July 2018.

The objective of the Research:

- To distinguish the determinants of inflation in Pakistan.
- To measure the volatility of inflation through the ARCH/GARCH model.
- To check the causality linking inflation and inflation volatility.

Literature Review

Arespa and Gonzalez (2022) in macroeconomic dimensions the exchange rate has a significant impact on country openness. Measured inflation dynamics were used instead of the level of inflation. It explores potential explanations and used conditional and unconditional variances. The results indicated that critical changes in agencies are to be considered as quality adjustments in products with macroeconomic variables to realize CPI volatility over time.

Köse and Ünal (2021), this study explored the association between oil prices and volatility of oil prices in turkey, and monthly data were taken from 1988 to 2019. The results showed that oil price volatility on limited and later it became significant. The exchange rate has a great impact on inflation and it was considered the biggest source of caused the inflation rate. Adil et al. (2021). Discussed the factor involved like household impact on inflation in the case of India. Mandeya et.al. (2022) this study explored the relationship between inflation and inflation uncertainty in economic growth. The results were evaluated by previous and present studies based on subject channel. The results were indicated on review of channels (Bredin & Fountas, 2021). This study explored the relationship between inflation and inflation uncertainty. Which discovered temporary and permanent shocks in inflation with short and long run inflation.

According to Keynesian inflation is caused when the economy's investment is greater than it's saving. On the other side, the recession was caused when investment lessen than economic savings. Due to this theory relationship between expenditure and aggregate income was focused on the equilibrium of employment, GDP, and price level. Theoretically, this theory is the sum of private consumption, investment, government expenditure, and foreign sector expenditure exceeded the employment output. So, inflation was dependent on excess demand relative to output. According to Monetarists Theory explained that inflation is caused by goods when so much money is chased. Inflation is the phenomenon of monetary. The monetarist's theory is related to price level inflation which originated from an increase in money supply (Milton Friedman, 1968).

Ogenyi and Umeh (2019) used the ARCH and GARCH to explain the determinants of inflation volatility. Data were collected from NBS, FAO, and CB of Nigeria. Hence, results indicated that past inflation, exchange rate, annual imports, exports, GDP, and money supply in the past two years increased inflation volatility in Nigeria. But on the other hand, unemployment and interest rates reduced inflation volatility within the period. Rizvi and Naqvi (2009) used the TGARCH and EGARCH methodology used to explain the inflation uncertainty. The results showed that in the case of Pakistan, inflation hit inflation uncertainty. Saleem, (2008) used the VAR analysis to explain the determinants of inflation volatility in Pakistan, and the data were taken from (1990-2007) on monthly basis. Results showed that IR, inflation, and MS were together, and ARCH and GRCH methodology conclude that inflation was volatile in nature.

Sweidan (2004), concentrated on the association between economic development and inflation in Jordan. The researcher used the inflation variables, MS, economic growth, and real growth fixed capital formation. The two techniques were used the ARCH model and the OLS method. The result indicated that the structure breakpoint effect occurs on inflation at 2 percent. This result explained that the method of MP was restricted. So, the CB in the study of Jordan should pay more attention to the inflation phenomenon and conduct a new policy. Kontonikas (2004); Bhar and Hamori (2004); and Caporale and McKiernan (1997) explained inflation and its uncertainty. The conditional volatility has been used as the proxy of the uncertainty of inflation in this research. The result was the same that positive inflation and inflation uncertainty.

Data and Methodology

Monthly data on the "inflation rate", "money supply", "exchange rate", and "exports" were used. The data used in this research is based on a monthly basis. The data was used over the time period from May 2015 to Jul 2018. This data has been analyzed by using E-views 9. The proxy of inflation volatility is conditional variance. The variance of inflation is generated by the GARCH variance equation. So, apply the ARCH/GARCH models. The ADF test has been used to analyze the unit root test in time series data to detect the presence and absence of non-stationary. For this deduction, this study used the ADF test which is an extension of the Dickey-Fuller test. We used lagged dependent difference operator, which is the point difference among DF and ADF tests. It is an LM-based test.

The ADF test hypothesis is:

H_0: α=0 (time series contain unit root)

H_1: α< 0 (time series contain stationary)

Mean equation:

$$Inf_t = \beta_0 + \beta_1 \sum_{j=0}^{p} Inf_{t-i} + \beta_2 \sum_{j=0}^{p} Ms_{t-i} + \beta_3 \sum_{j=0}^{p} Exc_{t-i} - \beta_4 \sum_{j=0}^{p} Exp_{t-i} + \varepsilon_t$$

Conditional variance equation:

$$h_t = \omega_0 + \sum_{i=1}^{p} \beta_i \, h_{t-i}$$

$$\theta_t = \omega_0 + \sum_{i=1}^{p} \beta_i \, \theta_{t-i} + \sum_{j=1}^{q} \alpha_j \, \varepsilon_{t-j}^2$$

ht stands for conditional variance or proxy of inflation volatility.

ω0 Denotes constant, α denotes ARCH term and β denotes GARCH term.

Mean equation:

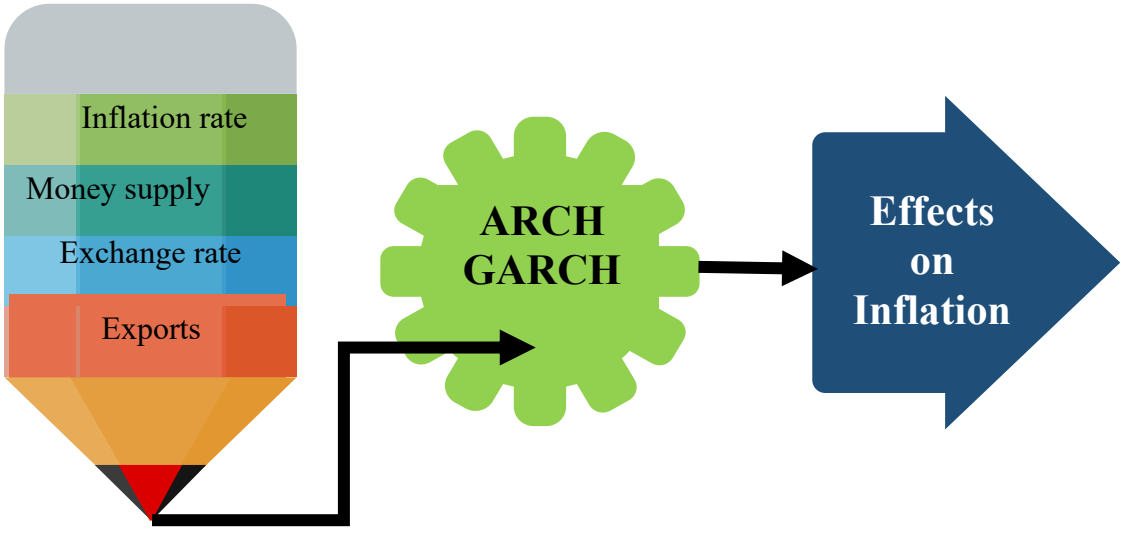
$$Inf_t = \beta_0 + \beta_1 Inf_{t-i} + \beta_2 Ms_{t-i} + \beta_3 Exc_{t-i} + \beta_4 Exp_{t-i} + \varepsilon_t$$

Volatility equation:

$$h_t = \varphi_1 + \lambda_1 \epsilon_{t-1}^2 + \lambda_2 h_{t-1}$$

Hence,
INF = inflation rate %
MS = money supply %
EXC = exchange rate %
EXP = export %
β_0 And φ_1 is constant
$\beta_1 \ldots \beta_4$ Coefficients
ϵ_{t-1}^2 ARCH term
h_{t-1} GARCH term
ε_t Error term
In this model inflation rate is a regressed variable and 1st lag of the inflation rate, the 2nd lag of "money supply", "Exchange rate" and "Export" will use as predicted variables.

Proposed Model



Granger Causality test

The main purpose of this test is used to conclude whether the one-time series is useful for forecasting another or not. If both variables' p-value is significant it means bi-direction causality exists and if one variable p-value is significant means uni-direction causality exists. But when the p-value is insignificant for both variables its mean causality does not exist for both variables.
This regression for function can be returned as:

$$infl_t = a_0 + \sum_{i=1}^{n} infl_{t-i} + \sum_{i=1}^{n} inflV_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots \text{(i)}$$

$$inflV_t = a_0 + \sum_{i=1}^{n} inflVc_{t-i} + \sum_{i=1}^{n} infl_{t-i} + \mu_t \ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

Where,

a_0 Stands for the constant term of regression granger causality test
n Denotes the lag length chosen for the granger causality test
$infl.$ Denotes the inflation rate and $inflV$ denotes the inflation volatility
The hypothesis of this equation is:
H_0: Inflation volatility does granger cause inflation
H_1: Inflation does granger cause inflation volatility

Result And Discussion

Unit Root Test

By using the ADF test check the stationary and the output shows that the export is "stationary" at the level or integrated order I (0). But the Inflation Rate, "Exchange Rate", and "Money Supply" are stationary at the first difference or integrated the Dickey-Fuller test.

Table No 1: Augmented Dickey-Fuller test (ADF)

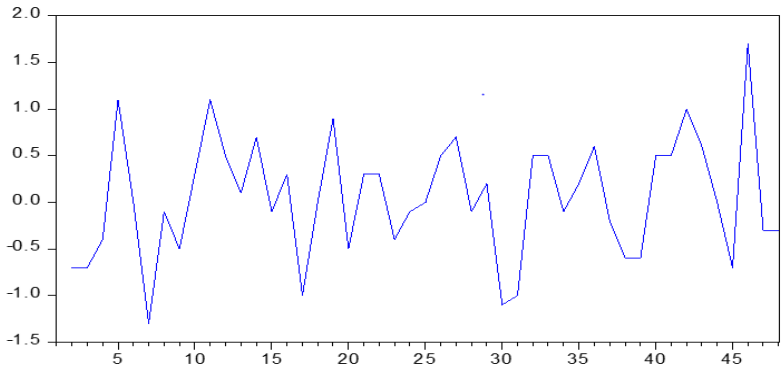
Variables	Constant	Constant and linear trend
Inflation rate	-1.3304	-3.2565***
	(0.6078)	(0.0862)
Δ Inflation rate	-6.3850*	-
	(0.0000)	
Exchange rate	1.9895	0.3499
	(0.9998)	(0.9983)
Δ Exchange rate	-12.2526*	-
	(0.0000)	
Export	-8.9212*	-
	(0.0000)	
Money supply	-2.4834	-2.5092
	(0.1268)	(0.3223)
Δ Money supply	-8.5340*	-
	(0.0000)	

The P-value in parentheses shows stationary at levels 5%*, 1% **, and 10%*.**

Graph of monthly inflation rate

We have been given unadjusted series of consumer price index and we computed plot series. Figure 1 shows the volatility is high.

Figure No1: Inflation rate monthly in Pakistan



Estimation of ARCH/GARCH model

Heteroscedasticity ARCH- LM test

Table No 2: Heteroscedasticity Test: (The ARCH-LM test)

FS	8.371504	Prob.	0.0064
Obs*R-squared	7.169402	Prob. ($\varkappa 2$)	0.0074

According to table 2, the "ARCH" effect has been confirmed. Its FS and Obs*R-squared prob. value is significant. So, there is an ARCH effect so, we did not reject our null hypothesis.

Estimation of the ARCH/GARCH model

Table No 3 variance equation shows that "ARCH and GARCH" are statistically significant at the level of 5 percent and the sum of α and β is 0.9148 it showed high volatility in series. If α+ β value is negative it means less volatility in the future.

Table No 3: ARCH/GARCH analysis Determinants of inflation in Pakistan

Mean Equation				
Var.	Coef.	S.E	Z-Statistics	p-value
$inf(-1)$	0.7352	0.0243	30.1616	0.0000
C	1.0882	0.0341	31.8408	0.0000
$Ms(-2)$	0.0695	0.0401	1.7330	0.0831
EXC	0.1394	0.0573	2.4303	0.0151
EXP	-0.0119	0.0079	-1.5137	0.1301
Var. Equation				
C	0.0235	0.0127	1.8473	0.0647
β(ARCH -1)	-0.1511	0.0274	-5.5106	0.0000
α(GARC-1)	1.0659	0.0213	49.9188	0.0000
R^2		0.57	(Mean) Dep-Variable	3.6769
Adj- R^2		0.5276	(Std.) Dep-var.	0.949
Akaike info criterion		1.8473	Durbin-Watson	1.2102
Schwarz criterion		2.1886	stat	

Post estimation tests

Now apply the following diagnostic test to check the effect of ARCH.

ARCH-LM test

Table No 4 indicates that the ARCH effect is not presented because its probability value is insignificant. So, did not reject our null hypothesis.

Table 1.4 Heteroscedasticity Test: (The ARCH-LM test)

FS	0.340983	Prob.	0.5629
Obs*R-squared	0.356549	Prob. ($\varkappa$2)	0.5504

Histogram

Figure 2 shows the graph that residuals are normally distributed.

Figure No2: Histogram

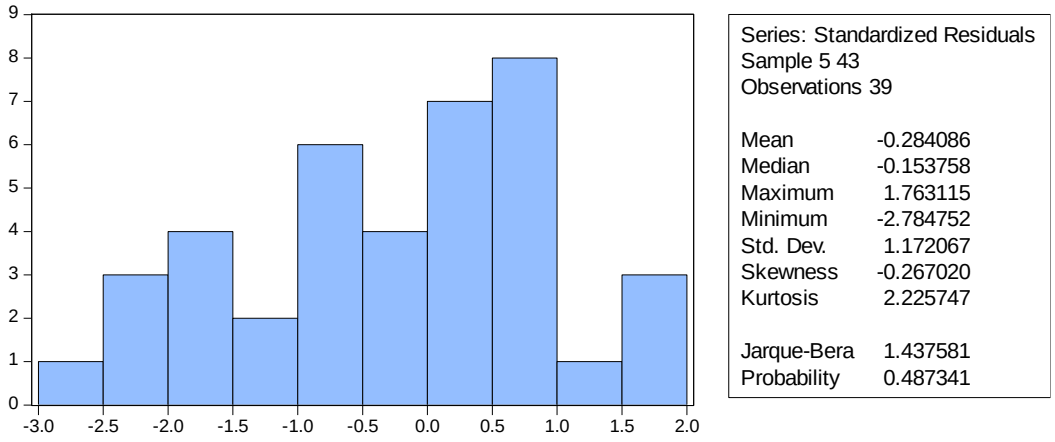


Figure shows that residuals are normally distributed because its probability value is 0.4873 which is greater than 0.05 percent.

Estimated Granger Causality Test

Table No 5: Granger causality test between inflation volatility and inflation

Lag	NH	F-S	P-value	Conclusion

Lag 4	INFV did not Cause Granger INF	1.89290	0.1418	**Accepted H_o**
	INF did not Cause Granger INFV	3.82231	0.0142	**Rejected H_o**
Lag 6	INFV did not Cause INF	3.63520	0.0133	**Rejected H_o**
	INF did not Cause Granger INFV	2.19466	0.0867	**Rejected H_o**
Lag 8	INFV did not Cause Granger INF	4.06141	0.0108	**Rejected H_o**
	INF did not Cause Granger INFV	2.28000	0.0848	**Rejected H_o**

Table 5 above shows that the F-statistics value is positive, and statistically significant when the lag is 4 at the level of 5 percent. The uni-direction reason occurs among boom and volatility inflation. This means that prosperity volatility is positively associated with inflation and high inflation variability that increased the inflation rate. But at lag six and eight bidirectional causalities happen among inflation volatility and inflation.

Result Discussion

In this section, time-series data has been utilized. Data related to MS, export, inflation rate, and exchange rate collected from state banks of Pakistan. Firstly check the Heteroscedasticity through the ARCH-LM test which is statistically significant, the previous inflation has a positive and important association with present inflation. Its outcome shows that the "money supply" and the "exchange rate" have an optimistic and significant connection with inflation. So, it confirms the theory of Demand-pull inflation that circulation in more money and higher, the demand for goods or services, as a result, higher the prices of commodities which the consumers paid.

Hence, inflation has a negative impact on exports as it increases the cost of inputs in the domestic country. In variance equation, showed that ARCH (1) and GARCH (1) at the level of 5% are numerically significant. The sum of α and β is 0.9148 showing high inflation volatility in series. Estimated results of Granger causality show that inflation volatility is positive and variability rises the inflation rate, this result supports the "Friedman hypothesis". Exports are also the causative factor of inflation. In the last few years, Pakistan has continuously declined in exports. So, the Pakistani government gets hold of essential steps to improve the exports and lessen the unnecessary tariffs, and taxes on the exports and also give incentives to foreign investors for local investment. We have used CPI as the proxy of inflation, so in future studies, researchers can use WPI as a proxy of inflation.

Recommendations

This study is recommended to increase the nominal exchange rate that tightened the monetary policy to control inflation. Exports are also the causative factor of inflation. In the last few years, Pakistan has continuously declined in exports. So, the government of Pakistan should take necessary steps to improve the exports and lessen the unnecessary tariffs, and taxes on the exports and also give incentives to the foreign investor for local investment. We have used CPI as the proxy of inflation so, in future studies, researchers can use WPI as a proxy of inflation.

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