

Dynamic Factors of Inflation in Pakistan

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Abstract: Research Question: This paper examines the long run and short run associations between inflation rate and its regressors such as unemployment rate, money supply growth rate, interest rate, labor productivity growth rate, output gap and inflationary shocks in Pakistan. The research specifically addresses how these macroeconomic variables influence inflation dynamically and whether inflationary shocks have asymmetric effects. **Motivation:** The persistent inflation in Pakistan, driven by both monetary and real sector factors, emphasizes the necessity for a comprehensive empirical investigation to support the formulation of effective economic policies. **Data:** The study uses annual data from 1991 to 2020, including inflation, unemployment, money supply, interest rate, labor productivity, and output gap. The data were collected from both monetary and real sectors including Federal Bureau of Statistics, State Bank of Pakistan (SBP), International Labor Organization Statistics (ILO) and World Development Indicators (WDI). **Method/Tools:** Bootstrap Non-linear Autoregressive Distributed Lag (NARDL) cointegration tests (McNown *et al.* 2018) is opted to identify the long-run cointegration among exogenous and endogenous variables. This approach also captures asymmetric effects by analysing how positives and negatives shocks influence inflation in Pakistan. **Findings:** The results show that there is a significant impact of labor productivity, output gap and unemployment rate on inflation rate. Monetary variables are also observed as the important drivers of inflation fluctuations. The findings suggest a contractionary monetary policy in the long run and expansionary monetary policy in the short run to stabilize inflation rate in Pakistan. This study also provides evidences on the positive impact of inflationary shocks on increase in inflation. Negative inflation shocks are found more influential than positive inflation shocks. **Contributions:** This study contributes to the inflation literature by introducing asymmetric dynamics using the NARDL approach and integrating real sector variables like labor productivity and output gap in the Pakistan, offering new insights for monetary policy formulation.

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1. Introduction

Inflation is one of the hindrances of development because it causes several adverse effects on social sector and economic activities in a country. It also affects exchange rate and erodes the gains from economic development because it creates inequality and uncertainty in the economy (Olamide *et al.*, 2022). Hence, there is a need to control inflation with effective strategy by identifying the exact root causes of its fluctuations. Inflation is usually caused by both supply-side and demand-side factors such as increase in money supply, exports, disposable income, oil prices, public debts and public expenditures (Albahouth, 2025). Other factors that could contribute to inflation rise are unanticipated changes in inflation rate, artificial scarcity, shortage of inputs, private sector expansion, gross domestic production, exchange rate and interest rate (De Alwis and Dewasiri, 2022). Labor market variables such as unemployment rate, wages and labor productivity also play important role in inflation changes (Rolim, 2025).

Pakistan is one of those countries that has remained ineffectual in controlling inflation challenges. Statistics showed that inflation rate has been accelerating considerably in recent years in Pakistan. According to International Monetary Fund, inflation rate was about 5.6% in 1990s increased to about 6.9% in 2000s and decreased to about 5.2% in 2010s. On the average, inflation rate was about 6% during the 1991 - 2017 period (Figure 1).

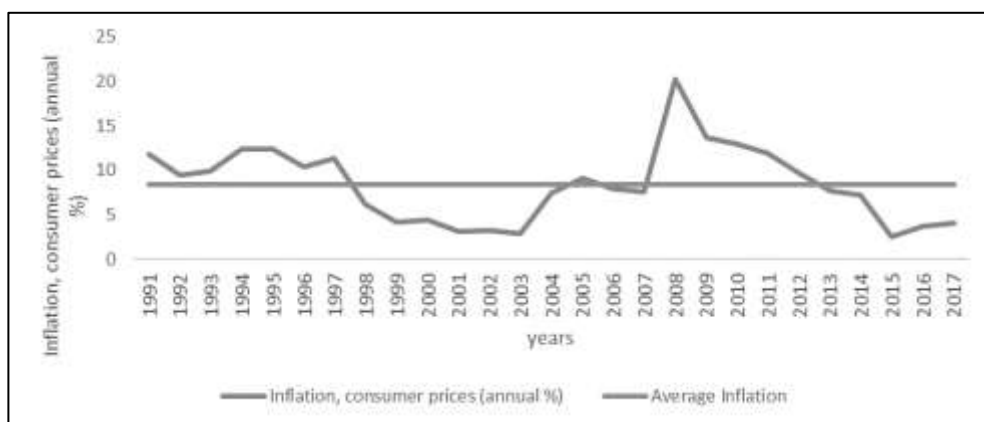


Figure 1: Inflation in Pakistan, 1991-2017

The constant rise of prices in Pakistan has been a point to ponder for economic policy-makers. Government gave little attention towards controlling labor market and monetary variables due to the prevalent of terrorism and political issues. Therefore, this paper aims to investigate the set of core determinants of inflation so that government can prioritize the variables to monitor as well as bring inflation growth rate into reasonable limits.

The contribution of this study is grounded in both methodological and empirical value addition to the existing literature. By building upon earlier work that examined inflation through limited or linear frameworks, this study introduces a broader and more integrative approach by combining key macroeconomic indicators from both monetary and labor market domains. While previous research has often treated inflation as a function of money supply or interest rate alone, this study includes variables such as unemployment and labor productivity, allowing for a more comprehensive analysis of inflationary behavior.

Moreover, the use of Bootstrap Non-linear ARDL methodology adds substantial analytical strength by enabling the detection of asymmetric and nonlinear relationships that conventional methods fail to capture. This nonlinear justification is particularly important in the context of Pakistan, where inflation does not respond uniformly to positive and negative shocks due to structural rigidities, labor market inefficiencies, and uneven policy transmission. For example, a rise in money supply or price level may generate a stronger inflationary response than an equivalent fall would reduce it, highlighting asymmetries that can only be modeled through a nonlinear framework. Linear models would overlook such disparities, potentially leading to misleading conclusions and ineffective policy recommendations. Therefore, the adoption of a nonlinear approach is not just methodologically sound, but necessary for capturing the complex real-world behavior of inflation in a developing economy.

The results of this study are not only expected to advance the academic understanding of inflation determinants but also offer practical value to policymakers by identifying which variables carry significant and consistent influence on inflation, and therefore require focused policy attention. This dual contribution positions the study as a meaningful addition to the ongoing discourse on inflation management in Pakistan. Importantly, the annual data from 1991 to 2020 is used to empirically analyze the results. Bootstrap Non-linear Autoregressive Distributed Lag (NARDL) cointegration tests (McNown *et al.*, 2018) is opted to identify the long-run cointegration among exogenous and endogenous variables. The beauty of using bootstrap NARDL is its ability to tackle the weak size and power properties which are not covered by the conventional ARDL approach. In contrast to Pesaran *et al.* (2001) ARDL, bootstrap NARDL increases the significance and power of F-test and T-test (McNown *et al.*, 2018). These characteristics differentiate the bootstrap NARDL from traditional ARDL. Bootstrap NARDL F1-bound test, F2-bound test and t-bound test statistics are evaluated to assess the long run relationship, while the error correction test is applied to find short run relationship among variables. Bootstrap NARDL is considered a sophisticated technique because money supply is linear in parameters but nonlinear in variable. Moreover, this “*nonlinear framework*” also verifies evidence of asymmetry which is determined by the “*cumulative dynamic multiplier*” (Zeb *et al.*, 2024).

The results of the study confirm statistically significant long-run and short-run relationships between inflation and its core determinants. Inflationary shocks arising from money supply are shown to be one of the most influential drivers of inflation fluctuations in Pakistan. Notably, negative shocks exhibit a stronger impact than positive ones, indicating the presence of asymmetry. The study finds that unexpected increases in price levels lead to persistent inflation, whereas declines in prices help suppress inflationary pressure. Additionally, when unemployment is high, labor productivity falls and wage pressures increase, resulting in a reduced overall supply that drives prices up over time. A negative output gap and low interest rates further fuel inflation. These findings suggest that inflation in Pakistan is highly sensitive to both monetary factors and labor market conditions. The study recommends a balanced mix of contractionary monetary policy in the long run and expansionary measures in the short run. It also emphasizes the importance of improving labor productivity, reducing unemployment, and closing the output gap through coordinated efforts across sectors to ensure stable and sustained inflation control.

Following the introduction, study reviews the relevant literature in section 2. Section 3 comprises methodology and section 4 covers analysis of results. Last section of this paper summarizes the concluding remarks and recommendations based on the results.

2. Literature Review

According to Thanh (2015), inflation has become a mutual sensation in the country since the pricing authorities continually increase the prices of vital commodities, thereby making the living conditions of common masses miserable. Broome (2015) assessed the circumstances and the diverse elements concerning rise in prices. Literature regarding inflation instability across the world and its causes are reviewed in this section.

Crowder and Hoffman (1996) estimated the long run inflation through fisher equation in relation to interest rate and found a negative association between inflation and interest rate. Del Negro and Schorfheide (2008) also noted that inflation rate is adversely affected by the interest rate for US because any reduction in interest rate causes increase in inflation rate. Through structural cointegrated VAR model analysis for G-7 countries, Cologni and Manera (2008) stated that inflation rate can be lowered by increasing interest rate, and contractionary monetary policy can help to reduce inflation rate. Laubach and Williams (2016) estimated inflation, interest rate and output gap for US and found a negative association of inflation with both output gap and interest rate. These studies collectively highlight the importance of interest rate management in inflation control, but they often overlook the interaction of interest rate with labor market variables.

Dib (2003) provided evidences on positive association between inflation and money supply for Canada while examining monetary policy shocks. Bashir *et al.* (2011) performed Johansen co-integration analysis to assess long run and short correlation between inflation and its regressors such as money supply and output of Pakistan over the period 1992-2010. Inflation was found to be positively correlated with money supply. Chaudhry *et al.* (2015) elaborated the direct relationship between inflation and money supply. Azam and Rashid (2015) showed that slight effects on Pakistan's inflation rise was due to increase in money supply using OLS estimation whereas, oil price and import prices have substantial effects on inflation.

Shah *et al.* (2014) analyzed the effects of exchange rate, wages, government borrowing and money supply on inflation rate of Pakistan and emphasized on contractionary monetary and fiscal policy for Pakistan. Alam and Rizvi (2017) focused on contractionary monetary policy for Islamic economies' stability. They observed that decline in interest rate and rise in lending of money resulted in economic growth and high inflation in Pakistan. They added that government role is important in reducing unemployment, eradicating poverty, increasing economic growth and stabilizing monetary variables. Moreover, Brauer and Gissy (2017) also supported contractionary monetary policy for a group of countries including Pakistan. While these studies focus on monetary aggregates, they generally do not account for labor-side effects, creating a narrow policy lens.

Rabanal (2007) examined contractionary monetary policy effect on inflation using DSGE model, and the findings indicated that tight monetary policy increases wage rate and consequently inflation rate, while interest rate has adverse effect on inflation rate.

Bårdsen *et al.* (2004) illustrated econometric evaluation of Keynesian Phillips curve and estimated tradeoff between inflation and unemployment for EU countries and Ratto *et al.* (2009) also stated inflation-unemployment trade-off while examining Euro area inflation shocks using DSGE model. Zaman *et al.* (2011) estimated Phillips curve for Pakistan over the period 1975-2009 and assessed short run and long run impact of unemployment increase on inflation rise. Shah *et al.* (2014) studied Phillips curve for Pakistan case and argued that the graphical illustration of Phillips curve relationship is L-shaped in the past few years, which indicates no relationship between inflation and unemployment.

Doménech and Gomez (2006) and Basistha and Nelson (2007) identified positive relationship between inflation and output gap for US while estimating Phillips curve. Fernald (2015) found a small and very slow impact of output gap on inflation rate for US.

On the other hand, Lim and Sek (2015) described negative effect of output gap on inflation rate. Asghar *et al.* (2013) employed ARDL approach to find determinants of Pakistan's inflation rate, and the results concluded that four-lagged inflation is a determinant of inflation rate. Results also indicated that money supply affects inflation positively at its second lag. Hayat *et al.* (2017) described long-run trade-off between inflation and output for the case of Pakistan using cointegration test and suggested that central bank of Pakistan should focus more on price stability instead of economic growth.

Thanh (2015) conducted regression estimation for five Asian countries, and the findings showed a positive association between inflation and economic growth. Chaudhry *et al.* (2011) used ARDL bound test approach and explored foreign exchange reserves as a determinant of inflation rate in Pakistan. Their study also revealed that state bank of Pakistan should have more foreign reserves to control inflation rate. Arby and Ali (2017) analysed the relationship between inflation and economic growth of Pakistan for 1976 to 2017 using OLS technique and identified a non-linear relationship, indicating that the causal relationship between inflation and economic growth varies for Pakistan.

Jašová *et al.* (2020) explained that in a flourishing economic situation, the output increases beyond its possible level, yielding a positive gap that leads to inflationary pressure. The reverse happens in developing countries in the form of negative gap with low inflation rate. Hossain (2015) suggested that low and stable inflation is important for Islamic banking and rule-based monetary policy will be helpful for Islamic economies. Kandil (2015) studied monetary policy shifts for developing countries and reported the effects of inflationary shocks on monetary policy.

Nasir and Malik (2011) examined inflation and output variability over the period 1991 to 2010 for Pakistan. They found that both demand and supply shocks cause rise in inflation and government should adopt forward-looking monetary policy. Khan and Ahmed (2011) reported some macroeconomic factors of inflation such as output, interest rate and exchange rate using structural VAR model to explain inflation dynamics in Pakistan over the period 1990 to 2017. This study stated that supply shocks are the main reason of Pakistan's current stagflation (i.e., low economic growth and high inflation rate) and it adversely affects inflation and unemployment.

This review indicates that while previous studies have examined the effects of money supply (Dib, 2003; Bashir *et al.*, 2011), unemployment (Zaman *et al.*, 2011), interest rate (Cologni and Manera, 2008), and output gap (Hayat *et al.*, 2017) on inflation separately, there is no comprehensive framework in the context of Pakistan that jointly analyzes these variables in both the short and long run using a nonlinear approach. In particular, the role of labor productivity remains missing.

This study seeks to address these evident limitations by presenting a more holistic and integrated framework that simultaneously evaluates a comprehensive set of monetary and labor market variables. Specifically, the research examines money supply, interest rate, inflationary shocks, output gap, unemployment rate, and labor productivity over a long time horizon (1991–2020) to uncover their dynamic relationships with inflation. In doing so, this study complements and significantly extends the insights of earlier works such as Bashir *et al.* (2011), Zaman *et al.* (2011), and Khan and Ahmed (2011) by extending their linear or variable-specific analysis into a broader, more dynamic model that better captures Pakistan's complex inflation behavior.

Methodologically, the adoption of the Bootstrap Non-linear ARDL (NARDL) cointegration approach represents a major advancement. Unlike traditional ARDL methods, Bootstrap NARDL improves the accuracy of estimations under small samples and enables the detection of nonlinear and asymmetric relationships between variables, which are essential in understanding the real-world behavior of inflation in developing economies.

This nonlinear framework is especially important for identifying whether inflation reacts differently to expansions versus contractions in money supply or shifts in labor market conditions. As such, this study not only fills critical empirical and methodological gaps in the existing literature but also offers substantial value for economic policy. The findings will provide policymakers with a more realistic understanding of inflation drivers in Pakistan and help design context-specific, forward-looking monetary and labor policies that can stabilize prices without compromising employment and growth.

3. Data and Methodology

We utilize datasets accessible from Federal Bureau of Statistics, State Bank of Pakistan (SBP), International Labor Organization Statistics (ILO-STAT), World Development Indicators (WDI) and International Monetary Fund (IMF). The aggregates of output gap are calculated by subtracting actual GDP of Pakistan from potential GDP, while the aggregates of labor productivity are labor productivity growth rates calculated from per labor cost data. Inflation rate is the average inflation rate of Pakistan with base year 2010 and unemployment rate reflects the count of jobless civilians (ages 15-24)¹ of Pakistan. Money supply series is the broad money growth rate, interest rate is proxied by call money rate in Pakistan². Inflationary shocks that are positive inflation shocks and negative inflation shocks are calculated from money supply. Description of variables measurement and their sources detail are shown in Table 1. Furthermore, descriptive statistics of all variables are presented in Table 2. The outcomes highlight the dispersion and normality properties of data.

Table 1: Data description (1991-2020)

Variables	Description & Sources
Inflation Rate	Average inflation rate at base year 2010 (WDI)
Interest Rate	Percentage per annum of Call Money Rate. (SBP)
Labor Productivity	Percentage change in Output per Worker at 2005 PPP (ILO-STAT)
Money Supply	Annual percentage change in broad money measured in local currency units of Pakistan. This series is converted to annual data from quarterly data by taking averages. (SBP)
Output Gap	Annual Growth rate of output gap calculated from real GDP by deducting real GDP from Potential GDP. (IMF)
Unemployment Rate	Young jobless civilians Percentage of total labor force ages 15-24. (ILO-STAT)
GDP Deflator	Inflation GDP deflator Index measure, Year-over-year change (Base year=2010) is used to correct all variables from inflation rate. (SBP)
GDP	Gross domestic product based on purchasing-power-parity (PPP) valuation of Pakistan's GDP (IMF)

Notes: WDI= World Development Index, SBP= State Bank of Pakistan, ILO= International Labor Organization, IMF= International Monetary Fund, PPP= Purchasing Power Parity and GDP= Gross Domestic Product.

¹ The data of unemployment rate (ages 15-60 years) are not used because some of the observations were missing for few years and were found subject to heteroscedasticity.

² Previous studies e.g., Shah *et al.* (2014); Bashir *et al.*, 2011 and Khan and Ahmed (2011) have also used this proxy because of the non-availability of actual interest rate.

Table 2: Descriptive statistics

Statistics	Series						
	INF	MSP	UMP	LBP	INT	OGP	GDP
Mean	0.866	1.160	0.234	3.482	0.763	9.321	11.165
Maximum	1.307	1.632	0.948	3.565	0.945	9.891	11.409
Minimum	0.403	0.634	-0.079	3.421	0.491	8.335	10.920
Std. Deviation	0.237	0.188	0.362	0.039	0.162	0.350	0.148
Skewness	-0.402	-0.376	1.058	0.502	-0.533	-1.276	0.037
Kurtosis	2.121	4.609	2.318	2.317	2.326	4.702	1.767

Notes: INT = Interest rate, LBP= Labour productivity, OGP= Output gap, MSP= Money supply, UMP= Unemployment rate, GDP = Gross Domestic Product and INF = Inflation rate.

It is worth mentioning that the selection of these variables is firmly grounded in macroeconomic theory. According to the Quantity Theory of Money money supply plays a central role in determining inflation (Friedman, 1968). Keynesian and New Keynesian frameworks emphasize interest rate and output gap as primary tools through which monetary policy influences inflation. The Phillips Curve suggests an inverse relationship between unemployment and inflation and reflects the cost-push dynamics. However, labor productivity is theoretically linked to inflation through unit labor costs, i.e., the higher productivity reduces production costs, thereby containing inflation (Gordon, 1990).

3.1 Econometric Model Specification

This study specifies the base model of inflation by combining financial and labor market variables. To regress inflation rate (*INF*) of Pakistan, five macroeconomic regressors are used namely money supply (*MSP*), interest rate (*INT*), output gap (*OGP*), labor productivity (*LBP*) and unemployment rate (*UMP*). Model is presented as follows.

$$INF_t = \alpha_1 + \alpha_2 INT_t + \alpha_3 LBP_t + \alpha_4 MSP_t + \alpha_5 OGP_t + \alpha_6 UMP_t + \varepsilon_t \quad (1)$$

where *INF* is inflation rate and *INT*, *LBP*, *MSP*, *OGP* and *UMP* are the predictors with their coefficients α_2 , α_3 , α_4 , α_5 , α_6 respectively, ε_t is the error term. To check the effects of inflationary shocks, the above model has been augmented with negative and positive shocks of money supply. The new model is presented as follows:

$$INF_t = \alpha_1 + \alpha_2 INT_t + \alpha_3 LBP_t + \alpha_4 OGP_t + \alpha_5 UMP_t + \alpha_6 POSMSP_t + \alpha_7 NEGMSP_t + \varepsilon_t \quad (2)$$

where *POSMSP* are the positive money supply shocks and *NEGMSP* are the negative money supply shocks. Whereas, α_6 and α_7 are the coefficients of money supply shocks. These money supply shocks are calculated based on Kandil (2015) formulation:

$$POSMSP_t = \frac{1}{2} \{ abs (MSP_t) + MSP_t \} \quad (3)$$

$$NEGMSP_t = -\frac{1}{2} \{ abs (MSP_t) + MSP_t \} \quad (4)$$

where *abs (MSP_t)* is the absolute value of money supply in each year.

To estimate the short-run and long-run relationships between inflation and its determinants, this study applies the Bootstrap Nonlinear ARDL (NARDL) approach proposed by McNown *et al.* (2018). This method enhances the traditional ARDL framework by generating bootstrapped critical values for the F- and t-statistics, thereby improving

inference in small samples and accounting for model uncertainty. The use of this method is particularly suitable given the limited number of observations and the suspected nonlinearities in inflation dynamics.

$$\begin{aligned} \Delta INF_t = & \alpha_1 + \sum_{n=0}^m \alpha_2 \Delta INT_{t-n} + \sum_{n=0}^p \alpha_3 \Delta LBP_{t-n} + \sum_{n=0}^q \alpha_4 \Delta OGP_{t-n} \\ & + \sum_{n=0}^r \alpha_5 \Delta UMP_{t-n} + \sum_{n=1}^s \alpha_6 \Delta INF_{t-n} + \sum_{n=0}^u \alpha_7 \Delta POSMSP_{t-n} \\ & + \sum_{n=0}^v \alpha_8 \Delta NEGMSP_{t-n} + \alpha_9 INT_{t-1} + \alpha_{10} LBP_{t-1} \\ & + \alpha_{11} OGP_{t-1} + \alpha_{12} UMP_{t-1} + \alpha_{13} INF_{t-1} + \alpha_{14} POSMSP_{t-1} \\ & + \alpha_{15} NEGMSP_{t-1} + \varepsilon_t \end{aligned} \quad (5)$$

where INF_{t-1} is the lagged inflation term, $POSMSP_{t-1}$ and $NEGMSP_{t-1}$ are the lagged money supply shocks. m, p, q, r, s, u, v are the lag lengths selected by Akaike information criterion (AIC). α_2 to α_8 estimate the short run dynamic while α_9 to α_{15} measure the long run association with the inflation rate.

An additional error correction term (ECT_{t-1}) is included in the model to estimate the speed of adjustment toward long-run equilibrium following short-run shocks. The statistical significance and negative sign of ECT confirms the presence of cointegration.

Moreover, cumulative dynamic multipliers are used to trace the time path of inflation's response to one-unit changes in positive and negative shocks, reinforcing the asymmetric modeling framework. By applying Bootstrap NARDL with these enhancements, the study captures the complex and nonlinear nature of inflation behavior in Pakistan.

4. Empirical Results and Discussion

The stationarity of the data for the seven variables was evaluated using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, and the results are presented in Table 3. The outcomes of both ADF and PP test statistics indicate that all variables become stationary after first differencing, with the exception of output gap and money supply, which are stationary at level. Specifically, inflation rate, interest rate, labor productivity, GDP, and unemployment rate are integrated of order one [I(1)]. While money supply and output gap are integrated of order zero [I(0)]. These results confirm that the model contains a mix of I(0) and I(1) variables. The results justifies the application of the ARDL and Bootstrap NARDL approaches, which are suitable for such a combination of integration orders.

Table 3: Unit Root Test results

Variables	ADF Statistic		PP Statistic	
	At Level	First Difference	At Level	First Difference
INF	-2.154	-5.054***	-2.261	-5.054***
INT	0.042	-3.696**	-0.586	-3.072**
LBP	-3.034	-3.586*	-1.883	-3.629**
MSP	-3.786**	-6.203***	-3.723**	-13.47***
OGP	-5.346***	-7.321***	-8.299	-12.85***
GDP	-3.037	-3.805**	-2.104	-3.805**
UMP	-1.060	-4.982	-1.139	-4.983**

Notes: ***, ** and * shows rejection of null hypothesis of unit root at 1%, 5% and 10% level of significance. INT = Interest rate, LBP= Labour productivity, OGP= Output gap, MSP= Money supply, UMP= Unemployment rate, GDP = Gross Domestic Product and INF = Inflation rate.

F-statistics obtained from Bootstrap NARDL cointegration process is reported for both models in Table 4. F-statistics and t-statistics values are greater than the critical upper bound values indicating the existence of long run co-integration relationship between inflation and its regressors.

Table 4: Bootstrap NARDL Cointegration Test results

F-Bound Test		
Panel A: Null Hypothesis: No levels relationship		
Dependent Variable	F-Statistics	
INF_t	23.055***	
Bound test	Lower Bound I (0)	Upper Bound I (1)
Critical Values		
1%	2.73	3.90
5%	2.17	3.21
10%	1.92	2.89
t-Bound Test		
Panel B: Null Hypothesis: No levels relationship		
Dependent Variable	t-Statistics	
INF_t	-13.23***	
Bound test	Lower Bound I (0)	Upper Bound I (1)
Critical Values		
1%	-3.96	-5.49
5%	-3.41	-4.85
10%	-3.13	-4.53
F-Test on Lagged Level Independent Variable (Bootstrap NARDL)		
Panel B: Null Hypothesis: No levels relationship		
Dependent Variable	F-Statistics	
INF_t	9.12***	
Bound test	Lower Bound I (0)	Upper Bound I (1)
Critical Values		
1%	3.99	6.66
5%	2.67	4.49
10%	2.13	3.67

Notes: ***, ** and * shows significance at 1%, 5% and 10% level. INF_t denotes inflation rate.

Long run and short run coefficient estimates are reported in Table 5. Panel (a) exhibits long run coefficient estimates. The result reveals some interesting findings. Output gap and labor productivity are found positively related to inflation rate. The positive effect of labor productivity implies that in Pakistan, productivity gains may be accompanied by increased wages and domestic consumption, which enhances aggregate demand and puts upward pressure on prices. Whereas the coefficient of output gap is negatively associated with inflationary shock included in the model. However, these results are not coincide with the Azam and Rashid (2015). Output gap of Pakistan reflects that actual GDP is less than the potential GDP. But, surprisingly, it has significant effect in our model and these results are coinciding with the existing literature (Fernald, 2015). The positive coefficient of output gap in other specifications reflects that when actual output approaches or exceeds potential GDP, it creates inflationary pressure, a behavior consistent with demand-pull inflation theory.

Table 5: Bootstrap NARDL long run and short run estimations

Panel a		
Variables	Coefficient	t-Statistic
GDP	-21.497**	4.991
INT_t	-10.171**	-3.138
LBP_t	17.066**	-3.343
OGP_t	0.992	2.212
UMP_t	-3.076**	-4.007
$POSMSP_t$	-0.861*	-1.531
$NEGMSP_t$	-3.526**	-3.597
C	175.868**	3.789
Panel b		
Variables	Coefficient	t-Statistics
C	3332.48	33.651
ΔINT_t	-3.238***	-13.464
ΔGDP_t	6.701**	3.817
ΔLBP_t	-11.048***	-6.931
ΔOGP_t	0.160***	7.725
ΔUMP_t	-0.498***	-8.345
$\Delta POSMSP_t$	-0.487***	-11.141
$\Delta NEGMSP_t$	-1.413***	-20.039
ECT_{t-1}	-0.604***	-27.582
Panel c		
<i>F-Statistics</i>		
Tests		
R-Sqr	0.993	
D.W	3.34	

Notes: ***, ** and * shows significance at 1%, 5% and 10% level. ECT_{t-1} is the error correction term. INT = Interest rate, LBP = Labour productivity, OGP = Output gap, MSP = Money supply, UMP = Unemployment rate, INF = Inflation rate, $POSMSP$ = Positive money supply shocks and $NEGMSP$ = Negative Money Supply shocks.

Interest rate and unemployment rate show a significant negative effect on inflation rate. The negative coefficient of interest rate supports the idea that higher interest rates reduce borrowing, slow down investment and consumption, and thereby reduce inflationary pressure. Similarly, the negative impact of unemployment on inflation confirms the traditional Phillips Curve view where excess labor supply suppresses wages and reduces demand-driven inflation. Unemployment-inflation tradeoff was also debated by Bårdsen *et al.* (2004) and Ratto *et al.* (2009).

Both positive and negative money supply shocks also have significant negative effect on inflation dynamics, which means that unanticipated increase in supply of money will cause decline in inflation rate in long run. However, these results are not coincide with the economic theory. One possible explanation is that in Pakistan, an increase in money supply may occur in a low demand environment or be offset by policy sterilization, thereby not translating into inflation. Additionally, strong monetary policy credibility or low velocity of money may dampen inflationary responses.

Coefficient estimates of money supply shocks show that negative shocks are more significant and influential in the long run to cause changes in inflation rate of Pakistan as compare to positive shocks of inflation. These results are –compatible to the results of Kandil (2015) for Japan, Korea and some other developing countries.

Panel (b) exhibits short run coefficient estimates. The coefficient of error correction term ECT_{t-1} is negative and significant in the short run. The value of -0.604 indicates that 60 percent of the deviation from equilibrium adjusts back each year, confirming a stable long-run relationship among the variables.

The results of short run coefficient estimates are quiet similar to the long run estimates. All variables are found negatively associated with inflation rate except interest rate and labor productivity (see Brauer and Gissy, 2017; Bashir *et al.*, 2011 and Asghar *et al.*, 2013 for similar relationships for Pakistan's inflation). Gross domestic product (GDP) shows positive relationship in short run and long run. This indicates that economic growth fuels inflation in Pakistan, likely through demand-pull mechanisms where higher income levels increase consumption and price levels. Interest rate shows negative relationship in short run and positive relationship in long run. In the short run, tight monetary policy reduces inflation, but in the long run, rising interest rates may reflect inflation expectations or structural rigidities that offset its intended effects.

However, labor productivity shows positive relationship in short run and negative relationship in long run. In the short run, increased productivity might stimulate output and consumption, raising inflation, while in the long run, it enhances supply efficiency and helps lower inflation.

Similarly, output gap effects on inflation change are found to be positive when inflationary shocks effects are estimated together with other regressors. This shows that even when other monetary shocks are accounted for, excess demand in the economy continues to exert upward pressure on inflation. The highest negative influence on inflation rate is caused by labor productivity and interest rate where the increase in labor productivity will translates into the decrease in inflation rate in short run, but, increase in inflation rate in long run. However, some studies show the reverse causation between labor productivity and inflation which can be seen in Del Negro and Schorfheide (2008), and Cologni and Manera (2008) studies. The impact of negative shocks of money supply on inflation rate dominant in short run indicating that the unanticipated decrease in inflation drops down the inflation rate in short run (similar results were obtained by Kandil (2015) for Australia and Austria. Money supply shocks are significant both in short run and long run. Surprisingly, unemployment has a negative effect on the inflationary shock in case of Pakistan. But, it could be negative because it concludes that most of the inflationary pressure is considered as cost push inflation. However, it can be justified that negative relationship between inflation and unemployment is just because of Phillips curve hold true in case of Pakistan.

Short run and long run results demonstrate more focus on monetary variables in Pakistan because the steadiness of these variables can stabilize inflation faster than other determinants. Government should preferably control the inflationary shocks occurrence in long run and short run because any unanticipated change in inflation rate influences positively the inflation fluctuations. Most importantly, cost push inflation is also a one of the major factor in Pakistan. Estimated results also propose that expansionary monetary policy for short run with decreasing interest rate and increasing money supply also caused to increase inflationary pressure on the economy and, hence, regulation of labor market instead of monetary policy control because the effect of monetary variables has become insignificant in short run when estimated in the presence of inflationary shocks and inflation fluctuations are found more influential by labor market variables.

For long run, results support that increase in interest rate and decrease in money supply that is contractionary monetary policy to cure inflation problem in Pakistan (supported by Alam and Rizvi, 2017; Brauer and Gissy, 2017; Cologni and Manera, 2008). Additionally, output gap is also an influential in inflation dynamics, so government should consider reducing the output gap to control inflation fluctuations and measures are needed to reduce inflationary shocks especially unanticipated increase in inflation should not occur in long run. Unemployment rate has also shown its sizable impact on inflation rate. Public and private sectors should contribute to lower unemployment rate by creating job opportunities. Arby and Ali (2017) purposed the contribution of public and private sectors of Pakistan for

job creation. Results clearly reveal the necessity of dynamic regulations that instability of macro variables must be addressed by state bank of Pakistan with the help of government and other concerned authorities for better formulation of economic and monetary policies to normalize or reduce inflation variations. In all terms, monetary variables appeared as prominent domestic drivers of inflation variations in Pakistan's economy.

Diagnostic tests were conducted to certify nonappearance of robustness of outcomes. Data also showed no signs of heteroscedasticity by ARCH test and serial correlation between variables was also found absent through LM test. To check the model specification, RESET test is conduct. Stability of variables is tested by using CUSUM and CUSUM Square tests (Figure 2).

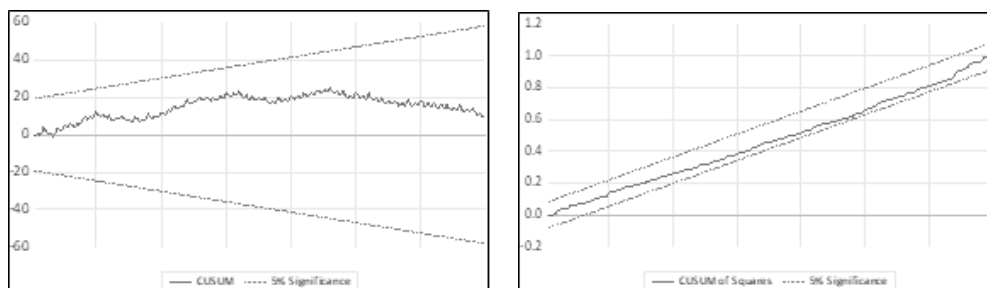


Figure 2: CUSUM and CUSUM square plots

Inflation is a monetary phenomenon and money supply is usually an important determinant of inflation. Price fluctuation is usually linked to monetary policy. Positive money supply shock is linked to an increase in inflation whereas negative money supply shock is linked to a decrease in inflation. The Phillips Curve proposes that unemployment can be reduced by accepting a slightly higher inflation. However, Kydland and Prescott (1977), among others, argued that the relation between inflation and unemployment is not stable if the public is rational and understand the motive behind the central bank's decision to inflate. Hence, in the long run, the exploitation of the inflation output trade-off leads to a higher than equilibrium rate of inflation (Hayat *et al.*, 2017). The use of monetary policy to pursue real economic growth may be ineffective and backfired in the long run (Hayat *et al.*, 2018).

Interest rate, which is the cost of borrowing capital can be an important source of inflation (Jalil *et al.*, 2014). Labour market i.e. productivity and unemployment are also important sources for inflation. An increase in unemployment will reduce inflation.

5. Conclusion

This study investigates the causes of Pakistan's inflation instability by using bootstrap NARDL cointegration approach. Long run as well as short run associations are found for inflation rate of Pakistan and its predictor aggregates such as interest rate, unemployment rate, money supply, output gap, labor productivity and inflationary shocks illustrated by NARDL F-bound test, t-bound test and ECM regression estimates. Inflationary shocks comes from the money supply are also proven important determinants of inflation changes because of their sizable impacts on inflation fluctuations. The results reveal that negative inflationary shocks are characterized relatively dominant factor in comparison with other inflation shocks. Any unanticipated increase in price level will cause high inflation rate in long run and short run. While the unanticipated decrease in price is found good to reduce inflation rate in Pakistan's economy. Additionally, if the Pakistan economy is working at less than full employment, there will be decrease of labor productivity caused by less wage

rate and because of less interest rate and negative output gap inflationary pressure is stimulated. Consequently, when the unemployment rate is high, labor costs will rise, overall supply will be decreased, and put pressure on commodity price to rise in the long run.

To retain the stability in prices, the financial policy must be perfect, and Pakistan administration should consider reformulating or if required, may even revolutionize the financial strategies to stabilize the prices of commodities in the country. These findings support the implementation of contractionary monetary policy in the long run by raising interest rates and controlling money supply to reduce inflation. In contrast, in the short run, expansionary monetary tools can be utilized to stabilize output and address unemployment pressures without fueling long-term inflation. Present study indicates that the central bank and the other monetary authorities should adopt contractionary monetary policies in long run and expansionary monetary policy in short run.

The results further highlight that labor market policies should aim to reduce unemployment and enhance productivity, which in turn can suppress inflation pressures through increased output and controlled wage dynamics. The strong negative influence of inflationary shocks also highlights the need for better inflation forecasting and macro prudential regulation. Continuous monitoring of inflationary shocks creating factors and regulation of labor markets can bring a significant change. To lower unemployment rate (while keeping high inflation in mind), all business and industrial sectors contribution is needed, it will also help to increase labor productivity and overall production of a country. Because, negative output gap is an obvious indication of less actual GDP whereas, Pakistan possesses high potential GDP which should be attained. To maintain stability in macro-economic variables, Pakistan' government must try to regulate and take adequate counteractive measures to control negative and positive components of inflationary shocks which will consequently help the macro economy to stabilize.

Although this study provides valuable insights, it also has certain limitations. The analysis is based on annual data from 1991 to 2020, which may mask short-term volatility and policy shifts. Moreover, the model focuses on selected macroeconomic variables and does not incorporate external factors such as exchange rate volatility, global commodity prices, or fiscal policy shocks that can also influence inflation.

Future research can extend this analysis by using quarterly data for greater precision, incorporating additional variables, or applying dynamic stochastic general equilibrium (DSGE) modeling to better capture structural relationships. Exploring regional inflation disparities within Pakistan or the role of inflation expectations through survey data could also provide further policy-relevant findings.

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