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"Unraveling the Complex Web: Exploring the Interplay of Inflation Rate, ER, and EG in Pakistan"

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Abstract

This paper explores the relationships between exchange rate (ER), inflation, and economic growth (EG) in Pakistan, utilizing time series data from 1980 to 2022. The study employs various econometric techniques, particularly the autoregressive distributed lag model, to explore both the short-run and long-run dynamics between these macroeconomic variables. ER depreciation has a significant positive impact on EG. This indicates that a weaker domestic currency can potentially boost EG by making exports cheaper and more competitive on the global market. Inflation also shows a significant positive impact on EG. However, the relationship between inflation and EG is nonlinear. At low levels of inflation, the relationship with EG are positive; suggesting that moderate inflation can spur economic activity by promoting outlays and investment. At high levels of inflation, the relationship becomes negative, indicating that excessive inflation can harm EG by creating uncertainty and eroding purchasing power. Investments in education, infrastructure, and healthcare services can enhance productivity and EG, thereby supporting a stable ER and moderate inflation.

Key words: Inflation rate, ER, EG, ADF, ARDL, Pakistan

Introduction

On one hand, low inflation improves the ER and causes the currency to be stronger that further affect the country's EG levels. But then other factors like EG, trade balance, interest rate, and the country's debt

situation also influence the ER. Both inflation and ER fluctuations have been recurring issues in Pakistan especially in recent decade.

Inflation is the gradual rise in the overall price level of goods and services or increase in the cost of living in a country over the period of time. Years preceding to 2022, Pakistan saw fluctuating inflation rates, often surpassing the government's targets. High inflation is caused by many factors including fiscal deficits by governments, increasing energy prices, and increasing food prices. While, ER is the price of one currency in terms of another currency and same as inflation, it is also influenced by many factors such as country's monetary policy, its balance of payments, and its foreign exchange reserves. In recent years, Pakistan has struggled and is still struggling to stabilize its ER that is primarily caused by the high trade deficit, and its external debt obligations.

Overall, Pakistan's EG remained inconsistent due to many economic challenges like political instability, fiscal deficits, energy shortages and inefficient economic policies. Even besides ER, ER regimes also significantly impacted the country's economy. ER regime refers to the systems or policies; a country uses to control its currency's value in term of other currencies. An ER regime signalized by unchanging and stable ER is termed as fixed ER regime. While the one marked by ER fluctuation depending upon the market forces is referred as the floating ER regime. The middle ground between fixed and floating ERs is commonly referred to as a managed floating ER regime. Since mid 1999, Pakistan has adopted a market-based (flexible) ER system. The ER is established based on the prevailing supply and demand dynamics within the domestic interbank foreign exchange market. All foreign exchange dealings, regardless of whether they involve the public or private sector use inter-bank rate to accomplish in flexibleER system.

Table 1: Pakistan's ER regime

ER Regime	Fiscal Period	Pakistan's currency
Fixed	Pre - 1982	Devaluation
Managed Floating	1982 - 1998	Devaluation
Flexible	1999 - present	Depreciation

Source: Economic Survey of Pakistan

When dealing with ER, there is also difference between nominal and real ER. While the former represents the actual rate at which currencies are exchanged, the latter adjusts for differences in price levels between countries, giving a clearer picture of a currency's purchasing power in international trade. Since nominal ERs are decided based on currency's demand and supply interactions and any factors that can influence those such as interest rates, inflation rate, government/public debt, current account deficit and government policies can change the nominal and real ER. In effect, real ER fluctuations can affect a country's

competitiveness and trade balance. For example, depreciation in real ER can boost the attractiveness of a country's exports and possibly can boost EG.

The objective of this paper is to analyze the impact of inflation and ER on EG in Pakistan. However, the impact of inflation on EG is complicated and differs depending on a country's specific conditions and even the level of inflation prevailing in that particular country. General agreement of researchers is on the view that moderate and stable inflation can have both positive and negative effects on EG depending upon the level of inflation, level of its stability, and overall economic policies and conditions of that particular country. Apart from inflation and ER, country's structural factors including county's economic policies, trade conditions, and fiscal discipline also significantly influence the overall rate of EG.

Similarly, the link between ER and EG is complicated as it is influenced by various factors such as ER regime and economic policies & conditions of particular country that are not possible to control. However, theory suggests a positive relationship between ER and EG meaning that currency devaluation or depreciation can potentially boost EG. In case of Pakistan, primarily Pakistan has its exports as raw materials and agricultural products and their demand is even limited in international markets, basically due to its failure to meet mandatory international standards. Not only export prices are low but also Pakistan imports expensive items like oil, machinery and high-tech goods that cause its trade balance to be consistently negative leading to low overall EG.

Prior research has underscored the existence of a nonlinear connection between inflation and the growth rate. It has particularly emphasized that low levels of inflation are conducive to promoting EG. Conversely, a pronounced increase in inflation levels exhibits a robust negative correlation with EG. This relationship has been explored in studies conducted by Bruno and Easterly (1996), Khan and Senhadji (2001), Sweidan (2004), Mubarik (2005), and Hussain (2005). Furthermore, the ER has been identified as a catalyst for EG, with a surge in the ER leading to increased exports and consequently an improvement in the demand for goods, as demonstrated by Mehmood et al. (2011).

Several empirical studies have demonstrated that trade openness fosters EG. Economists have extensively analyzed the association between trade openness and EG, with certain researchers, including Lee and Rigobon (2004), Marelli and Signorelli (2011), and, Kahnamoui (2013) concluding that trade openness indeed promotes EG. Conversely, other studies conducted by scholars like Hoekman,Vernon, & Sauvé (1998) and Findlay (1984) have suggested that trade openness may not necessarily contribute to growth. It's important to note that the findings on trade liberalization remain a topic of debate, and as of now, research and empirical evidence have not provided a conclusive answer to this complex relationship (Rodriquez and Rodrik, 2001).

Theoretical justification of the study

The study uses the Solow Neo-Classical growth model as a base to assess the impact of inflation rate and ER on EG.

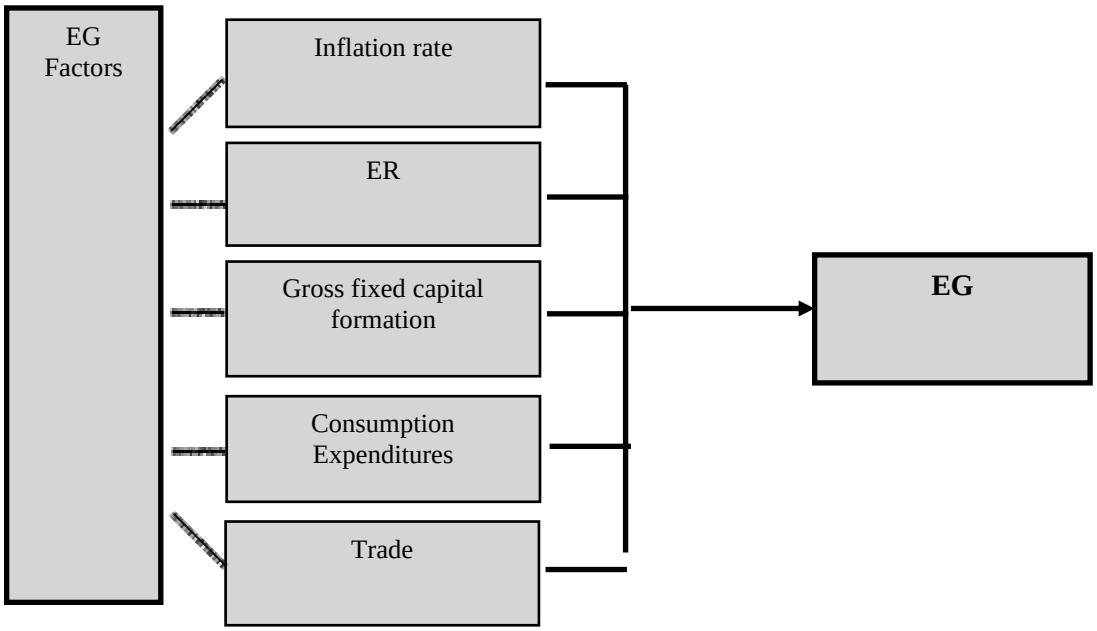

Figure 1: Conceptual model of the study

Graphical Representation

Figure 2 demonstrate the fluctuations of three main variables of this study. Right side of the figure shows the trend of variations between GDP growth rate & ER while left side shows the pattern of fluctuations between GDP growth rate and the inflation rate. Yearly data from 1980 to 2022 is used that is captured on horizontal axis. In the left panel, blue line of GDP growth percentage is recorded highest in 1980 at10.2 while GDP growth was recorded minimum in 2020 at -1.2741. Inflation recorded maximum trend in 2008 at 20.29 whereas it remained lower in 2015 at 2.53

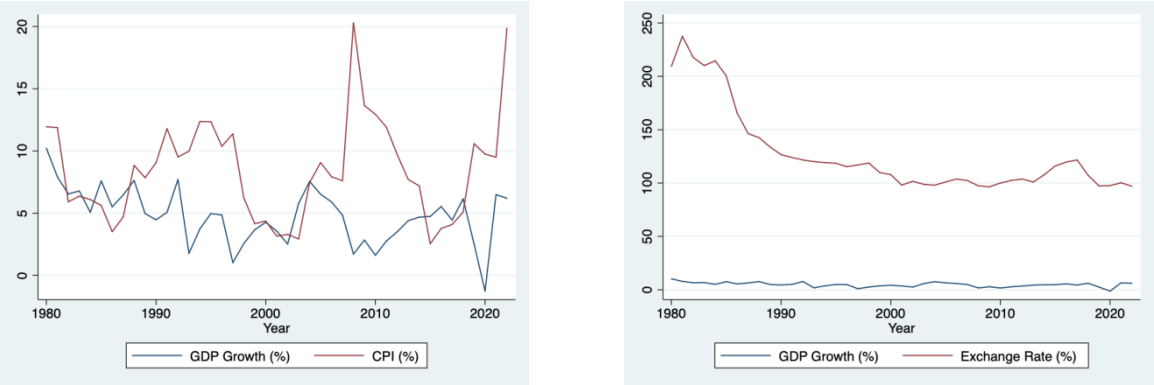

Figure 2: Behavior of Inflation Rate and ER in comparison to GDP growth rate in Pakistan during 1980-2022

Data and Modeling

This study relies on secondary data sources spanning a 43-years period, from 1980 to 2022 that is gathered from the World Bank, encompassing GDP growth rate, inflation rate, the real effective ER. GDP growth rates designated as the dependent variable, while the independent variables included are inflation rate, real effective ER, gross fixed capital formation (% of GDP), Consumption expenditures (% of GDP), and trade (% of GDP).

$$GDPG = \beta_0 + \beta_1 Inf_t + \beta_2 Inf_t^2 + \beta_3 exrate_t + \beta_4 gfcfp_t + \beta_5 consp_t + \beta_6 tradep_t + \epsilon_t$$

Where
GDPG =EG
INF=Inflation Rate
EXRATE = Real Effective ER
GFCFP = Gross Fixed Capital Formation (% of GDP)
CONSP = Consumption Expenditures (% of GDP)
TRADEP = Trade (% of GDP)
ε_t=Stochastic Error Term

Descriptive Statistics and Correlation Matrix

This study utilizes time series data to analyze the influence of inflation, and ER on EG in Pakistan. Table 2 provides a detailed description of the variables including mean, standard deviation and minimum & maximum value of all variables that are taken in the model. The descriptive statistics presented in Table 2, indicate that GDP growth was peaked in 1980.There has been a continuous but fluctuated decline in GDP growth from 1981 until 2020 with major decline in 2020 when negative growth rate of 1.27 was observed, as shown in Figure 3. The average inflation during the study period was 8.47 percent. The lowest inflation recorded was 2.53percent in 2015.The highest inflation was 20.29percent in 2008 and again 2022.The trend

line in Figure 3 illustrates that inflation rate contained the large fluctuations. The ER show a notable decrease over the study period, reflecting depreciation of Pak. rupee during this time span.

Table 2: Descriptive Analysis

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDPg	43	4.779	2.203	-1.274	10.22
Inf	43	8.467	4.087	2.529	20.29
Exrate	43	126.6	39.07	96.49	237.5
Gfcfp	43	15.77	1.729	12.52	19.11
Consp	43	88.68	4.011	82.60	96.24
Tradep	43	32.23	3.677	24.70	38.50

Source: Author's calculations

These findings emphasize the multifaceted challenges facing EG in Pakistan, including inflation, shifts in ERs, and their policy impacts. Grasping these trends is essential for developing strategies to minimize the adverse impacts on EG and ensure sustainable economic practices.

Table 3 presents the upshot of the correlation matrix for the key variables studied. The correlation matrix helps in understanding the linear relationships between the variables and assessing potential multicollinearity issues. The results indicate that no strong correlations are visible between the variables. This suggests that the variables do not exhibit strong linear relationships with each other. Multicollinearity can be a problem when high correlations exist between independent variables, as it can inflate standard errors and make coefficient estimates unreliable. However, the absence of high estimated values for correlation coefficients in this study indicates that multicollinearity is not a concern.

Table 3: Correlation Matrix

	Gdpg	Cpi	Exrate	Gfcfp	Popp	Tradep
GDPg	1.0000					
Inf	-0.1569	1.0000				
Exrate	0.5314	-0.1315	1.0000			
Gfcfp	0.2728	0.0975	0.4006	1.0000		
Consp	0.0484	0.2190	0.2341	-0.4486	1.0000	

	Gdpg	Cpi	Exrate	Gfcfp	Popp	Tradep
Tradep	0.0888	0.4940	0.2762	0.6344	-0.2182	1.0000

Source: Author's calculations

Unit Root Test

Before the application of bound test and other empirical assessment, it is necessary to ensure that the variables are stationary or have been differenced to achieve stationarity as stationarity is a important assumption for time series analysis. Therefore, the Augmented Dickey-Fuller (ADF) test is employed to assess whether the variables exhibit unit root properties, helping determine the most suitable modeling technique for our analysis. The outcomes of the unit root tests are presented in Table 4. The results indicate that all variables including CPI, ER, gross fixed capital formation, health expenditures, population growth and trade to GDP ratio are stationary at first difference while only GDP growth is stationary at level. However, no variable is integrated at the second difference. Since all variables are not integrated at same level of integration, so the results led to apply ARDL technique.

Table 4: Unit Root Test

(Null Hypothesis: Existence of unit root; Alternative Hypothesis: No unit root)

Variable	At Level				At First Difference				Order of Integration
	Intercept	P-Values	Intercept &Trend	P-Values	Intercept	P-Values	Intercept &Trend	P-Values	
GDPg	-4.648	0.0001	-4.784	0.0005					I(0)
Inf	-2.495	0.1166	-2.515	0.3207	-6.737	0.0000	-6.853	0.0000	I(1)
Exrate	-2.142	0.2280	-1.406	0.8592	-6.127	0.0000	-7.199	0.0000	I(1)
Gfcfp	-1.570	0.4989	-2.783	0.2033	-5.800	0.0000	-5.726	0.0000	I(1)
Consp	-1.174	0.6846	-1.884	0.6628	-7.364	0.0000	-7.762	0.0000	I(1)
Tradep	-2.396	0.1429	-2.659	0.2536	-6.540	0.0000	-6.453	0.0000	I(1)

Source: Author's calculation

Methodology

Autoregressive Distributed Lag (ARDL)model, developed by Pesaran et al. (1996) is a statistical and econometric technique, often used to estimate short run and long run (i.e., the dynamic) relationships with a time series context in a single-equation setting. In ARDL the current value of explained variable is permitted to be explained by its own past values — the autoregressive section — as well as the current and past values of other explanatory variables — the distributed lag section. It can accommodate variables that are I(0), I(1), or mixture of both, however, the ARDL model is not suitable if any variables are integrated of order I(2). As ARDL model includes the lags of the included variables to capture the lagged effects in these variable's relationship. Typically the optimum lag length is determined based on the Akaike or Schwarz information criteria (AIC or SIC). To test for cointegration, or to test the presence of long-run association among the variables of interest, equilibrium correction (EC) portrayal is used where ARDL model can also be used to separate the short-run and long-run effects. To investigate the long-run relationship between the explained and explanatory variables, the following model is developed:

$$Y_t = \alpha + \sum_{i=0}^{r} \beta_i Y_{t-i} + \sum_{i=0}^{s} \gamma_i X_{t-i} + \varepsilon_t$$

where

- Y_t is the explained variable
- X_t represents the set ofcontrolor explanatory variables
- α is the intercept term
- β and $\gamma$are the coefficients of the lagged dependent and control variables, respectively
- ϵ_t is the error term.
- r and s are the maximum lag orders for the explained and explanatory variables, respectively

The above model can be extended to include the error correction model (ECM) components to analyze the short-run dynamicswhereα_0 represents the drift component, Δ indicates the first difference, and ϵ represents the white noise error term. The general form of with ECM term is presented below:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{r} \beta_i \Delta Y_{t-i} + \sum_{j=0}^{s} \gamma_i \Delta X_{t-j} + \lambda ECT_{t-1} + \varepsilon_t$$

where

- ΔY_t is the first difference of the dependent variable.
- ΔX_{t-j} is the first difference of the independent variables.
- α_0 is the drift component.
- γ_j are the coefficients of the lagged differences of the dependent and independent variables, respectively.
- ECT_{t-1} is the error correction term from the long-run equilibrium relationship.

- λ is the speed of adjustment coefficient indicating how quickly departures from the longrun equilibrium are addressed. In other words the ECM coefficient measures the rate at which the dependent variable adjusts to restore equilibrium in the long run after deviations caused by short-run shocks.
- ϵ_t represents the white noise error term.
- r and s are the maximum lag orders for the explained and explanatory variables, respectively.

ARDL tests for co-integration indicates a long-term relationship between variables.Co-integration suggests that even if the variables may individually be non-stationary, their linear combination is stationary. The result of ARDL bound test for co-integration is reported in Table 5. The values of F-test and t-test are higher than lower and upper bound values, rejecting the null hypothesis of no long run relationship and indicating that long run relationship among the variables prevail.

Table 5: ARDL Bound Test (Long-Run Co-integration)

H_o: No level relationship			**F = 7.602** **t = —5.687**
	Significance	**I0 Bound**	**I1 Bound**
Critical Values Bound (F-statistics)	**10%**	2.348	3.752
	5%	2.843	4.451
	1%	4.056	6.149
	P-value	0.000	0.003
Critical Values Bound (t-statistics)	**10%**	-2.463	-3.938
	5%	-2.840	-4.401
	1%	-3.614	-5.355
	P-value	0.000	0.005

Source: Author's calculation

The estimated values for R^2 and adjusted R^2 are both higher than 64%, indicating that the model provides a good fit to the data. Once cointegration is established, ARDL models often include an Error Correction Model (ECM) component. The ECM captures the short-term dynamics by modeling how quickly the variables adjust to their long-term equilibrium.

After confirmation of both long run and short run associations between the variables through the ARDL bound test, the study evaluates the short run and long run parameters of the model. The long-run empirical results, shown in Table 6, suggest that an increase in inflation significantly boosts the EG. Specifically, a 1% rise in inflation can increase EG by up to 0.61%.The analyzed results are similar to the previous study of Mubarik (2005), Iqbal (2009), Hussain (2011), and Rasool et al. (2012) as they spotted a positive relationship between inflation and EG in their respective studies. Moreover, squared term of inflation is added to capture the non-linear relationship and this term is significant which shows that after particular inflation rate, the relationship becomes negative and further increase in inflation lead to decline in EG.

Long run positive and significant association between real effective ER and EG has been identified as 1% increase in ER increases the EG by 5%. The estimated findings of the study coincide with a previous study of Farooq and Javed (2009) and He (2010). Cheung and Lai (1998) investigates the relationship between ERs and growth across five Asian countries. Also, Chen (2012), using data from 28 Chinese provinces from 1992 to 2008, highlights the role of ERs in EG and confirms the positive impacts of the real ER on China's growth.

Table 6: ARDL Method [Selected Model: (2,4,0,2,0,0,0), Explained Variable: GDP Growth)]

	Coefficient	**Std.Error**	**t-stat**	**P-value**
ADJ				
L1. GDPg	-0.9361	0.1469	-6.37	0.0000
Long Run				
Inf	0.607	0.182	3.34	0.003
Inf2	-0.021	0.007	-3.05	0.006
Exrate	0.053	0.012	4.53	0.000
Gfcfp	-1.111	0.3866	-2.87	0.008
Consp	-0.307	0.104	-2.96	0.007
Tradep	0.024	0.069	0.35	0.728
Short Run				
LD.GDPg	0.4289	0.2089	2.05	0.051
D1.Exrate	-0.118	0.044	-2.71	0.012
D1. Gfcfp	2.497	0.4801	5.20	0.000
LD. Gfcfp	2.073	0.453	4.57	0.000

	Coefficient	Std.Error	t-stat	P-value
L2D. Gfcfp	1.122	0.402	2.79	0.010
L3D. Gfcfp	1.122	0.3311	3.39	0.002
D1. Consp	0.286	0.1649	1.74	0.095
Constant	68.11	17.782	3.83	0.001
No. Of observation	39		R-squared	0.7755
Adj R-squared	0.6446		Root MSE	1.4219

Source: Author's calculation

In shortrun analysis, variables such as ER, gross fixed capital formation, and consumption significantly influence EG. Table 6 also shows that a 1% increase in the lag value of EG and ER can boost EG by 0.43% and reduce EG by 0.12%, respectively. However, the study also finds that a 1% increase in consumption leads to a 0.29% increase in EG.

The measured coefficient of the Error Correction Model (ECM) should be both negative and significant, to confirm the presence of long run relationship among the variables. The negative sign shows the convergence while the magnitude of ECM represents the speed at which long-run equilibrium is restored following short-run shocks. In our study, the ECM coefficient is -0.94 and is highly significant, indicating that any divergence from the short run equilibrium between the variables can be corrected and restored by 0.95% each year in the long-run, as shown in Table 6.

Diagnostic Test

After confirmation of the long-term co-integration, this paper applied the histogram test for normality. The result of histogram test for normality of residuals is shown in Figure 3, indicates that the residuals are normally distributed. This study also applied the Breusch-Godfrey LM test and Durbin-Watson d-statistics to test for autocorrelation and their results fail to reject the null hypothesis of no autocorrelation. After confirming the residuals normality and stability of model, the results of the diagnostic tests are given in Table 7. The findings from these diagnostic tests indicate that our model exhibits no signs of serial correlation or heteroscedasticity. Additionally, the functional form appears to be well-matched to the data.

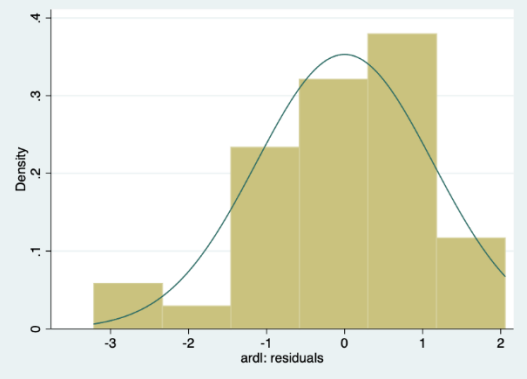

Table 7: Diagnostic Tests

Problem	Test Applied	Chi-Sq. (χ^2) or F-stat	Probability Value
Heteroscedasticity	Breusch-Pegan test	3.6	0.062
Autocorrelation	Breusch-Godfrey LM test	0.806	0.3693
Model Specification bias	Ramsey RESET test	0.44	0.7295

Source: Author's calculation

Stability Test in Error Correction Models (ECM)

Stability tests are used to evaluate the robustness, consistency and reliability of the models over time or across distinct data samples. Literature by Pesaran and Shin (1999) and Pesaran et al. (2001) have demonstrated that these tests are fruitful in assessing the fit of the ARDL model. Therefore, to verify the long-term relationships between the variables over the period of time, this paper uses the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) tests, as recommended by Brown et al. (1975). Under these tests, the residuals of the error correction model (ECM) are plotted to help in determining the stability of the coefficients within the ARDL model. If the test statistics fall within the critical boundaries at a suggested significance level (i.e., 5%), the results indicate that ARDL model coefficients are consistent throughout the sample period. The stability of this test ensures that the ARDL model is well-fitted and that the long-run and short-run relationships are reliable and robust over the study period.

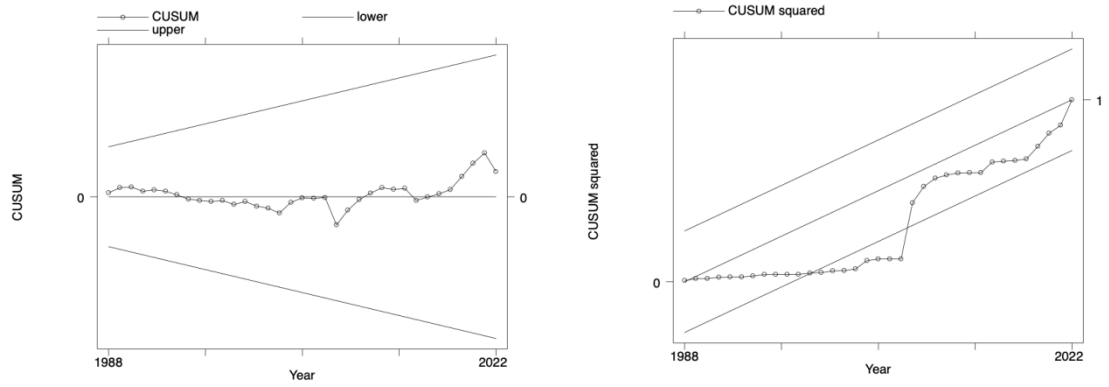

Figure 4: Stability Test

Conclusion

This research is done to explore the complex relationship between inflation, ERs, and EG in Pakistan from 1980 to 2022. Apart from inflation and ER, impact of other control variables on Pakistan's EG is also examined such as gross fixed capital formation, consumption expenditures, and trade. Additionally, this study reveals the nonlinear relationship of inflation with GDP growth by incorporating the square term of inflation. ARDL Model is employed to analyze the dynamics influencing of all said variables on GDP growth and results confirm the statistical significance of all variables except trade.

Clear evidence is found for the positive and significant impact of both inflation and ER depreciation on EG. However, it is also found that inflation has a nonlinear relationship with the EG as the square term of inflation is also statistically significant, positive at low levels and negative at higher levels. On the basis of this analysis, it could be suggested that moderate inflation stimulates spending and investment, thus fostering EG while high inflation erodes purchasing power, discourages savings, and creates instability. It means that moderate inflation is good for growth but after a certain level it have detrimental effect on growth.

To develop a country, among other requirements, there is need to increase imports of raw material and finished products necessary for the pace of development. This will put pressure on its demand of foreign exchange if its exports capacity is lower, causing its currency to depreciate and thereby effecting EG. However, ER depreciation also boosts exports and thus can have positive impact on EG (as our results indicate that) in case if country has no debt burden (this research can also be extended to include this variable). But since ER volatility can also create problems including increasing import costs, prompting inflationary pressures, and giving rise to economic uncertainty, our analysis suggests that policymakers should focus on maintaining economic stability through careful monetary and fiscal policies because stable and competitive ERs enhance export competitiveness and support EG.
The same situation exists for Pakistan as Pakistan is facing issues like inflation, ER volatility, trade deficit, and most important balance of payment problem. To develop Pakistan and to avoid ER volatility, there is need to work on increasing exports especially finished products. Those sectors or industries should be encouraged that can and are earning foreign reserves. Similarly unnecessary imports especially for consumption purposes should be discouraged. There is need to increase not only the volume of exports but also export prices by enhancing the standard of its export products. There is also need to avoid the inflation especially in the long run and beyond the certain limits as the whole society will bear the social cost of inflation.

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