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Investigating the Role of Energy Prices in Enhancing Inflation in Pakistan: Fresh Insight from Asymmetric ARDL Model

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ARTICLE DETAILS	ABSTRACT
History: Accepted 30 October 2021 Available Online December 2021	<i>Inflation is a serious problem of poor countries in this modern world because the majority of people live below the poverty line. It becomes difficult for poor people to fulfill their basic needs with higher inflation rate. The main objective of this study to analyze the impact of energy prices on the inflation rate in Pakistan. For analysis purpose the study uses time series data for the period 1990-2020. Consumer Price Index (CPI) is used as the dependent variable while independent variables include pump diesel domestic prices, pump gasoline domestic prices, GDP per capita, real effective exchange rate, government expenditure and imports of goods and services. The study uses non-linear Autoregressive Distributed Lag model (NARDL) econometric technique for estimation purpose. The results show that pump diesel and gasoline prices have U-shaped Kuznets curve, while economic growth, real exchange rate and government expenditures have emerged as important contributors of inflation in Pakistan. This study suggests that government should take effective measures to decrease dependence on imported energy resources and should rely on renewable energy resources to tackle the rising deficit in balance of payments (BOP).</i>
Keywords: Inflation, Consumer Price Index, Energy Prices, Economic Growth, Pump Diesel Prices, Pump Gasoline Prices	
JEL Classification: E31, D11, O13	
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1. Introduction

In this modern age, energy is considered as the most important sector of developing and developed countries because all economic activities heavily depend on energy. Without energy, no

country can run factories and provide jobs, housing and goods. Particularly energy is considered to be the biggest source of comfort and leisure, in emerging economies. Stable energy supply at reasonable prices play an important role in improving the economic growth (Abbasi et al. 2021). Energy development is directly linked to economic growth. Per capita energy consumption is considered an important component of any country's economic development. Energy plays an important role in improving quality of life of people (Esen & Bayrak, 2017).

Energy supply is an important source of productive activity in agriculture, manufacturing, trade and industry. Lack of energy supply leads to poverty and slows economic growth as well as prosperity (Anancharoenkij & Chinnakum, 2021; Ogbeide-Osaretin, 2021). In the age of globalization, along with high demand for energy, the dependence of any country on energy resources is a sign of development. In a country, almost all economic sectors are connected to every energy circulation. Changes in energy prices affect a country's overall economy and leave significant implications (Acheampong *et al.* 2021).

Energy prices in particular are considered to be the most difficult task compared to the prices of other commodities. In developing countries like Pakistan, the settlement of energy prices is taken as a major concern. Future development of the industrial sector and population growth have increased the demand for energy throughout Pakistan (Rehman *et al.* 2021). Proper pricing of energy are indispensable to promote the energy efficiency for achieving the sustainable energy segment (Mohsin *et al.* 2021). In global world oil prices are the main cause of energy inflation and variations in oil prices emerge due to control of oil supply by a few countries. Any disturbance in the supply of oil leads to the rise in goods prices. Pakistan is the major importer of oil and any disturbance in the oil supply causes adverse impact on economic activities in Pakistan and exerts the additional burden on import bills (Haider *et al.* 2013).

The oil shocks by Organization of Petroleum Exporting Countries (OPEC) was responsible for economic depression in 1970. The OPEC created a problem for oil importing countries all over the world and led to increase the energy prices and created a huge demand gap (Kolev & Riess, 2007). Since 1970s it has been observed that fluctuations and movements in energy prices have created many difficulties for practitioners, policymakers and particularly the business leaders.

Pakistan is endowed with enormous potentials for energy resources. The domestic production of energy is not sufficient to meet the domestic demand for energy in Pakistan. The rapid economic growth and increasing urbanization and high birth rate have increased the energy consumption with high pressure (Chisti & Muhammad, 1990).

The present study deals with the role of energy prices in persistent rising inflation in Pakistan. According to economic survey of Pakistan (2020), Pakistan consumed 19.68 million tons/annum of petroleum products against domestic supply of 11.59 million tons and forced to import remaining 8.09 million tons. The present study discusses the impact of pump diesel and gasoline prices per liters in Pakistan on domestic inflation. The graph of pump diesel and gasoline prices in Pakistan is presented below:

Figure 1 Pump Diesel prices and gasoline prices in Pakistan

It is observed that during 1990-2020 there are lot of fluctuations in pump diesel and gasoline prices.

Figure 2 presents Consumer Price Index (CPI) at the base year of 2010 which shows the rising trend of inflation in Pakistan due to sharp increase in diesel and gasoline prices were high.

Figure 2 Consumer price index(CPI)

This study is important as its results may provide deep insight into two burning issues related to energy prices and inflation in Pakistan. This study is different from previous studies on the research topic as it measures energy prices in domestic pump diesel prices and pump gasoline prices. While the previous studies have measured the energy prices on the basis of international crude oil prices per barrels and ignore the cost of government taxes, transportation cost, profits of the organization (Qasim *et al.*, 2021; Iqbal *et al.*, 2021; Aziz *et al.* 2016; Saleem & Ahmad, 2015). The energy prices on the basis of international crude oil prices is not a good measure of domestic energy prices. The key objective of this study to develop the non-linear empirical model that would enable to examine the impact of energy prices on inflation.

The present study is organized as follows. Section II presents the Review of Literature. Section III contains Data and Methodological Explanation. Section IV presents Results and Discussions while Section V presents Conclusion and Policy Recommendations.

2. Literature Review

The present literature review is related to the impact of energy prices on inflation. In Pakistan a few studies presented the connection between energy prices and inflation. While on the other hand in developed countries several studies have been conducted to check the impact of energy prices on inflation as energy prices got much importance after the oil shocks of 1973-74 and 1979-80 (Jalles, 2009).

In developed countries the role of energy prices in raising inflation rates have remained the main debatable issue after the oil shocks. It has been observed that an increase in the oil prices exert upward pressure domestic prices and also cause recession (Gisser & Goodwin, 1986; Stuber, 2001; Barsky & Kilian, 2004; Guo & Kliesen, 2005; Wribe & Kinnerfors, 2006; Brien & Weymes, 2010).

In developing countries several studies are available related to the impact of crude oil prices on inflation. Kiani (2010) analyzed the impact of high oil prices in Pakistan during 1990 to 2008. The results show that an increase in oil prices led to an increase inflation, budget deficit and depreciation of exchange rate which makes imports more expensive. Haider *et al.* (2013) examined the major determinants of energy inflation in Pakistan. Thee study concludes that international oil prices, bilateral exchange rate of Pakistan's rupee with the US dollar, energy import gap ratio, oil prices, tax revenue collection from the manufacturing sector and adaptive expectations are the important factors which have caused the energy inflation in Pakistan. Saleem and Ahmad (2015) tried to connect the crude oil prices with inflation in Pakistan during 1979-2012. The results show that there exists a positive and significant long run association between crude oil prices, inflation and exchange rate. Malik (2016) pointed out that an increase in oil prices have caused rise in inflation in Pakistan during 1980-2014. Aziz *et al.* (2016) studied that the impact of rising energy prices on consumer welfare in Pakistan during 1987 to 2012. The key objective of their study was to quantify the consumer welfare by the compensating variation. Consumer welfare is measured in four scenarios for pakistan in order to observe the impact of energy prices in different time periods. The analysis of the study shows that gasoline, coal and high speed diesel oil are less elastic, while natural gas and electricity are unit elastic. of price and income polices should be used for each energy source.

Qasim *et al.* (2021) studied the impact of exchange rate and oil prices on inflation for the period 2004 to 2019 in Pakistan. The results show that exchange rate and oil prices significantly impact the inflation. Iqbal *et al.* (2021) constructed the inflation energy index on various variables such broad money, energy imports, GDP, taxes and oil prices during 1991-2019 in Pakistan. The results indicate that in the long run oil prices, broad money and energy import significantly and positively affect the inflation energy index.

From the above review of literature it is evident that after oil price shocks in 1973-74 and 1979-80 energy prices have significant impact on economic growth and inflation in developing countries including Pakistan.

3. Theoretical Framework

The present study is motivated by the Kuznets (1955). Many researchers have applied the environmental Kuznets Curve (EKC) in their analysis and some other researchers have used Energy Kuznets curve. The present study tries to explore the U-shaped Kuznets curve as low pump oil prices reduce inflation while high pump oil prices increase inflation in Pakistan. This study uses two proxies of energy as pump diesel and petrol prices in domestic currency rupees. The theoretical

explanation is presented in figure 3.

Figure 3 Theoretical framework

4. Data and Methodology

This study uses annual time series data for the period 1990 to 2020. The data has been collected from World Development Indicators (WDI). Two proxies of energy pump diesel and petrol prices in domestic currency rupees have been used in economic analysis. The description of the variables is presented in Table: 1

Symbols	Variables	Units
CPI	Consumer Price Index	2010 = 100
PDP	Pump price for diesel fuel	Pak Rupees per liter
PGP	Pump price for Gasoline fuels (Petrol)	Pak Rupees per liter
REEX	Real effective exchange rate index	2010 = 100
GEEX	Government expenditure on education, total	% of GDP
GDPPC	GDP Per capita	Constant LCU
IMP	Imports of goods and services	% of GDP

4.1 Econometric Model

For estimation purpose the study uses following two models:

$$\text{Inflation} = f(\text{PDP}, \text{REEX}, \text{GEEX}, \text{GDPPC}, \text{IMP}) \quad (1)$$

$$\text{Inflation} = f(\text{PGP}, \text{REEX}, \text{GEEX}, \text{GDPPC}, \text{IMP}) \quad (2)$$

The Pump diesel and gasoline prices have non-linear association as presented in figure 3. The squares of both of these variables have been used for analyzing the long run association between energy prices and inflation. The econometric model are presented in Equation 3 and Equation 4.

$$\text{LNCPI} = \alpha_0 + \alpha_1(\text{LNPDPP})_t + \alpha_2(\text{LNPDPP})_t^2 + \alpha_3(\text{LNREEX})_t + \alpha_4(\text{LNGEEX})_t + \alpha_5(\text{LNGDPPC})_t + \alpha_6(\text{LNIMP}) + \varepsilon_t \quad (3)$$

$$\text{LNCPI} = \beta_0 + \beta_1(\text{LNPGP})_t + \beta_2(\text{LNPGP})_t^2 + \beta_3(\text{LNREEX})_t + \beta_4(\text{LNGEEX})_t + \beta_5(\text{LNGDPPC})_t + \beta_6(\text{LNIMP}) + \varepsilon_t \quad (4)$$

$LNCP I_t$ = Lag value of consumer price index

$LNPD P_t$ = Natural log of pump diesel prices

$LNPD P_t^2$ = Natural log of square of pump diesel prices

$LNPG P_t$ = Natural log of pump gasoline prices

$LNPG P_t^2$ = Natural log of square of pump gasoline prices

$LNREEX_t$ = natural log of real exchange rate

$LNGEEX_t$ = Natural log of government expenditure on education

$LNGDPPC_t$ = Natural log of GDP per capita

$LNIMP_t$ = Natural log of imports

In Equation 3 and 4, α_0 and β_0 are the intercept terms while ϵ_t are error terms of the model. While $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ and α_6 shows the coefficient of $LNPD P$, $LNPD P^2$, $LNREEX$, $LNGEEX$, $LNGDPPC$, and $LNIMP$. While $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ and β_6 are the parameters of $LNPG P$, $LNPG P^2$, $LNREEX$, $LNGEEX$, $LNGDPPC$, and $LNIMP$. The short run and long run association between dependent and explanatory variables are presented in equation 5 and equation 6.

$$\begin{aligned} \Delta LNCPI = & \alpha_0 + \sum_{k=1}^m \alpha_1 \Delta(LNCPI)_{t-k} + \sum_{k=1}^m \alpha_{2k} \Delta(LNPD P)_{t-k} + \sum_{k=1}^m \alpha_{3k} \Delta(LNPGDP)^2_{t-k} \\ & + \sum_{k=1}^m \alpha_{4k} \Delta(LNREEX)_{t-k} + \sum_{k=1}^m \alpha_{5k} \Delta(LNGEEX)_{t-k} + \sum_{k=1}^m \alpha_{6k} \Delta(LNGDPPC)_{t-k} \\ & + \sum_{k=1}^m \alpha_{5k} \Delta(LNIMP)_{t-k} + \lambda_1(LNCPI)_{t-1} + \lambda_2(LNPG P)_{t-1} + \lambda_3(LNPG P)^2_{t-1} \\ & + \lambda_4(LNREEX)_{t-1} + \lambda_5(LNGEEX)_{t-1} + \lambda_6(LNGDPPC)_{t-1} + \lambda_7(LNIMP)_{t-1} \\ & + \epsilon_t \end{aligned} \quad (5)$$

$$\begin{aligned} \Delta LNCPI = & \beta_0 + \sum_{k=1}^m \beta_1 \Delta(LNCPI)_{t-k} + \sum_{k=1}^m \beta_{2k} \Delta(LNPG P)_{t-k} + \sum_{k=1}^m \beta_{3k} \Delta(LNPG P)^2_{t-k} \\ & + \sum_{k=1}^m \beta_{4k} \Delta(LNREEX)_{t-k} + \sum_{k=1}^m \beta_{5k} \Delta(LNGEEX)_{t-k} + \sum_{k=1}^m \beta_{6k} \Delta(LNGDPPC)_{t-k} \\ & + \sum_{k=1}^m \beta_{5k} \Delta(LNIMP)_{t-k} + \lambda_1(LNCPI)_{t-1} + \lambda_2(LNPG P)_{t-1} + \lambda_3(LNPG P)^2_{t-1} \\ & + \lambda_4(LNREEX)_{t-1} + \lambda_5(LNGEEX)_{t-1} + \lambda_6(LNGDPPC)_{t-1} + \lambda_7(LNIMP)_{t-1} \\ & + \epsilon_t \end{aligned} \quad (6)$$

5. Results and Discussion

The first step in empirical estimation is to find the descriptive statistics of the model. In Table 2 mean, median, standard deviation and Jarque-Bera (JB) test of seven variables, are presented. The probability value of all variables is insignificant which means that our model has normally distributed.

Table 2 Descriptive statistics of the model

	LNCPI	LNGDPPC	LNPGP	LNPDP	LNIMP	LNREEX	LNGEEX
Mean	4.143	10.702	3.274	3.677	2.907	4.684	0.875
Median	4.021	10.702	3.442	3.882	2.943	4.674	0.936
Maximum	5.299	12.149	4.721	4.668	3.145	4.841	1.106
Minimum	2.890	8.981	1.548	2.357	2.584	4.569	0.405
Std. Dev.	0.723	0.992	1.113	0.767	0.151	0.088	0.185
Skewness	0.007	-0.129	-0.243	-0.339	-0.774	0.249	-1.142
Kurtosis	1.778	1.723	1.527	1.649	2.736	1.533	3.356
Jarque-Bera	1.928	2.194	3.109	2.951	3.185	3.102	6.905
Probability	0.381	0.334	0.211	0.229	0.203	0.212	0.032
Observations	31.000	31.000	31.000	31.000	31.000	31.000	31.000

To check the stationarity of the variables Augmented Dickey Fuller test (ADF) and Phillips Perron (PP) unit test are applied. The results presented in Table 3 show that the variables are of mixed order of integration that is either I(0) or I(1) at %, 5% and 10% level of significance.

Table 3 Results of Unit Root Test

	ADF		PP	
	I(0)	I(1)	I(0)	I(1)
	t-Statistic	t-statistic	Adj-t	Adj-t
LNCPI	-1.987	-3.782**	-2.030	-3.372*
LNPGP	1.182	-2.872*	2.194	-2.789*
LNPDP	-1.678**	0.798	-0.090	1.788**
LNREX	-1.082	-4.132*	-1.061	-4.001*
LNGDPPC				
LNIMP	-2.741***	-1.344	-8.788*	-1.3376
LNGEEX				

Note. ***, **, * has been used to mention the level of significance at 01%, 05% and 10% respectively For the existence of long run relationship among the variables bound test is applied. The results are presented in Table 4 which confirmed the existence of long run relationship between the variables.

Table 4 Bounds testing of Linear ARDL

Models	F-statistic	I(0) 10%	I(1) 10%
(LNCPI, LNPDP, LNPDP2, LNREEX, LNGEEX, LNGDPPC, LNIMP)	8.977	2.12	3.23
(LNCPI, LNPGP, LNPGP2, LNREEX, LNGEEX, LNGDPPC, LNIMP)	7.009	2.12	3.23

Table 5 shows the Error correction terms of Model 1 and Model 2 shows the values is -0.183 and -0.232 respectively. These values are statistically significant and carrying negative sign which shows that both the models are convergent to the equilibrium.

The long run coefficient of pump diesel prices (LNPDP) has been used as linear and quadratic. At level one percent increase in LNPDP statistically significant decline in LNCPI 1.932%. While at

higher level one unit increase in LNPD_P significantly declines LNCPI by 0.219%. At the level coefficient of LNPD_P is negative and quadratic coefficient is positive which proposes U-shaped Kuznets curve. The cut off value in Table 6 shows that below 96.814 rupees of pump diesel price reduces inflation in Pakistan. On the other hand in model 2 the pump gasoline prices appear as linear and quadratic. At level one percent increase in LNPG_P significantly declines LNCPI by 0.960% while the quadratic coefficient of LNPG_P increases LNCPI by 0.110%. The level coefficient of LNPG_P is negative and quadratic coefficient is positive proposing the U-shaped Kuznets curve in figure 4 by using the mean, standard deviation and constant term. In Table 6 the cut-off value of LNPG_P is 92.168 rupees which shows below this price of petrol, inflation in Pakistan is declined. It means that pump diesel prices and gasoline prices have not constant returns to scale so we reject our null hypothesis. The reduction in Petrol prices are more important as compared to the diesel prices, because all small vehicles and motorbikes run by the gasoline (petrol). Keeping in view the motorbikes and small vehicles are used by the poor in Pakistan. So, it can be concluded that lower pump diesel and petrol prices significantly decline inflation in Pakistan. The results of this study are consistent with those of (Qasim *et al.*, 2021; Iqbal *et al.*, 2021; Malik, 2016; Saleem & Ahmad, 2015).

Apart from pump oil prices there are also many other determinants which effect inflation in Pakistan. For example deprecation in the Real Exchange Rate (LNREEX) increases the import bill which increases inflation in Pakistan. In both models an increase in government expenditures also contributes to increase inflation. GDP per capita has positive impact on inflation. While imports are positively and insignificantly increase inflation in both models.

Table 5 Detail results of ARDL of long run and short run coefficients		
	ARDL(1, 0, 1, 1, 1, 0, 0)	ARDL(1, 0, 0, 0, 0, 0, 0)
Variable	Coefficient	Coefficient
LNPD _P	-1.932**(0.741)	
LNPD _P ²	0.219**(0.092)	
LNPG _P		-0.960*(0.246)
LNPG _P ²		0.110*(0.035)
LNREEX	-2.526**(1.040)	-1.606**(0.608)
LNGEEX	0.885*(0.305)	0.575**(0.211)
LNGDPPC	0.845*(0.122)	0.742*(0.083)
LNIMP	0.297(0.314)	0.139(0.213)
C	9.671(5.688)	4.410(3.295)
Short run coefficients		
D(LNPD _P)	-0.353* (0.100)	
D(LNPD _P ²)	0.048* (0.015)	
D(LNPG _P)		-0.186* (0.058)
D(LNPG _P ²)		0.025* (0.008)
D(LNREEX)	-0.188*** (0.107)	-0.373* (0.086)
D(LNGEEX)	0.085 (0.050)	0.133* (0.042)
D(LNGDPPC)	0.154* (0.053)	0.172* (0.063)
D(LNIMP)	0.054 (0.049)	0.032(0.045)
CointEq(-1)	-0.183* (0.061)	-0.232* (0.071)

Table 6 *Algorithm Classification Criterion*

	LNPDP	LNP GP
Level coefficients	-1.932	-0.960
Squared coefficients	0.219	0.110
Cut off	4.411	4.365
Antilog	96.814	92.198

Figure 4 Traced effects of logarithm fuel prices with inflation

The diagnostic test have been applied to check the problem of serial correlation, model specification, normality, and heteroskedasticity. The results are reported in Table 7.

Table 7 *Details of Diagnostic Tests (Long run Model)*

	Model 1	Model 2
	Prob.	Prob.
Serial Correlation	0.193	0.6963
Functional Form	0.165	0.1325
Heteroscedasticity	0.2778	0.4632
Normality	0.4326	0.8952

The results presented in Table 7 shows that the models are correctly specified and are free from heteroskedasticity and serial correlation.

CUSUM and CUSUMSQ reveal that both the models are stable.

Figure 5 Plot of CUSUM and CUSUMSQ Stability Tests

6. Conclusion

The present study empirically estimates the impact of energy prices on inflation in Pakistan for the period of 1990-2020. The unit-root tests are used to find the order of integration. The pump diesel and gasoline prices have non-linear behavior due to the fluctuations in international market. So, quadratic values of pump diesel and gasoline prices are used for the estimation purpose. Non-linear ARDL econometrics technique is applied to find the nexus between energy prices and inflation in two separate models. The F-statistics values of both the models are greater than upper critical bound which confirms the existence of long run relationship between the energy prices and inflation. The error correction terms have negative and significant signs showing that both models are convergent. The long run coefficients of pump diesel and gasoline prices show the U-shaped Kuznets curve. The cutoff values of diesel and gasoline prices are 96.814 and 92.168 rupees respectively which means that the government should set these prices below their cutoff values to minimize the extent of inflation in Pakistan. It is important to note that reduction in gasoline prices are more important as compared to the diesel prices, because vehicles and motorbikes use gasoline as fuel. This study is different from other studies as it uses the diesel and gasoline prices in analysis. In order to minimize the domestic inflation Government of Pakistan should set the pump diesel and petrol prices below the cutoff level. If there is a sudden increase in international prices the government should subsidize the energy sector. Furthermore, government should promote the alternative renewable energy resources and induce the private investors to use environment friendly resources in the production processes.

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