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Impact of Macroeconomic Variables on Deforestation in Pakistan

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ABSTRACT

The main aim of this research is to identify the indirect drivers of deforestation to macroeconomic factors such as unemployment, inflation, and the development of Pakistan's population (1991-2016). The long-term relationship between the variables is determined using ARDL. With rapid population growth, rising unemployment, and double-digit inflation, Pakistan has a declining number of forest areas each year, increasing the pressure on land resources. As a result of this enormous rate of deforestation, financial damage such as floods, drought, less rainfall, rising temperatures, air pollution, damage to the atmosphere, and all human organisms is caused by climate change. This research shows the need to quantify the economic costs of deforestation, to increase the rate curve of forests from a declining trend by regulating macroeconomic factors. The outcome supports long-term and short-term inter-factor co-integration.

Keywords: Deforestation, Macro-Economic Variables, Auto-Regressive Distributed Lag Model.

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1. INTRODUCTION

Forests cover about 30 percent of the world over 4 billion hectares. The importance of forests cannot be trivialized. They are essential for survival, from breathing air to nurturing and sheltering millions of people who rely on natural resources. Also, provide the world with wood, paper products, oil, and medicine for use. The ecosystem in which forests are created has a vital role to play and sustains life on Earth. Forests also provide essential tasks such as providing habitats for many species and livelihoods for men, regulating the climate, inhaling carbon dioxide, filtering water, preventing soil erosion, and improving soil quality. Also, the forest offers a multitude of nutrients, rainfall, and greenhouse gasses that reduce global warming. They persist in drought, floods, and purification of the environment. Unfortunately, despite the recognition of the value of the forest, the world has quickly lost its forest area. Every year, the world has an insufficient forest area, and the rest of the forest remains of inferior quality. Between 1990 and 2016, the total loss of forest land amounted to about 502,000 square miles (1.3 million square kilometers), which is considerably more than that of South Africa as documented by the World Bank. However, massive tree killings amount to about 46% for wood reported in the journal Nature (2015). The Amazon rainforest has demolished more than 11 percent in the preceding 50 years and the killing of fresh trees is on the increase. If the rate of deforestation does not decrease,

the remaining forest will eventually disappear for about 100 years. The 2015 WWF study indicated that more than 230 million hectares of forest would disappear before 2050 unless a move had been made and forest damage had been reduced to almost zero by 2020 to prevent hazardous environments and financial disasters from changing. We need trees for a variety of purposes, they play a vital role in digesting greenhouse gases. Scattered forest means entering a large number of greenhouse gasses into the atmosphere that accelerates global warming, which contributes to climate change. Besides, more than 80 percent of plants and animals on earth is covered by the forest and help ensure the availability of water, energy, and food for all. Forests also make an economic contribution while we continue to lose forests on an alarming scale. Because of the loss of habitats, biodiversity, and climate change on the planet. For the sake of self-benefit, natural resources have vanished rapidly, neglecting externalities, which are costs that indirectly impose on the economy in the form of floods, drought, less rainfall, and rising temperatures through unsustainable logging provided by the world's timber and paper products. Illegal trade in timber occurs, ignoring the actual valuation of forestation to achieve private benefits and neglecting the social cost of deforestation.

1.1. Economic Valuation of Forest Services

Valuation of the costs of services provided by forests is a complicated task, such as regulating water management through rainfall, maintaining soil quality, controlling erosion, and ensuring soil quality and protection. Also, climate moderation reduced emissions of carbon dioxide and greenhouse gasses from the atmosphere, as well as being part of biodiversity and habitats. Forests provide not only ecological services but also economic services, socio-cultural services, and eco-tourism services, which should be measured in numbers. The fact is, however, that there is no accepted global standard scale that can measure such an estimate so that the economic valuation of forestation is completely ignored and the financial value of the different forestry facilities is crucial for estimating the significance of them for their overwhelming use of short-term advantages.

The economic valuation of forests should demonstrate in a quantified manner that can enhance our understanding of the multiple benefits of forestation. For this purpose, the study uses the cost of a commercial tree which has been taken forever from nature and has demonstrated the value of a commercial tree and considers its intangible benefits in terms of prices.

Production of oxygen	Rs. 0.25 million
Humidity control and recycling water	Rs. 0.30 million
Air population control	Rs. 0.50 million
Controlling of soil erosion and fertility	Rs. 0.23 million
Nesting of birds, squirrel, insects & plants	Rs. 0.25 million
Total	Rs. 1.530 million

Less intangible benefits are assumed where wood, fruit, flowers, and many other benefits are not included. But it enhances our understanding that one tree has at least an intangible benefit of about Rs. 1,530,000. According to World Watch Magazine, the world flushes or dumps around 27,000 trees that are cut only for the production of toilet paper. So, if we multiply intangible benefits in terms of tree loss prices for toilet paper, mathematically, the figures show that economic losses per year are very surprising.

$$27000 \times 1530000 = 41{,}310{,}000{,}000 \text{ (forty-one billion three hundred and ten million)}$$

However, we only include a single forest product that causes huge economic losses in a quantified manner. We need to work out all the costs of forestry products in terms of how many trees we are losing by making these products and how many intangible benefits are being sacrificed. It's just one side of the picture, the other

side is more surprising, because when we cut the trees, not only do we sacrifice the jobs that the trees do for us, but also economic damage occurs in the form of floods, less rainfall, drought and temperature increases, etc., which impose high economic costs that are not even considered.

As reported by the US World Resources Institute, only a flood in Pakistan caused a loss of three hundred and thirty-four billion a year. It concludes, therefore, that a quantified economic valuation is essential to establish that the intangible benefits of tree deforestation and the intangible costs of deforestation are much higher than the value of the forest sector product.

1.2. Objectives

The precise objectives of this study are as follows:

- Promote awareness of the benefits of forests and the unfavorable effects of deforestation to put the problem of deforestation on the road.
- Explain pauses in the knowledge of policymakers and the need to emphasize forest policy monitoring.
- Distinguish the quantifying macro-economic variables that may play an important role in deforestation.
- Highlights the economic benefits and economic losses of deforestation.
- Emphasize the immediate need to quantify the economic valuation of forestry.
- Intimate potential solutions for bending the forest curve (Figure **1**) towards the upward direction of promoting a green economy for a viable future.

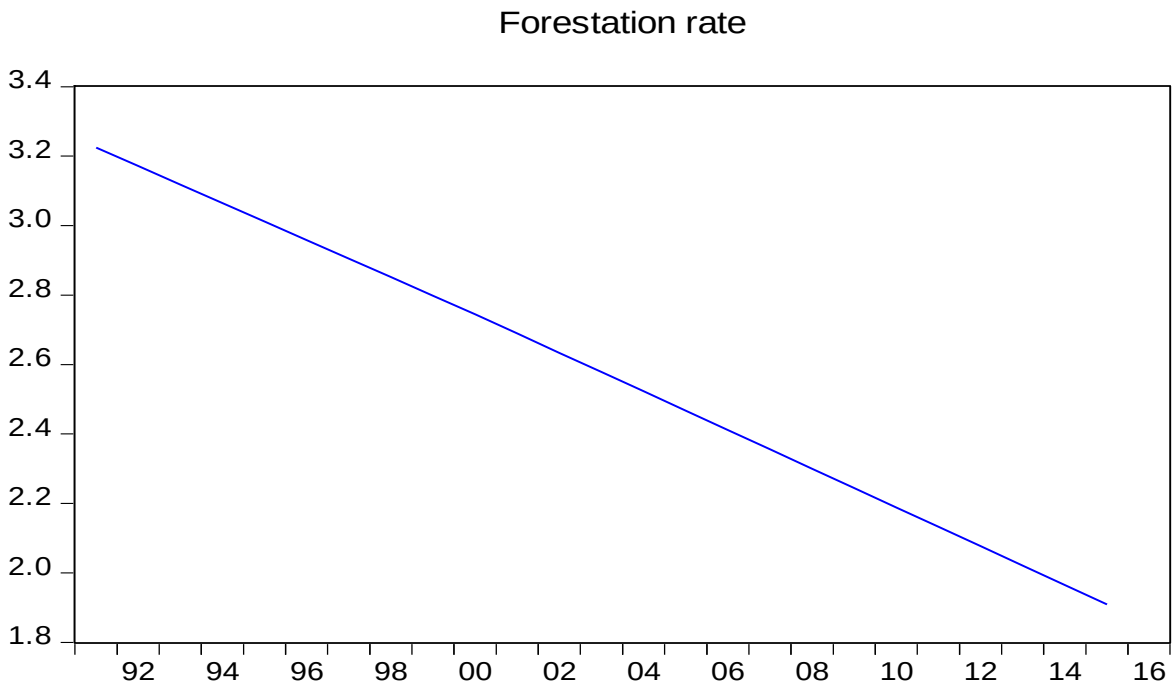

Figure 1. Forest land depletion in Pakistan. (Source: Author's estimation).

The total forest area in Pakistan is over 4.55 million hectares. It comprises approximately 1.36, 1.33, 0.84, 0.51 million hectares in the province of Khyber Pakhtunkhwa, Baluchistan, Sindh, and Punjab, respectively. Forests of Pakistan are very rich in biodiversity and present a unique blend of the tree, grass, shrub, and animal species that exist in a wide range of ecological (climatic) zones. In the meantime, the contribution of forests to Pakistan's GDP is 27 percent (2016). Unfortunately, Pakistan is now rapidly losing forest land and becoming a forest-deficient country. The World Wide Fund for Nature WWF addresses evidence that some 61,000

hectares (approximately 151,500 acres) of forest have been transformed into non-forest use in Pakistan since its dependence. Forests currently make up only 2.5 percent of the total land, while the average forest land standard is 25 percent. Pakistan has an unusual annual rate of deforestation in Asia.

Moreover, the nation still struggled to reach its 2.1 percent containment level in 2015 with the Millennium Development Goals (MDGs) accounting for 6 percent of forestland from 2.5 percent in 2015. The transition from wood to other uses is still not monitored.

In the Indus valley, mangroves account for approximately 2.3 percent of waste, while coniferous trees and ravine forests have been reduced by approximately 1.99 percent and 0.23 percent, according to the World Nature Fund (WWF) accounts.

The Table **1** shows how province-forest land transformation to different uses reveals that Punjab exceeds the list.

Table 1. Province-Forest Land Transformation.

Province Name	Reformation of Forest Land
Punjab	99,711 acres
Sindh	27,874 acres
Baluchistan	13,693 acres
Khyber Pakhtunkhwa (KPK)	9,296 acres
Azad Jammu and Kashmir (AJK)	577 acres

1.3. Main Agents of Deforestation in Pakistan

Deforestation has many causes due to different social and economic drivers, the dynamics of which are still not entirely clear, but human deforestation is, unfortunately, the main cause of deforestation. In this study, some variables of the macro-level are briefly examined as follows:

The population explosion is the main issue that is responsible for deforestation in Pakistan. This spread the need for food and shelter and put high pressure on the consumption of wood. The rate of population growth in Pakistan is 2% per year, while the current rate of deforestation is 2.8% if this rate of deforestation and population growth progress in the same direction as the remaining forests disappears to meet the growing demand for food, wood and other necessities that intimate the alarming situation to the competent authorities.

Poverty is the other main agent of deforestation. Enforce people to use the forest as a source of livelihood. According to the Pakistan Economic Survey (2015 to 2016), the metropolitan poverty level is 9.3% and the rural poverty level is 54.6%. As a result, rural people consume natural means available to them for their living endurance. The lack of gas and electricity or the unavailability of renewable resources at an affordable rate in those areas, wood is the only source of energy.

Agriculture expansion is the main responsible for cutting trees to plant or farm livestock for beef, harvesting wood for fuel or industrial purposes Forest land is immediately converted to crops to meet the expected demand for food, over-grazing, and large-scale commercial harvesting are also the main determinants of deforestation. The rising unemployment rate is also a key determinant. When the unemployment rate rises, people start using natural resources quickly, which has a low cost to meet their basic needs?

The high rate of inflation is also responsible for cutting trees when the general price level of goods is rapidly increasing, which reduces the purchasing power of the commons and forces them to recover from natural resources. Inflation has a positive relationship with employment, therefore high inflation means high employment, but in Pakistan, the rate of employment is falling, while inflation is moving faster, which is becoming a serious disease for the economy, so that people have limited alternatives to sustaining their

livelihoods and are moving towards natural resources while neglecting the economic costs of forestation. However, we can take advantage of the economic benefits of forests if we sustainably use them to keep them alive and use their resources without destroying them.

1.4. Impact of Deforestation on Climate and Economic Damage in Pakistan

As a result of the high level of deforestation and variability in yearly rainfall, temperatures, and ocean levels, or increasing intensity and number of risks, Pakistan faced changes to climate in its socio-ecological structures. We don't only neglect the value of forest resources; we also disregard the impact of the natural disaster that we impose on the economy. The Pakistani economy suffered significant damage to infrastructure, pollution, crop destruction, human death, estate damage, and degradation of health conditions due to natural disasters. The Pakistani economy has undergone substantial damage. As a result of these risks, the number of resources wasted and government expenditures are increased to overcome the conditions that should be stated in the figures to measure the loss of deforestation, while these economic losses are completely ignored.

1.5. Analysis of Eco-Variables with Deforestation Rate in Pakistan from 1991 to 2016

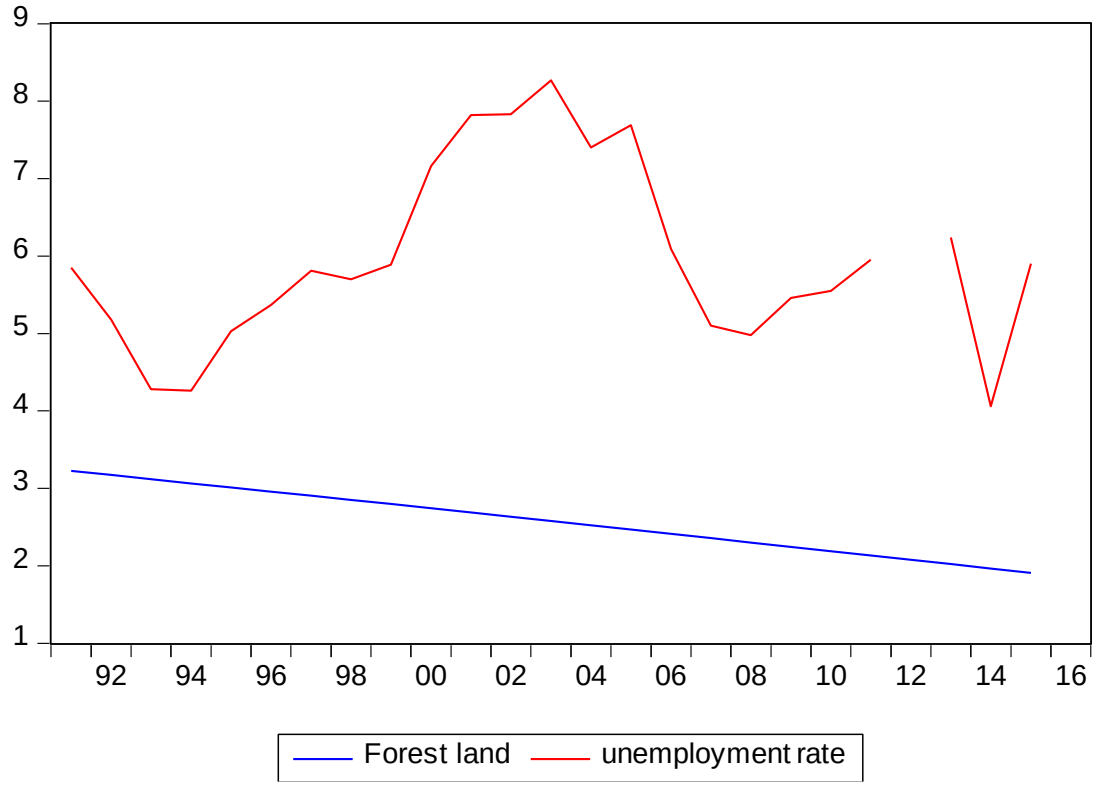

Figure 2. Analysis of forest land with unemployment in Pakistan. (Source: Author's own estimation).

Figure **2** of unemployment indicates many fluctuations throughout the period (1991 to 2016) and shows an increase in the unemployment rate in Pakistan's economy, while the forest area is steadily declining.

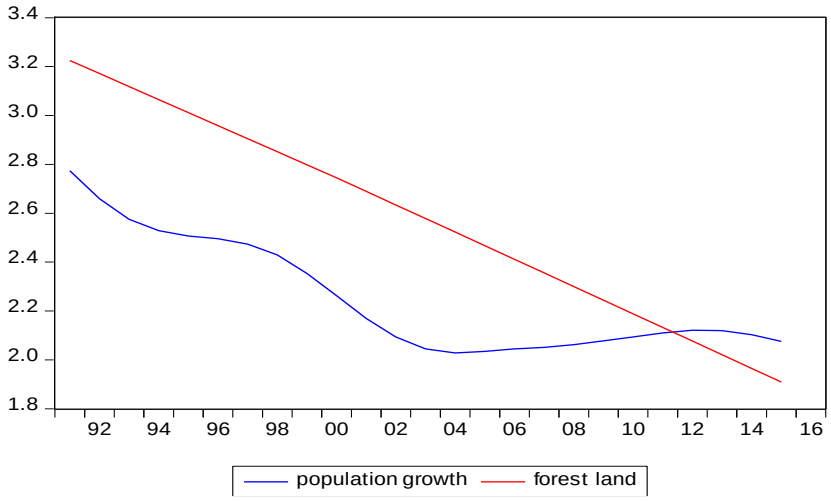

Figure 3. Analysis of population growth with forest land in Pakistan. (Source: Author's own estimation).

The population is expanding significantly as more and more people feel satisfied to move their families and businesses, which are responsible for dramatic and dramatic social change. These essential reforms have led to a modern era of urbanization and inventions. Pakistan's growth rate is about 2.1 percent higher than in the previous period as a result of the application of firewood, pasture pressure, land conversion, and illegal logging responsible for deforestation. Figure **3** shows several fluctuations over the period (1991 to 2016), indicating that the population explosion is higher than the forest land area so that the macro-economic factor exerts pressure on forestry.

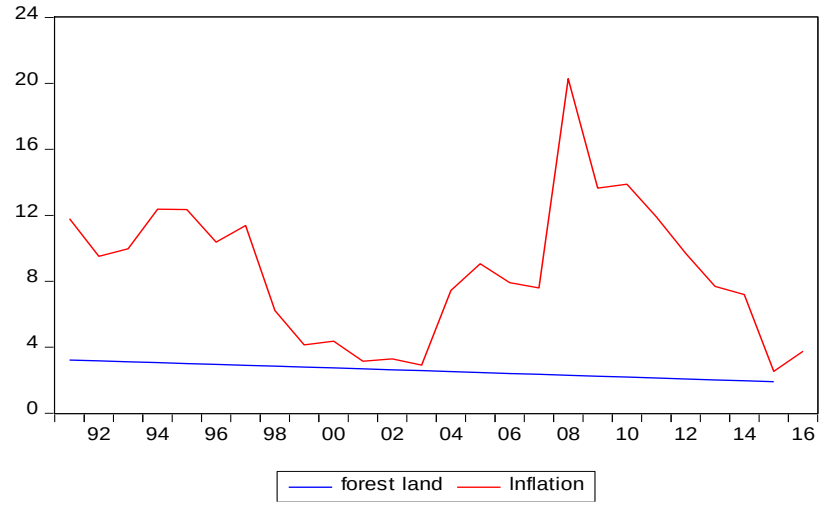

Figure 4. Analysis of inflation with forest land in Pakistan. (Source: Author's own estimation).

Inflation is growing rapidly with double digits in the Pakistan economy (1991 to 2016). Figure **4** shows many fluctuations with an increasing trend, which reveals that the inflation rate is not stable. As a result, people's purchasing power is going down, so they're starting to consume natural resources for survival while the rate of forestation is very low as compared to inflation as shown in the figure.

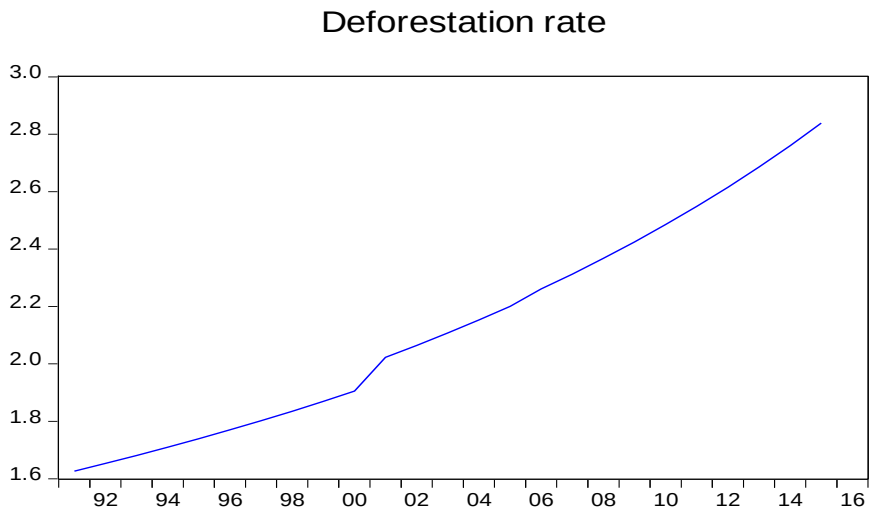

Figure 5. Analysis of deforestation in Pakistan. (Source: Author's own estimation).

Figure **5** shows the upward trend of deforestation in Pakistan (1991 to 2016) which shows an accurate picture of the steady increase in deforestation, which indicates an alarming condition. The only way to reduce the influences of globally warmed up is to reduce Pakistan's annual loss of 2.1 percent of its forests. Deforestation deprives us every day of basic necessity and has an adverse effect on emissions of greenhouse gases that may have a destructive impact on climate change.

2. REVIEW OF LITERATURE

Ahmad *et al*. (2018) examine that Pakistan's influential deforestation and degradation operators are increasingly responsible for the local population, poor law enforcement, and cultural attitudes towards carbon emissions.

Mehmood *et al*. (2018) recommends that human beings be the main deforestation agent and that their actions stem from the transformation of forest land and ecological changes, as well as the loss of biodiversity, through the inclusion of local people from Swat, Khyber Pakhtunkhwa, Pakistan.

Otum *et al*. (2017) contribute to an economic analysis of the nature and degree of deforestation in Nigeria and highlight agricultural expansion and macro-economic variables are responsible for deforestation by applying descriptive statistics. Also, the study highlights the economic losses caused by deforestation.

The research of Cuaresma (2017) bridges the gap between economic progress and the misuse of natural resources, such as forests that directly reshape climate change, biodiversity, and increase carbon in the atmosphere. The research notes that the per capita income is the significant differentiation in a cross-border woodland cover that most strongly shows the deforestation curve of an economic Kuznets exit.

Tagar *et al*. (2015) investigates the determinants of ecosystems and deforestation in Sindh, Pakistan, and finds that mismanagement lands sources, insufficient water resources, increased population pressure, unplanned rapid urbanization, and industrialization are responsible for ecosystem deterioration and rapid deforestation.

Ali *et al*. (2014) focuses on urbanization as the key deforestation agent affecting climate change and rising global temperature through carbon dioxide emissions and their impact in Pakistan.

Doupé (2014) explores the economic growth cycle by cleaning up the forest area to place more additional costs over benefits while reducing the deforestation rate proposes implementing a fixed compensation rate linked to the stochastic carbon price for reduced deforestation.

Robertsen (2012) examines the link between forest deforestation and forest cover in the Brazilian Amazon. Besides, determine that deforestation is the third-largest contributor to greenhouse gas emissions. Many other agents, such as capital distance, population density, and road density, are affecting the rate of deforestation.

Lopez *et al*. (2005) highlighted structural linkages to deforestation in Brazil, Indonesia, Malaysia, and the Philippines and suggested that trees in all four countries are affected by the agrarian development trade strategy. Economic development is the most contradictory and virtually enormous effect on forest cover.

Saeed (2003) identifies Pakistan's deforestation determinant and forest degradation by incorporating the views of all stakeholders on population pressure, fuel wood dependence, inefficient forest management, unscientific grazing, hazardous, ineffective financial inputs, and lack of association between participants.

2.1. Contribution to this Study

As multiple research on national and international levels highlight the fact that, population growth, logging, harvesting, and weak law enforcement is the main drivers of deforestation. However, in case of Pakistan, the central point of many studies is the man-made cause of deforestation such as logging actives and weak law enforcement is abundantly focused. The current study has attempted to point out some additional macroeconomic variables which execute a crucial role to increase in deforestation such as unemployment, inflation, and population growth.

2.2. Domains for Further Research

The determinations of this research suggest further analysis in the collection of the authentic and credible forest, biodiversity, and ecology data. Besides, the economic value of forestation and economic loss due to quantified numbers of deforestation can also make significant use of addressing information gaps in policymaking and raising awareness of long-term damage to short-term deforestation gains.

3. DATA AND METHODOLOGY

The time-series data for the period 1991-2016 are used in this study. The research was performed using the World Bank Database Annual Report as a basis for professional surveillance of inflation, population growth, and unemployment on the deforestation rate.

This ARDL econometric technique is used for the analysis of co-integration. A long-run partnership needs to perform a test of co-integration. Variables should be co-integrated when a stationary linear mixture of random non-stationary factors occurs. The econometric model shall be given as;

$$Ln(DeforestationRate) = \beta_0 + \beta_1 Ln(Inf) + \beta_2 Ln(Unemployment) + \beta_3 Ln(PG) + u_1$$

Where $\beta's$ are parameters

Deforestation rate = deforestation rate annual in percentage
INF = inflation consumer price index percentage
UNEMP = unemployment rate percentage (national estimate)
PG = population growth

The input of the dependent variable as well as the explanatory variable in equation specification by using Views for estimation. The coefficients are estimated and the hypothesis is developed.

H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (no cointegration)

H_1: $\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (Ho is rejected)

This research is intended to analyze the causality between the three measures. Augmented-Dickey-Fuller (ADF) is used to detect stationary or integrated sequence indifferent orders during the root experiment of the first phase unit. That is, the series I(0) and I(1) have a mixture. The co-integration test for long-term relationships is being developed in the second phase. The relevant measure of co-integration is the Pesaran, Shin, and Smith Bond Examination (2001). Hypothesis decision criteria for a related test (10 percent, 5 percent, or 1 percent significant level).

If f-statistics are calculated to be higher than the critical value for bottom bound I(1), it is assumed that co-integration or long-standing interaction exists in such a way that nullification is rejected. If the calculated f-statistics are less than the critical value of the reduced limit I(0). Then it is said that no cointegration exists and therefore no long-term relationship and that no null assumption is rejected. If the f stats fall from the I(0) bottom to the I(1) top-bottom. The test is then considered to be incomplete.

In the third step, if the series are cointegrated, ARDL is used to demonstrate a long-term relationship. The study performs various diagnostic and stability tests, such as autocorrelation and heteroskedasticity and CUSUM. After being co-integrated, this is analyzed the short-term dynamic using ARDL-ECM. The ECM lag represents the speed adjustment between long-term and short-term balances. After that, the diagnostic and stability tests will be applied to the model to investigate whether the model is stable over a long period.

4. RESULT AND DISCUSSION

Table 2. ADF Unit Root Result.

Test	Variables	At Levels		First Differences		Order	Remark
		T-Statistic	Probability	T-Statistic	Probability		
ADF	Deforestation rate	4.044516	1.0000	-3.089446	0.0415	1(1)	Stationary
	INF	-2.134507	0.2337	-6.110835	0.0000	1(1)	Stationary
	PG	-3.018804	0.0494			1(0)	Stationary
	UNEMP	-1.775111	0.3821	-4.894363	0.0010	1(1)	Stationary

The variables 1(0) and 1(1) are integrated from the Table **2**. The variables are therefore suitable to be used for analytical purposes using the ARDL approach.

Table 3. Level of Significance.

Model	F-Statistic	Level of Significance	Lower Bound	Upper Bound
DEFOESTATION RATE = f(INF,PG,UNEMP)	18.25711	10%	2.37	3.2

The ARDL Cointegration Bound Test shows a rejection of the null assumption of non-cointegration by 10 percent importance, as the F-statistical value exceeds the critical high bound value as shown in Table **3**. There is a clear long-run connection between the factors.

Table 4. Long-Run Test.

Variable	Coefficient	T-Statistic	Probability	Decision
C	0.100812	0.769513	0.4544	Ho accepted
LOG(DEFORSESTION_RATE(-1))	0.987416	23.41821	0.0000	Ho accepted
LOG(INF(-1))	0.010301	1.283084	0.2203	Ho accepted
LOG(PG(-1))	0.399150	1.465149	0.1650	Ho accepted
LOG(UNEMP(-1))	-0.001577	-0.099677	0.9220	Ho rejected

To achieve the long-lasting relation between dependent and autonomous factors, the long-run analysis is examined and results are shown in Table **4**, which indicate that the inflation and population growth is positively related to deforestation by 0.010301 and 0.399150, respectively as a 1 percent increase in inflation and in Pakistan, the development of inhabitants contributes to a 1.03 percent and 39.92 percent, respectively rise in deforestation. The unemployment rate has also been negatively related to deforestation. As unemployment rises by 1 percent, the rate of deforestation will decrease by 0.16 percent. In that case, the null hypothesis is rejected as we believe that more unemployment will compel people to move to natural resources. Yet the result suggests that several individuals generate revenue through natural resources. Since the reduction in the rate of deforestation will increase unemployment, it suggests that the government should introduce other ways of generating income.

Table 5. ECM Results.

Case 2: Restricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Probability**
DLOG(INF)	-0.001081	0.004302	-0.251180	**0.8053**
DLOG(PG)	-0.510879	0.080954	-6.310740	**0.0000**
DLOG(UNEMP)	-0.000571	0.010973	-0.052005	**0.9593**
CointEq(-1)*	-0.012584	0.001162	-10.83361	**0.0000**
R-squared	0.348057	Mean dependent variable		**0.022931**
Adjusted R-squared	0.239400	S.D. dependent variable		**0.009006**
S.E. of regression	0.007854	Akaike info criterion		**-6.692596**
Sum squared resid	0.001110	Schwarz criterion		**-6.494225**
Log likelihood	77.61856	Hannan-Quinn criterion		**-6.645866**
Durbin-Watson stat	2.715556			

Using a log-level ARDL error correction model (ECM), it was proceeded to analyze the short-run dynamics after established cointegration. The ECM(-1) valuation is equal to -0.012584, indicating a velocity of 1.26 percent per year of change between short and long balance periods (Table **5**). This means that the mechanism should correct its previous cycle of imbalance at a rate of 1.26 percent per annum, the value of ECM(-1) being negative with a statistically significant probability of 0.0. The R-squared value indicates that Pakistan's population growth, inflation, and unemployment are explained by the 34 percent variance in the rate of deforestation. Besides, there is long-term and short-term cointegration between the variables.

Table 6. Diagnostic Specification.

Specifications	Normality Test	Heteroscedasticity	Autocorrelation	
Stat _P-value	JarqueBera Normality	Bruesch Pagan (Heteroscedasticity)	Bruesch Godfrey (Autocorrelation)	Durbin Watson
	64.20713 0.000000	1.318441 0.3116	2.117378 0.1631	2.314428

The diagnostic and stability tests that are important in analytical research are given in Table **6**. The diagnostic tests monitor serial correlation, heteroskedasticity. The diagnostic result indicates that the model is without serial correlation, heteroskedasticity. This means that the findings for concluding are good and reliable.

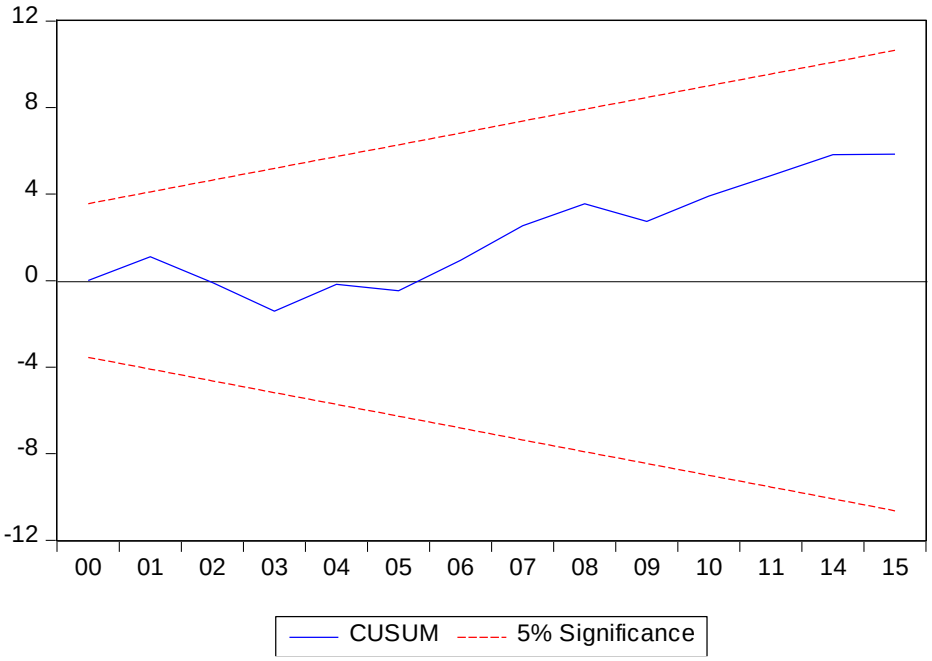

Figure 6. Determination of the model stability using CUSUM *vs*. time.

Subsequently, the stability of the model is investigated using the cumulative amount of recursive residuals (CUSUM). If CUSUM is plotted against time within the meaning of 5 percent, the model is stable as the blue line is within two red lines, so the graph lies within the meaning level boundaries of 5 percent (Figure **6**).

5. CONCLUSION

Forest land in Pakistan has been steadily declining at a frightening rate over the last decades, and there is no doubt that human beings are the main drivers of deforestation, but macro-economic variables cannot be neglected because they force individuals to move towards natural resources. Prohibition on forest land transformation, industrial harvesting, and allotment are necessary measures for immediate control of the negative trend but do not aim to control deforestation unless the government has to provide alternatives and take bold action to curb deforestation. Besides, policymakers must target forestation more than twice as much as the population growth rate. It is necessary to eradicate poverty in forest areas and to provide locals with alternative means of electricity, gas, and other renewable sources at an affordable rate. Urgent measures have been proposed to the competent authorities to address the problem of double-digit inflation and unemployment. Also, there is a need for diversification in other activities rather than dependence on agriculture alone, such as

support for fishing, farming, and green businesses with a strong potential by giving them incentives. Besides, establish a hydroponic agriculture system to meet growing demand. Reduced and introduced the gap between production and consumption of wood by planting commercial trees. The government should aim not only to withstand the current rate of forestation but also to exert pressure on reforestation and to bend the curve of forest land towards the upward direction by reforestation and planting a tree on an immediate basis to make the land green. In particular, when the conversion of forest land becomes inevitable, compensation must be made twice in law to recover the decline of forests, and strict legislation imposes a complete ban on illegal trade in timber.

Most importantly, the government ensures a plan that has begun while raising awareness of the need for green growth, its economic valuation, and the economic loss of deforestation in a quantified manner among common peoples. Furthermore, proper laws and legislation to control land conversion and restoration by predators of forest land shall be enforced. Since government monitoring is the first stage in the prevention of deforestation, the involvement of society, and the private sector in promoting green growth is mandatory.

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