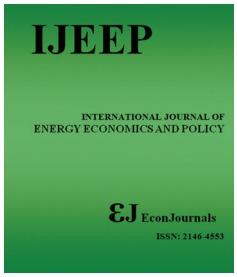

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Trade-Environment Nexus in Environmental Kuznets Curve Hypothesis Framework: A Time Series Study for Uzbekistan

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ABSTRACT

This study examines the impact of trade on environmental degradation in Uzbekistan. However, to capture the individual effect of exports and imports, this study includes exports openness and imports openness as factors of environmental degradation. Moreover, this study also examines the environmental Kuznets curve (EKC) hypothesis. Thus, these two objectives make this study unique for Uzbekistan. This study determined cointegration through bounds test approach. Moreover, one can also capture short run and long run effects through this Bounds approach. The results of this study show that exports openness has a negative but insignificant effect on environmental degradation, whereas imports openness has a positive and significant effect on environmental degradation. These results demonstrate that negative effects of exports openness is not upsetting the deteriorating effect of imports openness therefore, it is concluded that trade is leading to environmental degradation in Uzbekistan. Additionally, the result of this study confirms EKC hypothesis in Uzbekistan.

Keywords: Exports Openness, Imports Openness, Environmental Degradation, EKC Hypothesis
JEL Classifications: F18; O44; Q56

1. INTRODUCTION

Trade is one of the most important areas of research, not only in the context of economic development, but also in the context of environmental quality as well (Nasir and Rehman, 2011; Haq et al., 2016; Khan et al., 2023). There are many studies which validated exports-led growth hypothesis (Adedoyin et al., 2022; Lee and Dolfriandra, 2020; Ibrahim and Abdalla, 2020). Likewise, imports-led hypothesis also documented in the literature (Raghutla and Chittedi, 2020; Panta et al., 2022). There are several reasons explained by the advocates of trade to link trade with economic growth. First, economies of scale happen as more and new markets are found through exports. Second, technological diffusion takes place between trading partners, which helps in economic growth. Third, trade integrates world economies and countries are getting experience about socio-economic development of each other. Fourth, trade encourages competition, which results in welfare (Shafik and Bandyopadhyay, 1992; Adedoyin et al., 2022). However, in empirical literature, researchers also give due importance to trade as a factor of environmental quality. The trade literature highlighted three effects of trade on environmental quality. First, the scale effect, which postulates that trade openness leads to greater exports of domestic economy and consequently increasing economic activities; thus, putting deteriorating pressure on environmental quality. As more economic activities lead to more emissions. Second, trade openness leads to competition among domestic producers. Thus, domestic producers may focus on efficient production to reduce costs. Henceforth, efficient production may positively affect environmental quality. Third, the technique effect of trade can affect environmental quality positively

as imports of efficient technologies make environmentally friendly production domestically. Lastly, trade helps in changing the economic structure of the economy through composite effect. However, the effect of trade on this depends on whether domestic economy has competitive advantage in dirty industries or in cleaner industries. Thus, the composite effect of trade may deteriorate or improve environmental quality (Nasir and Rehman, 2011; Haq et al., 2016).

The Environmental Kuznets Curve (EKC) hypothesis great attention in environmental economics literature after the pioneering work of Grossman and Krueger (1991). This hypothesis postulates that in the first phase of economic development, people and government are not using are using resources extensively for greater production and Employment Generation. However, in in this phase, economies are achieving economic development at the cost of environmental quality. As income increases after persistent growth, then a threshold level of income reaches after increase in income is not accompanied by extensive environmental degradation as the increase in income enables the stakeholders to take steps for sustainable development. Henceforth, the EKC hypothesis portrays an inverted U-shaped relationship between income and environmental degradation, there are numerous studies who examined the EKC hypothesis. For instance, among others, these studies found EKC hypothesis (Mahmood et al., 2019; Yıldırım and Yıldırım, 2021) whereas some studies did not confirmed EKC hypothesis (Ozturk and Almulali, 2015; Haq et al., 2016).

Uzbekistan is significantly affected by climate change as a result of environmental degradation. Consequently, the average annual temperature in the country is on the rise. This will further worsen the environmental issues such as extreme weather events, glacier degradation, frequent droughts and scarcity of water. It is expected that weather further becomes hot and dryer as a result of climate change. Furthermore, climate change is intensifying desertification and degradation of land; thus, badly affecting agriculture productivity and biodiversity (Development Strategy Center, 2024; Eurasian Research Institute, 2024). Although, climate change and environmental degradation issues are severe in Uzbekistan, but research studies in this regard are scarce. There are few studies conducted in this regard. Kuziboev et al. (2023) studied the volatility of carbon emissions in Uzbekistan while Khalimjonov and Rikhsimbaev (2023) examined the relationship between agriculture, economic growth and energy in Uzbekistan. Henceforth, this current study is a novel study and fill this research gap for Uzbekistan on several grounds. First, the study examined the effect of trade on environmental degradation in Uzbekistan. Second, it is a novel study to examine this effect of trade on environmental degradation in the framework of the EKC hypothesis. Third, the study considers the impact of exports and imports openness on environmental degradation, instead of foreign trade or trade openness. Thus, the result of the study will capture the individual or partial effect of exports and imports on environmental degradation. Lastly, from a methodological point of view, this study employed ARDL bound test for long run relationship between variables as well as to determine the long run and short run effects along with adjustment mechanism for the model to come to equilibrium from any external shock. Moreover, the long run estimates are also validated through dynamic ordinary least squares (DOLS).

2. LITERATURE REVIEW

The proponents of trade liberalization argue that trade helps in the diffusion of technology, especially green technology with other managerial approaches. Consequently, the technique effect outweigh the scale effect of trade. Henceforth, trade improves environmental quality in the domestic economy. Additionally, trade liberalization favors the composition effect of trade on positive aspects as trade helps an increase in per capita income. Therefore, trade promotes demand for environmental friendly production, as well as practices (Shafik and Bandyopadhyay, 1992). The opponents of trade liberalization point out that trade is a two edged sword, as it offers opportunities to improve environmental quality on one side, but same time, makes it riskier from environmental point of view as it may increase pollution on the other side.

There are numerous literature that investigated EKC hypothesis in a single country case by utilizing time series data, for example, Udeagha and Ngepah (2019) studied the impact of trade on environment in case of South Africa. This study found that trade has different impact on environmental quality in long run and short run as trade is improving environmental quality in short run, whereas it is worsening environmental quality in long run. Therefore, the study concluded, then the scale effect of trade is prevailing in South Africa. Likewise, Mahmood et al. (2019) investigated the effect of trade on environmental quality in framework of the EKC hypothesis. They used carbon emissions as a proxy for environmental degradation. They found that trade is deteriorating the environmental quality in Tunisia as it positively affect carbon emissions. Besides, this study proved the EKC hypothesis in Tunisia. In a comparative study. Iorember et al. (2019) also considered carbon emissions to capture environmental degradation in Nigeria and South Africa. They analyze quarterly time series data to examine the effect of trade on environmental degradation in Nigeria and South Africa. This study concluded that the positive effect of trade surpasses negative effects of trade on environmental quality in case of Nigeria, while opposite is true for South Africa. Similarly, Twerefou et al. (2016) studied the effect of trade on carbon emission in Ghana in a time series study. The study found that scale effect of trade outweigh the technique and composite effect of trade as trade is accumulating carbon emissions thus; aggravating environmental degradation in Ghana.

Bozkurt and Akan (2014) examined the EKC hypothesis for Turkey. This study considered other explanatory variables for environmental degradation as well, like trade, openness, population and energy. The result of this study confirmed the EKC hypothesis and also concluded that explanatory variables are significant factors of environmental degradation and concluded that trade worsening environmental quality in Turkey. Similarly, Yıldırım and Yıldırım (2021) also studied the EKC hypothesis in a time series study for Turkey. They examined the long run co-integration between variables through ARDL technique. This study considered trade along with energy and construction sector

activities as factors of environmental degradation. The results of this study show that trade and energy significantly contributing to environmental degradation as these variables exhibit positive impact on carbon emissions in Turkey. Likewise, the study affirmed EKC hypothesis for Turkey.

Ahmed and Qazi (2014) in a time series study examined the impact of trade on environmental degradation in Mongolia. This study also considers other important factors of environmental degradation, like economic growth and energy. Additionally, this study also tested EKC hypothesis for Mongolia. Results of the study concluded that trade is aggravating environmental degradation. This study also affirmed EKC hypothesis in Mongolia. Ozturk and Almulali (2015) tested the EKC hypothesis for Cambodian economy. However, this study did not find some support for EKC hypothesis in case of Cambodian economy. Likewise, Haq et al. (2016) investigated the relationship between trade and environmental degradation. This study also tested EKC hypothesis for Morocco economy but did not validate EKC hypothesis and results also documented that trade has negative impact on carbon emissions. Henceforth, concluding that trade can help to reduce environmental degradation in Moroccan economy.

Nasir and Rehman (2011) studied the effect of trade on environmental degradation in a time series study for Pakistan. The study used carbon emission as a proxy for environmental degradation. Beside this study also test the EKC hypothesis for Pakistan. The result of the study confirmed that trade is aggravating environmental degradation in Pakistan. Additionally, the study confirmed EKC hypothesis in Pakistan. Likewise, Khan et al. (2023) studied the effect of trade on carbon emissions in a time series study in Pakistan. The study implied ARDL technique to quantify the effects of trade on carbon emissions in short run and long run in the framework of EKC hypothesis. This study concluded that trade deteriorates environmental quality in Pakistan as trade has positive effect on carbon emissions in short run and in long run as well. Moreover, this study confirmed the EKC hypothesis in Pakistan. In a similar manner, Primbetova et al. (2022) analyzed the EKC hypothesis in Kazakhstan along with globalization for Kazakhstan. They analyzed the time series through ARDL. This study confirmed EKC hypothesis and concluded that globalization is aggravating environmental degradation.

The literature above can be summarized as that trade openness is used as a factor of environmental degradation, whereas many research studies used carbon emission per capita as a proxy for environmental degradation. Likewise, many research studies tested the EKC hypothesis in a time series study for a single country. Therefore, the mathematical functional form for this study can be written as:

$$ED = f(TO, YPC, YPC^2) \quad (1)$$

Where *CEP*, *TO*, *YPC* and YPC^2 denotes environmental degradation, trade openness, income per capita and income per capita square respectively. However, this study decomposes trade openness into exports openness (XO) and imports openness (MO) therefore, Equation (1) is modified as follows:

$$ED = f(XO, MO, YPC, YPC^2) \quad (2)$$

The econometric model of the study after considering log is provided in Equation (3) as follows:

$$logED_t = b_0 + b_1 logXO_t + b_2 logMO_t + b_3 logYPC_t + b_4 logYPC_t^2 + u_t \quad (3)$$

In the above Equation (3), the consideration of the log will help to deal with heteroskedasticity at initial stage and also log transformation helps in interpretation in percent form. In Equation (3), b_0 is intercept while b_i is the respective variable coefficient whereas u and t is error term and time respectively. Table 1 provides details about description of variables and expected sign for explanatory variables.

3. RESEARCH METHODOLOGY

The objectives of the current study are to figure out the effect of trade on environmental degradation and to test the EKC hypothesis in Uzbekistan. As discussed earlier, this study distinguish the exports openness and import openness effect on environmental degradation. Therefore, this time series data for Uzbekistan is gathered on per capita income, exports openness and import openness from World Bank (2024). The data on carbon emissions per capita is collected from sustainable development index (SDI) organization (2024). Additionally, the unit of per capita income in constant US Dollars while export openness and import openness are measured in percentage of GDP respectively. Carbon emission per capita is measured in metric tons. It is important to mention that that this study is using carbon emission per capita as a proxy for environmental degradation in Uzbekistan.

It is important to check time series data whether it is trended and is suffering from non-stationarity or not. This is because if time series data is analyzed without looking for trend, then estimates may be biased and inconsistent, which is referred as spurious regression. Therefore, the first step in methodology in case of time series is to apply unit root test to check and to test the characteristics of the data like trend and non-stationarity.

Table 1: Variables description

Variable Description	Abbreviation	Unit	Source	Expected sign
Environmental degradation	ED	Carbon emissions metric tons per capita	SDI organization	
Exports openness	*XO*	Percentage of GDP	World Bank	±
Imports openness	*MO*	Percentage of GDP	World Bank	±
Income per capita	*YPC*	Constant USD (2015)	World Bank	+
Income per capita square	YPC^2	Constant USD (2015)	World Bank	-

This study will apply augmented Dickey-fuller test (Dickey and Fuller, 1979). The results of this test will show whether time series variables of this study are facing non-stationarity at level or not. Usually, if time series data has non stationarity problems or unit root, then differencing of the data can be a remedy in such situation. However, it is not the case every time and sometime, variables are stationary at level, while some may be stationary at first difference henceforth, a technique is required to take care of combination of stationarity at level and first difference to determine long run relationship The autoregressive distributed lagged models, also known as bounds testing approach, is answer to this (Pesaran et al., 1996). The ARDL bounds approach can take variables of any nature, whether variables are stationary at level or at first difference, or variables are combination of both stationary at level or first difference. This technique has advantages, if compared to another technique for long run relationship, the advantage of this technique on other technique, is that it can be used for small sample as well, and still results are reliable. The long run relationship is decided under this technique in such manner that the calculated F-test value is greater than upper critical bound, then long run relationship is confirmed (Haq et al., 2022). This technique has two critical bounds value, upper and lower. If calculated value is lower than lower bound value, then it can be concluded that there is no long run relationship. Likewise, if values lies between these two bounds, then test is inconclusive. Additionally, the ARDL bounds approach also provides short run and long run estimates, along with error correction mechanism about equilibrium of the model. If the value of error correction term is significant and negative, then the estimated model will be in equilibrium (Primbetova et al., 2022). Besides, the magnitude of this error correction term (ECT) will show that how much time the model will take to bring back itself to equilibrium from external shock. Besides, this study will also estimate long run estimates through dynamic ordinary least squares (DOLS) as it encounters endogeneity and give consistent and unbiased estimates (Stock and Watson, 1993).

4. RESULTS AND DISCUSSION

Before moving onto results and discussion, let shed light on economic and environmental situation in Uzbekistan. Uzbekistan achieved tremendous economic development in last two decades. Figure 1 depicts the annual economic growth in Uzbekistan between 2000 and 2023. The annual GDP growth rate was around 4% between 2002 and 2003 however, it shoot up to above 7% in 2004. The annual growth rate of GDP continuously increased from 7% to about 9% in 2007. This mean, during this period, Uzbekistan economy expanded well however, for any economy it is difficult to maintain such level of growth so same with the case of Uzbekistan too. Therefore, one can witness that during 2008 and 2015 the annual GDP growth rate fell from 9% to around 7% which further fell to around 4% and four and half percent in 2017. During 2018 and 19, Uzbekistan maintained around 6% GDP growth. A certain decrease in GDP growth can be seen in 2020 because of the COVID-19, the economy recovered quickly itself from this shock, and once again, economic growth crossed 7%. The GDP growth was around 6% in 2023. To sum up, Uzbekistan economy from 2000 to 2023, achieved around on average 6% in annual growth rate. This sound growth enables Uzbekistan to increase the per capita income by almost three times during same period of time. Figure 2 presents the per capita income of Uzbekistan in constant US dollars.

Figure 3 depicts the trade situation of Uzbekistan. It depicts the export and imports ratio to GDP. The exports to GDP and imports to GDP was around 24% and 19% respectively in 2000 both ratios got momentum since then and reach to around 42% and 35% respectively, and 2004 however, export ratio to GDP fell to 36 and half, while import to GDP ratio fell to 31% in 2006. The important point about this trade these, this trade ratios, is that during 2000 to 2000 a export ratio was greater than the import ratio. However, since 2010 the imports ratio is more than export ratio. The gap between export ratio and import ratio widened since 2017 and 2023, exports ratio is 26 and half wide. Import ratio stood around 46% this means that Government of Uzbekistan adopted liberalization policy in current regime.

Figure 4 portrays the carbon emission, metric tons per capita of oil equivalent in Uzbekistan during the period 2000-2023 although climate change affected the country. But if one looks into carbon emission per capita, it continuously is on decrease. This means that increase per capita made it possible for the government to take care of the environmental quality. The government is continuously working to reduce it further and is committed to bring it to half of

Figure 1: Annual GDP growth

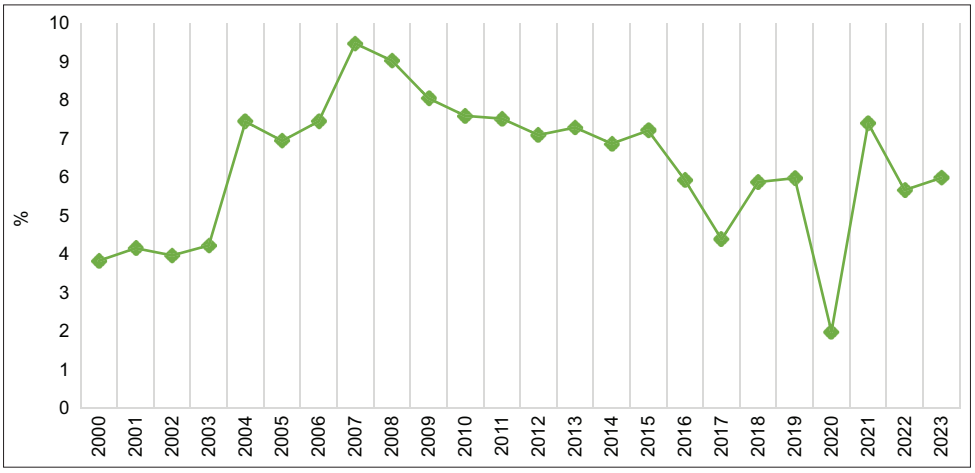


Figure 2: Income per capita

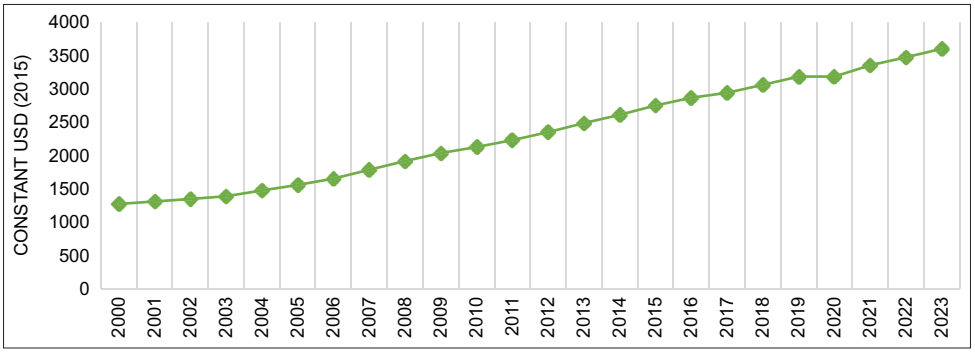


Figure 3: Exports openness and imports openness

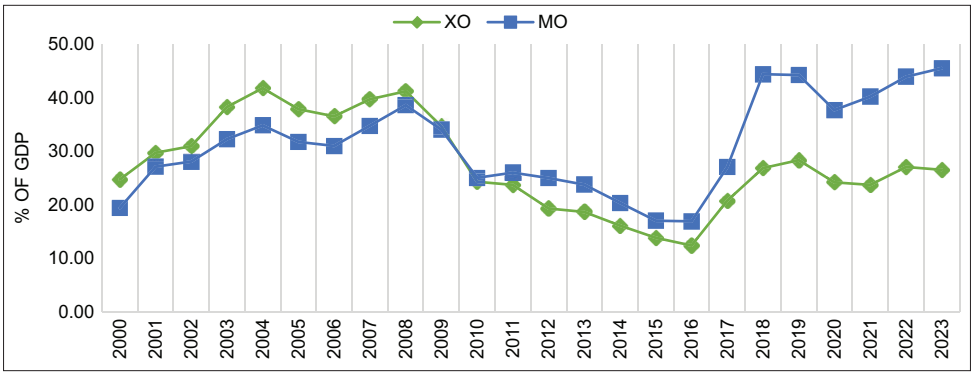
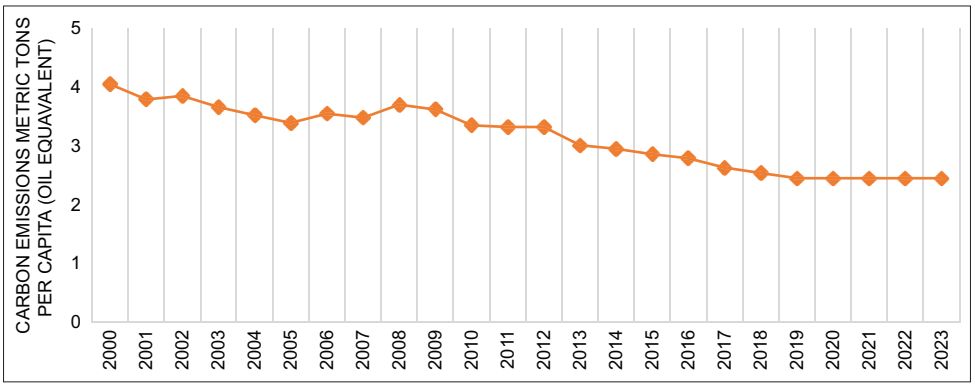


Figure 4: Carbon emissions per capita



2017 level up to 2030. The tremendous increase in per capita, and a continuous decrease in carbon emission in Uzbekistan, made an interesting case to test. E, KC hypothesis empirically.

Table 2 depicts the results of augmented Dickey-Fuller test. These results for variables of the study show that variables are non-stationary at level. This means there is a problem of unit, true. So the study took the first difference, and it is observed that variables are stationary at first difference, these results provided the background for the ARDL bounds test. The results of ARDL bound test are provided in Table 3. The F calculated value of ARDL bound is greater than upper bounds. So the result shows that variables are in long run relationship. This long run relationship results can be interpreted, in other words, in such manner that the explanatory variable are factors of environmental degradation in Uzbekistan as ARDL bound test differentiate between the endogenous and exogenous variables (Haq et al., 2021).

After determining long run relationships, the estimates from ARDL bound test are presented in Table 4. The upper part of Table 4 presents the short run estimates. The import openness has significant positive effect on environmental degradation, while exports openness is carrying negative but insignificant effect in short run. These results did not confirm EKC hypothesis in short run as per capita income and square of it is not carrying expected sign and also are not significant as well. The ECT is carrying expected sign and is significant thus, approving that model of the study is stable. Additionally, the model will bring itself back to equilibrium within a year after any external shock. The long run results are provided in lower part of the Table 4. Exports openness and imports openness has significant negative and significant positive effect on environmental degradation, respectively. These results are similar to short run results, although exports openness has a negative effect on environmental degradation but is insignificant. Thus, it can be concluded that trade is degrading environmental quality in Uzbekistan. These results are similar with

Table 2: Augmented Dickey-Fuller test results

Variables	t-value (at level)	t-value (at difference)	Decision
logCEP	−2.60	−15.14[a]	*I(1)*
logYPC	−0.62	−3.56[b]	*I(1)*
$logYPC^2$	0.99	−3.60[b]	*I(1)*
logXO	−0.01	−4.11[a]	*I(1)*
logMO	0.17	−3.56[b]	*I(1)*

a Denotes significance at 1%

Table 3: ARDL bounds test cointegration result

Test Statistic	Value	K=3
F-statistic	19.32[a]	
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
1%	4.29	5.61

[a]Denotes significance at 1%

Table 4: Short run and long run estimates based on ARDL bounds test

Short run results			
Variable	Coefficient	Standard Error	t-Statistic
Δ(*logXO*)	−0.18	0.14	−1.29
Δ (*logMO*)	0.28b	0.13	2.13
Δ (*logMO* (−1))	−0.10	0.06	−1.69
ΔD (*logYPC*)	−19.78	12.71	−1.56
Δ (*logYPC*(−1))	2.25[b]	0.92	2.44
Δ ($logYPC^2$)	1.23	0.81	1.51
ECT (−*1*)	−0.94[a]	0.06	−15.20
Long Run Results			
Variable	Coefficient	Standard Error	t-Statistic
logXO	−0.19	0.16	−1.23
logMO	0.25[b]	0.10	2.49
logYPC	3.22[c]	1.90	1.70
$logYPC^2$	−0.26[b]	0.12	−2.11
Constant	−9.68	6.98	−1.39

[a,b]and [c]denote significance at 1%, 5% and 10% respectively

Nasir and Rehman (2011) who also conclude that trade is aggravating environmental degradation on other hand contradicting the study of Haq et al. (2016) who conclude that trade is responsible for improvement of environmental quality in Morocco. If one looks into the trade structure of Uzbekistan, especially on the three categories like machinery and transport, chemical and similar products and industrial goods. So the composition of machinery and transport is around 34% in total imports.

Likewise, industrial goods constitutes 20% of total imports, while chemical and similar products are constituting 15% so 70% imports are lies in these three categories. On the other hand, exports composition in the similar categories is as follows. The industrial goods are constituting 23% while the machinery and transport is constituting only 2% in exports. Likewise, chemical and similar products are constituting only 4% in total exports. Keeping the composition of the trade of Uzbekistan, it is not wondering that why imports comes out like having aggravating effect on the environmental degradation compared to exports, as the composition from machinery, transport, chemical and similar products and industrial goods, is constituting about 70% of imports

Table 5: DOLS long run results

Variable	Coefficient	Standard Error	t-Statistic
logXO	−0.16	0.14	−1.08
logMO	0.26	0.11	2.39
logYPC	6.92	1.63	4.24
$logYPC^2$	−0.52	0.11	−4.91
Constant	−24.06	5.72	−4.21

[a]and [b]denote significance at 1% and 5% respectively

of Uzbekistan, while in the same category, exports only constitutes 29%. As far as the results about EKC hypothesis are concerned in long run, these results shows that per capita and its square are not only significant, but also carrying the expected sign. Thus, it can be concluded that EKC hypothesis is confirmed in Uzbekistan. The results of about EKC hypothesis are similar with Nasir and Rehman (2011), Ahmed (2014) and Khan et al. (2023) while this result is contrary to Ozturk and Almulali (2015) and Haq et al. (2016) as these study do not confirmed EKC hypothesis in Cambodia and Morocco respectively.

This also testified the long run estimates through DOLS. The long run estimates obtained through DOLS are presented in Table 5. These long results also confirm the long run results of ARDL bounds approach. These results in the long run also documented those exports openness has an insignificant effect on environmental degradation while imports openness has significant positive effect on environmental degradation. Additionally, these long run results of DOLS also confirmed the EKC hypothesis in Uzbekistan.

5. CONCLUSION AND RECOMMENDATIONS

Trade can affect environmental degradation through three channels. The scale effect prevails if trade is aggravating environmental degradation, while the technique effect of trade is prevailing, if trade helps in improved environmental degradation or lesser environmental degradation. The composite effect of trade can be beneficial or harmful for the environment, as it depends how trade changes the economic composition of the domestic economy. On the other hand, EKC hypothesis is well established in literature. This hypothesis postulates that when countries are in the first stage of development, they are utilizing resources extensively and are not taking care of environmental quality. However, a certain level of economic development reaches after which the increase in per capita income is not accompanied by an increase in environmental degradation. The reason is that after this level, government and all stakeholders are taking steps to ensure sustainability. Therefore, this study set two objectives which are to examine the effect of trade openness on environmental degradation and to test EKC hypothesis in Uzbekistan. This is a time series study, therefore, this study applied unit root test to check whether variables are stationary at level or first difference. Additionally, they study applied ARDL bound test approach for long run co-integration to determine long run relationship between variables of the study. Moreover, this study obtained short run and long run estimates.

The results of bound test approach confirm the long run co integration between variables. The long run estimates show

that export openness has an insignificant negative effect on environmental degradation, whereas import openness has significant positive effect on environmental degradation. The results also affirmed the EKC hypothesis in Uzbekistan. For robustness check, the study also implied DOLS for long run estimates, as it deals with endogeneity problems if exist, along with including leads and lags to provide robust estimates. The result of DOLS also confirmed the long run estimates of ARDL. The error correction of ARDL suggested that model is stable and can bring itself to equilibrium from any external shock within a year, as the study found that imports openness is detrimental to environment in Uzbekistan, therefore, the government has to look into imports quality. The government has to check on intermediate imports, whether these products are environmentally friendly, likewise, the capital imports, like machinery and technology, the government should encourage efficient and green technology to make production environmentally friendly.

The affirmation of EKC hypothesis shows that the commitment of the government towards sustainable and environment and measures to ensure sustainable economic growth will not aggregate environmental degradation. Besides, the EKC hypothesis confirmed that the level of economy is in that stage where government can take steps to cope with problems like climate change.

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