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The Impact of Textile and Clothing Export on Environmental Quality in Bangladesh: An ARDL Bound Test Approach

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ABSTRACT

The purpose of the study is to investigate the impact of Textile and clothing (T&C) exports on environmental quality in Bangladesh's economy. The fact that Bangladesh's clothing industry is one of the biggest T & C exporters in the world, justifies the importance of environmental evaluation in the case of Bangladesh's T&C. In this regard, this study has used the yearly time series data of T&C sector exports, CO_2 per capita, and ecological footprint per capita (EF) as a measure of environmental quality measurement from 1983 to 2019. The empirical investigation is carried out by applying the Autoregressive distribution lag model (ARDL) method. The findings of the study have identified the significant impact of the T&C industry on the environment of Bangladesh. The empirical findings demonstrate that T&C exports have made a significant positive contribution to environmental degradation in Bangladesh (both CO_2 and EF). The study recommended that policymakers can introduce environmentally friendly ways of production. To reduce carbon dioxide emissions, one should start a cleaner production while taking energy consumption and economic growth into account. Hence, the policy focuses on improving various aspects of production, especially green manufacturing to mitigate the adverse effect of the industry on the environment.

INTRODUCTION

At present, the environmental quality is facing deterioration. The greenhouse gas (GHG) emissions are the major reason for the continuous environmental degradation. Mainly, due to the numerous industrial activities, a large amount of GHG emissions reach the atmosphere. The increased production scales and the role of advancements in industrialization in the current time are resulting in an increased amount of GHG discharge in the environment (Akter et al. 2017).

Precisely, the manufacturing process involved in the textile industry and the finishing results are responsible for the augmented greenhouse gas emissions. In this regard, It is stated that the textile sector contributes 1 ton of carbon from the entire 19.8 tons of carbon emission in the atmosphere. The textile industry is heavily dependent on a fossil-based energy source, resulting in carbon dioxide emission that ultimately constitutes a major part of greenhouse gasses (Heo et al. 2019).

Textile industries cause both direct and indirect effects on environmental degradation. The burning of fossil fuels involved in the manufacturing process of textiles generates direct GHG in the atmosphere. The textile industry indirectly increases harmful emissions because it uses more electricity along its whole supply chain. Numerous studies on the textile industry have revealed that higher energy use has resulted in higher CO_2 emissions and consequently adverse environmental impacts (Huang et al. 2017a). Even though, the existing literature is unable to explore the conclusive role of the textile industry in causing environmental damage. Very few empirical investigations are done to examine the impact of textile export on CO_2 emissions. In response to this, the current study is motivated to examine the role of textile manufacturing on CO_2 emissions. Precisely, the objective of the current study is to empirically examine the T & C export on environmental degradation of Bangladesh. Many studies elaborated that developing countries are mostly responsible for environmental degradation due to their main focus on self-survival and economic growth. Hence, the current study is novel for evaluating the textile-environment link in the context of Bangladesh's textile industry. The novelty of the current study would be able to identify how the textile industry can threaten or hurt environmental stability.

Furthermore, the findings of the current study will provide some policy suggestions to the government in identifying the threats that can result from the expansion of the textile industry in Bangladesh. Moreover, the findings will allow the policymaker to impose ecologically beneficial industrial practices in the textile sector by reducing the use of fossil-based energy and finding environmentally friendly alternatives to green energy sources. The findings may have policy ramifications for the government in identifying the genuine potential of the textile industry in the country's growth process, as well as being beneficial to environmental issues.

The remainder of the paper is given below. The next section will provide a review of available research to define the predicted relationship between the variables of interest. A brief description of the methodology is provided in section three. The study's findings are provided and discussed in section four. Finally, part five brings the study to a conclusion with suggestions and policy implications.

PAST STUDIES

Sustainable development is based on environmentally sound economic growth principles. The familiar setting is relevant in this context. According to Kuznets theory, economic growth and improvements have a detrimental impact on environmental quality, but after a nation reaches a particular income level, the increase in wealth has a positive impact on the environment. In this context, various studies looked at how the textile sector operates, how its carbon footprint is increasing, and how dependent it is on energy. It has been condemned that the textile industry is one of the world's worst polluter offenders. As one of the most energy and carbon-intensive industries, the textile industry uses large amounts of chemicals, water, and fossil fuels in its manufacturing process, producing pollution from the soil, sound, water, and air. Different effective government policies should be implemented to solve the problems of energy and environmental pollution. The production of textiles must be controlled strictly (Huisingh et al. 2015).

Similarly, numerous studies aim at studying the role of carbon dioxide in the textile industry. Wang et al. (2011) looked at the contribution and sources of carbon dioxide emissions in the Chinese textile sector. According to the study, the expansion of China's textile industry is the primary driver of increased greenhouse gas emissions. In terms of Bangladesh's textile industry is the world's second-largest T & C exporter after China.

Bangladesh is a South Asian country and its economy is rapidly growing. The garment industry is one of Bangladesh's promising industries. The garment industry is the backbone of the economy of Bangladesh. It is the second-largest exporter of textile products in the world after China. Rapid growth in the textile industry, also called garment and industry significantly strengthened the economy. It is the second biggest garment industry in the world and the export of Bangladesh is mostly dominated by the textile industry. In the fiscal year 2018-19, the total value of the T & C export of Bangladesh to the world was approximately US$ 34 million out of its total export of US$ 40 million which is almost 84% of the total export value (BGMEA 2020). Bangladesh textile industries cause a range of environmental problems, mostly the pollution of water resources (Ahmed &Tareq 2008).

Fig. 1 clearly shows an upward increase in T & C export as well as the CO_2 emission at the same time. The increase in garment export is good for the country and has a big role in economic development but the sharp increase in carbon emissions is also very noticeable. The carbon emissions of Bangladesh have increased more than ten times in 2019 compared to 1983. While carbon emission was 8236 metric tons in 1983, it increased to 93761 metric tons in 2019. Trade-related carbon dioxide (CO_2) emissions are measured

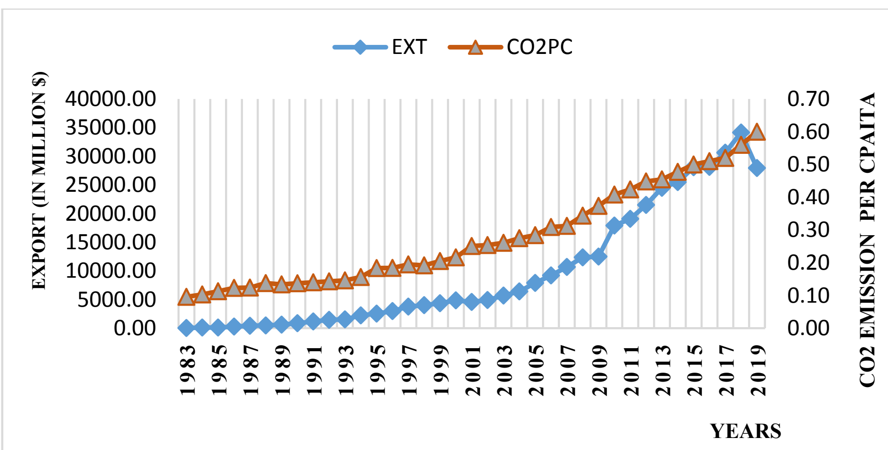

Fig. 1: Bangladesh's total CO_2 emission and RMG export.

(Source: World Bank and BGMEA 2019)

as whether the emissions are exported or imported as the percentage of domestic production emissions. It is evident from Fig. 2 that the RMG export and the ecological footprint are increasing simultaneously after the year 2007 and onward.

Lin & Ahmad (2017) studied the causes which increased power-related CO_2 emissions in the textile industry from 1990 to 2014 in the Pakistani textile sector. The study found that the country's growing population is a major contributor to rising carbon emissions. Furthermore, the findings revealed that economic growth is a key factor in accelerating environmental deterioration in Pakistan's textile sector. The relation between environmental quality and Taiwan textiles was studied Hong et al. (2010). The research examined the outcomes of 303 companies in terms of energy conservation, and the author observed that taking energy-saving measures in the workplace helped reduce the textile industry's carbon emissions to 143,669 tonnes, which might enhance the environment in Taiwan. A similar analysis of recycling measures in the textile business and their possible impact on environmental deterioration was also undertaken in the textile industry in Sweden by Zamani et al. (2015). The results showed that burning had negative environmental impacts and significantly added to the degradation of the atmosphere. Even after that, the literature did not successfully identify the textile industry's conclusive role in environmental causes damage because very few investigations have been carried out on the exclusive effects of production or empirically analyzed CO_2 emission textile manufacture.

DATA AND METHODOLOGY

The total T & C export yearly data was collected from the Bangladesh Garments Manufacturer and Exporter Association (BGMEA). The remaining data was obtained from the World Development Indicator (WDI 2019). Table 1 shows the descriptions of all variables and their sources. The present study adopts Autoregressive Distributed Lag (ARDL) with Bounds testing. This study uses annual data starting from 1983 to 2019 for Bangladesh.

To estimate the ARDL model, at first, we check the stationarity of all the variables by employing some conventional unit root tests, such as Augmented Dickey-Fuller (ADF) test (ADF 1979) and Phillips-Perron (PP) test (Perron 1990). We check the cointegration among the variables by using the bounds test developed by Pesaran et al. (2001). To confirm the cointegration: the null hypothesis $H_o: \beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ which indicated that there is no cointegration against alternate $H_1: \beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$ which indicated there is cointegration among the variables.

Pesaran et al. (2001) suggested that when the value of the F-test is larger than the upper bound critical value, the null hypothesis of no cointegration will be rejected which tells the existence of the long-term relationship. Alternatively, if the estimated value of the F-test is below the critical value it means there is no long-run relationship (Pesaran & Pesaran 1997).

ESTIMATED MODELS

Following the studies by Mrabet & Alsamara (2017) and Altintaş & Kassouri (2020), the general form of our empirical model used in this study is as follows:

$$ED = f\,(EX, GDP, GDP^2, FD, EU) \qquad \ldots(1)$$

Where, *ED* refers to indicators of environmental degradation which is captured in our paper by per capita carbon emissions (CO_2) and per capita ecological footprint (EF). To provide further insights we used these two proxies of environmental degradation. We estimated separate models for both proxies. By taking the natural logarithmic forms of all variables, we can specify the models we used in this paper. Since this paper compares two different indicators for environmental degradation, the empirical analysis will estimate two different specifications derived from equation (1): the first specification uses CO_2 emissions, whereas the

Table 1: Summary of variable and data sources.

Variables	Description	Sources
Carbon emission per capita (LnCO_2)	CO_2 Emission measured in per capita metric tons	World Bank
Ecological footprint of consumption (Ln*EF*)	It is measured in global hectares per capita	Global Footprint Network
T & C Export (Ln*Ex*)	T & C export in current US$	Bangladesh Garments Manufacturer and Exporter Association (BGMEA)
Economic growth (L*GD*P)	Per capita GDP measured in constant 2010 US $	World Bank
Square term of GDP (LGDP^2)	Square term of GDP to check the nonlinear relationship	World Bank
Energy consumption (Ln*EU*)	Energy consumption per capita kg of oil equivalent	World Bank
Financial development (Ln*FD*)	Domestic credit to the private sector (% of GDP)	World Bank

second one uses the ecological footprint (EF) as an indicator for the environmental degradation.

$$lnCO2_t = \alpha_0 + \alpha_1 lnEX_t + \alpha_2 lnGDP_t + \alpha_3 lnGDP_t^2 + \alpha_4 lnFD_t + \alpha_5 lnEU_t + €_t \quad \ldots(2)$$

$$lnEF_t = \beta_0 + \beta_1 lnEX_t + \beta_2 lnGDP_t + \beta_3 lnGDP_t^2 + \beta_4 lnFD_t + \beta_5 lnEU_t + € \quad \ldots(3)$$

To check the long-term linear relationship amongst the selected variables, therefore, the model specification is designed on ARDL Bound approach following Pesaran & Shin (1998) and Pesaran et al. (2001). To check the impact of T & C export on carbon emission proxy in Bangladesh, we perform the following econometric model:

$$\Delta lnCO2_t = \beta_0 + \beta_1 lnCO2_{t-i} + \beta_2 lnEX_{t-i} + \beta_3 lnGDP_{t-i} + \beta_4 lnGDP_{t-1}^2 + \beta_5 lnEU_{t-i} + \beta_6 lnFD_{t-i} + \sum_{i=1}^{r} \varphi_i \, \Delta lnCO2_{t-i} + \sum_{i=1}^{r} \pi_i \, \Delta lnEX_{t-i} + \sum_{i=1}^{r} \tau_i \, \Delta lnGDP_{t-i} + \sum_{i=1}^{r} \delta_i \, \Delta lnGDP_{t-1}^2 + \sum_{i=1}^{r} \Upsilon_i \, \Delta lnEU_{t-i} + \sum_{i=1}^{r} \Omega_i \, \Delta lnFD_{t-i} + €_t \quad \ldots(4)$$

Taking the ecological footprint (EF) proxy to examine the impact of T & C export on the environment the following model is estimated:

$$lnEF_t = \beta_0 + \beta_1 lnEF_{t-i} + \beta_2 lnEX_{t-i} + \beta_3 lnGDP_{t-i} + \beta_4 lnGDP_{t-1}^2 + \beta_5 lnEU_{t-i} + \beta_6 lnFD_{t-i} + \sum_{i=1}^{r} \varphi_i \, \Delta \, lnEF_{t-i} + \sum_{i=1}^{r} \pi_i \, \Delta lnEx_{t-i} + \sum_{i=1}^{r} \tau_i \, \Delta lnGDP_{t-i} + \sum_{i=1}^{r} \delta_i \, \Delta lnGDP_{t-1}^2 + \sum_{i=1}^{r} \Upsilon_i \, \Delta lnEU_{t-i} + \sum_{i=1}^{r} \Omega_i \, \Delta lnFD_{t-i} + €_t \quad \ldots(5)$$

Where *ln* is the natural logarithm, T= 1,2,….., T for time period that takes the years from 1983 to 2019. Concurrently, to determine the short-run relationships of the variables, this study applied the error correction model and the short-term models for both carbon emission and ecological footprint in models (4) and model (5) as follows:

$$\Delta lnCO2_t = \beta_0 + \beta_1 lnCO2_{t-i} + \beta_2 lnEX_{t-i} + \beta_3 lnGDP_{t-i} + \beta_4 lnGDP_{t-1}^2 + \beta_5 lnEU_{t-i} + \beta_6 lnFD_{t-i} + \sum_{i=1}^{r} \varphi_i \, \Delta lnCO2_{t-i} + \sum_{i=1}^{r} \pi_i \, \Delta lnEX_{t-i} + \sum_{i=1}^{r} \tau_i \, \Delta lnGDP_{t-i} + \sum_{i=1}^{r} \delta_i \, \Delta lnGDP_{t-1}^2 + \sum_{i=1}^{r} \Upsilon_i \, \Delta lnEU_{t-i} + \sum_{i=1}^{r} \Omega_i \, \Delta lnFD_{t-i} + \theta ECT_{t-i} + €_t \quad \ldots(6)$$

$$\Delta lnEF_t = \beta_0 + \beta_1 EF_{t-i} + \beta_2 EX_{t-i} + \beta_3 GDP_{t-i} + \beta_4 GDP_{t-1}^2 + \beta_5 EU_{t-i} + \beta_6 FD_{t-i} + \sum_{i=1}^{r} \varphi_i \, \Delta \, EF_{t-i} + \sum_{i=1}^{r} \pi_i \, \Delta \, EX_{t-i} + \sum_{i=1}^{r} \tau_i \, \Delta \, GDP_{t-i} + \sum_{i=1}^{r} \delta_i \, \Delta \, GDP_{t-1}^2 + \sum_{i=1}^{r} \Upsilon_i \, \Delta \, EU_{t-i} + \sum_{i=1}^{r} \Omega_i \, \Delta \, FD_{t-i} + \theta ECT_{t-i} + €_t \quad \ldots(7)$$

Where θ is the measure of the speed of adjustment of how quickly variables return to their long-term equilibrium following a short-term shock, and ECT is an error correction term.

The descriptive statistics and correlation are shown in Table 2 and Table 3 in Appendix. The results of unit root test ADF and PP confirm all variables are stationary either at levels or in first differencing. The results are shown in Table 3. Our empirical results for all tests are found stationary at level I(0) or level one I(1) and similar results are obtained for all three tests. Thus, we find that none of the variables is integrated into order two. We estimate two types of environmental quality measurements separately. In model (1) the dependent variable environmental quality is proxied by the carbon emission per capita (CO_2), while it is proxied by the ecological footprint (EF) in model 2. Both models are estimated with an unrestricted constant and restricted trend. The results of the ARDL bounds F-test are displayed in Table 5. We find that the F-statistics for both models are greater than the upper bound critical values (I(1) at a 5% significant level. Hence, we conclude the presence of a cointegration relationship among the various variables for both models under consideration.

Before we estimate the short and long-term coefficients, it is important to check for the validity of the estimated models by performing a series of diagnostic tests, such as the normality tests, the serial correlation tests, and the tests of the absence of heteroscedasticity of the error term. The findings of diagnostic tests are presented in Table 6. They indicate that the error terms are normally distributed, not correlated, and not heteroscedastic as all p-values are higher than 5%. Thus, both models pass the diagnostic tests. Besides, the

Table 2: Descriptive statistics.

	CO_2	EF	EXT	GDP	EU	FD
Mean	0.278233	0.491924	9828.257	635.3309	162.0121	27.04676
Median	0.250765	0.466320	4859.830	541.2917	153.5601	24.17959
Maximum	0.600000	0.603059	34133.27	1287.822	229.2464	47.58330
Minimum	0.095610	0.409406	31.57000	378.0920	107.6725	9.034444
Std. Dev.	0.149971	0.066260	10644.79	258.0097	42.95986	12.34052
Skewness	0.611013	0.605627	0.949620	1.008287	0.396944	0.353714
Kurtosis	2.068077	1.827289	2.441163	2.916355	1.677778	1.658397
Observations	37	37	37	37	37	37

Note: Number of observations 37. The figures represent the raw data.

results of CUSUM and CUSUMQ came out stable. Figures (2) and (3) are shown in appendix 1.

Now, finally, we turn to present the results of the estimation of the error correction models in Tables 7 and 8 respectively. The next step of the estimation is to examine the long and short-run impact of T & C export, real GDP per capita, energy use per capita, and financial development on environmental degradation using the ARDL method. In the case of the first specification (CO_2 model), the results show that the long-run coefficients are found statistically significant. In specific, the export of T & C exports has a positive and significant impact on CO_2 emissions. The results show that a 1% increase in export of T & C increases CO_2 emissions by 0.0468%. The real GDP per capita and the per capita real GDP squared have a positive and negative impact on CO_2 emission, respectively. The result of this indicates that the relationship between CO_2 emission and real GDP per capita is inverted U-shaped which means the EKC hypothesis is valid for Bangladesh when using CO_2 as an indicator of environmental degradation. This result is according to the EKC curve theory, which implies in the long run, the increase in economic growth will be responsible for reducing the CO_2 emission. Our finding is consistent with many previous studies, in which an inverted U-shaped curve has also been found between economic growth and CO_2 emissions. All these studies have found an important role in enhancing the environmental quality of different countries by increasing economic growth. The results of the study imply, however, that increases in the actual income level stimulate carbon emissions to some degree, and then mitigate Bangladesh's pollution (Shahbaz et al. 2014, Kasman & Duman, 2015).

Moreover, energy use has a long-run positive and significant impact on CO_2 emissions. The result shows that a 1% increase in energy use increases CO_2 emission by 0.76%. This long-run positive impact is expected as Bangladesh's textile industry is heavily dependent on non-renewable energy sources like fuel oil, coal oil, and natural gas. An increase in energy consumption also leads to an increase in CO_2 emission in long run. The financial development variable has a positive and statistically significant impact on CO_2

Table 3: Pair-wise correlations.

	LNCO$_2$	LNEF	LNEXT	LNEU	LNFD	LNGDP
LNCO$_2$	1					
LNEF	0.910002	1				
LNEXT	0.947077	0.765357	1			
LNEU	0.992438	0.92605	0.930614	1		
LNFD	0.991401	0.882139	0.962913	0.985764	1	
LNGDP	0.978909	0.945569	0.889327	0.976515	0.952779	1

Note: Correlation analysis of the variables shown represents their natural logarithmic values.

Table 4: Unit root tests.

VARIABLES	AUGMENTED DICKEY-FULLER TEST (ADF)		PHILLIPS PERRON TEST (PP)		Order of Integration
	Level	1st Difference	Level	1st Difference	
LCO$_2$PC	3.8407 (1.0000) -0.0596 (0.9937)	-4.1592 (0.0025)*** -6.0575 (0.0001)***	7.1920 (1.0000) 1.3037 (0.9999)	-4.0956 (0.0030)*** -7.8937 (0.0000)***	I(1)
LEF	1.0775 (0.9965) -1.3894 (0.8455)	-4.7468 (0.0006)*** -5.4666 (0.0005)***	0.8214 (0.9929) -1.3895 (0.8454)	-4.8275 (0.0005)*** -5.4650 (0.0005)***	I(1)
LEXT	1.8562 (0.9996) -4.2223 (0.0126)**	-3.7456 (0.0090)*** -4.0362 (0.0195)**	0.6259 (0.9885) -1.6420 (0.7558)	-5.5069 (0.0001)*** -5.9240 (0.0001)***	I(1)
LRGDP	11.707 (1.0000) 5.4086 (1.0000)	-0.9385 (0.7638) -2.6394 (0.0002)***	10.6692 (1.0000) 4.8174 (1.0000)	-0.4172 (0.8953) -2.5012 (0.0012)***	I(1)
LEU	0.3113 (0.9757) -1.8256 (0.6713)	-2.7478 (0.0766)* -2.6126 (0.2774)	0.1861 (0.9679) -1.9450 (0.6105)	-5.8045 (0.0000)*** -5.7763 (0.0002)***	I(1)
LFD	-1.9497 (0.3068) -3.9104 (0.0218)**	-7.7154 (0.0000)*** -7.5865 (0.0000)***	-2.1787 (0.2171) -3.9104 (0.0218)**	-13.4098 (0.0000)*** -14.2603 (0.0000)***	I(1)

Note: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and P-value are below the coefficient values in parantheses.

emissions in the long run. This result reveals that an increase of 1% in financial development will cause a 0.49% increase in CO_2 emission in Bangladesh. A possible reason is that the share of capital used by the financial activities will promote the economic activity, export, and production of Bangladesh which contributes to environmental degradation in the future. This indicates the development of the financial sector could stimulate the demand for energy consumption and expansion of the production scale, which increases carbon emissions from Bangladesh's perspective. A similar result was found for Bangladesh by Hossain & Hasanuzzaman (2012) for Malaysia but this study is different from the results of Mrabet & Alsamara (2017).

Table 8 also provides the short-run results for the first specification of the CO_2 model which are the results of error correction representation. The T & C export is increasing the carbon emission in the short-run but this result becomes significant in long-run estimation. It means the garment and production are responsible for environmental degradation in the short run. The (DRGDP) coefficient is positive which means economic growth causes carbon emissions in the short run for Bangladesh. The (DRGDP2) coefficient is negative and non-significant for the short run. This result indicates the EKC hypothesis is not valid in the short run. On the other hand, the energy consumption (DEU) coefficient is positive and non-significant for the short run but in long run, we found a similar relationship with a significant value. The financial development (DFD), the positive and significant results will increase carbon emissions by 0.356 percent with a 1% increase in financial development. The same result is also found for (LFD) in a long-term estimate. The error correction term is correctly signed and significant with a negative value of 0.80 percent to validate earlier results of the long-run relationship among variables in model 1a. It suggests a high speed of adjustment of the dependent variable to equilibrium. This result supports the long-run relationship between the selected variables and indicates that any adjustment in CO_2 emissions from the short run towards long-run equilibrium will occur by 0.8% every year.

In the case of the second specification (EF model), the long-run estimated coefficients are found statistically significant except for GDP and GDP^2. In the context of per capita real GDP and per capita real GDP squared have positive and negative impacts on EF respectively, but because the

Table 5: Results of ARDL Bounds test.

Carbon emission Model (Model 1)			
	Lower bound	Upper bound	Significance levels (%)
	2.08	3	10
F= 8.101470	2.39	3.38	5
K=5	3.06	4.15	1
Ecological footprint Model (Model 2)			
	2.49	3.38	10
F= 4.886144	2.81	3.76	5
K=5	3.5	4.63	1

Note: k is the number of regressors. The model selection method is the Akaike info criteria (AIC).

Table 6: Results of diagnostic tests.

		Carbon emission Model	Ecological footprint Model
		Model 1	Model 2
Normality test	Jarque-Bera (p-value)	0.46 (0.79)	0.34 (0.84)
Breusch-Godfrey Serial correlation LM test	F-stat. (p-value)	1.53 (0.23)	1.04 (0.59)
Breusch-Pagan-Godfrey Heteroscedasticity	F-stat (p-value)	5.01 (0.75)	3.7 (0.80)
CUSUM		stable	stable
CUSUMQ		stable	stable

Note: Figures in parenthesis show p-values

GDP squared value is insignificant, we can conclude there is the absence of the EKC hypothesis. In other words, the existence of an inverted U-shaped nexus is missing when considering the ecological footprint as a proxy of environmental degradation in Bangladesh. However, this finding is opposite to the result of model 1 where we used CO_2PC as a proxy for environmental degradation. This result is in line with Al-Mulali et al. (2015) who investigated the EKC hypothesis for different income groups and countries by using ecological footprint (EFP) measures. This result implies that the EKC hypothesis was not confirmed in Bangladesh. This result indicates in the long run it is expected Bangladesh relies on the production and the exports of T& C products to sustain its economic growth. This will create an increasing volume of polluted goods. Moreover, this result shows that the connection between revenue and pollution does not reach the point at which the relation between the two components is negative.

The other explanatory variables have similar effects on the ecological footprint. The T & C export has a significant effect on the ecological footprint by 1% increase in export will increase the ecological footprint by 0.0132%. This result is in line with Kurniawan et al. (2018). They discovered that trade is responsible for increasing environmental degradation (ecological footprint).

Energy use has a significant and positive impact on the environmental footprint, which will increase the environmen-

Table 7: Long-Run estimates.

	Carbon emission Model	Ecological footprint Model
Variables	Model 1 Coefficient (p-value)	Model 2 Coefficient (p-value)
LEX	0.0468** (0.0084)	0.0132** (0.0744)
LGDP	6.6948** (0.0048)	13.1869** (0.0115)
$LGDP^2$	-0.4123** (0.0115)	-0.8048 (0.1229)
LEU	0.7658** (0.0360)	0.8727** (0.0546)
LFD	0.4938** (0.0021)	0.4825** (0.0323)
Constant	-16.554** (0.0023)	-30.919** (0.0081)

Note: (*) Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%; the values between parentheses are p-values.

Table 8: Short-Run estimates.

	Carbon emission Model	Ecological footprint Model
Variables	Model 1	Model 2
	Coefficient (p-value)	Coefficient (p-value)
D(EX)	0.0183 (0.5018)	-0.0474 (0.1170)
D(EX(-1))		0.0511 (0.0186)
D(GDP)	16.691 (0.2274)	32.563** (0.0080)
D(GDP(-1))		-0.3889 (0.9755)
D(GDP^2)	-1.4279 (0.2030)	-2.4822** (0.0112)
D(GDP^2(-1))		-0.0568 (0.9565)
D(EU)	0.3380 (0.1523)	-0.5444** (0.0118)
D(EU(-1))		0.1339 (0.4529)
D(FD)	0.3565**(0.0012)	0.1288 (0.1067)
D(FD(-1))		0.0070 (0.9175)
ECT(-1)	-0.8080**(0.0014)	-0.6205**(0.0007)
R-squared	0.7610	0.643
Adjusted R-squared	0.6615	0.472
Durbin-Watson	1.748	2.118

Note: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at 1%; the values between parentheses are p-values.

tal footprint by 0.87 percent 1 percent. The use of energy, therefore, increases Bangladesh's environmental degradation. This study is consistent with a previous study by Destek & Sarkodie (2019) that explored the effect of the use of energy on the ecological footprint and the main variables which degrade the environment, taking 11 industrialized countries as samples and consumption of food energy. Furthermore, Nathaniel & Khan (2020) also found a similar result about the impact of energy consumption on the ecological footprint (EF) of Indonesia. Additionally, this finding is consistent with the result on the relationship between energy use and the CO_2 emission model. This finding is complemented by those who found the impact of energy consumption to be a significant factor in extended environmental degradation. For example, Huang et al. (2017b) identified the key cause of the Chinese garment industry's increased emissions of coal.

Financial development has a positive and significant impact on the ecological footprint, this means that when financial development increases by 1% in Bangladesh, it stimulates the ecological footprint by 0.4825%. Therefore, financial development is attached to negative environmental consequences as it creates more damage to the ecological system. This result confirms that financial development promotes economic activity, which in turn increases the global human demands on nature and contributes to environmental degradation. In addition, these findings are in line with several earlier studies, for example, Al-Mulali et al. (2015) have examined the link between financial development and carbon emissions in European-focused countries, founding that financial development can increase long-term carbon emissions.

Table 8, also reports the short-term result for the specification of taking ecological footprint (EF) proxy. The T & C export is found to increase the environmental quality in the short run but the effect becomes positive and significant with the value of 0.05% in 1st lag (D(EX(-1), justifying that the T & C industry reduces the environmental quality of Bangladesh. The coefficient of (DGDP) shows positive and significant but it becomes negative and insignificant in the first lag. The coefficient of D(GDP2) is negative and significant with a value of 2.48% but after taking one lag the coefficient becomes insignificant with a value of 0.056%. The energy consumption (DEU) has a sign with a negative value of 00.544% at a 5% significant level. Whereas, the change of EU with 1 year lagged effect D(EU(-1)) has a positive and insignificant effect on the ecological footprint of Bangladesh. The change in financial development has a positive coefficient in both D(FD) and D(FD(-1)) and the value is insignificant in the short run but eventually, in the long run, the value becomes significant. This means financial development is responsible for reducing the ecological footprint of Bangladesh. In model 2a, the error correction term is correctly signed and significant with a negative value of 0.62 percent to validate earlier results of the long-run relationship among variables. it suggests the high speed of adjustment (62%) of the dependent variable to equilibrium as shown in model 2a.

CONCLUSION AND POLICY IMPLICATIONS

Bangladesh's largest manufacturing industry is textile production. The expansion of this sector, as well as other small and medium-sized businesses, has unquestionably benefited national economic development; yet, there are also environmental issues. The objective of this study is to investigate the impact of T & C export, per capita real GDP, energy use, and financial development on environmental degradation in the case of Bangladesh over the period of 1983-2019, by employing the ARDL approach. To this end, we compare the results of two alternative environment indicators: CO_2 emissions and EF. The CO_2 emissions represent only a small share of total environmental degradation, whereas the EF is considered a more comprehensive measure of environmental damage. The current climate condition of Bangladesh is declining due to the numerous industrial activities. In specific, fabrics are considered to create atmospheric pollution and the increased number of T & C manufacturing augmented GHG emissions. The findings confirmed that the effect of T & C export on the environment is positive and significant for both measures of the environment (CO_2 emission and EF). This result is consistent with Hasseb et al.'s (2020) study where they found T & C industries positively contribute to the CO_2 emissions in China, Indonesia, Pakistan, and India.

The long-run estimation result indicates a positive and significant effect of per capita real GDP emission and a negative impact of per capita real GDP squared on the CO_2 emissions. This result is in line with Al-Mulali et al. (2015) who investigated the EKC hypothesis for different income groups and countries by using ecological footprint (EFP) measures. In their study, they found that the EKC hypothesis is missing for lower-middle-income and upper-middle-income countries. Similar signs of GDP and GDP squared on EFP. However, the values are significant for the CO_2 emission measure but not significant for EFP. Thus, we can conclude that the EKC hypothesis is supported when we use CO_2 emission but using EFP did not support the EKC hypothesis. Similar results were also reported by Jorgenson et al. (2017) and Ghazali & Ali (2019); Imamoglu (2018) for Turkey & Mrabet & Alsamara (2017) for Qatar. All these studies confirmed the non-existence of the EKC phenomena while taking the ecological footprint as a proxy. Mrabet et al.

(2017), used ecological footprint and found in their long-term estimates show that the environmental quality of economic growth is degraded by increasing the ecological footprint for Qatar. This result indicates in the long run it is expected Bangladesh relies on the production and the exports of T&C products to sustain its economic growth. This will create an increasing volume of polluted goods. The rest of the variables were found similar in both measures.

Energy consumption is found to significantly affect the environment of Bangladesh. In both proxies, energy consumption is found to have a significant and positive impact on the environment both short-term and long-run. The policymakers need to explore alternative modes of energy consumption (green energy) to reduce the continuous environmental degradation in Bangladesh. It is also recommended Bangladesh prioritize energy efficiency projects to improve energy saving and enhance the role of renewable energy in reducing the ecological footprint arising from the consumption of energy mostly oil, and fossil fuels. In addition, policymakers need to urgently up their investments in renewable sources (like wind, solar, tides, bioenergy, etc.) because renewable sources are clean and low in emissions. Moreover, trade-related actions and strategies to increase environmental protection is needed to initiate because T & C export increases the ecological footprints of Bangladesh. The adoption of suitable trade openness policies is a further policy alternative emissions of dioxide and thus environmental improvement which will help to reduce carbon levels quality. Bangladesh needs to take steps in energy conservation and environmental protection policies to curb CO_2 emissions and find out alternative and green sources of energy. Technological improvement through research and development is necessary in this regard.

The result of this study concluded that financial development led to an increase in environmental degradation. Financial development is another factor that has become more important recently. Various studies focused on including this factor in EKC estimates. The government, banks, and other institutions should participate in projects or activities that acknowledge the significance and adopt a code of good practice in Bangladesh in environmental matters. In the future, Bangladesh can employ carbon intensity in the financial embodied of government policy. The current study suggests that the regulators adopt some policies that promote environmental protection for the textile industry. Green technology must also be promoted in T&C sector processing in Bangladesh. In addition, this study suggests that government and policymakers increase investments in textile and focus on research and development to promote eco-friendly technologies related to the textile sector production and distribution. In addition, carbon tariffs have to be introduced to discourage the emission of greenhouse energy to reduce adversity environmental pollution. Furthermore, the cooperation of many stakeholders should be encouraged to raise the environmental awareness of staff, directors, retailers, manufacturers, and traders so that Bangladesh can get continuous benefit from the textile sector's growth as well as environmental sustainability. The current study is limited to recognizing the overall effect of garments and production on environmental degradation, which is useful in determining the garment industry's overall impact on CO_2 discharge, however, future studies can be recommended to augment the textile-environment nexus with a detailed examination of garment process, such as spinning, weaving, dyeing, wetting, printing and so on.

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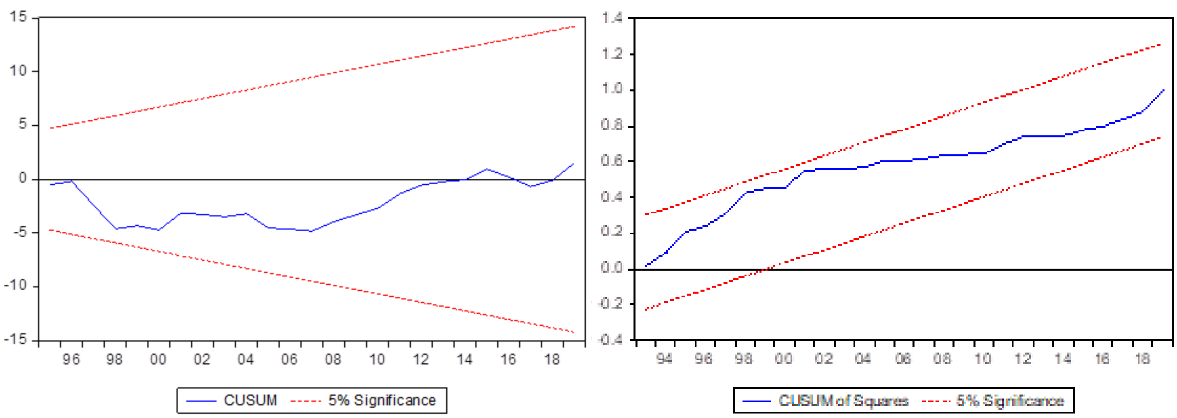

Fig. 2: CUSUM and CUSUMQ (CO_2PC model)

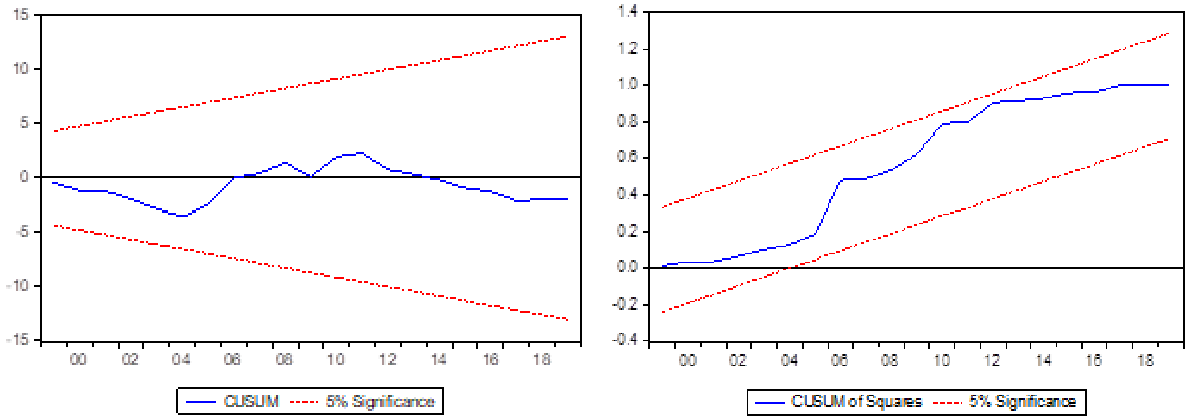

Fig. 3: CUSUM and CUSUMQ (EF model).

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