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THE IMPACT OF FINANCIAL DEVELOPMENT ON ACCELERATING THE ENVIRONMENTAL DEGRADATION IN BANGLADESH

Purpose. To examine long-run and short-run effects of industrial financial development on carbon emissions in Bangladesh.

Methodology. The auto-regressive distributed lag model was implemented on the data collected from 1976 to 2020 to exhibit cointegration in regression form. Traditional unit roots as well as the Zivot-Andrews structural break test was conducted for investigating a significant single-break. The auto-regressive distributed lag model (ARDL) model approved long-run cointegration having a structural break in this study.

Findings. The results conclude that energy consumption triggers carbon emissions with a significant effect on short and long-run models but financial development has no significant effect on environmental degradation. A considerable U-shape Environmental Kuznets Curve hypothesis is observed at the nexus of carbon emissions and economic growth.

Originality. The current study proposed to contribute to the existing literature by assessing the effects of financial development, economic growth, and energy consumption on environmental degradation in Bangladesh using modern econometric methodologies.

Practical value. The results obtained will be useful to scientists, economists and practitioners dealing with economic and environmental development of different industries.

Keywords: *financial development, industry, energy consumption, ARDL, economic growth, environmental degradation*

Introduction. Environmental degradation is a global threat and human race is in vulnerable stage to battle with it. CO_2 emission is a foremost factor of the greenhouse effect, and study on this aspect has enacted much attention of scholars in recent years. Consumption of coal, oil, and natural gas is responsible for emitting CO_2 in a larger amount. Triggers behind this emission are numerous, top sources are income, energy consumption, population, foreign trade. Financial development is being investigated as a potential source of CO_2 emissions. In spite of the fact that previous research has addressed the relevance of economic growth in explaining carbon emissions, there is little information available about the relationship between financial development and carbon emissions. Financial development (FD), in particular, stimulates foreign direct investment (FDI), which, in turn, stimulates economic development. Therefore, financial progress ultimately leads to an increase in carbon emissions through increased energy use [1]. The Environmental Kuznets Curve (EKC) Hypothesis postulated that economic development, as measured by income per capita, is associated with an increase in environmental deterioration, as measured by the amount of some sort of air pollution (emissions) until a certain point, at which the connection takes a negative turn. This algebraic but naïve theory plays as a crucial role in formulating climate change policy and developmental strategies, which can be validated by studying the relationship between economic development, financial development, energy consumption, and environmental impacts. The Environmental Kuznets Curve (EKC) Hypothesis is evaluated nowadays as a country's ecological footprint to measure environmental degradation. Thus, the nation's ecological footprint is implemented as a sign of environmental degradation.

Literature review. Based on differentiability in income, 93 countries were investigated to show an inverted U-shaped relationship between financial development to the ecological footprint. This study depicted the EKC Hypothesis in the context of high-income and upper-middle-income countries but not for lower-middle-income and low-income countries. Furthermore, urbanization, industrialization, and energy usage escalate all nations' environmental degradation, regardless of wealth level. For instance, In Turkey from 1974 to 2014, the ARDL bound testing approach (Gregory-Hansen and Hatemi-J Cointegration Test) was employed to analyze the short-term and long-term correlation amid urbanization, economic growth, financial development, energy consumption, and carbon dioxide emission. The test observed a long-term link between these variables. On the other hand, energy consumption showed no effect on carbon dioxide emissions [2]. In Kenya from 1980 to 2012, the Environmental Kuznets Curve Hypothesis was inspected analogous to the ARDL approach. The investigation divulged that energy consumption, financial development, economic development, and urbanization augmented air pollution for both long-term and short-term models. Hence, the so-called EKC hypothesis did not exist for Kenya. The EKC Hypothesis detects the earliest scale of financial development, environmental degradation, and pollution. When a country achieves a certain degree of progress, the tendency reverses, assuming the connection is represented by an inverted U-shaped curve, i. e., the amount of CO_2 emission increases in the early phase. However, it starts to decline after reaching the highest extremity with elevated economic development. The environment and the economy do not have to be diametrically opposed. The two may look unconnected in the short term, yet they are intimately linked in the long run. Both must be incorporated for long-term economic success; else, citizens will face serious implications later. Economic activity has expanded in recent decades, increasing concerns about its impact on the environment on a national and worldwide scale. Since Grossman and Krueger presented the Environmental Kuznets Curve (EKC) theory, the link between economic development and environmental quality has received a lot of at-

tention. According to the EKC hypothesis, economic growth has an advantageous effect on CO_2 emissions during the initial stage, but it has a negative effect after CO_2 emissions reach the maximum level associated with a specific amount of income per capita [3]. According to one research study, financial development increases CO_2 emissions [4]. Economic expansion also has a negative impact on the environment. Globalization has been demonstrated to have a detrimental impact on CO_2 emissions. Financial development and CO_2 emissions have a U-shaped and an inverted N-shaped link. From 1985 to 2015, the ARDL approach was used to examine the impacts of globalization on Vietnam's CO_2 emissions. It shown that, whereas energy consumption, industrialization, and GDP per capita all raised CO_2 emissions, globalization reduced them.

Environmental awareness has never been emphasized in the academic curriculum, resulting in a lack of knowledge. The repercussions may already be seen in deforestation and indiscriminate hill cutting; loss of wetlands; depletion of soil nutrients; emissions of harmful particles into the sky; and, most importantly, surface and ground-level water contamination, among other things. Natural calamities such as floods, cyclones, and tidal bores have a devastating impact on the environment and the economy. Given Bangladesh's exceptional economic growth, a combination of possible EKC trajectories is evaluated to identify the implications for Bangladesh's financial development in light of the impending environmental problem. Globalized economies achieve trade competitiveness and high economic growth in a sustainable environment [5]. It is vital to focus on the finance–environment nexus because it has the ability to enhance environmental quality through lowering carbon emissions.

Unsolved aspects of the problem. Within the EKC framework, this study will investigate the environmental implications of financial sectors and energy use (CO_2 emissions) in Bangladesh. In light of the preceding debate, it is possible to infer that the expansion of the financial sector can have an impact on environmental performance. However, there is a scarcity of empirical data, including a relationship between financial sector expansion and environmental degradation in Bangladesh. Therefore, the current study intends to contribute to the existing literature by evaluating, through modern econometric methodologies, the effects of financial development, economic growth, and energy consumption on environmental degradation in Bangladesh between 1976 and 2020.

Purpose. To apply modern econometric methodologies for assessing, analyzing and forecasting the effects of financial development, economic growth, and energy consumption on environmental degradation in Bangladesh.

Methods. ***Variables & data.*** As carbon dioxide is the fundamental cause of environmental degradation, the current article employs carbon emissions per capita as a proxy. This study considers variables such as financial development, per capita energy use (oil kg equivalent) and per capita real GDP (US$ at 2010 prices) for Bangladesh from 1976 to 2020. The entire dataset is derived from World Bank indicators [6]. For analysis purposes, Eviews version 10.0 has been used.

Model. This study discloses both long-run and short-run effect of financial development, energy consumption and economic growth on the carbon emission of Bangladesh.

The following is the required model

$$LCE_{it} = \alpha_i + \beta_1 LEC_{it} + \beta_2 LFD_{it} + \beta_3 LY_{it} + \beta_4 LY_{it}^2 + \varepsilon_{it}, \quad (1)$$

where *LCE* stands for natural log of per capita CO_2 emissions; *LEC* – for natural log of per capita energy consumption; *LFD* – for natural log of financial development; *LY* – for natural log of real GDP per capita, and ε is the white noise error term. The probable sign of $\beta_1 > 0$, as it increases the speed of greenhouse gases, β_2 is ambiguous as it will increase or decrease, which impacts carbon emission. Therefore, mature or immature financial sectors maintain or demolish environmental sustainability.

Estimation techniques. This study employs the ARDL model to exhibit short-run, and long-run carbon emission evaluates with other control variables under the Bangladesh economy context. It estimates better contemporary methods on small or large sample sizes. Hence, equation (2) can be written as

$$\Delta LCE_t = \alpha_0 + \sum_{i=1}^{z} \gamma_{1i} \Delta LCE_{t-i} + \sum_{i=1}^{z} \gamma_{2i} \Delta LEC_{t-i} + \\ + \sum_{i=1}^{z} \gamma_{3i} \Delta LY_{t-i}^2 + \sum_{i=1}^{z} \gamma_{4i} \Delta LFD_{t-i} + \sum_{i=1}^{z} \gamma_{5i} \Delta LY_{t-i} + \mu_1 \Delta LCE_{t-1} + \quad (2) \\ + \mu_2 \Delta LEC_{t-1} + \mu_3 \Delta LFD_{t-1} + \mu_4 \Delta LY_{t-1} + \mu_5 \Delta LY_{t-1}^2 + \varepsilon_{1t}.$$

Here γ's are short-run, μ's are long-run coefficients, α_0, Δ and ε_{1t} are intercept, difference operator and white noise error term, respectively. The null hypothesis of no cointegration relationship between variables is

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = 0,$$

and the alternative hypothesis is

$$H_1: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq 0.$$

In Narayan, P. K., 2005 and [7] both suggested a two-bound F-statistic of critical values (lower bound and upper bound) for both large and small samples. If examined F-values surpassed the upper bound, then there is cointegration under a certain significance level. If the F values lie between lower and upper bound, then inferential statistics remain indecisive, and t-statistics needs asymptotic approximation. On the contrary, if F-statistic lies under a lower bound, then there is no cointegration. Before this ARDL estimation, strong prohibition of variables of the absence of I (2) series. Therefore, a unit root test is necessary. Hence, the ARDL-ECM model is given as follows

$$\Delta LCE_t = \alpha_0 + \sum_{i=1}^{z} \gamma_{1i} \Delta LCE_{t-i} + \sum_{i=1}^{z} \gamma_{2i} \Delta LEC_{t-i} + \sum_{i=1}^{z} \gamma_{3i} \Delta LFD_{t-i} + \\ + \sum_{i=1}^{z} \gamma_{4i} \Delta LY_{t-i} + \sum_{i=1}^{z} \gamma_{5i} \Delta LY_{t-i}^2 + \mu_1 \Delta LCE_{t-1} + \mu_2 \Delta LEC_{t-1} + \quad (3) \\ + \mu_3 \Delta LFD_{t-1} + \mu_4 \Delta LY_{t-1} + \mu_5 \Delta LY_{t-1}^2 + \theta ECT_{t-1} + \pi_1 D_{1t} + \varepsilon_{1t}.$$

The error correction term (ECT) in this context explains the speed of adjustment and displays how the dependent variables run towards equilibrium in the short run due to the effect of independent variables. Its value must be negative and statistically significant. As structural break hampers further estimation, this study assembles a single break in an exogenous variable. Further stability test (CUSUM & CUSUSQ) and diagnostic tests (Heteroscedasticity, normality, and serial correlation) are applied to promote the ARDL model and fulfill its assumption.

Results. This study works on four variables of long-run & short-run relationship on carbon emission and other variables from 1976 to 2020 in Bangladesh. Each variable is converted on a natural logarithm for easier explanation and removing heterogeneity issues. From Table 1, it can be seen that financial development (LFD) has a slightly larger deviation than others do on standard deviation (SD) and Sum square deviation sense. On skewness and Kurtosis, Financial development has a negative or left-skewed and leptokurtic curve. Others are quite symmetric curves. Jarque-Bera statistic of all variables resembles normal dataset at 5 % level of significance as the annual dataset is considered for 45 years.

Having some pitfalls of the EKC hypothesis, this study implemented Auto-regressive distributed lag model (ARDL) suggested by Pesaran, Shin, and Smith for exhibiting the long-run relationship between carbon emission and other regressors. Before this, we are checking stationary or robustness, which is necessary for empirical analysis. In both drift and

Table 1

Basic statistics of five variables

Basic statistics	LCE	LEC	LFD	LY	LY[1]
Mean	–1.642	4.966	2.830	6.264	3.666
Median	–1.619	4.928	2.995	6.153	3.634
Maximum	–0.598	5.562	3.862	7.093	3.918
Minimum	–2.691	4.559	0.651	5.808	3.518
SD	0.634	0.303	0.835	0.371	0.116
Skewness	0.050	0.478	–0.835	0.726	0.659
Kurtosis	1.810	1.994	2.986	2.305	2.198
Jarque–Bera	2.675	3.614	5.231	4.856	4.467
Probability	0.263	0.164	0.073	0.088	0.107
Sum	–73.871	223.470	127.342	281.894	164.988
Sum Sq. Dev.	17.695	4.042	30.684	6.065	0.596
Observations	45	45	45	45	45

[1] estimated

drift with the trend, we apply traditional unit root tests such as the Augmented Dickey-Fuller and Philips-Perron tests (Table 2). At a 1 % level of significance, all variables are stationary at first difference. So, carbon emission, energy consumption, economic growth, and financial development are I (1) series. The ARDL model is more spurious, having a structural break. As a result, we apply the Zivot-Andrews unit root test to a time series with a single endogenous structural break, which provides information on an unknown structural breakpoint.

The Z-A test, stated in Table 3, provides a structural break based on the minimum breakpoint t-statistic. Therefore, only 1 % of significant test statistics reject the null hypothesis on both intercepts & intercept with the trend. As minimum values exhibit an intercept with the trend, we show a structural but statistically significant break.

In ARDL estimation, the null hypothesis of no cointegration is rejected at a 1 % significance level in Table 4. So, there is a strong relationship between carbon emission, financial development, energy consumption, and economic growth, as it surpasses the upper bound value at a 1 % level of significance.

Table 2

Unit root tests of variables

Variables	ADF test		PP test	
	Intercept	Intercept with trend	Intercept	Intercept with trend
LCE	0.065	–2.620	–0.171	–3.947**
LEC	2.512	–0.760	4.867	–0.852
LFD	–2.369	–3.92**	–4.617***	–2.039
LY	4.238	1.173	8.415	0.335
LY^2	4.086	0.402	7.090	–0.363
D(LCE)	–6.787***	–6.700***	–16.316***	–15.311***
D(LEC)	–8.261***	–9.314**	–8.238***	–11.920***
D(LFD)	–4.866***	–5.246***	–7.144***	–8.387***
D(LY)	0.425	–3.905***	–5.633***	–9.507***
$D(LY^2)$	0.080	–4.611***	–6.382***	–10.467***

Note: (*) Significant at 10 %; (**) Significant at 5 % and (***) Significant at 1 %

Table 3

Zivot-Andrews Structural break test of variables

Variables	At level			
	T statistic	Time break	T statistic	Time break
	Intercept		Intercept & trend	
LCE	–5.208**	2004	–6.031**	2010
LEC	–3.560	2000	–3.566	1999
LFD	–4.764*	1985	–5.908*	1984
LY	–1.190	1998	–1.030	1997
LY2	–1.567	1997	–1.514	1988
At first difference				
Variables	T statistic	Time break	T statistic	Time break
	Intercept		Intercept & trend	
LCE	–6.929**	2011	–7.336**	2008
LEC	–9.320**	1984	–9.784**	2006
LFD	–9.799**	1988	–10.049**	1994
LY	–12.431**	1989	–12.661**	1990
LY2	–12.715**	1989	–13.212**	1990

Note: (*) Significant at the 5 % and (**) Significant at the 1 %

Table 4

F-statistic values of Auto-regressive distributive lag (ARDL) (2, 2, 0, 0) model

Variables	F-statistic	P-value
$H_{(LCE(/LEC,LFD,LY,LY2)}$	7.1995	0.0000
Critical bound value	I(0)	I(1)
10 %	2.45	3.52
5 %	2.86	4.01
1 %	3.74	5.06

Note: estimated

Table 5 summarizes the findings of short-and long-run estimations. In the short run, energy consumption has a positive and statistically significant effect on carbon emissions at a 1 % significance level. The speed of adjustment explains 78.29 % disequilibrium in the long run of carbon emission to other regressors. In addition, the dummy has a significant positive break towards carbon emission. In the long run, financial development has a positive but insignificant effect on carbon emission. Moreover, the square term of economic growth reveals a positive and significant effect on carbon emission. Hence, the EKC hypothesis has a U-shaped effect under this study. In 1984, the political breakdown happened and massively affected economic conditions. The political strategy has changed as civil government is nipped on Bangladesh's economy. For this, a dummy is chosen after Zivot-Andrews structural break test and ARDL with break estimation. Further diagnostic tests (Jarque-Bera t-statistic for normality, Breusch-Pagan-Godfrey for heteroscedasticity, and Breusch-Godfrey for serial correlation) support ARDL estimation. Additionally, CIUSUM (Cumulative sum of recursive residuals) and CUSUMSQ (Cumulative Sum of Square of recursive residuals) are statistically significant at a 5 % level of significance for parameter stability.

Developing countries like Bangladesh are prime victims of climate change issue The goal of this study is to demonstrate how economic expansion, energy consumption, and financial development effect environmental deterioration and carbon emissions in Bangladesh. On this empirical model, we discov-

Table 5

Summary of short-and long-run estimations

Variable	Coefficient	SE	t-Statistic
Long–run estimates			
LEC***	2.4372	0.3782	6.4446
LFD	0.0076	0.0565	0.1352
LY***	–6.2242	1.1118	–5.5983
LY^{2}***	18.6352	4.0365	4.6167
Short–run estimates			
C	–33.7828	5.3543	–6.3095
D(LCE(–1))**	0.2996	0.1246	2.4056
D(LEC)***	1.4478	0.2035	7.1152
D(LEC(–1))***	–0.989	0.2474	–3.9977
D1984***	0.09	0.0183	4.9162
ECT(–1)***	–0.7829	0.1240	–6.3161
Test	Test statistic	p–values	–
Normality	1.889	0.388	–
Heteroscedasticity	1.009	0.392	–
Serial correlation	0.784	0.481	–
Test	Support	–	–
CUSUM	Stable	–	–
CUSUMSQ	Stable	–	–

Note: (*) significant at 10 %; (**) significant at 5 % and (***) Significant at 1 %.

ered a long-run connection or cointegration using the ARDL model. After independence, the energy crisis has become a primary concern for both industrialized and developing countries [8]. As a result, the relationship between energy use and economic development was given the highest emphasis [9]. This study confirms the EKC hypothesis on long-run elasticities with a U-shaped curve as on liner form, the coefficient of economic growth per capita is negative, but its square is positive with a 1 % level of significance. This evidence is similar to current literature [10]. As a developing country, Bangladesh's energy industry is still reliant on traditional sources, with little usage of renewable energy. Bangladesh has progressed from being a low-income to a lower-income nation [11]. As a result, it presents additional difficulties to policymakers in terms of maintaining economic momentum while reaching SDG targets. Over the previous two decades, per capita energy consumption has more than doubled, yet fossil fuel usage remains the highest. Energy consumption is surging as a result of changes in our economic structure during the previous four decades [8]. Our GDP is mostly derived from the service sector, with agriculture not accounting for the lion's share. The Economic Commission's (7^{th} Five-Year Plan) strategy offers a credible vision for high income in 2041. As a result, officials are concerned that if demand from energy supply fills the gap and economic growth continues, its future will not be jeopardized. It will be a monumental undertaking to host as a middle-income nation by 2021 and a high-income country by 2041 unless a sustainable and uninterrupted supply of energy at a reasonable price is secured at every industrial and this remark is supported by other experts [8]. As the economy grows, so does demand for energy, which is growing far faster than in the previous two decades [12]. Economists and governments must choose between stronger environmental protection and faster economic growth to boost economic growth [13]. This occurs because fossil fuel combustion is prevalent with long lead times, while increasing renewable energy is still a worry.

Conclusion. During the last two decades, climate change and global warming have turned into vulnerable issues. Bangladesh is living evidence of this as cyclone, floods, or earthquakes have given their footstep in this country. Also, too many oaths on conferences, organizations, or conferences have taken place to lessen carbon emission before industrialized nations build. Specifically, on the Paris Agreement, a target has been fixed to limit temperature to less than 2 degrees Celsius due to the demand of climate-vulnerable countries like Bangladesh. Bangladesh vigorously participates in the 'United Nations Climate Change Conference (UNCCC)' conversation favoring vulnerable countries' climate change [14]. Bangladesh has admitted to lessening carbon as well as Greenhouse Gas emission in the long run. Using data from 1976 to 2020 in the current study to exhibit the long-run relationship, the researcher employs ARDL bound test by rejecting the null hypothesis of no cointegration. For checking out the order of variables, traditional unit root tests suggested that all variables are stationary at first order except carbon or GHG emission. Due to loss of test power and spurious regression, Structural break tests are performed under Zivot-Andrews structural single break test. With a single break as a dummy variable, long-run and short-run estimates are analyzed. In the long run, the Square term of economic growth reveals positive while it is negative. So, no EKC hypothesis is proved on the effect of financial development and economic growth in Bangladesh.

The results suggest that policies under carbon mitigation stand on two pillars – energy use & income which is not prolific for financial development. As carbon emission is not the sole contributor to greenhouse mitigation, our financial development activities weaken environmental quality. The reasons behind these include the laws or policies that are not strictly followed due to the intention for encouraging business investments, surging banking-based loans, inspiring donors to capitalize at low cost, and depriving opportunities of eco-friendly production. As a result, reformation of the financial sector, including the implementation of tough legislation and the implementation of environmentally beneficial initiatives, must begin. Firms from private sectors have to be concerned about ecological balance and preserving these assets. They can change the shape of the economy through an eco-friendly atmosphere from methane or carbon surging air to a healthy environment. The implementation of a green economy, which makes efficient use of limited resources, has secured long-term development. Apart from these market policies, monetary policy needs some action to examine loan performance through marginal interest rate, appreciating projects or unemployed to start biodegradable business or firm and lessening carbon or GHG emission through recycling resources in a massive manner. Financial sectors stand-alone a vast economy sector, so activities under them, firstly, loan borrowers to be addressed with sustainable development using biodegradable products. Secondly, using the power of mass media, inspiring entrepreneurs to take a loan and alleviate poverty, ignorance, and unemployment through recycling waste management, lessening coal emission, using renewable energy, and balancing both economy and ecology. This study does not find any evidence of linkage between financial development and carbon emission as in previous literature [15].

Additionally, the study is capable of establishing the presence of Bangladesh's environmental Kuznets curve. As a result, Bangladesh's economic growth is related to environmental degradation at both low and high-income levels. Bangladesh is not in a position to slow economic expansion in order to maintain environmental standards. Energy consumption is associated with boosting environmental degradation on a large scale. Some policies have been taken to reduce environmental reduction [14]. In addition, some funds are raised to protect the environment. However, some limitations of this study have remained. As a start, instead of relying on a single variable to evaluate financial sector development, this empirical model

can be enhanced by integrating an index of financial development rather than a single variable to measure financial sector development. Second, the model can be tweaked by including additional variables into the cointegrating connection, such as democracy, information, and the development of the communication sector and others. Finally, this model addressed financial development through macroeconomic issues with limited variables regardless of monetary policy.

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Вплив промислового фінансового розвитку на прискорення деградації навколишнього середовища в Бангладеш

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Мета. Дослідити довгострокові й короткострокові наслідки промислового фінансового розвитку на викиди вуглецю в Бангладеш.

Методика. Авторегресивна модель розподіленого відставання була реалізована на даних, зібраних із 1976 по 2020 роки, щоб показати коінтеграцію у формі регресії. Традиційні одиничні корені, а також тест на структурний розрив Zivot Andrews були проведені для дослідження значного одиничного розриву. Авторегресивна модель розподіленого відставання підтвердила довготривалу коінтеграцію, що має структурний розрив у цьому дослідженні.

Результати. У результаті автори прийшли до висновку, що споживання енергії викликає викиди вуглецю, які мають значний вплив на коротко- й довгострокову модель, але фінансовий розвиток не має значного впливу на погіршення стану навколишнього середовища. Значна U-подібна гіпотеза екологічної кривої Кузнеця спостерігається при поєднанні викидів вуглецю та економічного зростання.

Наукова новизна. У проведеному дослідженні пропонується зробити внесок до існуючої літератури, оцінивши вплив фінансового розвитку, економічного зростання та споживання енергії на погіршення стану навколишнього середовища в Бангладеш за допомогою сучасних економетричних методологій.

Практична значимість. Отримані результати стануть корисними вченим, економістам і практикам, які займаються питаннями економіко-екологічного розвитку різних галузей промисловості.

Ключові слова: *фінансовий розвиток, промисловість, енергоспоживання, ARDL, економічне зростання, деградація навколишнього середовища*

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