ASSESSING THE IMPACT OF DE FACTO TRADE GLOBALIZATION AND REGULATORY QUALITY ON ECOLOGICAL FOOTPRINT. EVIDENCE FROM JAPAN

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ABSTRACT

Japan is one of the developed nations in the Asian continent and holds enormous geographical and geopolitical importance in the cross-border movement of goods, services, people, and technology. Hence, it is substantial to analyse the impact of its de facto trade globalization and regulatory quality on ecological sustainability. Therefore, the study employs the autoregressive distributed lag (ARDL) model. Our results confirm that de facto trade globalization and regulatory quality have a positive impact on environmental sustainability, whereas economic growth has a negative impact on the sustainability of the ecology. The results validate that PHEH holds in Japan which means that it promotes environmentally safe trade and technology and its regulatory framework is firm enough in promoting clean trade. The relative decoupling situation is tantamount to an environmentally conscious society with rising economic performance.

Keywords: trade globalization, regulatory quality, ecological footprint, PHEH.

INTRODUCTION

The most crucial issue that mankind is currently facing is environmental sustainability due to its major global impacts (Muhammad & Khan, 2021). Global warming and climate change are the grave environmental threat to humanity (Khan et al., 2020; Naseem et al., 2022). Economic development is considered to be one of the determinants of the environmental health of a nation. In order to achieve higher economic growth, imperishable ecological development has largely been neglected (Adeleye et al., 2022). To cater to this problem, the United Nations set an agenda for achieving sustainable development by 2030 (Khan et al., 2020). It encompasses 17 sustainable development goals (SDGs), out of which, SDGs 7, 8, 13, and 15 focus on achieving rational economic and ecological evolution (Naseem et al., 2022). In spite of taking numerous steps in combating the issue all across the globe, uncommon environmental patterns state that there are still miles to go (Mehmood et al., 2021).

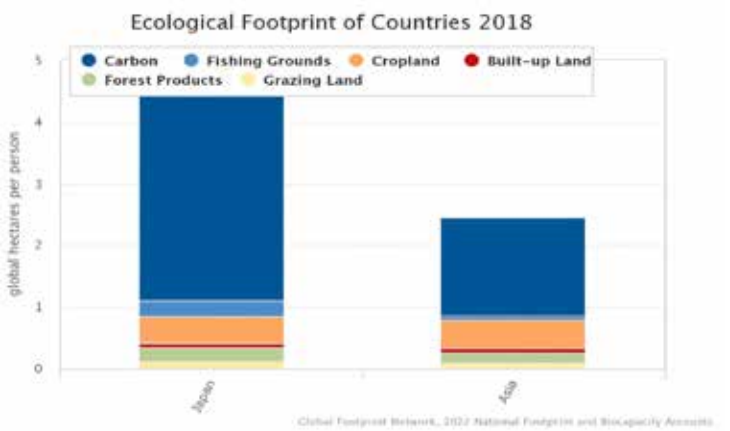


Fig. 1 The per-person ecological footprint in Japan and Asia (gha)

Source: Author's calculation based on Global Footprint Network database.

Japan is one of the developed and largest economies of the Asian region and is a part of the C6 nations which is a group of the top six CO2 emitters (Liu et al., 2023). Figure 1 shows the comparison between per-person ecological footprint (EF) in Japan and Asia in global hectares. It is quite evident from the figure that the ecological depletion caused by Japan is much higher than that done by all the Asian economies taken together. According to the Global Footprint Network, the per-person EF of Japan is about 4.61 gha versus 2.45 gha for the entire Asian continent. Fig. 2 depicts the substantial contribution of Japan to the per capita CO2 emissions (in metric tons) in comparison to its South Asian counterparts. This underlies the fact that the brunt of the rising economic performance of Japan is borne by its environment. For maintaining its strong foot in the global market, trade globalization is a major area for policymakers of Japan.

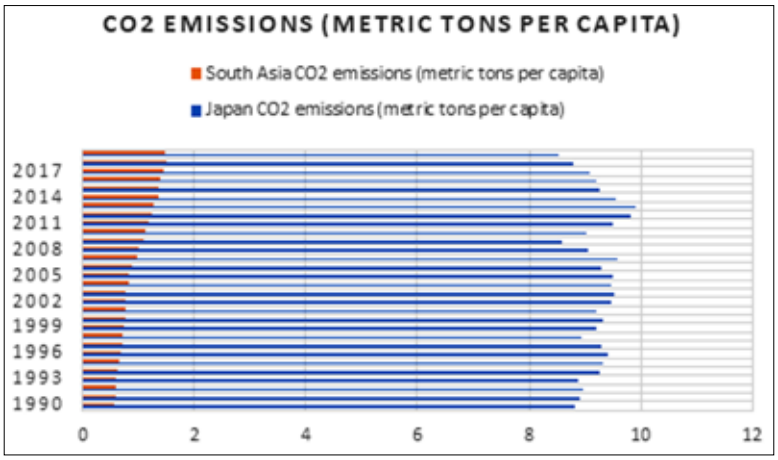


Fig. 2 CO2 emissions (metric tons per capita) for South Asia and Japan.

Source: Author's calculation based on World Development Indicators, World Bank database

Globalization refers to the increasing interrelation of the economies across the world through the spread of trade, investment, information, and technology. The process of globalization has fast-tracked in recent times, driven by technology, trade and investment policies, and the growth of multinational corporations (Azam et al., 2022; Iqbal et al., 2023). But it has doubtful advantage in the sense that rising trade globalization with loose environmental regulations makes the nation a pollution haven for high-emitting businesses (Bekoe & Jalloh, 2023; Khochiani & Nademi, 2020). The pollution haven hypothesis (PHH) states that globalization has a negative impact on host nation's environment (Adebayo, 2022; Xie & Sun, 2020). According to PHH, to increase foreign trade and investments, environmental regulations are eased up to allow 'unhealthy' technology to enter the host nation, leading to increased emissions (Hashmi et al., 2023; Naseem et al., 2022). The counter argument states that foreign funds and trade accompany environmentally healthy technologies resulting in increased use of green energy. This environment friendly impact of globalization of the host nation is defined as Pollution halo effect hypothesis (PHEH) (Adebayo, 2022; Bandyopadhyay & Rej, 2021; Hashmi et al., 2023; Xie & Sun, 2020). With the rising trade globalization in Japan, testing the PHH and PHEH is important.

As globalization has expanded, it has led to increased development and growth of the economy in most of the parts of the world. However, it has also been accompanied by concerns about environmental degradation and regulatory quality. As per the World Bank, regulatory quality is the government's ability to ensure development of private sector by devising sound regulations. It includes trade, business, and competition regulations (Ibrahim & Ajide, 2021). Effective regulations establishes efficient management of the waste-producing establishments, thereby furthering economic growth without creating pressure on the environment (Güngör et al., 2021).

The literature has discussed the impact on environmental degradation from the point of view of globalization (Adeleye et al., 2022; Agila et al., 2022; Rafindadi & Usman, 2019), regulatory quality (Güngör et al., 2021; Ibrahim & Ajide, 2021), and urbanization (Bekun et al., 2022; Hashmi et al., 2023; Hatmanu et al., 2022; Naseem et al., 2022). However, there is a fervent need to study the relationship between trade globalization, regulatory quality, and environmental sustainability because de facto trade globalization ensures economic growth on the one hand promotes green growth on the other (as postulated by PHEH) (Hongqiao et al., 2022). Also, the level of regulatory quality of a nation determines its level of trade. Therefore, exploring the complex trade-governance-ecology nexus is necessary for one of the developed economies of the Asian continent, i.e., Japan so that policy makers can devise important policies and provide a way forward for the other Asian counterparts. Hence, the present study aims to investigate the impact of these macroeconomic variables on EF of Japan. The paper discusses PHH/ PHEH in trade-governance-ecology relation. To the best of our knowledge, our study is second to none in exploring the influence of trade globalization de facto and regulatory quality on EF with a special focus on PHH/

PHEH in the case of the country which forms the eastern edge of Asia. We have also employed the decoupling index (DI) to disentangle EF from economic development.

Because of the geographical and geopolitical importance of Japan not only for Asia but also for the rest of the world, it is substantial to analyse the impact of its de facto trade globalization and regulatory quality on the ecological sustainability. In the pursuit of the said purpose, EF has been used to proxy environmental degradation since it captures the pressure on the environment not only from the lens of CO2 emission but more holistically (Khan et al., 2021). According to (Rees & Wackernagel, 2008; Wackernagel & Yount, 1998), EF is the capacity of the nature to fulfil man's requirements and absorb waste that is released by various human activities. Our paper is a useful contribution to the existing body of knowledge as it analyzes the impact of trade globalization de facto and regulatory quality on EF, incorporating economic growth, and urban population growth as control variables. The study employs the autoregressive distributed lag (ARDL) model. ADF unit root test is applied for testing the stationarity in the data, while Akaike Information Criterion (AIC) is used for ascertaining the lag order. It is followed by the long run form and bounds test for testing the existence of cointegration. ARCH and LM tests are applied to test for heteroscedasticity and autocorrelation respectively. The constancy of the model has been duly checked. Our results confirms that de facto trade globalization and regulatory quality have a positive impact on the ecology, whereas economic growth has a negative impact on sustainability. The results validate that PHEH holds in Japan which means that it promotes environmentally sustainable trade and technology and its regulatory framework is firm enough in promoting clean trade. The DI value of 0.3210 signals relative decoupling situation, which means that although EF is rising but the rate of growth of the economy is greater.

The flow of the paper is as follows. Section 2 includes the literature review; data, model specification, and methodology are discussed in the third section, followed by results and findings (section 4), and conclusion, policy recommendations, and research gaps (section 5).

LITERATURE REVIEW

There are a number of studies investigating the impact of various macroeconomic variables on environmental degradation. However, in this paper, the review is limited to the studies investigating the trade globalization- regulatory quality-environment connection.

Globalization- Environmental Depletion

The existing studies provide varied opinions on the impact of globalization on environment. (Leal et al., 2021) analysed the de facto and de jure dimensions of globalization for the period 1995 to 2017 for a panel of 58 nations and concluded that de facto economic globalization reduces CO2 emissions in developed countries. In the case of BRICS-T nations, it was reported by (Hashmi et al., 2023) that expanding financial globalization de facto degrades the environment. For South Korea, (Agila et al., 2022) stated that trade globalization has negative impact on the load capacity factor which means that the development of trade reduces environmental quality. Parallel results

were conveyed by (Awosusi, Xulu, et al., 2022) in the case of Uruguay as trade globalization depletes the environment. However, (Ahmed & Le, 2021) confirmed the positive impact of trade on the environmental quality of ASEAN. (Pata & Yilanci, 2020) also stated similar results in the case of G7 nations for the period stretching from 1980-2015. (Sheraz et al., 2021) also found that financial development and globalization reduces degradation of the environment in G20 nations. This study was conducted from 1986-2018.

Regulatory quality- environment depletion

The literature suggests that stricter regulations determine environment sustainability. The quality of governance was found to improve the environment quality in the long-run for BRICS-T nations implying that strict policies ensures proper monitoring of dirt releasing industries (Hashmi et al., 2023). Existence a direct relationship between regulatory quality and reduction in CO2 emissions in the case of MENA economies was reported by (Omri & Ben, 2020) for the period 1996–2014. The institutional quality of E-7 nations was found to limit ecological footprint for the period 1992-2015 (Uzar, 2021). However, opposing results were testified for BRICS nations for the period of 1996 to 2018 by (Ibrahim & Ajide, 2021).

METHODOLOGY

Data

In the pursuit of finding whether trade globalization and regulatory quality have an adverse implication on the environmental sustenance in Japan, the study uses EF to measure environmental degradation (Khan et al., 2021) (refer table 1 for variable description). We have expressed it as a function of de facto trade globalization and regulatory quality. Macroeconomic factors such as urbanization and economic development are used as control variables. Data on trade globalization de facto are extracted from KOF Globalization Index (Gygli et al., 2019). The data for regulatory quality (expressed in percentile rank), GDP per capita, and urban population growth rate are collected from the World Development Indicators, World Bank Database. Per capita GDP (constant 2015 US$) and urban population growth rate are used to measure economic growth, and urbanization respectively. The data on EF is taken from the National Footprints Account of the Global Footprint Network. Time series data from 1990 to 2021 is used. Since the data was missing for a certain number of years for some variables, we used linear interpolation for filling the data gaps (Gygli et al., 2019; Hashmi et al., 2023).

Table 1: Variable's description.

S. No.	Variables	Measuring unit	Sources
1	Ecological footprint (EF)	Global hectares per capita	Global footprint Network 2019)
2	De facto trade globalization (Trade)	Score out of 100	KOF Globalization Index (2019)
3	Regulatory quality (Regulate)	Percentile rank	WDI-(2020)
4	Economic growth (GDP)	Per capita GDP (constant 2015 US$)	WDI-(2020)
5	Urbanization (UBPG)	Urban population growth rate	WDI-(2020)

Source: Author's compilation. The data included for the purpose of the study stretches from 2019 to 2021 since it is the most recent data available for the variables. The year mentioned in the 'sources' column is the year in which the index was introduced/ developed but it is inclusive of the data from 1990 to 2021.

Model specification

The econometric model used in the study is as follows:

$$\text{Log(EF)} = \alpha_0 + \alpha_1 \text{ Log(Trade)} + \alpha_2 \text{ Log(Regulte)} + \alpha_3 \text{ Log(GDP)} + \alpha_4 \text{ Log(UBPG)} + \mu \qquad (1)$$

where, Log(EF), Log(Trade), Log(Regulate), Log(GDP), and Log(UBPG) are the natural logs of ecological footprint, trade globalization de facto, regulatory quality, per capita GDP, and urban population growth rate respectively, μ is the error term. The logarithms of the variables have been taken to guarantee variance' stability. α1, α2, α3, α4, α5 are the coefficients of the independent variables.

Methodology

1. Cointegration test

A cointegration test helps in ascertaining long-run relationship between the variables. ARDL Long Run Form and Bounds Test, developed by (Pesaran et al., 2001), is used for this purpose because of two important reasons. Firstly, it is an apt measure for establishing the relation of those variables that are I(0) or I(1) but not I(2), secondly it is the best estimation technique for a small sample (Awosusi, Rjoub, et al., 2022; Danish et al., 2019). The null states that there is no cointegration, i.e., α1, α2, α3, α4 (in eq. 1) are not equal to 0 and the alternative is that α1, α2, α3, α4 are equal to 0. If the F-value exceeds the upper bound, then the null is rejected (Narayan, 2005; Pesaran et al., 2001). ARDL equation of the variables is as follows (eq.2):

$$\Delta \text{LogEF}_t = \alpha_0 + \sum_{k=1}^{u} \alpha_u \Delta \text{LogEF}_{t-k} + \sum_{k=0}^{v} \alpha_v \Delta \text{Log(Trade)}_{t-k} + \sum_{k=0}^{w} \alpha_w \Delta \text{Log(Regulate)}_{t-k} + \sum_{k=0}^{x} \alpha_x \Delta \text{Log(GDP)}_{t-k} + \sum_{k=0} \alpha_y \Delta \text{Log(UBPG)}_{t-k} + \mu_t \qquad (2)$$

After testing for a cointegration relation, the long and short-run coefficients are estimated using error correction models (ECM). The error correction term (ECT) used in ECM measures the speed with which an endogenous variable adjusts to long-run equilibrium. The convergence of ECT(γ in eq. 3) to the long-term level is confirmed if its value is negative and statistically significant. The ECM used for the short-run dynamics is as follows (eq.3):

$$\Delta LogEF_t$$

$$= \alpha_0 + \sum_{k=1}^{u} \alpha_u \Delta LogEF_{t-k} + \sum_{k=0}^{v} \alpha_v \Delta Log(Trade)_{t-k} + \sum_{k=0}^{w} \alpha_w \Delta Log(Regulate)_{t-k} + \sum_{k=0}^{x} \alpha_x \Delta Log(GDP)_{t-k}$$

$$+ \sum_{k=0} \alpha_y \Delta Log(UBPG)_{t-k} + \gamma ECT_{t-1} + \mu_t \quad (3)$$

2. Diagnostic tests

To emphasise the robustness of the model, autocorrelation and heteroscedasticity are tested using Breusch-Godfrey Serial Correlation LM and autoregressive conditional heteroskedasticity (ARCH) test respectively. The stability is confirmed using cumulative sum of recursive residuals (CUSUM) and its square (CUSUM2).

3. Decoupling index model

The decoupling index (DI) was developed by the OECD countries in 2002. Decoupling refers to the rate of growth of the environmental pressure and of a casually linked economic variable (Ruffing, 2007). It measures the ratio between the change in environmental degradation (EF) and in economic growth (GDP) at a particular period. The decoupling phenomenon is explained when the rate of growth of GDP is more significant than the growth rate of environmental depleting variable (Naseem et al., 2022). The decoupling ratio (DR) equation is mentioned below:

$$DR = \frac{(EF_t/GDP_t)}{(EF_{t-1}/GDP_{t-1}} \quad (8)$$

DR lies between (-∞ to 1); DR<1 implies existence of decoupling. Subtracting from DR from one denotes DI as mentioned below:

$$DI = (1- DR) = 1- \frac{(EF_t/GDP_t}{EF_{t-1}/GDP_{t-1}} \quad (9)$$

Here, t-1 is the initial and t is the last year of the selected time span. The interpretation of the results is as follows; DI>zero (near to one) means absolute decoupling exists, i.e., falling EF (environmental depletion) with rising GDP (economic growth). It is the most desirable situation. DI>zero (near to zero) means a relative decoupling situation wherein EF and GDP rise simultaneously but the rise in GDP is faster than that of EF. DI<zero is a scenario of coupling or no decoupling which is an undesirable situation since it implies that both EF and GDP are increasing but the growth of EF is greater than that of GDP. For the purpose of this study, we have calculated the DI values for three periods plus the DI of the total period so as to analyze the relation between the two variables in different periods. However, the results of the total period depict the overall picture of the economy.

RESULTS AND FINDINGS

ARDL Cointegration test

1. Stationarity test

Table 2 represents the results of the ADF test conducted for testing the stationarity of the variables. All the variables (except regulatory quality) are stationary at first difference. We can now go ahead with testing the cointegration using the ARDL model.

Table 2: Augmented Dickey-Fuller (ADF) unit root test results.

Level					Interpretation
Country Variables	**ADF**		**PP**		
	Constant	Constant trend	Constant	Constant trend	
EF	-1.0458	-3.0492	-0.7579	-2.8554	-
Trade	-1.4705	-1.5467	-1.4768	-1.7247	-
Regulate	-26.7762***	-16.0426***	-19.8181***	-26.8981***	I(0)
GDP	-1.5771	-3.1543	-1.7391	-2.7512	-
UBPG	-1.0115	-1.4133	-1.0115	-1.5795	-
First Difference					
EF	-5.0465***	-4.9500***	-6.8813***	-6.7464***	I(1)
Trade	-4.1599***	-4.2136***	-3.9458***	-3.9769***	I(1)
Regulate	-138.358***	-212.649***	-75.6519***	-124.035***	I(1)
GDP	-5.7488***	-5.6612***	-8.1042***	-8.9597***	I(1)
UBPG	-4.1468***	-4.1769***	-4.0632***	-4.0449***	I(1)

Note: ***, **, * indicate significance level at 1per cent, 5 per cent, 10 per cent respectively.
Source: Author's calculation.

2. Bounds test

As the F-statistics lie well above I(1) at 1 per cent significance level, therefore, it is inferred that the variables are cointegrated. We can now estimate the short- and long-run coefficients using ARDL model.

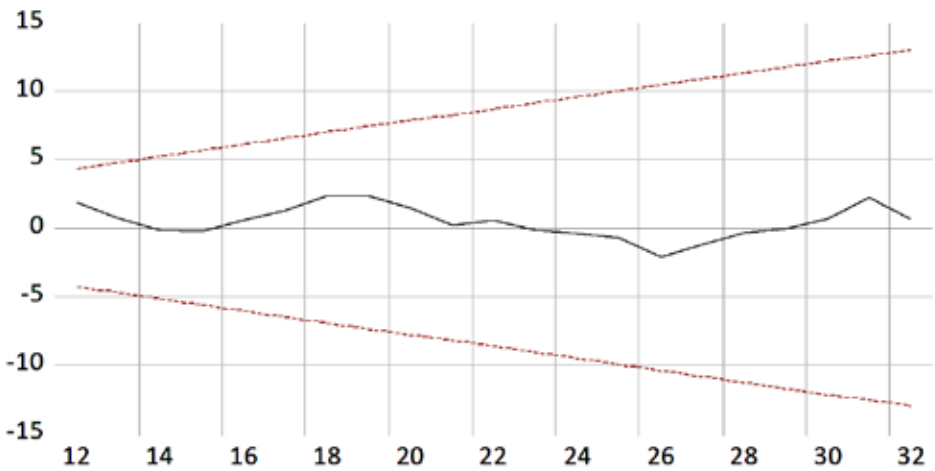
Table 3: The ARDL bounds test to cointegration.

F-statistics (p value)	Level of significance	I(0)	I(1)
5.8271*	10 per cent	2.2	3.09
	5 per cent	2.56	3.49
	2.5 per cent	2.88	3.87
	1 per cent	3.29	4.37

Note: ***, **, * indicate significance level at 1per cent, 5 per cent, 10 per cent respectively.
Source: Author's calculation

3. ARDL estimates

According to the results (table 4), de facto trade globalization reduces EF in the long-run as 1 per cent increase in lnTrade leads to 0.6922 per cent reduction in EF. This testifies the validity of PHEH in Japan and we may thus conclude that the rising trade reduces the ecological pressure since the economy promotes clean trade and technology. Our results corroborate with that of those reported by (Pata & Yilanci, 2020) for G7 nations. But (Wang et al., 2020) found an inverse relation between economic globalization and CO2 emission for G7. Besides, with 1 per cent rise in lnRegulate, statistically significant drop of 0.0373 per cent and 0.0762 per cent is observed in EF in the short- and long-run respectively. Our findings corroborate with those reported by (Güngör et al., 2021) in the case of South Africa, Pakistan (Khan & Safdar, 2022), and MENA economies (Omri & Ben, 2020) while contradictory results are reported in the case of BRICS nations (Ibrahim & Ajide, 2021). These findings imply that the regulatory framework of Japan is such that it not only attracts humongous investments due to its pro-trade and business conducive regulations but also ensures the strict abidance of the environmental laws thereby leading to rational holistic growth. It means that maintaining the institutional quality may help achieve a pro- environment outlook for Japan and reducing the footprints. Although, the economic growth of Japan has an adverse impact on the ecology. If GDP rises by a per cent, EF shoots by 0.4202 per cent in the short-run and 1.1468 per cent in the long-run. A substantial reduction in the use of fossil fuels for economic activities may help turn the situation positively. Hence, it may be inferred that the growth of the Japan's economy is coming at the cost of its eco quality. An insignificant 0.0024 per cent plunge in the short-run and an ascent of 0.0066 per cent in the long-run is observed in EF with a per cent rise in UBPG. The adjustment of the endogenous variables to the long-run equilibrium 46.43 per cent and is statistically significant as well as depicted by ECT.



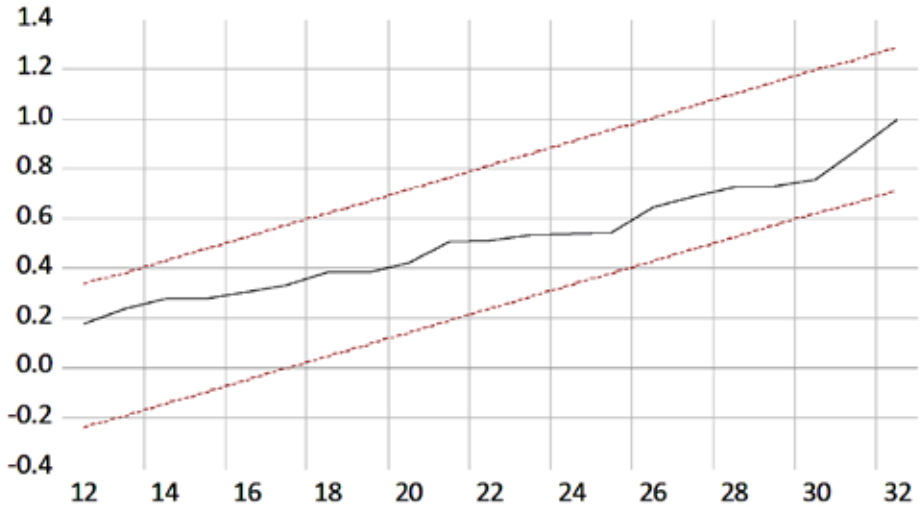


Figure 3. Stability diagnostics

Table 4: ARDL short- and long-run estimates.

Short-run estimates		
Variables	Coefficients	T-ratio
lnTrade	0.0206	0.3817
lnRegulate	-0.0373***	-6.6036
lnGDP	0.4202***	2.1443
UBPG	-0.0024	-0.6481
Long-run estimates		
lnTrade	-0.6922***	-3.3213
lnRegulate	-0.0762***	-2.2198
lnGDP	1.1468*	1.7728
UBPG	0.0066	1.0292
ECT (-1)	-0.4643***	-6.5793

Note: ***, **, * indicate significance level at 1 per cent, 5 per cent, 10 per cent respectively.
Source: Author's calculation

The absence of autocorrelation, and heteroscedasticity in the data (as per table 5) guarantees the constancy of our model. In figure 1, the stability of the estimated lines (blue) in the graphs depicts the stability of the model.

Table 5: Diagnostic tests.

Test	Prob. Chi-square	Interpretation
Serial correlation	0.3769	No serial correlation
ARCH	0.9854	No heteroscedasticity
CUSUM	-	Stable
CUSUM^2	-	Stable

Source: Author's calculation

4. Decoupling index model

The results of decoupling index (table 6) are calculated for three periods; 1990-1999, 2000-2009, 2010-2021, and the combined index from 1990-2021. According to the results, the DI values remain greater than zero but less than one for all the periods. The DI value of 0.1583 for the period of 2000-2009 is the highest in comparison to the other two tranches (excluding the total period) which affirms that the period witnessed a rising economic growth in comparison to the environmental depletion growth. This can be attributed to various environment conscious steps taken by the Japanese government post the Paris agreement on climate change like Asia Forest Partnership (2002) to facilitate sustainable forest management in Asia, the Stockholm Convention on Persistent Organic Pollutants (POPs) (2004) which instructs its signatories the duty to take measures to reduce inadvertent emissions of POPs generated in the process of waste ignition. However, the total period value of 0.3210 shows a relative decoupling situation where the rate of economic prosperity is higher than that of ecological depletion.

Table 6. Decoupling index values.

Period	DI Values
1990-1999	0.1110
2000-2009	0.1583
2010-2021	0.0937
1990-2021	0.3210

CONCLUSION, POLICY RECOMMENDATIONS, AND RESEARCH GAPS

In order to maintain economic competitiveness in the global market, de facto trade globalization and regulatory quality have become significant issues in Japan. Additionally, the Asian economy is also focusing on protecting the ecosystem alongside continued economic prosperity. To analyse the impact of de facto trade globalization and regulatory quality on the environmental quality (measured by EF) in Japan, the study employs the autoregressive distributed lag (ARDL) model. Economic growth, measured by per capita GDP and urban population growth rate are used as control variables. Lastly, we have used DI to separate the speed of growth

of the economy and EF. To the best of the authors' limited knowledge, this happens to be the first study to reveal the trade globalization-regulatory quality-environment nexus using the above-mentioned variables and employing DI to disentangle economic growth from EF.

Our findings indicate that there exists significant inverse relationship between trade globalization de facto (long-run), regulatory quality (short- and long-run) and environmental degradation. This testifies the fact that PHEH holds in case of Japan, implying that stern green regulations boost 'clean' trade in the host nation. It is a major lesson for the rest of the Asian and developing economies that the trade- and environment- related policies need to be framed in concurrence with each other to deter polluting industries and foster cleaner sectors. It is also concluded that investment in clean technology helps in reducing the detrimental impact of manufacturing and trade globalization on the ecology. The positive relation between economic growth and EF shows that increasing GDP leads to an increase in EF. Therefore, sustainable production and consumption patterns, and increased share of renewable energy in the energy mix would render the desired results of reduced EF with rising GDP. Finally, the DI values depict that the Japanese economy shows relative decoupling situation wherein the growth of GDP is higher than that of EF and therefore, the policy makers should continue to focus and invest in environmentally sustainable trade, technology and institutional quality.

Despite a few additions to the existing literature, the study has some limitations which may be pursued by the researchers in the future. Firstly, due to data unavailability, this paper is confined to 32-year period and therefore it can be extended further in future for more generalizable results. Secondly, the impact of other types of globalization, namely financial, political, social globalization (de facto & de jure) and governance quality, has not been studied at large and can be studied in future. Lastly, the established model can be applied to other group of nations like BRICS, ASEAN, G20, EU, etc. so as to get deeper insights into region specific environment sustainability.

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