Tsujimoto, Masao

Article

Achievement of both growth and environmental conservation by digital platform providers

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Tsujimoto, Masao (2022). Achievement of both growth and environmental conservation by digital platform providers. In: International Journal of Energy Economics and Policy 12 (4), S. 78 - 86.
https://econjournals.com/index.php/ijeep/article/download/13152/6822/30740.
doi:10.32479/ijeep.13152.

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(4), 78-86.

Achievement of both Growth and Environmental Conservation by Digital Platform Providers

Masao Tsujimoto*

Department of Business Management, Tokyo-Shibuya Campus, Japan University of Economics, Japan.
*Email: masao.tsujimoto@gmail.com

Received: 03 March 2022 **Accepted:** 07 June 2022 **DOI:** https://doi.org/10.32479/ijeep.13152

ABSTRACT

This study explores the achievement of both growth and environmental conservation by digital platform providers, employing financial performance and environmental impact data from six providers in the US and Japan. (1) The regression analyses confirm the Environmental Kuznets Curve hypothesis in three combinations of earnings per share (EPS)–electricity consumption or waste generation, treasury stocks–water consumption, and an inverted N-shaped curve in the combination of EPS–Scope 2 CO_2 emissions. (2) The growing trend of Environment, Society, and Governance (ESG)-oriented investment has acted as competitive pressure on the providers for fundraising, especially in spurring them to disclose information. (3) Both increasing EPS to the verified thresholds and ESG-oriented management are deciding factors, and any advanced EPS and ESG-based approaches could contribute toward developing academic frontiers.

Keywords: Earnings per share, Environment, society, and governance, Investment and information disclosure, Environmental Kuznets Curve hypothesis
JEL Classifications: L21, Q40, Q56

1. INTRODUCTION

This study explores the achievement of both growth and environmental conservation by digital platform providers. The study uses financial performance and environmental impact data of six providers, Google, Amazon, Facebook (newly named Meta Platforms), and Apple (GAFA) in the US and Rakuten and Z Holdings (100% shareholder of Yahoo Japan) in Japan, focusing on environment, society, and governance (ESG) investment and information disclosure, for two primary purposes.

First, amid the COVID-19 pandemic, the challenge for the providers to achieve both growth and environmental conservation has become increasingly urgent. Second, with the award of two Nobel Prizes in Economics, broader and deeper considerations have become essential in the two fields of theory of industrial organization and environmental economics; the analysis of market power and regulation in 2014, followed by the integration of climate change into long-term macroeconomic analysis in 2018.

Despite its importance, the author's thorough review of academic journals reveals that minimal research has been conducted from this paper's trans-Pacific perspective and accounting approach. The lack of prior research is assumed to be due to a lack of data related to insufficient disclosure of ESG information and inconsistency in company and rating agency standards (Section 3.1). Therefore, this research endeavors to explore this unexplored field to clarify and discuss the regression analysis results revealing trends in ESG-oriented investment and disclosure for decoupling growth and environmental impact.

Moreover, during the COVID-19 outbreak, US and Japanese government reports have sounded the alarm regarding the insufficient power supply and network infrastructure capacity.

US Energy Information Administration (EIA, 2021) reported that US electricity customers experienced over eight hours of power interruptions on average in 2020, the worst since EIA began collecting data in 2013. Japan Science and Technology Agency (JSTA, 2021) also proposes energy conservation at data centers, as domestic power consumption will be 90 TWh in 2030 and 12,000 TWh by 2050, compared to 14 TWh in 2018 with the spread of cloud services, medical image diagnosis, and face recognition. So, power saving and decarbonization of data centers will become even more important.

Notably, GAFA combined emitted 93.13 million tons in 2019 and 95.30 million tons of CO_2 (market basis) in 2020, up 2.3% (Section 3.1 “Sources”). And the six providers, including Rakuten and Z Holdings, emitted 97.63 million tons in 2019 and 101.11 million tons in 2020, up 3.6%, which is nearly equivalent to Qatar’s 99.49 million tons in the same year (European Commission, 2021). Hence, the issue has precipitated, making it imperative to achieve both growth and environmental conservation.

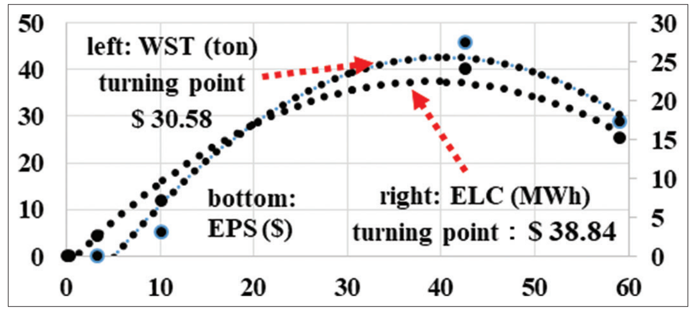
2. DEFINITIONS

First, definitions are based on the following two Articles of the two Acts in Japan. “Digital platforms” refer to services provided to many persons through the internet or other advanced information and telecommunications networks, where information regarding goods, services, or rights of persons who intend to present offers is usually displayed. And “digital platform providers” refer to entities that provide online platforms alone or in collaboration (Article 2, Act No. 38 of 2020 on Improving Transparency and Fairness of Digital Platforms). Then, “specified digital platform providers” subject to the Act has been designated by the Ministry of Economy, Trade and Industry (METI) of Japan; those providers are Rakuten and Yahoo Japan (subsidiary of Z Holdings) as well as GAFA’s subsidiaries in Japan. That is why the author selected the six providers based on the definition of the Article (METI’s website).

Moreover, “environmental conservation” means preventive measures against global warming, the ozone layer depletion, marine pollution, decrease in wildlife species and others which are caused by human activities, and that contributes to the welfare of mankind as well as to the healthy and cultured living of the people (Article 2, Act No. 91 of 1995 on Basic Environment Law).

Second, the Environment Kuznets Curve (EKC) hypothesis is examined. The EKC hypothesis is an economic theory that illustrates the relation between growth and environmental impacts. This is an application of the theory of economic growth and income inequality postulated by Dr. Simon Kuznets, a Nobel laureate in Economics. The academic discussions on the EKC hypothesis have started in the 1990s by Grossman and Krueger (1991) and World Bank (1992), then, the discussions have extended from air pollutions to water contaminations and deforestation. (Aruga 2019; Benoit et al. 2022; Csereklyei et al. 2017; Galeotti et al. 2009; Gopakumar 2022; Selden et al. 1999; Sorgea et al. 2020; Tsujimoto 2018 and 2021). Especially, in the hypothesis, environmental impacts increase up to a certain level of economic growth and then start to decrease, showing an inverted U-shaped curve at the turning point. The hypothesis is valid when the linear term (positive: $\beta > 0$) and the squared term (negative: $\beta < 0$) are significant (Figure 1 in Section 3.2).

Figure 1: Earnings per share (EPS)–electricity consumption (ELC) or waste generation (WST)



However, the prior research does not help answer some of the main questions in the three following points: (1) the validity of EKC hypothesis, (2) the income levels when the EKC is valid, and (3) factors behind the validity. That is why it is worth considering the hypothesis. In particular, while previous studies often apply the EKC hypothesis to the verification of specific countries or regions, this paper applies it to the verification of firms.

In addition, the success or failure of a cubic curve is tested, as an applied form of the EKC hypothesis. It is desirable to illustrate an inverted N-shaped curve in investigating the relationship between growth and environmental impact. The inverted N-shape is valid in cases wherein the environmental impact increases (positive: $\beta > 0$) at the first turning point (bottom), it decreases (negative: $\beta < 0$) at the second turning point (top) (Figure 2 in Section 3.2).

3. VERIFICATION

3. 1. Method

This section verifies the relationship between the six digital platform providers’ financial and environmental impact data, employing linear, quadratic, and cubic regressions. The method is outlined below.

3.1.1. The six target providers

GAFA, Rakuten, and Z Holdings. This paper highlights two Japanese platforms, in addition to GAFA, partly because the two Japanese present relatively good data, which makes the survey more fruitful. Also, it will offer useful information for overseas researchers to focus on the progress of environmental conservation by digital platformers in Japan, which has not received much attention.

3.1.2. Dependent and explanatory variables

The number of basic regression formulas includes 24 combinations of 4×6. The number of advanced formulas is 42 by 7×6 because each item decomposed in Scopes 1, 2, and 3 is tested in addition to total CO_2 emissions in Table 1. The verification of CO_2 employs Scope 1 (direct emissions) and supply chain emissions, which include the sum of the entire flow, from raw material procurement, manufacturing, distribution, and sales to disposal. The overall

Figure 2: Scope 2 CO_2 emissions(SCP2)–earnings per share (EPS)

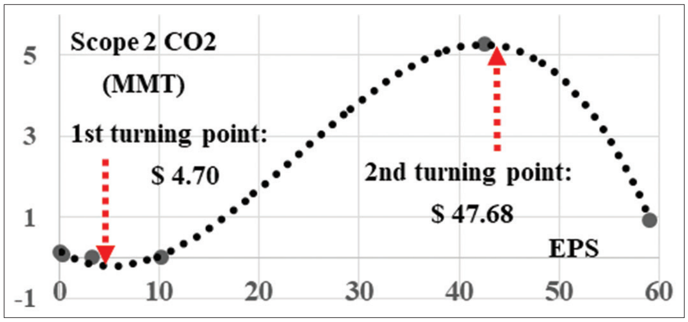


Table 1: Dependent and explanatory variables (abbreviation)

Dependent variables: Basic - 4, Advanced - 7	Explanatory variables: 6
(1) CO_2 emissions (million MT)	(1) Net sales (SAL)
• CO_2 (total) = Scope 1+2 + 3 emissions	(2) Net income (INC)
	(3) Earnings per share (EPS)
• Scope 1 (SCP1)	(4) Total assets (TAS)
• Scope 2 (SCP2)	(5) Property, plant, and equipment (PEQ)
• Scope 3 (SCP3)	
(2) Electricity consumption (ELC, MWh)	(6) Treasury stocks (RES)
(3) Water consumption (AQU, m^3)	(1, 2, 4, 5, 6): million USD,
(4) Waste generation (WST, tons)	(3): USD

emissions activities should be captured without being passed on to upstream and downstream firms. Definition of Scope 1-3 (Environment Agency of the US, 2021) are:

- Scope 1: Direct emissions by the business itself.
- Scope 2: Indirect emissions from the use of electricity, heat, and steam supplied by other companies.
- Scope 3: Indirect emissions other than Scopes 1 and 2; emissions of other companies related to business activities, consisting of 15 categories, including employees' commuting and business travel.

However, the following exceptions also apply. The degree of disclosure varies among companies. The non-disclosure policies of Amazon and Facebook, as depicted in Table 3 in Section 3.3 and Table A2 in the Appendix, limit verification. As for the two dependent variables of (3) water consumption and (4) waste generation, the former is calculated using five providers, and the latter is reckoned using four providers.

3.1.3. Target year of data

Cross-section data are for the year 2020. Available environmental impact data before 2019 is insufficient or inconsistent, rendering time series analysis impossible. For example, Google (2020) says, "to align with industry best practices for Scope 3 reporting. We extended our reporting boundaries (p.79)." Thus, Google's Scope 3 CO_2 emissions in 2020 (9.376 million tons) were 2.45 times higher than that reported in 2017 (2.719 million tons). The extension of the range suggests that the measurement method used before 2017 was insufficient. Google (2020) also indicates, "2019 is the first year for which we're disclosing gross global water consumption and gross global water discharge data; therefore, we do not publish data from any prior years." Moreover, the regression analysis requires at least three or four years of data in the difference equation to prevent spurious regression. Thus, 2020 cross-sectional data were mainly adopted for accuracy in this research study.

Though the data is limited, it illustrates the circumstances of each company before and during the COVID-19 pandemic, disclosing certain implications in the relationship between growth and conservation; this paper discusses inductively to find certain criteria and rules from the disclosed information.

3.1.4. Sources

Financial data (Table A1): Sources include US Form 10-K Reports for GAFA and Japan's Annual Securities Reports (Yuka Shouken Hokokusho, abbreviation: Yuho in Japanese) for Rakuten and Z Holdings. Japan's Yuho is equivalent to Form 10-K, filed with the US Securities and Exchange Commission. The reliability of Yuho is ensured through statutory audits submitted to government authorities such as the Finance Bureau (Amazon 2021a; Apple 2021a; Facebook 2021a; Google 2021a; Rakuten 2021a; Z Holdings 2021a). Explanatory variables (1) to (4) are listed at the beginning of Yuho in a common format, forming the core of the financial results.

Environmental impact data (Table A2): Each digital platform's environmental and ESG reports (Amazon 2021b; Apple 2021b; Facebook 2021b; Rakuten 2021b; Z Holdings 2021b).

Then, consolidated data are examined because non-consolidated financial and environmental data are not disclosed in detail. Moreover, minor differences are not considered in accounting standards of GAFA for US GAAP and the two Japanese Rakuten and Z Holdings for IFRS.

First, the linear regression model is as follows, where CO_2 emission is the dependent variable and each variable from (1) SAL to (6) RES is placed as the explanatory variable.

$$Y\,(CO_2) = \alpha + \beta_1\,(SAL) + \varepsilon, \tag{1.1.1}$$

$$Y\,(CO_2) = \alpha + \beta_2\,(INC) + \varepsilon, \tag{1.2.1}$$

$$Y\,(CO_2) = \alpha + \beta_3\,(EPS) + \varepsilon, \tag{1.3.1}$$

$$Y\,(CO_2) = \alpha + \beta_4\,(TAS) + \varepsilon, \tag{1.4.1}$$

$$Y\,(CO_2) = \alpha + \beta_5\,(PEQ) + \varepsilon, \tag{1.5.1}$$

$$Y\,(CO_2) = \alpha + \beta_6\,(RES) + \varepsilon. \tag{1.6.1}$$

The significance level of the p-value is set at 5% ($P < 0.05$). In principle, non-significant results are omitted in the text for brevity. Readers are invited to reproduce all of the author's calculations from the raw data listed in the Tables in Appendix. α and ε indicate constant and error terms, respectively. The significance of the constant term is not considered. The data is presented to three digits after the decimal point to ensure rigor. If zero continues after the third digit (e.g., 0.0001381), it is not presented as 0.000, but as an exponent, 1.381E-04. The order of the equation numbers indicates the dependent variable, the explanatory variable, and the monomial/polynomial equation. 1.1.1 refers to the CO_2 - Net Sales - linear equation. Then, the order of the explanatory variables is the same as above, only replacing the dependent variable, while equations (2)-(5) are omitted.

Second: electricity consumption (ELC).

$$Y\ (ELC) = \alpha + \beta_1\ (SAL) + \varepsilon, \tag{2.1.1}$$

- - - - - omitted - - - - -

$$Y\ (ELC) = \alpha + \beta_6\ (RES) + \varepsilon. \tag{2.6.1}$$

Third: water consumption (AQU).

$$Y\ (AQU) = \alpha + \beta_1\ (SAL) + \varepsilon, \tag{3.1.1}$$

- - - - - omitted - - - - -

$$Y\ (AQU) = \alpha + \beta_6\ (RES) + \varepsilon. \tag{3.6.1}$$

Fourth: waste generation (WST).

$$Y\ (WST) = \alpha + \beta_1\ (SAL) + \varepsilon, \tag{4.1.1}$$

- - - - - omitted - - - - -

$$Y\ (WST) = \alpha + \beta_6\ (RES) + \varepsilon. \tag{4.6.1}$$

Secondly, the EKC hypothesis is examined. The number of basic formulas is 24, and the advanced ones include 42 formulas, which mirror the cases in the linear regression. The examples of the formula are:

$$Y\ (CO_2) = \alpha + \beta_{11}\ (SAL) + \beta_{12}\ (SAL)^2 + \varepsilon, \tag{1.1.2}$$

- - - - - omitted - - - - -

$$Y\ (CO_2) = \alpha + \beta_{61}\ (RES) + \beta_{62}\ (RES)^2 + \varepsilon. \tag{1.6.2}$$

Thirdly, the success or failure of a cubic curve is tested. The examples of the formula are:

$$Y\ (CO_2) = \alpha + \beta_{11}\ (SAL) + \beta_{12}\ (SAL)^2 + \beta_{13}\ (SAL)^3 + \varepsilon, \tag{1.1.3}$$

- - - - - omitted - - - - -

$$Y\ (CO_2) = \alpha + \beta_{61}\ (RES) + \beta_{62}\ (RES)^2 + \beta_{63}\ (RES)^3 + \varepsilon. \tag{1.6.3}$$

4. RESULTS

First, the linear regression analysis in Table A3 indicates significant monotonic relationships in eight cases of the 42 tested. The results illustrate a trend in which when financial performance expands, environmental impact increases. For example, total CO_2 emissions increase as net sales increase.

Second, quadratic regression analysis confirmed the validity of the three combinations of

- EPS (earnings per share)–ELC (electricity consumption),
- EPS–WST (waste generation), and
- RES (treasury stocks)–AQU (water consumption).

$$\begin{aligned}
&Y\left(ELC\right) = \alpha + \beta_{31}\left(EPS\right) + \beta_{32}\left(EPS\right)^2 + \varepsilon,\\
&= -999{,}337.615 + 1{,}205{,}056.904\left(EPS\right)\\
&\qquad \left(p = 0.473\right) \qquad \left(0.007\right)\\
&-15{,}511.959\left(EPS\right)^2 + 2{,}017{,}553.246.\\
&\qquad \left(0.015\right)\\
&Adj.-R^2 = 0.955,\ F = 54.681\left(p = 0.004\right),\\
&turning\ point:\ \$38.84.
\end{aligned} \tag{2.3.2}$$

$$\begin{aligned}
&Y\left(WST\right) = \alpha + \beta_{31}\left(EPS\right) + \beta_{32}\left(EPS\right)^2 + \varepsilon,\\
&= 1{,}210.525 + 14{,}188.673(EPS)\\
&= 1{,}210.525 + 14{,}188.673(EPS)\\
&\quad \left(p = 0.516\right) \left(0.031\right)\\
&-231.972\left(EPS\right)^2 + 1{,}634.887.\\
&\qquad \left(0.032\right)\\
&Adj.-R^2 = 0.993,\ F = 221.233\left(p = 0.048\right),\\
&turning\ point:\ \$30.58.
\end{aligned} \tag{4.3.2}$$

$$\begin{aligned}
&Y\left(AQU\right) = \alpha + \beta_{61}\left(RES\right) + \beta_{62}\left(RES\right)^2 + \varepsilon,\\
&= 180{,}303.203 + 771.897\left(RES\right)\\
&\quad \left(p = 0.645\right) \left(0.002\right)\\
&-0.010\left(RES\right)^2 + 516{,}719.655.\\
&\qquad \left(0.002\right)\\
&Adj.-R^2 = 0.992,\ F = 246.600\left(p = 0.004\right),\\
&turning\ point:\ \$37{,}531.822\ \left(million\ USD\right).
\end{aligned} \tag{3.6.2}$$

Figure 1 illustrates the explanatory variables (EPS) on the X-axis, while the dependent variables (ELC and WST) are on the Y-axis, revealing that the relationships depict inverted U-shaped curves with the turning points.

Third, the inverted N-shaped curve is confirmed by the combination of EPS– Scope 2 CO_2 emission.

$$\begin{aligned}
&Y\left(CO_2SCP2\right) = \alpha + \beta_{31}\left(EPS\right)\\
&+ \beta_{32}\left(EPS\right)^2 + \beta_{33}\left(EPS\right)^3 + \varepsilon\\
&= 0.172 - 0.144\left(EPS\right) + 0.015\left(EPS\right)^2\\
&\left(p = 0.172\right) \quad \left(0.024\right) \left(0.003\right)\\
&-2.138E-04\left(EPS\right)^3 + 0.1199\\
&\qquad \left(0.002\right)\\
&Adj.-R^2 = 0.996,\ F = 505.697\left(p = 0.002\right),\\
&turning\ points:\ \$4.70\ and\ \$47.68.
\end{aligned} \tag{ISCP 2.3.3}$$

In summary, the EKC hypothesis is confirmed in three cases and an inverted N-shaped curve is observed in only one case. Moreover, the results verify EPS as key to the significant cases: the turning points are $38.84 for ELC and $30.58 for WST in the EKC and $47.68 for SCP2 in the inverted N-shaped, in addition to RES ($37,531 million for AQU), which can be regarded as a background factor for EPS increase (Section 3.3).

5. DISCUSSION

The reasons or factors behind the significance should be considered. Regarding the monotonic increase, the responses of the platform providers to market expansion are worth noting. For example, the electricity consumption of Meta-Facebook data centers has been increasing (3.245 TWh 4.918 TWh in 2019, up 51.6%, and 6.966 TWh in 2020, up 41.6% year on year respectively), while they maintained the same level of Power Usage Effectiveness (PUE) in 1.11 in 2019 and 1.10 in 2020; the closer the value is to 1.00, the more efficient it is (Facebook, 2021b). In addition, external factors, such as the lack of business partner environmental impact reduction efforts in Scope 3, should also be mentioned.

Regarding the significant cases confirmed in the EKC hypothesis and the inverted N-shaped curve, ESG-oriented investment and information disclosure progress should be noted. Investors' emphasis on ESG has been functioning as the compelling or driving force to advance digital platform providers' implementation of ESG-related environmental conservation activities, particularly in terms of information disclosure, through financing requirements, such as loans and underwriting of securities and bonds.

First, the impact of the United Nations' Principles for Responsible Investment (PRI) have been increasing (PRI, 2022). Signatory investors are bound by six principles as follows;

- Principle 1: We (signatory investors) will incorporate ESG issues into investment analysis and decision-making processes.
- Principle 3: We will seek appropriate disclosure on ESG issues by the entities in which we invest.

The number of signatory investors increased from 63 in 2006 (start year) to 3,404 in the end of 2021, and the total amount of assets under management increased from $6.5 trillion in 2006 to $121 trillion. Table 2 presents the PRI signatory investors in the top five at GAFA; the PRI has impacted digital platform providers' disclosure and conservation efforts through financing.

Second, the amount of issuance of new environment-related bonds, known as green bonds, reached 266.9 billion in 2019, up 55.6% from 2018, and 290.1 billion in 2020, up 8.7% (latest data at the time of writing). The share and percentages of the top three categories were Energy (35.4%), Buildings (26.2%), and Transport (22.9%) in 2020 (Climate Bond Initiative (CBI), 2022). This increase in bond issuance is an indication of the growing interest of investors.

Third, shareholder proposals have also begun to exercise influence, as environmental concerns have been raised at digital platform providers' shareholders' meetings. For instance, at the meeting in 2021, Amazon was requested to disclose the number of plastic containers used and to clarify a corporate strategy to reduce their use, though the proposal was rejected (Amazon 2021d).

Table 2: GAFA's major shareholders of PRI signatories as of February 2022

Company	Top five shareholders - investment ratio: %
Google	1 Vanguard Group 7.21%, 3 Fidelity Management and Research 4.15%, 4 State Street Global Advisors Fund Management (SSGA) 3.69%, 5 T. Rowe Price Associates 2.44%
Amazon	1 Vanguard Group 6.19%, 3 T. Rowe Price Associates 3.23%, 4 SSGA 3.22%, 5 Fidelity Management and Research 2.88%
Meta-Facebook	1 Vanguard Group 7.30%, 2 Fidelity Management and Research 5.12%, 4 T. Rowe Price Associates 4.10%, 5 SSGA 3.91%
Apple	1 Vanguard Group 7.35%, 4 SSGA 3.81%, 5 Fidelity Management and Research 1.95%

Source: CNN Business, 2022. The top five shareholders of Rakuten and Z Holdings are yet to sign PRI

The perspectives of the platform providers also should be considered. First, without appropriate disclosure of ESG information, the digital platform providers face challenges in raising funds through the issuance of bonds and securities. In addition, disclosure requires the formulation and execution of corporate strategies that are worthy of disclosure, and the promotion of ESG activities, such as participation and signature on various ESG initiatives. Furthermore, data is disclosed on sponsoring organizations' websites regarding whether the providers signify and the attending ratings. As a result, the platform providers are driven to compete with rivals for information disclosure, as if the dominoes are beginning to fall.

In summary, investors' emphasis on ESG has led digital platform providers to compete in ESG activities, particularly information disclosure. As a result, the platform providers have joined and signed various ESG initiatives to promote information disclosure. The following initiatives and ratings are relatively large and influential (the number of signatory/rating companies as of the end of 2021).

(1) Task Force on Climate-related Financial Disclosures (TCFD): This task force examines and recommends climate-related information disclosure and targets; 2,616 (TCFD's website).
(2) Science-Based Targets/Science-Based Targets initiative (SBT/SBTi): An initiative to achieve the goals of the Paris Agreement; 2,466 (SBT's website).
(3) Renewable Electricity 100 (RE100): An initiative to achieve 100% renewable energy for electricity in business operations; 349 (RE100's website).
(4) CDP (formerly known as Carbon Disclosure Project): Advocates disclosing information such as climate change mitigation, water security, and forests while maintaining consistency with the TCFD, publishing a rating with the highest grade of A; 13,189.
(5) Morgan Stanley Capital International (MSCI) ESG Ratings:

An index of global research affiliated with Morgan Stanley; about 2,900 (MSCI's website).

Table 3 presents the adherence and ratings of the six digital platform providers examined in this study.

Regarding green bonds, Amazon, Apple, Google, and Z Holdings have announced that they raised $1 billion, $4.7 billion, $5.75 billion, and ¥20 billion ($182 million), respectively, between 2020 and 2021(Amazon 2021c; Apple 2021c; Google 2021c; Z Holdings 2021c). For example, Amazon has ordered 100,000 units of electric vehicles, while Google has spent nearly $1.25 billion on green building projects to achieve a Platinum Rating in Leadership in Energy and Environmental Design certification. Z Holdings announced the construction of data centers with a PUE of less than 1.5 and the procurement of renewable energy sources to operate its data centers, while Google has introduced one of the highest PUE data centers; they have an annual PUE of 1.08 in 2020 (Google 2021c).

Consequently, the reason that the EKC hypothesis and the inverted N-shaped curve were confirmed appears to be that the growing trend of ESG-oriented investment exerting competitive pressure on digital platform providers for fundraising, particularly in spurring environmental information disclosure.

It is necessary to investigate further the reasons certain combinations are significant: the EKC hypothesis for three of earnings per share–electricity consumption or waste generation and treasury stocks–water consumption, and the inverted N-shaped curve for only earnings per share–Scope 2 emissions. Knowledge of accounting and management is critical for classifying the reasons into (A) common and (B) irregular, even if it is difficult to prove mathematically.

A-(a) Strategy change: a shift from prioritizing sales and name recognition in the growth phase to emphasizing capital efficiency and ESG in the mature phase.

A-(b) Tactical change: the introduction of expensive, high-performance, state-of-the-art technologies and equipment based on elevated access to financing in more favorable conditions due to increased scale and name recognition. Also effective are fixed assets' retirement at a certain point for tax saving and introducing more expensive, energy-efficient properties through green bonds and loans for less waste generation.

B-(a) ELC, AQU and WST: indicators that are easy to initiate through, for example, installing LEDs, motion sensors, wireless switches, and water-saving faucet at offices and factories for less electricity consumption, and reducing plastic and paper waste.

Table 3: Digital platform providers' adherence (☑) and ratings

	TCFD	SBT	RE100	CDP*	MSCI
Google	☑		☑	A	BBB
Amazon		☑		F	NA
Meta-Facebook		☑	☑	NA	B
Apple		☑	☑	A-	A
Rakuten	☑		☑	A-	BBB
Z Holdings	☑	☑**		B	AAA

Sources: Each website as of February 2022. *CDP scores are based on the category of Climate Change 2020. **Signed as Yahoo Japan.

B-(b) Scope 2 CO_2 emissions: successful participation in initiatives of the RE 100 and the providers' investment in highly efficient renewable sources. For instance, Apple has already achieved zero emissions of Scope 2.

B-(c) EPS and RES: investors think highly of EPS for efficiency of investment. Moreover, treasury stocks (RES) contributes to increasing EPS by reducing the number of outstanding stocks. As such, RES can be considered as a background factor for EPS increase. Therefore, significant combinations of EPS–ELC or WST and RES–AQU in the EKC and EPS–SCP2 in the inverted N-shaped curve indicate platform providers' uptake of ESG-oriented management that emphasizes ESG activities, especially information disclosure, on the requests of investors upholding, for example, the principles of PRI.[1]

6. CONCLUSION AND IMPLICATIONS

The results of the regression analyses identified a monotonic increase in eight cases out of 42, and the EKC hypothesis is confirmed in the three combinations of earnings per share–electricity consumption or waste generation, and treasury stocks-water consumption, and an inverted N-shaped curve is demonstrated in the cubic regression of earnings per share–Scope 2 CO_2 emissions in the relation between the financial performance and the environmental impact of the six digital platform providers. Therefore, it is concluded that both increasing EPS to the verified thresholds and ESG-oriented management were deciding factors for the significance of the hypothesis and the curve.

Of course, the following issues remain to be examined. It is necessary to consider why only the three cases in the EKC hypothesis and the one in the inverted N-shaped test are significant, whereas others are not. Long-term verification is also needed because environmental statistics are subject to revision. Additionally, the digital platform providers themselves have been facing various challenges in abusing monopolistic market power, improving corporate governance structure, protecting personal information, preventing "fake news," and paying fair taxation.

However, it is implied that the emergence of the turning points in Figures 1 and 2 indicates the germination or beginning of the decoupling of growth and environmental impact. Their ESG-oriented management and increasing EPS to the thresholds, that is, $38.84 for ELC and $30.58 for WST in the EKC and $47.68 for SCP2 in the inverted N-shaped curve, could serve as guidelines or benchmarks for potential new entrants and existing digital platform providers for the decoupling. This eventually could contribute to global environmental conservation, given their magnitude of economic influence.

1 The following are not for consideration: (1) A small number of explanatory variables tends to produce significant results. (2) Rounding and unit conversion, such as from gallons to cubic meters, may have had some impacts.

Moreover, if subsequent and further studies support and reinforce the results of the EPS increase and ESG-based approach presented in this paper under the progress of convergence and refinement of environmental data and standards, any advanced approaches could contribute toward expanding the frontiers of environmental economics and the theory of industrial organization. Therefore, it is recommended that the academic community keep exploring the relationship between growth and environmental conservation.

ACKNOWLEDGEMENT

The author is grateful for the valuable comments received during the 2022 Conference of the CIRIEC (Centre Interdisciplinaire de Recherche et d'Information sur les Entreprises Collectives)-Japan. The author is solely responsible for the accuracy of this article.

REFERENCES

Amazon. (2021a), Form 10-K, 2021. Available from: https://ir.aboutamazon.com/sec-filings/default.aspx.

Amazon. (2021b), Sustainability Report, 2021. Available from: https://www.aboutamazon.com/planet.

Amazon. (2021c), Press Release. Available from: https://press.aboutamazon.com.

Amazon. (2021d), Notice of 2021 Annual Meeting of Shareholders and Proxy Statement. Available from: https://press.aboutamazon.com

Apple. (2021a), Form 10-K. Available from: https://investor.apple.com/sec-filings/default.aspx

Apple. (2021b), Environmental Progress Report. Available from: https://www.apple.com/environment/

Apple. (2021c), Press Release. Available from: https://www.apple.com/newsroom/

Aruga, K. (2019), Investigating the Energy-Environmental Kuznets Curve Hypothesis for the Asia-Pacific Region. Sustainability, 11, 2395

Benoit Mougenot, B., María, R.D.S., Koc Olcese, C. (2022), Testing the environmental Kuznets Curve hypothesis: An empirical study for Peru. International Journal of Energy Economics and Policy, 12(1), 193-199.

CDP. (2022), Companies Scores. Available from: https://www.cdp.net/en/companies/companies-scores [Last accessed on 2022 Mar 19].

Climate Bond Initiative. (2022), Market Date. Available from: https://www.climatebonds.et/market/data [Last accessed on 2022 Mar 19].

CNN Business. (2022). US Stocks. Available from: https://www.money.cnn.com/data/us_markets [Last accessed on 2022 Mar 27].

Csereklyei, Z., Mar Rubio-Varas., M.D., Stern, D.I. (2017), Energy and economic growth: The stylized facts. Energy Journal, 37(2), 223-255.

Environment Agency of the US. (2021), Scope 3 Inventory Guidance. Available from: https://www.epa.gov/climateleadership/scope-3-inventory-guidance [Last accessed on 2021 Nov 08].

Environment Agency of the US. (2021). Scope 1 and Scope 2 Inventory Guidance. Available from: https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance [Last accessed on 2021 Nov 08].

European Commission. (2021), Emissions Database for Global Atmospheric Research. Available from: https://www.edgar.jrc.ec.europa.eu/country_profile [Last accessed on 2021 Nov 11].

EIA. (2021), Press Release. United States: EIA.

Facebook. (2021a), Form 10-K. Available from: https://investor.fb.com/financials/default.aspx.

Facebook. (2021b), Sustainability Report. Available from: https://sustainability.fb.com/data-centers/

Facebook. (2021c), Press Release. Available from: https://sustainability.fb.com/news-resources [Last accessed on 2021 Jan 21].

Galeotti, M., Manera, M., Lanza, A. (2009), On the robustness of robustness checks of the environmental kuznets curve hypothesis. Environmental and Resource Economics, 42, 551-574.

Google. (2021a), Form 10-K. Available from: https://sustainability.google/reports.

Google. (2021b), Environmental Report. Available from: https://abc.xyz/investor.

Google. (2021c), Environmental Report. Available from: https://sustainability.google/reports/

Google. (2021d), Sustainability Bond Impact Report 2021. Available from:https://sustainability.google/reports/.

Gopakumar, G., Jaiswa, R., Parashar, M. (2022), Analysis of the existence of environmental Kuznets Curve: Evidence from India. International Journal of Energy Economics and Policy, 12(1), 177-187.

Grossman, G.M., Krueger, A.B. (1991), Environmental Impacts of a North American Free Trade Agreement; NBER Working Paper Series 3914. Cambridge, MA: National Bureau of Economic Research.

JSTA. (2021), Current Status and Future Forecast of Network-related Energy Consumption and Technical Issues, The Impact of Progress of Information Society on Energy Consumption. India: JSTA.

Markandya, A., Golub, A., Pedroso-Galinato, S. (2006), Empirical analysis of national income and SO2 emissions in selected European countries. Environmental and Resource Economics, 35, 221-257.

METI. (2022), Digital Platforms. Available from: https://www.meti.go.jp/policy/mono_info_service/digitalplatform/index.html [Last accessed on 2022 Feb 14].

Ministry of Environment. (2022), The Basic Environment Plan. Available from: https://www.env.go.jp/en/policy/plan/basic/outline.html [Last accessed on 2022 Mar 27].

MSCI. (2022), ESG Ratings and Corporate Search Tool. Available from: https://www.msci.com/our-solutions/esg-investing/esg-ratings/esg-ratings-corporate-search-tool [Last accessed 2022 Feb 08].

Panayotou, T. (1997), Demystifying the environmental Kuznets Curve: Turning a black box into a policy tool. Environment and Development Economics, 2(4), 465-484.

Perman, R., Stern, D.I. (1999), Evidence from panel unit root and cointegration tests that the Environmental Kuznets Curve does not exist. Australian Journal of Agricultural and Resource Economics, 47(3), 325-347.

PRI. (2022), Signatories. Available from: https://www.unpri.org/signatories [Last accessed on 2022 Feb 08].

Rakuten. (2021a), Annual Securities Report. Japan: Rakuten. Available from: https://corp.rakuten.co.jp/investors/documents

Rakuten. (2021b), ESG Report. Japan: Rakuten. Available from: https://corp.rakuten.co.jp/sustainability

RE100. (2022), RE 100 Members. Available from: https://www.there100.org/re100-members [Last accessed on 2022 Feb 08].

SBT. (2022), All Companies. Available from: https://www.sciencebasedtargets.org/companies-taking-action?status=Committed#table [Last accessed on 2022 Feb 08].

Selden, T.M., Song, D. (1999), Environmental quality and development: Is there a Kuznets curve for air pollution? Journal of Environmental Economics and Management, 27, 147-162.

Sorgea, L., Neumann, A. (2020), Beyond the inverted U-shape: Challenging the Long-Term Relationship of the environmental Kuznets Curve hypothesis. Economics of Energy and Environmental Policy, 9(2), 165-179.

Stern, D.I., Common, M.S. (2001), Is there an environmental Kuznets Curve for Sulfur? Journal of Environmental Economics and Management, 41: 162-178.

TCFD. (2022), Search. Available from: https://www.fsb-tcfd.org/supporters [Last accessed on 2022 Feb 08].

Tsujimoto, M. (2018), Economic growth and air pollution in the Persian

(Arabian) gulf states: Environmental Kuznets Curve hypothesis. Journal of the Japan Institute of Energy, 97(1), 16-22.

Tsujimoto, M. (2021), Economic growth and GHG emissions in the Japan's ODA recipients countries: Environmental Kuznets Curve hypothesis revisited and beyond. Journal of Energy and Environment Education, 15(1), 53-60.

World Bank. (1992), World Development Report. Washington, DC: World Bank.

Z Holdings. (2021a), Annual Securities Report. https://www.z-holdings.co.jp/ja/ir/library/securities.html

Z Holdings. (2022b), ESG Data Collection. Available from: https://www.z-holdings.co.jp/sustainability/stakeholder/esg [Last accessed on 2022 Mar 19].

Z Holdings. (2021c), Press Release. Tokyo, Japan: Z Holdings.

APPENDIX

Table A1: Financial performances of the six digital platform providers (2020)

	(1) net sales ($ million)	(2) net income ($ million)	(3) EPS ($)	(4) total assets ($ million)	(5) property, plant, and equipment ($ million)	(6) treasury stocks ($ million)
Google	182,527	40,269	59.15	319,616	84,749	31,149
Amazon	380,064	21,331	42.64	321,195	113,114	1837
Meta-Facebook	85,965	29,146	10.22	159,316	45,633	72,358
Apple	275,414	57,411	3.31	323,888	36,766	6,298
Rakuten	6,159	502	0.37	22,235	6,409	796
Z Holdings	11,298	835	0.17	62,744	1,430	163

Sources: Form 10-Ks of GAFA and Annual Securities Reports of Rakuten and Z Holdings. Mid-year exchange rates for the results of Japanese provider.

Table A2: Environmental impact data of the six digital platform providers (2020)

	(1) CO_2 emissions (MMT)	breakdown of CO_2 emissions (MMT)			(2) electricity consumption (MWH)	(3) water consumption (m^3)	(4) waste generation (t)
		CO_2 Scope 1	CO_2 Scope 2	CO_2 Scope 3			
Google	10.326	0.037	0.911	9.376	15,138,543	1,4191,508	28,864
Amazon	60.64	9.620	5.270	45.750	24,000,000	NA	NA
Meta-Facebook	4.067	0.029	0.009	4.029	7,170,000	2,202,000	NA
Apple	22.6	0.047	0.000	22.550	2,580,000	4,871,824	45,713
Rakuten	1.114	0.003	0.066	1.045	178,909	215,000	5231
Z Holdings	2.366	0.004	0.114	2.249	287,355	687,586	4,746.9

Sources: Environmental Reports/Environmental Progress Reports/Sustaiability Reports/ESG data of each company. Gallons and pounds in the original data are converted to m^3 and tons respectively with rounding. Apple's Scope 2 CO_2 means procurement from 100% renewable energy sources in accordance with the RE100 principle

Table A3: Results of the single regression analysis (significant results only: 8 cases)

Dependent variables	Explanatory variables (P-value)				
	Constant	Coefficient	Standard error	Adj.-R^2	F-value
(1) CO_2 emissions (total)		(1) Net sales			
	−4.824 (0.503)	1.381E-04 (0.012)	10.590	0.786	19.308
CO_2 emissions (Scope 3)		(1) Net sales			
	−2.915 (0.502)	1.089E-04 (0.005)	6.386	0.865	32.971
(2) Electricity consumption (ELC)		(3) Earnings per share			
	1,814,513.246 (0.541)	327,897.486 (0.026)	5,334,746.073	0.689	12.071
		(5) Property, plant, and equipment			
	−2,013,592.678 (0.230)	213.241 (7.226E-04)	2,232,116.536	0.946	87.799
(3) Water consumption (AQU)		(3) Earnings per share			
	1,244,258.146 (0.322)	217,787.924 (0.011)	1,970,229.425	0.883	31.061
		(5) Property, plant, and equipment			
	−1,036,695.945 (0.611)	156.300 (0.029)	2,672,550.336	0.784	15.511
(4) Waste generation (WST)		(1) net sales			
	3,378.854 (0.106)	0.149 (0.002)	1,667.981	0.993	424.044
		(2) net income			
	4,081.209 (0.158)	0.689 (0.006)	2,620.934	0.983	170.554