ORIGINAL ARTICLE

The Impact of FinTech on Environmental Degradation: An Empirical Evidence from APEC Economies

Neha Akbar[1] Muhammad Hafeez [2], Abdul Ghafoor [3], Mubashra Saman[4]

Author's Affiliation:

Ph.D. scholar
Institute of Business Management Sciences, University of Agriculture Faisalabad, Pakistan.

Professor
Institute of Business Management Sciences, University of Agriculture Faisalabad, Pakistan.

Assistant Professor
Institute of Business Management Sciences, University of Agriculture Faisalabad, Pakistan.

Lecturer
Institute of Business Management Sciences, University of Agriculture Faisalabad, Pakistan.

Article History:

Submitted: October 21, 2024
Revised: November 04, 2024
Accepted: November 24, 2024
Published online: December 01, 2024

Corresponding author(s):

Muhammad Hafeez
Muhammad.Hafeez@uaf.edu.pk

ABSTRACT

Purpose: Fintech innovation is booming in the Asia-Pacific Economic Cooperation region, with established players and emerging start-ups like launching new products and services. This study aims to determine how Fintech affects Environmental Degradation.

Design/Method/Approach: This study consists 17 out of 21 APEC economies region based on data availability from world development indicators. The Stochastic Impacts by Regression on Population, Affluence, and Technology model utilized to formulate the conceptual frame by using 2nd generation panel econometrics approaches.

Findings/Results: The empirical analysis reveals that FinTech has a positive impact on CO2 and GHG emissions in APEC economies, implying that advancements in financial technologies may initially drive-up environmental degradation. The Environmental Kuznets Curve (EKC) hypothesis supports an inverted U-shaped relationship between FinTech and CO2 emissions, suggesting that at early stages of FinTech development, emissions rise but may eventually decline as economies mature and adopt greener technologies. Similarly, the relationship between FinTech and GHG emissions follows a downward ∩-shaped pattern, reflecting a reduction in emissions as economic growth slows down due to diminishing returns from GHG-intensive industries. In the short run, bidirectional causality exists between CO2 emissions and the number of ATMs, and unidirectional causality from GDP to both CO2 and ATM expansion indicates that economic growth initially drives environmental degradation. However, in the long run, FinTech may contribute to greater economic efficiency, potentially reducing environmental harm.

Originality: Further research is required to fully recognize this delicate assimilation among fintech (financial technology) and environmental degradation, as well as to develop mitigation strategies for any detrimental effects. Based on the available existing literature, there doesn't seem to be any empirical research that examines how fintech affects environmental degradation in the APEC region. There is a dearth of hard data to measure the ecological impact of fintech in APEC regions, and most existing research rely on qualitative evidence.

Research Implications:

FinTech may exacerbate environmental degradation in the short term, its long-term impact could be mitigated through sustainable practices and technological advancements in green finance. This analysis highlights the need for policies promoting eco-friendly FinTech innovations to balance the dual goals of economic growth and environmental protection in APEC economies.

Keywords: Fintech, Environmental Degradation, CO2, APEC
JEL: G23, Q5, Q00, O53

1 | INTRODUCTION

Financial Technology (FinTech) means the technological development to establish financial innovation to uplift the financial services by incorporating the new business models, applications, and processes (Board, 2017). FinTech industry revolutionizes the online shopping, payment system, insurance, crypto trading, and the credit market with blockchain digital ledger (Thakor, 2020). The synchronization of technology with a financial system made financial services more accessible to the general public; investment, borrowing, stocks, and payments. Hence, the FinTech revolution is in full swing globally to improve financial activities in existing conventional financial culture through technology usage (Thakor, 2020).

FinTech, in general, refers to modernizing and expanding healthcare systems by lowering the costs of traditional financial services such as mortgages, deposits, capital raising and digital payments (Su et al., 2020). The digital divide has now severely and inadvertently hampered lower-income people's ability to finance such as technologies that deliver high-standard welfare outcomes. As a result of expensive commercial counseling, digital currencies and online financial services are readily available (Su and Song, 2021). Technological advancement in the financial system can significantly enhance financial services; however, it might pose a threat to the natural environment (Chang et al., 2020). The environment gives basic materials for the formulation of products and resources, as well as absorption of undesirable by-products in the form of waste emissions. It is also a vital component in reducing flood risk, regulating local weather, and providing clean water to economies and societies (Stern, 2004). The influence of climate variability and global warming on the condition of life has increased. The rise in industrial production and resultant environmental degradation are thought to be one of the main contributors to this phenomenon (Gutti, 2012). The degree of the ecological effect depends on the basis, the surroundings, and the plants and animal species that live there. Environmental degradation is mainly cause by humans and their actions (Bourque et al., 2005). Environmental degradation relates to the degeneration of natural surroundings caused by several components such as Contamination, Loss of Biodiversity, Animal Extinction, Deforestation and Climate Change (Tian, 2004).

Figure 1-3 are reflecting the patterns of FinTech (Financial Technology) and environmental indicators, respectively. The association between FinTech and Environmental Degradation has become more difficult to grasp from an environmental perspective due to the rapid growth of FinTech industry. The relationship between these two variables, as well as the actual results, is still being debated. There are two things that must be done. The first question is: what are the best possible connections between the two. The second question is: how FinTech integrates with other big picture of environmental issues. Despite the fact that there aren't many scholars and experts who delved in this subject. There is no consensus about the effects of FinTech on environmental degradation, that's why there is no consensus about the implications of technology. The findings of this study may related to benefits and drawbacks of FinTech (Cherniwchan, 2012).

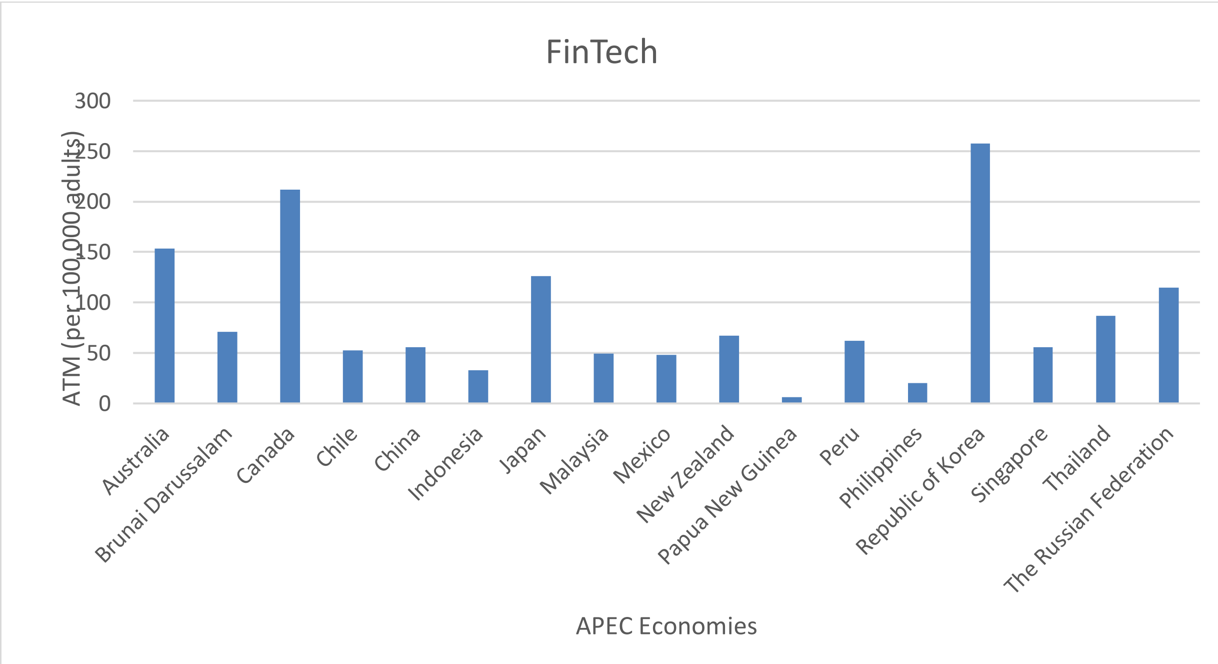

Figure 1 FinTech pattern in APEC Economies

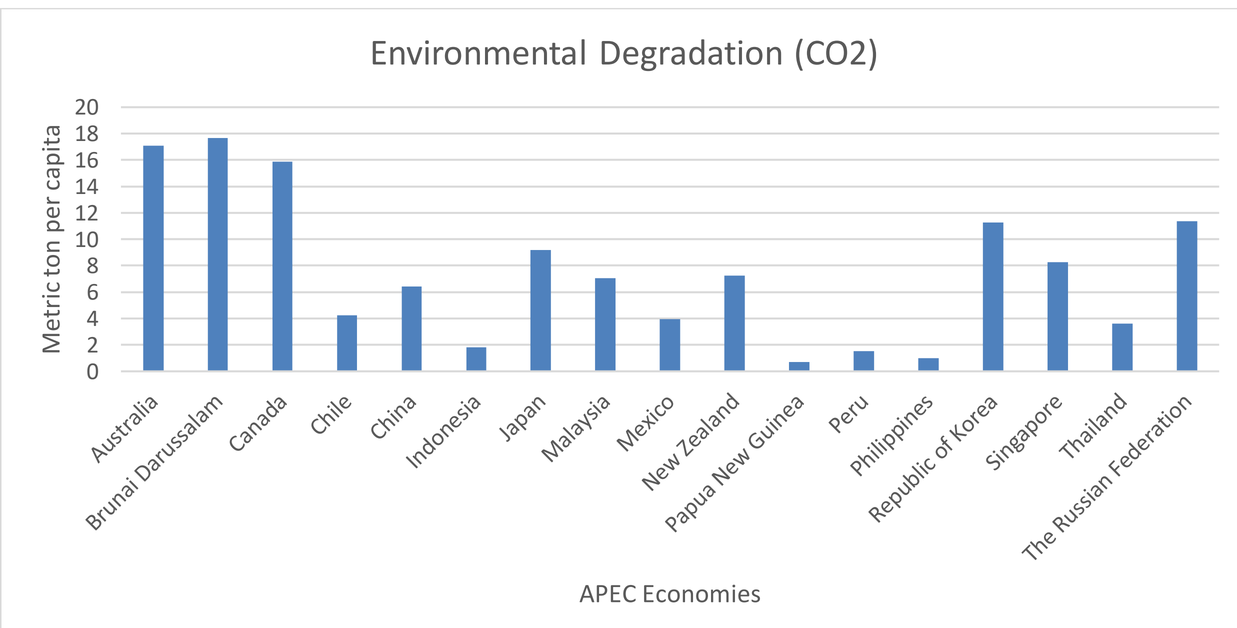

Figure 2 Environmental Degradation pattern in APEC Economies

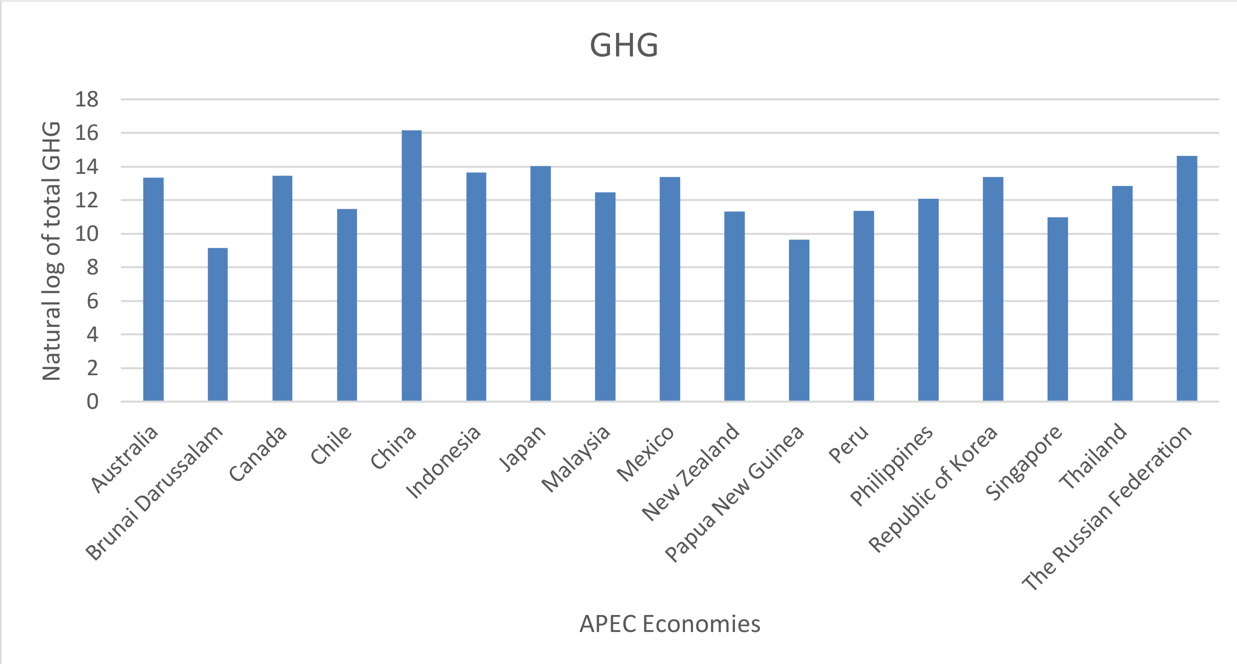

Figure 3 GHG pattern in APEC Economies

The emergence of digital currency and blockchain technology has also brought attention to worries about energy usage and the potential implications of climate change (Dorfleitner and Braun, 2019). Further research is required to fully recognize this delicate assimilation among FinTech and environmental degradation, as well as to develop mitigation strategies for any detrimental effects. Based on the literature (Puschmann, 2020), there doesn't seem to be any empirical research that examines how FinTech affects environmental degradation in APEC region. Furthermore, an advanced econometric approach will provide a robust and suitable analysis on FinTech's environmental impact would be beneficial in the areas of energy use, electronic waste and carbon dioxide (CO2) emissions. There is a dreath of hard data to measure the ecological impact of FinTech in APEC region, and most existing research rely on qualitative evidence (Bhuiyan et al., 2022). Further, competitive research across the Asia-Pacific-Economic Cooperation (APEC) member economies is required to find best practices and policy situations for fostering long-term growth in the FinTech sector, despite the fact that several have made substantial strides in encouraging finance and regulating FinTech. Therefore, this study has been planned to determine how FinTech impact environmental degradation in APEC economies.

To fulfill the aforementioned research plan, the present research may be treated as pioneer to model the Environmental Kuznets Curve (EKC) to examine FinTech-Environmental Degradation nexus for APEC region. The objectives of this paper are threefold: First, we want to examine the FinTech growth trends in APEC economies. Second, we want to evaluate the role of FinTech on Environmental Degradation in APEC economies and third, we want to suggest policy recommendations based on findings.

2 | LITERATURE REVIEW

Zaki and Aliasuddin (2022) explained the impact of commercial expansion, usage of antique fuel along with the use of sustainable resources had a positive influence on carbon emissions in APEC upper and lower-middle-income economies. The research showed that upper and lower-middle APEC governments prepared to enhance the renewable energy system and use in all sectors of development, transportation and domestic use. Therefore, carbon emissions would be reduced.

Li et al., (2021) evaluated that sustainable development had made a significant contribution to environmental degradation through improved financial sectors in the One Belt and Road initiative (BRI) sector. Therefore, as part of the study, One Belt and Road sustainable development index was created. It then outlined the link between energy advancements and ecological destruction, along with also assessed the part of fiscal growth indexes in the One Belt and Road economy. This study used robust average groups to quantify the long-term limited effects of energy advancement, fiscal growth indexes, use of energy, and urban spread on ecological destruction individually. Limited effects suggest an inverted U-shaped Kuznets curve for energy advancement in the Belt and Road region. Energy advancement, energy usage, and urban spread had increased ecological destruction. While fiscal growth indicators created an interaction between sustainable development and financial development that adversely affected the environmental degradation. Therefore, improving fiscal growth indexes would assist to attain energy advancement.

Khan and Khan, (2021) explained the effect of Carbon dioxide (CO_2) emissions through fiscal growth and energy usage through balanced panel information. The findings of the two-step difference and the system Generalized Method of Moments (GMM) analysis investigated that fiscal growth contributed to Carbon dioxide (CO_2) emissions reduction, and the SUR outcomes indicated that fiscal growth had a significant effect on CO_2 emissions. The economic growth investigated findings showed a positive effect on CO_2 emissions, and commercial expansion square validated the EKC hypothesis, in 184 nations. The research had important implications for policy makers in terms of environmental advancement, pure animation savings and effective monetary systems. Additional instructions were proposed on the conclusions considered.

Hafeez et al., (2019) examined that finance played a critical role in rapidly growing economies, which give rise to ecological destruction. The empirical relationship between saving as well as funds. It additionally a revealed non-linear effect of saving along with funds on ecological destruction. Ecological matters were mostly focused on particular narratives revealed individual areas, although a broad investigation rarely possible. The panel was divided within five sections: universal, local, revenue-based, OECD-based and carbon-based. A cross-section dependence analysis was employed to determine the cross-sectional dependence between each of the 16 subdivisions. A 2nd-generation panel analysis was used and adjusted for unit root computation, correlation, long-run and short-run kinetics of the variables under consideration. As a result, inverse EKC and U-shaped EKC occurred in 10 and 3 out of 16 units in relation to the relationship between environmental degradation and economy. 8 and 2 out of 16 showed inverted EKC and U-shaped EKC with regard to the link between ecological destruction and funds. CO2 emissions increased due to energy consumption in 12 out of 16 units. DH causal link among commercial, fiscal as well as energy usage.

Zaidi et al., (2019) identified a strong relationship among internationalization, fiscal growth and carbon emissions in Asia-Pacific Economic Cooperation (APEC) economies in the existence of power violence as well as commercial success within the Environmental Kuznets Curve (EKC). The Westerlund Cointegration method for finding long-term cointegrations, Continuously Modified Biased Correlation method (CUP-BC) and Continuously Updated Full Correction method (CUP-FM) for testing long-term elasticity between variables. Empirical evidence showed a particular and fiscal growth had significantly decreased carbon emissions, although commercial development and power violence had enlarged carbon emissions. Dumitrescu and Harling's causal tests showed that internationalization caused Granger's CO2 emissions. Internationalization had also led to fiscal growth and power violance. There was a response affected by fiscal growth and CO2 emissions. And while fiscal growth brought commercial development. Finally, the study showed major strategical outcomes relevant to APEC economies.

Jing et al., (2022) examined the effect of financial technology (fintech) on health consequences in Asian countries. The results confirmed the adverse effects of ATMs and debit cards on infant mortality in both the 2SLS and GMM models. Regardless of the technology intended, ATMs and debit cards had positive influence on life expectancy for people living in Asian economies. Likewise, the relationship between the internet and infant mortality had a negative impact. On the other hand, this link was significant in the area of web as well as life cycle for both 2SLS and Generalized Methods of Moments (GMM). From these results, we confirmed that the convergence of innovation and monetary sector could help to enhance the health consequences in Asian countries. Therefore, the integration of FinTech in the healthcare sector should be an integral part of any healthcare policy in selected areas.

Appiah-Otoo and Song, (2021) explored the primary as well as the secondary effect of fintech and its subscale payments and the third-party credit on need, household usage. The findings showed a particular financial technology along with these subsidized actions had reduced needs in China. The findings equally highlighted that financial technology correlates the commercial expansion and fiscal growth for reduction of wants or needs in China.

Wang, (2021) evaluated the prospective effect of financial technology on the banking business. The findings presented a particular growth of the fintech in commercial banking which led to increased profitability, financial innovation and better risk management. In general, commercial banks could use financial instruments to enhance traditional company's plan for consumers; therefore, increasing the overall competition. They also found specific stages of that benefits differed between banks according to their levels of acceptance of the latest innovations.

Khiewngamdee and Yan, (2019) explained the purpose of such research was to explore financial technology digital payments affected commercial expansions within the Asia-Pacific-Economic-Corporation's (APEC) economies, especially in income, efficiency, cost instability as well as economic imbalance. They used the electronic payments indicator presented through RMIT University and TRPC and applied quantile regression accompanied by the GME technique. The levels of quantile regression 0.25, 0.50 and 0.75 were considered. For low-level commercial expansion indicator and financial technology had the greatest effect on these variables as compared to the medium and high-level commercial expansion. On the other hand, financial technology additionally supported low levels of growth and productivity, but also reduced-price volatility and income inequality. Further research presented a particular application of digital compensation along with innovation enhancements were helped economic development, especially growth and productivity.

3 | ECONOMETRIC MODEL SPECIFICATION

The STIRPAT framework, proposed by (Dietz and Rosa, 1997), has been implemented to compute the impact of FinTech on Environmental Degradation across APEC economies though EKC hypothesis. Eq.1 explains the basic formulation for the "Stochastic Impacts by Regression on Population, Affluence, and Technology" model:

$$I_t = a\, P_t^b A_t^c T_t^d \ldots\ldots (1)$$

Where EF measures I (environmental impact), GDP and GDP2 Measures A (affluence), technological innovation Measures T (technology), and Population Measures P (population effect) in the STIRPAT model. The pattern in the direction of long-term evaluation is as follows:

$$LOGEF_{it} = \delta_\theta + \delta 1_{it} LOGGDP + \delta 2_{it} (LOGGDP)^2 + \delta 3_{it} LOGFT + \delta 4_{it} LOGP + \omega_1 \ldots\ldots (2)$$

Latest research is carried out on targeted APEC nations (Canada, Australia, Brunei Darussalam, Chile, China, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, The Philippines, The Russian Federation, Singapore & Thailand) from 2004 to 2022, and the duration is required to information about data accessibility on scientific origination of financial technology (fintech) and environmental degradation. This research is unable to incorporate few economies because of the absence of data. The data of fintech as ATM (per 100,000 adults) came from WDI, and the data on CO2 emission (per capita), GHG (kt of CO2 equivalent) and GDP & GDP2 (per capita) are obtained from World Development Indicators (WDI). The WDI database contains technological advancements (all patents related to products). The variable log transformation is a critical step to increase the accuracy of analysis and smoothen the results (Kihombo et al., 2021); Hence variables are changed towards algorithmic model. Table 1 and 2 depict the dataset of 17 out of 21 APEC economies and variable description, respectively.

Table 1 APEC economies

Sr. No	Country	Sr. No	Country	Sr. No	Country
1	Australia	7	Japan	13	Peru
2	Brunei Darussalam	8	Republic of Korea	14	Philippines
3	Canada	9	Malaysia	15	Russian Federation
4	Chile	10	Mexico	16	Singapore
5	China	11	New Zealand	17	Thailand
6	Indonesia	12	Papua New Guinea		

Table 2 Variables description

Variable	Acronym	Measure	Source	Time span
FinTech	FIN	ATMs (per 100,000 adults)	WDI	2004-2022
Environmental Degradation	ED	CO2 emission (per capita)	WDI	2004-2022
Green House Gas emission	GHG	GHG emission (kt of CO2 equivalent)	WDI	2004-2022
Gross Domestic Product	GDP	GDP (per capita)	WDI	2004-2022

WDI World Development Indicator, (2016)

Table 3 indicates the APEC panel correlation matrix. Environmental degradation CO2 emission is positively correlated with ATM and GDP, while very weak negatively correlated with GHG. Environmental degradation is more correlated with ATM and GDP compared to financial technology. Similarly, the GHG is found negatively associated with ATM and GDP. The association among these indicators, the correlation does not exist causation and the power of these relation changes, while some relations are moderate and others are in very weak trends. However, a significant positive association is witnessed among ATM and GDP.

Table 3 Panel correlation matrix

	CO2	**ATM**	**GDP**
CO2	1.0000		
ATM	0.6443	1.0000	
GDP	0.7363	0.5015	1.0000
	GHG	ATM	GDP
GHG	1.0000		
ATM	-0.0116	1.0000	
GDP	-0.1798	0.5015	1.0000

4 | EMPIRICAL OUTCOMES AND DISCUSSIONS

4.1 Panel unit root tests

Panel Unit Root test is a statistical method used to determine whether a time series variable in a panel data set (which includes multiple cross-sectional units, such as individuals, firms, or countries, observed over time) is non-stationary and possesses a unit root. In essence, it tests if the time series is integrated of order one, I(1), implying that it requires differencing once to become stationary. Panel Unit Root tests are extensions of unit root tests for single time series and are designed to exploit the cross-sectional dimension of panel data, providing more power and robustness compared to individual unit root tests. The panel unit root tests outcomes with CADF are presented in table 4.

4.2 Panel Co-integration tests and long-run estimates

Panel Co-integration refers to a statistical method used to examine the long-term relationship between two or more non-stationary time series data across multiple cross-sectional units, such as countries, companies, or regions. Unlike standard cointegration, which deals with single time series, panel cointegration incorporates both time series and cross-sectional data, providing more robust results due to increased data variability and sample size. Panel cointegration tests typically include Pedroni's test, Kao's test, and the Johansen-Fisher panel cointegration test. These tests are used to determine whether a set of non-stationary series is cointegrated in the context of panel data, ensuring that the long-term relationships among the variables are statistically significant. The empirical outcomes of Driscoll-Kraay analysis for long-run estimation are displayed in table 5. The results validate the long-run relationship between FinTech and Environmental Degradation in panel of APEC economies. Moreover, we also apply Robustness analysis with Newey Regression for the validity of results and the results are reported in table 6.

Table 4 Panel unit root test with CADF results

CADF test results Variable I(0)								
C				C&T				
	t-bar	Cv10	Cv5	Cv1	t-bar	Cv10	Cv5	Cv1
CO_2	-3.375*	-2.100	-2.210	-2.400	-3.632*	-2.630	-2.730	-2.920
GHG	-3.309*	-2.100	-2.210	-2.400	-3.333*	-2.630	-2.730	-2.920
ATM	-2.287*	-2.100	-2.210	-2.400	-2.523*	-2.630	-2.730	-2.920
GDP	-3.281*	-2.100	-2.210	-2.400	-3.197*	-2.630	-2.730	-2.920

CADF test results Variable I(I)								
C				C&T				
	t-bar	Cv10	Cv5	Cv1	t-bar	Cv10	Cv5	Cv1
CO_2	-4.348*	-2.100	-2.210	-2.400	-4.189*	-2.630	-2.730	-2.920
GHG	-3.885*	-2.100	-2.210	-2.400	-3.677*	-2.630	-2.730	-2.920
ATM	-3.718*	-2.100	-2.210	-2.400	-3.482*	-2.630	-2.730	-2.920
GDP	-2.906*	-2.100	-2.210	-2.400	-2.674*	-2.630	-2.730	-2.920

Table 5A Panel co-integration test and long-run estimates

CO_2	Coefficient	Std. Error	t-value	Prob.
ATM	.0218941	.0016815	13.02	0.000
GDP	.0003916	.000023	17.04	0.000
GDP^2	-3.91e-09	4.08e-10	-9.58	0.000
Constant	.5369036	.2673844	2.01	0.060
R-squared		0.6734		
F-statistics		657.92		
No. of groups		17		
No. of observations		322		

Table 5B Panel co-integration test and long-run estimates

GHG	Coefficient	Std. Error	t-value	Prob.
ATM	4260.456	1066.853	3.99	0.001
GDP	-47.55012	6.791025	-7.00	0.000
GDP^2	.0002715	72493.9	2.21	0.040
Constant	1505986	72493.9	20.77	0.000
R-squared		0.0418		
F-statistics		457.37		
No. of groups		17		
No. of observations		322		

Table 6A Robustness analysis with Newey Regression

CO2	Coefficient	Std. Error	t-value	Prob.
ATM	.0218941	.0036734	5.96	0.000
GDP	.0003916	.0000577	6.79	0.000
GDP^2	-3.91e-09	9.19e-10	-4.25	0.000
Constant	.5369036	.2614519	2.05	0.041
F-statistic		186.62		
No. of observations		322		

Table 6B Robustness analysis with Newey Regression

GHG	Coefficient	Std. Error	t-value	Prob.
ATM	4260.456	1100.411	3.87	0.000
GDP	-47.55012	13.00923	-3.66	0.000
GDP^2	.0002715	.0001857	1.46	0.145
Constant	1505986	272856	5.52	0.000
F-statistic		12.77		
No. of observations		322		

4.3 Dumitrescu and Hurlin causality

The results of short-run causality based on heterogeneous panels, developed by (Dumitrescu and Hurlin, 2012), are depicted in Table 7. The outcomes indicate that there is bidirectional causality between ATM and CO2 emissions. This implies that changes in ATM and CO2 influence each other. While the EKC typically focuses on GDP and emissions, this finding suggests complex associations between different types of pollutants. GDP homogeneously causes CO2 emissions, but CO2 does not homogeneously cause GDP. This is consistent with the EKC hypothesis, where economic growth initially leads to increased emissions, but at higher levels of income, the trend reverses due to increased environmental awareness and regulations.

GDP homogeneously causes ATM, but ATM does not homogeneously cause GDP. Similar to the GDP-CO_2 relationship, this supports the EKC hypothesis, indicating that economic growth leads to increased ATM at lower levels of income, but this relationship may change as income increases, and more resources are devoted to pollution control. Whereas the results with the other dependent variable GHG shows that we reject the null hypothesis. This suggests that ATM homogeneously causes GHG across the panel data. GHG also homogeneously cause ATM because the p-value of GHG 0.0000 is less than 0.05 and reject the null hypothesis. In the relationship of GDP and GHG the p-value 0.0000 is less than 0.05. So, we reject the null hypothesis and conclude that GDP homogeneously causes GHG. Whereas, among the relationship of GHG and GDP p-value 0.2071 is greater than 0.05. Due to higher value, we do not reject the null hypothesis. Also suggests that GHG does not homogeneously cause GDP. The p-value in given table 1.E-06 or 0.000001 is less than 0.05, indicating that we reject the null hypothesis. This suggests that GDP does not homogeneously cause ATM across the panel data. P-value 0.4111is higher than 0.05, so we do not reject the null hypothesis, and ATM does not homogeneously cause GDP across the panel data.

Table 7A Pairwise Dumitrescu Hurlin panel causality tests

Null Hypothesis	W-Stat.	Zbar-Stat.	Prob.
ATM does not homogeneously cause CO2	4.03659	2.29567	0.0217
CO2 does not homogeneously cause ATM	9.43422	9.86696	0.0000
GDP does not homogeneously cause CO2	7.60547	7.30175	3.E-13
CO2 does not homogeneously cause GDP	3.30182	1.26500	0.2059
GDP does not homogeneously cause ATM	5.88183	4.88399	1.E-06
ATM does not homogeneously cause GDP	2.98602	0.82202	0.4111

Table 7B Pairwise Dumitrescu Hurlin panel causality tests

Null Hypothesis	W-Stat.	Zbar-Stat.	Prob.
ATM does not homogeneously cause GHG	4.30051	2.66586	0.0077
GHG does not homogeneously cause ATM	11.1994	12.3430	0.0000
GDP does not homogeneously cause GHG	10.4398	11.2775	0.0000
GHG does not homogeneously cause GDP	3.29947	1.26170	0.2071
GDP does not homogeneously cause ATM	5.88183	4.88399	1.E-06
ATM does not homogeneously cause GDP	2.98602	0.82202	0.4111

5 | CONSLUSION

The empirical analysis reveals that FinTech has a positive impact on CO_2 and GHG emissions in APEC economies, implying that advancements in financial technologies may initially drive-up environmental degradation. The Environmental Kuznets Curve (EKC) hypothesis supports an inverted U-shaped relationship between FinTech and CO_2 emissions, suggesting that at early stages of FinTech development, emissions rise but may eventually decline as economies mature and adopt greener technologies. Similarly, the relationship between FinTech and GHG emissions follows a downward ∩-shaped pattern, reflecting a reduction in emissions as economic growth slows down due to diminishing returns from GHG-intensive industries.

In the short run, bidirectional causality exists between CO_2 emissions and the number of ATMs, and unidirectional causality from GDP to both CO_2 and ATM expansion indicates that economic growth initially drives environmental degradation. However, in the long run, FinTech may contribute to greater economic efficiency, potentially reducing environmental harm. Thus, while FinTech may exacerbate environmental degradation in the short term, its long-term impact could be mitigated through sustainable practices and technological advancements in green finance. This analysis highlights the need for policies promoting eco-friendly FinTech innovations to balance the dual goals of economic growth and environmental protection in APEC economies.

5.1 Policy Proposal

The findings of this research are innovative in the field for future researchers. This study opens a new way of doing research. In practice, this study guides investors and financial advisors, financial institutions, government, policy makers in financial decision-making.

- FinTech positively impacts CO_2 and GHG emissions, policy measures should promote FinTech products focused on sustainable development and eco-friendly financial services.
- An inverted U-shaped relationship with CO_2 suggests that emissions could rise before falling as FinTech matures. Carbon pricing can help drive emissions reductions earlier in the curve by low-carbon financial innovation.
- The bidirectional causality between CO_2 and ATMs, making ATMs and other FinTech infrastructure eco-friendlier can directly reduce emissions.
- A downward ∩-shaped EKC for GHG implies that economic growth could lead to reduced GHG emissions over time, particularly if FinTech is focused on sustainable financing.

5.2 Future Research Direction

The future researcher utilizes the more defined population growth should be used in future research. Population Growth of the APEC economies could be taken into the account in future studies. Large sample size should be taken in future research for more accuracy. Future research should be done by adding more variables like labor force and population. More complex and interconnected relationships among the variables of the present model could be studied. Future researchers can employ the findings of this research to the comparison of study held that took data for another country. A comparison among developing and developed economies should be undertaken in future research. Further research can be done to enhance the population growth trend through technological strategies and innovations among people.

REFERENCES

Appiah-Otoo, I., & Song, N. (2021). The impact of fintech on poverty reduction: Evidence from China. *Sustainability*, *13*(9), 5225.

Bhuiyan, M. A., Zhang, Q., Khare, V., Mikhaylov, A., Pinter, G., & Huang, X. (2022). Renewable energy consumption and economic growth nexus—a systematic literature review. *Frontiers in environmental science*, *10*, 878394.

Board, F. F. S. (2017). *Financial stability implications from Fintech: supervisory and regulatory issues that merit authorities' attention*. Financial Stability Board.

Bourque, C. P. A., Cox, R. M., Allen, D. J., Arp, P. A., & Meng, F. R. (2005). Spatial extent of winter thaw events in eastern North America: historical weather records in relation to yellow birch decline. *Global Change Biology*, *11*(9), 1477-1492.

Cherniwchan, J. (2012). Economic growth, industrialization, and the environment. *Resource and Energy Economics*, *34*(4), 442-467.

Dietz, T., & Rosa, E. A. (1997). Effects of population and affluence on CO2 emissions. *Proceedings of the national academy of sciences*, *94*(1), 175-179.

Dorfleitner, G., & Braun, D. (2019). Fintech, digitalization and blockchain: possible applications for green finance. In *The rise of green finance in Europe: opportunities and challenges for issuers, investors and marketplaces* (pp. 207-237). Cham: Springer International Publishing.

Dorfleitner, G., & Braun, D. (2019). Fintech, digitalization and blockchain: possible applications for green finance. In *The rise of green finance in Europe: opportunities and challenges for issuers, investors and marketplaces* (pp. 207-237). Cham: Springer International Publishing.

Dumitrescu, E. I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic modelling*, *29*(4), 1450-1460.

Gutti, B., Aji, M. M., & Magaji, G. (2012). Environmental impact of natural resources exploitation in Nigeria and the way forward. *Journal of Applied technology in Environmental sanitation*, *2*(2), 95-102.

Hafeez, M., Yuan, C., Yuan, Q., Zhuo, Z., Stromaier, D., & Sultan Musaad O, A. (2019). A global prospective of environmental degradations: economy and finance. *Environmental Science and Pollution Research*, *26*(25), 25898-25915.

Jing, R., Ma, Y., Zhang, L., & Hafeez, M. (2022). Does financial technology improve health in Asian economies?. *Frontiers in Public Health*, *10*, 843379.

Khan, S., Khan, M. K., & Muhammad, B. (2021). Impact of financial development and energy consumption on environmental degradation in 184 countries using a dynamic panel model. *Environmental Science and Pollution Research*, *28*(8), 9542-9557.

Khiewngamdee, C., & Yan, H. D. (2019, October). The role of Fintech e-payment on APEC economic development. In *Journal of Physics: Conference Series* (Vol. 1324, No. 1, p. 012099). IOP Publishing.

Kihombo, S., Ahmed, Z., Chen, S., Adebayo, T. S., & Kirikkaleli, D. (2021). Linking financial development, economic growth, and ecological footprint: what is the role of technological innovation?. *Environmental Science and Pollution Research*, *28*(43), 61235-61245.

Li, X., Yu, Z., Salman, A., Ali, Q., Hafeez, M., & Aslam, M. S. (2021). The role of financial development indicators in sustainable development-environmental degradation nexus. *Environmental Science and Pollution Research*, *28*(25), 33707-33718.

Puschmann, T., Hoffmann, C. H., & Khmarskyi, V. (2020). How green FinTech can alleviate the impact of climate change—the case of Switzerland. *Sustainability*, *12*(24), 10691.

Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World development*, *32*(8), 1419-1439.

Su, C. W., Qin, M., Tao, R., & Umar, M. (2020). Financial implications of fourth industrial revolution: Can bitcoin improve prospects of energy investment?. *Technological Forecasting and Social Change*, *158*, 120178.

Su, C. W., Song, Y., & Umar, M. (2021). Financial aspects of marine economic growth: From the perspective of coastal provinces and regions in China. *Ocean & Coastal Management*, *204*, 105550.

Thakor, A. V. (2020). Fintech and banking: What do we know?. *Journal of financial intermediation*, *41*, 100833.

Tian, Q., Zhou, Z. Q., & Jiang, S. R. (2004). Research progress in butachlor degradation in the environment. *PESTICIDES-SHENYANG-.*, *43*(5), 205-208

Wang, Y., Xiuping, S., & Zhang, Q. (2021). Can fintech improve the efficiency of commercial banks?—An analysis based on big data. *Research in international business and finance*, *55*, 101338.

Zaidi, S. A. H., Zafar, M. W., Shahbaz, M., & Hou, F. (2019). Dynamic linkages between globalization, financial development and carbon emissions: evidence from Asia Pacific Economic Cooperation countries. *Journal of cleaner production*, *228*, 533-543.

Zaki, S. A., Aliasuddin, A., & Syahnur, S. (2022). The effects of economic growth, fossil energy consumption, and renewable energy consumption on carbon emission in selected APEC countries. *International Journal of Advanced Research in Economics and Finance*, *4*(4), 107-114.