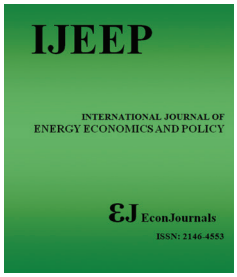

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Business Density, Financial Development and Carbon Footprints: Examining the Energy-Sustainability Trade-off in East Asia and the Pacific

Romanus Osabohien[1]*, Amar Hisham Jaaffar[1], Jeniboy Kimpah[2], Mamdouh Abdulaziz Saleh Al-Faryan[3]

[1]Institute of Energy Policy and Research, Universiti Tenaga Nasional (UNITEN), Kajang, Malaysia, [2]Faculty of Business, Economics and Social Development, Universiti Malaysia Terengganu, Malaysia, [3]Board Member and Head of the Scientific Committee at The Saudi Economic Association, Riyadh, Saudi Arabia. *Email: romik247@gmail.com

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ABSTRACT

This study investigates the relationship between business density, financial development, and their potential trade-off with carbon footprints in the world's largest continent. Rapid economic growth and industrialization in Asia have led to concerns about its environmental impact, particularly with regards to carbon emissions and sustainable development. By analysing data from various countries in East Asia and the Pacific, this study aims to shed light on the intricate relationship between business density, financial development, and the trade-off between carbon footprints and sustainable development. The study utilizes a panel dataset covering multiple countries in East Asia and Pacific, allowing for a comprehensive analysis of the economic, financial, and environmental dimensions Carbon footprints are assessed based on carbon emissions, energy consumption, and environmental sustainability indices. Findings suggest a positive correlation between business density and financial development, indicating that countries with higher business density tend to experience greater financial growth. However, this growth often comes at the expense of increased carbon footprints, as reflected in higher carbon emissions and energy consumption. These findings highlight a potential trade-off between economic development and environmental sustainability in the context of Asia. The research contributes to the existing literature on the nexus between business density, financial development, and sustainability in Asia. It provides valuable insights for policymakers, businesses, and environmentalists to better understand the challenges and opportunities associated with balancing economic growth and environmental conservation in the region.

Keywords: Business Density, Financial Development, Carbon Footprints, Sustainable Development
JEL Classifications: G20, L11, Q01, Q54

1. INTRODUCTION

The world's largest continent, Asia, is home to a diverse range of economies, each striving for economic growth and development. However, the pursuit of economic prosperity often raises concerns about its environmental consequences, particularly in terms of carbon footprints and sustainable development (Adeleye et al., 2021a; 2021b Udemba et al., 2022; Osabohien et al., 2023; Xushi et al., 2023). As countries in this vast continent experience rapid industrialization, it becomes imperative to understand the relationship between business density, financial development, and the trade-off between carbon footprints and sustainable development.

By basic definition, business density means to the concentration of business establishments within a given area, indicating the level of economic activity and entrepreneurship. Higher business density is often associated with increased employment opportunities (Osabohien et al., 2023; 2022; 2020b), enhanced productivity, and overall economic growth. In the context of the world's largest

continent, business density plays a crucial role in shaping its economic landscape. On the other hand, financial development, encompasses the growth and effectiveness of financial systems, including banking institutions, capital markets, and regulatory frameworks (Okafor et al., 2023). Robust financial systems are essential for mobilizing capital, facilitating investment, and fostering economic growth. The interplay between business density and financial development is critical for understanding the economic dynamics of the continent.

However, as economic activity intensifies, concerns about carbon footprints and their impact on the environment arise. Carbon footprints represent the total amount of greenhouse gas emissions, primarily carbon dioxide, generated by human activities, including industrial processes, transportation, and energy consumption.

The substantial carbon footprints associated with rapid economic growth raise questions about their compatibility with sustainable development goals. Sustainable development seeks to balance economic progress with environmental stewardship and social well-being. It emphasizes the need to meet present needs without compromising the ability of future generations to meet their own needs. Achieving sustainable development requires mitigating environmental degradation, reducing carbon emissions, and transitioning towards cleaner and more efficient technologies. This study aims to explore the intricate relationship between business density, financial development, carbon footprints, and sustainable development in the world's largest continent, using East Asia and Pacific as a case study. It seeks to investigate whether a trade-off exists between carbon footprints and sustainable development as countries strive for economic growth, which has been executed in the context of the empirical literature. Furthermore, it examines the role of financial development in mediating this trade-off and facilitating the transition towards sustainable practices.

2. INSIGHTS FROM THE LITERATURE

2.1. Business Density, Carbon Footprints-Energy Nexus and Sustainable Development

Xiaokun et al. (2023) investigated the effect of air pollution on entrepreneurial activity in China The results, which were based on registration data from 2000 to 2018, showed that significant air pollution might cause a 36% decline in the number of newly registered businesses, indicating a detrimental impact on entrepreneurship. The two-stage least square approach was used to solve the possible endogenous issues and enhance the causal assumption. The outcome is resilient to many model parameters and various air pollution measures. The research also examined how factors like brain drain, social capital, beginning expenses, and financial constraints have an impact on entrepreneurship.

Here is a concise review of the studies you provided:

Osabohien et al. (2025) analyze the interconnections between economic growth, climate change, and clean energy in a post-COVID era. The study explores the challenges and opportunities presented by climate policies, emphasizing the role of clean energy in sustaining economic growth. Using empirical data, the authors argue that clean energy adoption is essential for mitigating climate risks while maintaining economic stability.

Guo et al. (2025) examine the influence of political institutions and natural resources on sustainable development in Asia. The study highlights how governance quality, resource management, and institutional frameworks shape economic growth and sustainability outcomes. The findings suggest that strong political institutions are crucial in ensuring resource efficiency and long-term sustainability.

Sahan et al. (2025) provide a systematic literature review on green human resource management (GHRM), energy-saving behaviour, and environmental performance. The study synthesizes existing research to establish a connection between GHRM practices and environmental sustainability, emphasizing the importance of corporate strategies in enhancing energy efficiency. Osabohien et al. (2024) investigate the impact of renewable energy, carbon footprints, and natural resource depletion on economic growth in Africa. The study underscores the trade-offs between economic expansion and environmental sustainability, advocating for policies that promote renewable energy while curbing natural resource depletion.

Xushi et al. (2023) studied the importance of environmental entrepreneurship in order to achieve stable green growth in growing Asian regions including China, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Thailand, Malaysia, and Singapore. In the research, two alternative proxies for environmental entrepreneurship electricity output from renewable sources and nuclear and renewable energy production were utilized. The research used ARDL-PMG to estimate data empirically. The panel-ARDL PMG conclusions supported the long-term and short-term benefits of producing electricity from sustainable sources for green economic growth. Likewise, the creation of renewable energy boosts both short- and long-term green economic growth.

Du et al. (2022) explored the spatial spill over impact and transmission mechanism between digital money and environmental pollution, utilizing panel data from 30 Chinese provinces. The study's findings showed that as digital banking advances, it progressively has a more adverse impact on local environmental degradation. It's noteworthy to note that environmental pollution in the neighbourhood is significantly reduced by financial technology. The facilitating impact demonstrated that through enhancing technical innovation, industrial upgrading, and organizational rationalization, electronic banking can reduce environmental pollution.

Gan et al. (2022) looked at the connection between air pollution and VC investment. Using data on VC investment from 2005 to 2018, the research discovered that firms with high levels of air pollution are less likely to acquire funding from VCs and receive less investment from them. Considering endogeneity issues and different stability checks, the analysis's conclusions are solid. Additionally, air pollution has an adverse impact on entrepreneur innovation and entrepreneurial activities, which in turn has a significant impact on VC investment. To counteract the negative effects of air pollution, VCs want to co-invest with other VCs.

Guo et al. (2022) investigated the relationship between air pollution and a person's predisposition for entrepreneurship in China. This research's favoured model proposed that proximity to higher levels of air pollution reduces one's inclination for entrepreneurship. The framework used an instrumental variable approach to tackle endogeneity emerging from filtering into entrepreneurship and geographical options. The research also discovered that the association between entrepreneurship and air pollution is moderated by production and self-efficacy. The association between air pollution and self-efficacy is significantly moderated by gender and educational level.

Udemba et al. (2022) evaluated the effects of urbanization, entrepreneurship, and economic expansion on environmental performance. In order to determine whether they have a limiting impact on the nation's carbon emissions, evaluations of financial development and renewable energy sources were also included. For the investigation, Malaysian data from 1992Q1 to 2017Q4 were used, and suitable econometric methodologies were utilized for a more thorough and understandable understanding of the research. Results from NARDL revealed that the chosen variables had a major effect on carbon emissions. In particular, entrepreneurship, urbanization, financial development, and renewable energy sources reduce carbon emissions, whereas economic growth increases them. The results from DOLS and Granger causality provided additional insight into the trajectory of the effects of economic expansion on the Malaysian environment through the inverted U-Shape EKC hypothesis, supporting the results from the NARDL.

Gu and Zheng (2021) examined the association between entrepreneurship, economic growth, and environmental pollution using a panel regression model. The environmental Kuznets model was examined from an entrepreneurial standpoint. From the standpoint of company heterogeneity, the environmental Kuznets curve, entrepreneurial impacts under various geographies, industrial properties, and ownership rights were taken into consideration. The findings revealed that an N-type environmental Kuznets curve is displayed by China's reported polluting firms. Although entrepreneurship has a direct negative impact on the environment by encouraging pollution, it also has negative structural, scale, and technology impacts on the environment.

Azam et al. (2018) investigated the impact of tourism on carbon dioxide emissions-related environmental pollution in Malaysia, Thailand, and Singapore from 1990 to 2014. The unit root and the existence of a structural break in the data were determined using the Zivot-Andrews analysis. Analytical method for evaluation of unidentified parameter was fully Modified Ordinary Least Squares estimation. According to the research findings, tourism significantly reduces Malaysia's environmental pollution. However, in Thailand and Singapore, there was a negative correlation between tourist and environmental damage.

Yaacob et al. (2015) investigated Kelantan, Malaysian batik entrepreneurs' knowledge of the environment. In-depth interviews with three business owners in the industry in Kelantan were used in the research. Ultimately, the analysis's findings showed that batik business owners were somewhat cognizant of issues relating to the environment, albeit this varied by individual. The results of this study are instructive and call for additional efforts from many stakeholders to raise Batik entrepreneurs' understanding of environmental concerns because it is thought to be a requirement for environmentally sound practices in the sector.

2.2. Financial Development, Carbon Footprints and Sustainable Development Nexus

Islam (2022) investigated the effects of financial development (FD) and energy use (ENC) as well as per capita income (PCI) as controls on CO_2 emissions in five South Asian economies. The research used annual panel data for the years 1980-2018 and used the Dumitrescu–Hurlin panel causality test, panel pooled generalized least square (GLS) estimate, pooled mean group (PMG) estimate, and second-generation unit root and cointegration tests. A long-term link between the variables was established by the Westerlund cointegration test. According to the GLS assessment findings, environmental pollution is significantly impacted by FD, ENC, and PCI. Since there is an inverse correlation between FD and CO2 emissions, FD does not increase environmental pollution. ENC and PCI have an adverse impact on environmental quality.

Tayyaba et al. (2022) evaluated the function of the financial development sector in attaining sustainable financial development and environmental quality in South Asian countries from 1990 to 2020 by regulating labour force participation, globalization, industrialization, and the education sector. To examine the association between the variables, a workable generalized least squares (FGLS) panel data econometric approach was utilized. The findings revealed a U-shaped link between financial development, carbon emissions, and economic expansion. Additionally, financial development and CO_2 emissions are greatly increased by labour force participation, industrialization, globalization, and educational school enrolment.

Ching-Chi et al. (2021) used an econometric forecasting between the years of 2000 and 2018 in 28 Chinese provinces to investigate the relationship between green innovation and the effectiveness of financial development. It was discovered that the advancement and invention of green technologies followed financial development. Emissions are reduced through green innovation and financial growth, and it is clear that as environmental rules spur technological advancement, human resources become more superior. The results showed that while long-term loans have no influence on excess investment in renewable energy and the intermediary effects is unmaintainable, green finance reduces short-term lending, hence restricting clean energy excessive investment. In the meanwhile, green financial growth will lessen overinvestment in renewable energy while, to some level, increasing investment performance.

Tahir et al. (2021) examined the effects of energy use, globalization, and financial development on the environmental quality of South Asian countries from 1990 to 2014. The Breusch-Pagan-Lagrange multiplier, Pesaran-scaled Lagrange multiplier, bias-corrected-scaled Lagrange multiplier, and Pesaran cross-sectional dependence analyses were employed to account for cross-sectional dependence. The stationarity level of the variables was ascertained using the second-generation tests. The cointegration

between the variables was also validated using the Westerlund panel cointegration analysis. Fully modified ordinary least squares, dynamic ordinary least squares, and pooled mean group estimators were employed to analyse the long-term associations. The findings demonstrated that globalization has the ability to reduce carbon emissions while financial development increases emissions.

Hunjra et al. (2020) explored the relationship between financial development and environmental quality In South Asia. Panel data from five South Asian nations (India, Bangladesh, Nepal, Sri Lanka, and Pakistan) from 1984 to 2018 make up the study sample. According to the research, financial development in this area results in higher CO_2 emissions, which suggests that South Asian nations have used financial development for capitalization rather than advancing production technologies. The effectiveness of institutions reduces the detrimental effects of financial development on the long-term viability of the environment.

Saleem et al. (2020) examined the impact of financial development, energy consumption sources, and other conceivable hypothetical variables on CO_2 emissions, utilizing data from a few Asian nations between 1980 and 2015, The panel Fully Modified OLS (FMOLS), the panel Granger causality evaluation, namely the Dumitrescu-Hurlin test (2012), and the Innovative Accounting Approach were employed in the research. In the backdrop of 10 Asian economies, the outcome of FMOLS for the entire panel set suggested the existence of an EKC hypothesis, according to which the effects of economic growth and the square of GDP growth on CO_2 emissions are termed both favorable and adverse.

Madhu et al. (2015) looked into the effects of financial development, economic growth, and energy consumption on environmental degradation in the Indian economy, utilizing time series data for the years 1971-2011. Appropriate econometric techniques were used to determine whether the variables' stationary qualities were present. The Autoregressive Distributed Lag bounds analysis methods for co-integration was used to look at the long-term relationship, while the error correction method (ECM) was used to look at the short-term dynamics. The factors' long-term associations were supported by the research. In India, environmental degradation seemed to be becoming worse as the economy developed. Economic expansion, energy use, financial development, and urbanization are the key causes of environmental degradation. The findings also provided evidence for environmental Kuznets curves in the context of the Indian economy.

Jalil and Feridun (2011) examined the effects of financial development, economic growth, and energy consumption on environmental pollution in China from 1953 to 2006. Utilizing the Autoregressive Distributed Lag (ARDL) bounds testing method, the findings of the analysis showed that the coefficient of financial development had an adverse effect, indicating that China's financial success had not come at the expense of environmental degradation. On the other hand, it was discovered that financial growth had resulted in less environmental damage.

3. RESEARCH METHOD

3.1. Data

This study carried out a panel data analysis that covers the East Asia-Pacific region which includes 21 countries for the period, 2017 to 2021. The dependent variable, environmental pollution, which was measured by carbon emissions was sourced from the WDI database. The independent variables in this study which includes entrepreneurship, financial development, population, and income were also sourced from the WDI database. Only government institutions which was another independent variable was sourced from the WGI database. Table 1 presents the variables their measurements and respective sources.

3.2. Model Specification and Estimation Techniques

Pooled OLS and the generalised method of moments (GMM) were used in this study to estimate the impact of entrepreneurship and financial development on environmental pollution. The pooled OLS was utilised in this study because of the independent variables in this study are non-stochastic and exogeneous. The pooled OLS is stated in this work as follows using the style of Adeleye et al., (2021a; 2021b):

$$lnCFP_{it} = \beta_0 + \beta_1 lnENT'_{it} + \beta_2 lnFDEV'_{it} + \beta_3 lnC'_{it} + \mu_{it} \quad (1)$$

Where β_0 represents the constant term in the econometric model, β_1, β_2, and β_3 represents the coefficients of the independent variables, μ is the disturbance term, i represents the country ID which ranges from 1 to 21, and t represents the period with ranges from 1 to 5. Furthermore, *ENT'*, *FDEV'*, and *C'* represent the covariate of entrepreneurship, financial development, ant the control variables in this study, respectively. To correct for the setbacks of the pooled OLS which includes endogeneity problems, the GMM was also used as a technique in estimating the relationship between entrepreneurship, financial development, and environmental pollution (Arellano & Bond, 1991; Wooldridge, 2016). Following the style of Roodman (2009), the GMM model is stated in equation (ii) below.

$$lnCFP_{it} = \beta_0 + \beta_1 lnCFP_{it-1} + \beta_2 lnENT'_{it} + \beta_3 ln\, FDEV'_{it} + \beta_4 lnC'_{it} + \mu_{it} \quad (2)$$

Where β_0 represents the constant term in the econometric model, β_1, β_2, and β_3 represent the coefficients of the independent variables, μ is the disturbance term, i represents the country ID which ranges from 1 to 21, and t represents the period with ranges from 1 to 5. Furthermore, *ENT'*, *FDEV'*, and *C'* represent the covariate of entrepreneurship, financial development, ant the control variables in this study, respectively. Lastly, CFP_{it-1} represents the first lag of carbon footprints.

The two techniques were utilised in this study to remove the biases associated with the correlation between the dependent variable, and the disturbance term, to exclude individual effects and to prevent the endogeneity between entrepreneurship, financial development, and environmental pollution.

Table 1: Variables, measurements, and sources

Variables	Measurement	Source	Expectations
Carbon Footprints	Kt	WDI	Not Applicable
Entrepreneurship	Business density	WDI	Positive/Negative (+/−)
Financial Development	Percentage	WDI	Positive/Negative (+/−)
Population	Number	WDI	Positive (+)
Income	USDs	WDI	Positive/Negative (+/−)
Institution	Index	WGI	Positive (+)

WDI, and WGI means World Development Indicators, and World Governance Indicators, respectively
Source: Authors' Compilation

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics of the Variables

Table 2 below shows the summary statistics of the following variables: carbon footprints (CFP), entrepreneurship (ENT), financial development (FDEV), population (POP), per capita income (PCI), and institutions (INST) for the East Asia-Pacific region, East Asia region, and Pacific region.

Carbon footprints has a mean value of 844598.8 kilotons in the East Asia-Pacific region. It means that the entire region emits an average of 844598.8 kilotons of carbon into the atmosphere. On a subregion level, it was revealed that the kilotons of carbon emissions were higher in East Asia region (1136507) than in the Pacific region (114826.9). Also, the country which has 140 kilotons of carbon which is the minimum value in the entire region was recorded in the Pacific region while the country which has 12700000 kilotons of carbon which is the maximum value in the entire region was recorded in the East Asia region. Entrepreneurship which is measured by new business density has a mean value of 3.6095 in the East Asia-Pacific region. This indicates that the average new business density (per 1000 people) value is 3.6095 in the entire region. On individual region level, it was revealed that the new business density was higher in Pacific region (5.8219) than in the East Asia region (2.7246). This means that more new businesses are established in the Pacific region than in the East Asia region. Furthermore, the country which has a business density value of 0.0285 which is the minimum value in the entire region was recorded in the Pacific region and the country which has a business density value of 18.5237 which is the maximum value in the entire region was also recorded in the Pacific region.

Financial development which is measured by domestic credit to the private sector as a proportion to GDP has a mean value of 95.122%. On individual region level, it is revealed that the financial development was greater in Pacific region (95.6315%) than in the East Asia region (94.94%). In addition, the country which has a domestic credit to the private sector value of 12.9962% which is the minimum value in the entire region was recorded in the East Asia region and the country which has a domestic credit to the private sector value of 193.516% which is the maximum value in the entire region was also recorded in the East Asia region.

Total population, a control variable in this study, has a mean value of 109,000,000 people in the East Asia-Pacific region. On a subregion level, it was revealed that the average population was higher in East Asia region (150,000,000) than in the Pacific region (5,162,844). Also, the country which has a population of 104,951 people which is the minimum value in the entire region was recorded in the Pacific region while the country which has a population of 1,410,000,000 people which is the maximum value in the entire region was recorded in the East Asia region.

Per capita income has a mean value of 22534.46 US Dollars in the East Asia-Pacific region. On a subregion level, it was revealed that the average per capita income was higher in East Asia region ($24288.94) than in the Pacific region ($18148.26). Also, the country which has a per capita income amounting to $1937.089 which is the minimum value in the entire region was recorded in the Pacific region while the country which has a per capita income amounting to $106032.2 which is the maximum value in the entire region was recorded in the East Asia region.

Government institutions, which is captured by the voice and accountability index, has a mean index value of about 2.4753 in the East Asia-Pacific region. On a subregion level, it was revealed that the average voice and accountability index value was higher in Pacific region (3.5157) than in the East Asia region (2.0591). That finding indicates that on average, the institutions in the Pacific region is more credible than that in the East Asia region. Also, the country which has an index of 0.6835 which is the minimum value in the entire region was recorded in the East Asia region while the country which has an index of 4.1219 which is the maximum value in the entire region was recorded in the Pacific region.

4.2. Interplay between Entrepreneurship, Financial Development, and Environmental Pollution

In this study, carbon footprints, entrepreneurship, financial development, population, per capita income, and institutions were all proxied by greenhouse gas emissions, new business density, total population, real GDP per capita, and voice and accountability, respectively. The pooled panel regression and the Generalised methods of moments were utilised to predict the estimates of the independent variables in this study. Table 3 shows the impact of the key independent variables, such as entrepreneurship and financial development, and control variables, such as population, per capita income, and institutions, on environmental pollution in the entire East Asia-Pacific Region, East Asia Region, and Pacific Region. The pooled panel regression column reveals the pooled panel OLS estimates for the variables in the three regions while the GMM column presents the one-step system GMM estimates for the variables in the three regions.

The relevant variables in this study were logged and the implication is that the variables' estimates would be interpreted in elasticity form. Following the rule of thumb, the coefficients of the independent variables in this study would be considered statistically significant at levels 1%, 5%, and 10%. The probability of the F-Statistic which is 0.000 indicates that the systemic variations in the dependent variable, carbon footprints, are jointly explained by the independent variables in this study. While the

Table 2: Descriptive statistics of the variables

Variable	Entire region			East asia region			Pacific region		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
CFP	844598.8	120	12700000	1136507	5910	12700000	114826.9	120	623270
ENT	3.6095	0.0285	18.5237	2.7246	0.0718	10.1929	5.8219	0.0285	18.5237
FDEV	95.122	12.996	193.516	94.94	12.996	193.516	95.631	37.760	160.494
POP	109000000	104951	1410000000	150000000	430276	1410000000	5162844	104951	25700000
PCI	22534.5	1937.1	106032.2	24288.94	3070.809	106032.2	18148.26	1937.089	49774.34
INST	2.4753	0.6835	4.1219	2.0591	0.6835	3.5769	3.5157	3.0986	4.1219

Source: Authors' Compilation

Table 3: Pooled panel regression and generalised method of moments

Variables	Pooled panel regression			GMM		
	Entire region	East asia	Pacific	Entire region	East asia	Pacific
$lnCFP_{it-1}$				0.8883049*	0.815619*	0.4785896*
				(0.000)	(0.000)	(0.001)
lnENT	0.2648802*	0.2378708*	0.0750129**	0.0308656**	0.0590215*	0.0692656*
	(0.000)	(0.000)	(0.043)	(0.014)	(0.005)	(0.001)
lnFDEV	−0.1279608**	0.000335	−0.1506629*	−0.0162501	−0.0081446	−0.0480874
	(0.029)	(0.997)	(0.002)	(0.121)	(0.563)	(0.120)
lnPOP	0.9968063*	0.9421764*	1.215744*	0.1173849**	0.1826546*	0.6208468*
	(0.000)	(0.000)	(0.000)	(0.012)	(0.006)	(0.001)
lnPCI	0.5257977*	0.4480875*	0.3738528*	0.0519914**	0.0810824**	0.192961*
	(0.000)	(0.000)	(0.000)	(0.046)	(0.021)	(0.001)
lnINST	0.0676986	0.1346601	0.4712926	0.0035438	0.0620416	−0.0338473
	(0.415)	(0.223)	(0.343)	(0.815)	(0.195)	(0.906)
_cons	−9.69318*	−8.571637*	−11.53377*	−1.099076**	−1.707351*	−5.639743*
	(0.000)	(0.000)	(0.000)	(0.018)	(0.009)	(0.001)
R square	0.9881	0.9722	0.9999			
F-Stat	1482.29*	447.06*	38843.87*			
	(0.000)	(0.000)	(0.000)			
AR (1)				−3.36*	−3.12*	−1.88***
				(0.001)	(0.002)	(0.060)
AR (2)				1.12	1.52	1.21
				(0.261)	(0.130)	(0.225)
Wald				1.08e+07*	7.76e+06*	5.56e+06*
				(0.000)	(0.000)	(0.000)

*, **, *** means significant at 1%, 5% and 10%, respectively
Source: Authors' Compilation

estimates of the impact in the entire region would be discussed, the emphasis would be made also on the two distinct regions.

Based on Table 3, the pooled panel OLS estimates revealed that entrepreneurship has a positive statistically significant impact on carbon footprints in the entire East Asia-Pacific region. This agrees with my expectations in this study which predicted it to have either a positive or negative impact. Some researchers such as Xushi et al. (2023) who analysed the importance of environment pollution on green growth in the Asian regions, and Gu and Zheng (2021) who analysed the relationship between entrepreneurship, economic growth and environmental pollution, found this positive relationship to be true in their research output while others such as Udemba et al. (2022) who analysed the effect of entrepreneurship on environmental performance, and Chuanbo et al. (2023) who explored the relationship between green businesses and greenhouse gases, found the relationship to be negative.

A significant positive relationship between entrepreneurship and carbon footprints in the region indicates that the rise in carbon emissions is associated with the rise in the number of new businesses in the East Asia-Pacific region. By using the Pooled OLS estimates from the table below, this study predicted that a 1% rise in the number of new businesses in the region would result in a rise in the kilotons of carbon emissions by 0.26%. When the GMM technique was used, it was still revealed that entrepreneurship has a positive impact on carbon emissions in the East Asia-Pacific Region. One notable difference between the two techniques was the estimate. The estimate of entrepreneurship was far lower than that predicted by the pooled panel OLS technique. It was predicted by this technique that a 1% rise in entrepreneurship would result in a 0.03% increase in kilotons of carbon emissions. Following these results, it can be seen that the nature of entrepreneurship is not sustainable as it contributes to the environmental pollution in the region and can hamper the potential in achieving SDG2.3, SDG3.8, SDG6, SDG11, and SDGs13 and 15.

The pooled panel regression estimates also revealed that entrepreneurship was statistically significant in leading to a rise in carbon emissions in the two individual regions. According to the findings, new firms in the East Asia Region contribute much more to the growth in carbon emissions related to entrepreneurship in the East Asia-Pacific Region than new firms in the Pacific Region. The one-step system GMM also revealed the positive

and statistically significant relationship between entrepreneurship and carbon footprints but predicted that the new businesses in two distinct regions contribute almost the same percentage of kilotons of carbon emissions in the East Asia-Pacific Region. For this reason, regulations should be made by authorities on new firms in the East Asia-Pacific Region to make sure they use sustainable business practices so that the carbon emissions in the region can be reduced drastically. Also, aid and benefits should be made to sustainable entrepreneurs so that other entrepreneurs can be encouraged to prioritise environmental health over profits.

As regards the impact of financial development, the pooled panel regression estimates revealed that financial development has a negative and statistically significant impact on environmental pollution in the entire East Asia-Pacific Region. The negative relationship revealed was in line with the expectations established in this study. Authors such as Jalil and Feridun (2021) who analysed the effect of financial development on environmental pollution in China, and Islam (2022) who investigated the effected of financial development on energy use, agreed with this negative relationship while some authors such as Hunjra et al. (2020) who examined the relationship between financial development and environment quality in South Asia, and Tahir et al. (2021) who examined the effects of energy use, globalization and financial development on environmental quality of South Asian countries, disagreed. As established from the insights of several works of literature, financial development has a two-sided relationship with environmental pollution. The negative relationship finding indicates that improvement in financial development reduces the growth of environmental pollution in the region. From the estimates, if financial development increased by 1%, the kilotons of carbon emissions would reduce by 0.13%.

The GMM estimations also found a negative, although not statistically significant, relationship between financial development and environmental pollution. Just like that of entrepreneurship, the coefficient of financial development when the GMM was used was far lower than the estimated coefficient predicted by the pooled panel regression technique. The GMM predicted that a 1% rise in financial development would cause the kilotons of carbon emissions to reduce by 0.02%. This finding encourages the countries in the entire East Asia-Pacific Region to continually improve their financial sector by offering credits to a wide range of businesses and individuals to invest in renewable energy sources to see a reduction in carbon emissions.

When the two regions (East Asia Region and Pacific region) were compared using the pooled panel OLS estimates, it was observed that financial development has almost no impact on carbon footprints in the East Asia Region but has a negative and significant impact on carbon footprints in the Pacific Region. When the GMM technique was adopted, it was revealed that the impact of financial development on carbon footprints in the two subregions was negative but not significant.

According to the pooled panel OLS estimates, the population has a positive and statistically significant impact on carbon footprints in Nigeria. The relationship indicates that an increase in population would increase the amount of carbon emissions. The pooled OLS estimated that an increase in population by 1% would result in an increase in kilotons of carbon emissions by about 0.97%. This finding justifies why countries in that region are pursuing population policies to curtail the growth of the region.

The finding was similar when the GMM technique was used. The GMM predicted that an increase in the population by 1% in the East Asia-Pacific region would result in a rise in the emissions of carbon by 0.12% in that region. The pooled panel OLS also revealed that population has a positive and significant impact on environmental pollution in the two subregions. The finding was also similar to that revealed by the GMM technique. The Pooled OLS predicted that a 1% rise in population in the East Asia region would result in a 0.94% rise in carbon emissions in that region and that a 1% rise in population in the Pacific region would result in a 1.22% rise in carbon emissions in that region. The GMM estimates revealed that if the population in the East Asia Region increased by 1%, the kilotons of carbon emissions would increase by 0.18% and that if the population in the Pacific Region increased by 1%, the kilotons of carbon emissions would increase by 0.62%. One notable observation revealed by the two techniques is that the positive impact of population on environmental pollution was larger in the Pacific region than in the East Asia Region.

Per capita income has a positive and significant effect on carbon footprints in the East Asia-Pacific Region according to the Pooled OLS estimates. This indicates that an improvement in the region's per capita income is associated with a rise in carbon emissions. The pooled OLS predicted that a 1% rise in per capita income is associated with a 0.53% rise in carbon emissions in that region. The GMM technique also revealed this positive and significant relationship between the two variables in the region. The GMM estimates predicted that an increase in the per capita region by 1% would result in a 0.05% increase in kilotons of carbon emissions. This indicates that the majority of the firms in the region utilise non-renewable energy sources to produce outputs.

On a sub-regional level, the pooled OLS revealed that there was a positive and significant relationship between per capita income and carbon emissions in the two regions. The positive and significant relationship between the two variables was also revealed by the GMM estimates. The pooled OLS estimates indicated that per capita income increases carbon emissions in the East Asia Region, and Pacific Region by 0.45% and 0.37%, respectively while the GMM estimates revealed that per capita income increases carbon emissions in the East Asia Region, and Pacific Region by 0.08% and 0.19%, respectively. These findings indicate that the government in those regions should enact policies that should limit the kilotons of carbon emissions released by the firms to build a sustainable environment.

The results from the pooled panel regression column revealed that government institutions have a positive, although not significant, impact on carbon emissions in the East Asia-Pacific Region. This indicates that the impact of institutions on environmental pollution is not significant in the region. The finding was similar to the GMM technique which also revealed that government institutions have a

positive but not significant impact on carbon emissions. Also, in each subregion, the pooled OLS revealed that an improvement in the institutions was associated with a rise in carbon emissions. The impact was also not significant in the two subregions. The GMM estimates revealed a heterogeneous result, that is, it revealed that institutions have a positive, although not significant, impact on carbon emissions in the East Asia region and that institutions have a negative, although not significant, impact on carbon emissions in the Pacific region. One possible explanation for why institutions did not have a significant impact in the entire region and subregions is the failure to implement some of the carbon emission policies as the process could be very costly. Another possible explanation is that neighbouring countries' institutions are not enforcing their carbon emission policies in the region, making the institutions less effective in reducing carbon emissions in the region.

The estimation results showed that entrepreneurship but not financial development is a significant factor that could increase carbon emissions in the region. Achieving a reduction in emissions of carbon is very necessary for building a sustainable environment for the present and future population which is addressed in one of the sustainable development goals (SDG 13 - "to combat climate change and its impacts"). Therefore, firms especially in the East Asia region should adopt the use of renewable energy sources and should prioritise long-term environmental health over short-term profits. The two individual regions should also support firms who could focus in creating renewable energy projects or products at lower cost so that renewable energy sources can be made readily available to the populace in the region. Also, the financial institutions can play a major role by investing in and offering credits to start-ups or existing firms whole goals are focused on environmental and social goals. When these happens, the potential to achieve SDG 13 would increase.

5. CONCLUSIONS AND RECOMMENDATIONS

Entrepreneurship and financial development are two factors that play a crucial role in reducing the kilotons of carbon emissions globally. The United Nations' Sustainable Development Goals (UNSDG) outline the need for tackling environmental pollution in some of its goals (SDG 7, SDG 9, and SDG 13). In view of that, the objective of this study was to examine the impact of entrepreneurship and financial development on environmental pollution. The data used to carry out this analysis was sourced from the world bank indicators (WDI), and the world governance index (WGI). Two panel estimation techniques which include the pooled OLS and the GMM were used in achieving the objective.

The finding from our analyses indicated that entrepreneurship has a positive and significant impact on environmental pollution in the East Asia-Pacific region. In other words, an increase in the number of new businesses was associated with the rise in carbon emissions. This indicates that the majority of the firms in the region especially in the East Asia region are pursuing unsustainable business practices causing an increase in carbon emissions globally. This study recommends that all countries especially the ones in the East Asia Region should encourage their firms to adopt the use of renewable energy sources through their policies. That act can go a long way in improving the potentials of new businesses to curtail the emissions of carbon.

The finding also revealed that financial development has a negative, although not significant, impact of environmental pollution in the East Asia-Pacific region. This means that although financial development is associated with a reduction, in carbon emission, its impact is not quite significant. Therefore, this study recommends that countries' financial institutions such as commercial banks and development banks in the region especially the East Asia region should prioritise offering credit to businesses and individuals with the aim of building sustainable projects. They should also invest in development projects like electric cars, solar, and other renewable energy sources that have the potentials in curtailing carbon emissions.

This study recommends that countries in the East Asia-Pacific region should develop and check population growth in the region so as to prevent the increase in carbon emissions. By curtailing the population growth in the region, the region can play a crucial role in achieving SDG goals such as clean water and sanitation (SDG 6), sustainable cities and communities (SDG 11), and climate action (SDG 13). Also, renewable energy sources should be made available and affordable to the rising population in the region because that could enable both the rural and urban population to improve their consumption of renewable energy for heating. This could help in achieve on of the SDG goal which is responsible consumption and production (SDG 12). Lastly, the potentials of these recommendations would not be achieved if the institutions are not effective. Therefore, the institutions in the countries in that region should be greatly improved to play a crucial role in reducing carbon emissions in the region.

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