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Research Article

Ex-Post Empirical Assessment of Green Entrepreneurship's Influence on Sustainable Development: Evidence from the Bottom Billion Countries

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ABSTRACT

Introduction: The paragraph discusses how Industry 5.0 and rapid technological advancements have reshaped global development trends, highlighting the need for sustainable approaches that integrate economic, social, and environmental goals. Green entrepreneurship (GE) is presented as a vital force for innovation and sustainability, especially in addressing environmental issues and promoting cleaner, more efficient solutions. The role of GE is particularly critical in low-income nations, where poverty, climate change, and lack of infrastructure present major barriers to achieving the Sustainable Development Goals (SDGs). The article emphasizes the importance of customized strategies and data-driven approaches, such as econometric modeling, to assess the impact of GE on sustainable development across different income levels.

Objectives: By emphasising the importance of new businesses' environmental orientation in fostering sustainable growth, this work adds to the body of previous research on econometric entrepreneurship. This study examines empirically the possible relationships between a nation's percentage of GEA, social development, and economic growth and its rates of environmental deterioration. Research and early data indicate that new eco-friendly firms have a greater positive influence on the economy and society and are less detrimental to the environment than other new businesses.

Methods: The research empirically investigates the effects of GEA rates as a percentage of total entrepreneurial activity on GDP, the modified HDI, and CO2 emissions using OLS regressions.

Results: The result demonstrated a favorable correlation between social and economic development and increased GEA proportions. Further studies revealed that the findings were robust to changes in time lag, economic development levels, and dependent and independent variable measurements. The necessity for further legislative actions to encourage the discovery, development, and utilisation of environmentally friendly business opportunities is justified by the acknowledged importance of GEA in the economy and society.

Keywords: Sustainable development, OLS, Environmental orientation, Green entrepreneurship, HDI, GDP, CO2.

INTRODUCTION

The emerging era of Industry 5.0, which is distinguished by its widespread internet use and technology breakthroughs, has significantly altered the trends of both individual and social development. Even if the economy has grown significantly and human progress has advanced over the last century, urgent and greater focus is still needed to address pressing social concerns including population growth, environmental degradation, and climate change. Often referred to as the "bottom billion," low-income nations deal with intricate and multifaceted development issues. They have little infrastructure and resources, high rates of poverty, and are vulnerable to climate change. Pursuing a sustainable development model that simultaneously has positive effects on the economy, society, and environment is thus essential. This all-encompassing strategy " satisfies current generations' demands without endangering the capacity of future generations to satisfy their own" (United Nations, in 2023), recognizing these areas' interconnectivity and their vital responsibilities in achieving long-term human well-being. The Global Goals, often referred to as the Sustainable Development Goals (SDGs), are an all-encompassing and inclusive effort to eradicate poverty, save the environment, and advance world peace and prosperity. Among other significant challenges, the 17 objectives broaden the scope of the SDGs by addressing climate change, innovation, economic inequality, peace, sustainable consumption, and justice. The fact that four of these SDGs specifically address

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innovation and entrepreneurship highlights how important these concepts are to sustainable development. A topic of great political and academic interest is the role that new businesses and innovators who create, discover, and seize entrepreneurial opportunities play in advancing the three core tenets of sustainable development. As noted by Shepherd and Patzelt (2011), Hall et al. (2010), Dean and McMullen (2007), and others, innovation and entrepreneurship are part of the United Nations Sustainable Development Goals. Eco, environmental, or green entrepreneurship is a kind of entrepreneurship that has lately drawn a lot of interest from academics and practitioners. In contrast to conventional and social entrepreneurs, green entrepreneurs emphasize fixing environmental market failures and give the environment first priority (Dhahri and Omri, 2018). They are a subset of sustainable businesses (M ´endez-Picazo et al., 2021). Given their focus on the environment, it is anticipated that they would promote both the environmental and economic aspects of sustainable development.

One method of applying the circular economy to the realm of entrepreneurial growth is via green entrepreneurship (GE). The model states that an entrepreneur should be able to provide new goods or services to the green market and have a strong vision for promoting environmentally responsible innovation. Therefore, maintaining ecological values is essential to achieving the goals. The assertion is consistent with the research of Rupasingha and Goetz (2013), who highlighted the establishment of new companies by producing goods that have positive environmental effects. With the help of this system, entrepreneurs may actively contribute to the future maintenance of sustainability. Additionally, given the entrepreneurship sector's explosive growth, entrepreneurs need to continuously innovate and push for changes to the corporate structure. Additionally, the capacity of millennial entrepreneurs to become environmentally conscientious innovators will be put to the test by an impending wave of destruction. Given the speed at which digital technology is developing, young entrepreneurs must take advantage of the opportunity to advance sustainable thinking. GE acts as a bridge between the circular economy with the goals of sustainable development, or SDGs. Thus, a green entrepreneur has to be careful to implement methods that will benefit the environment and the economy both now and in the future. Several studies demonstrate the beneficial connection between green enterprises and sustainable growth. Environmental responsibility is what motivates green businesses and contribute to the advancement of sustainable business practices, according a research by Nuringsih (2021).

According to a different research, green entrepreneurship developed in response to environmental risks and is essential to reaching sustainable development objectives (S.V et al., 2022). As stated to Lotfi et al. (2018), green entrepreneurship is an ethically grounded activity. According to their study, green entrepreneurs serve as facilitators of sustainable development, while green goods have a direct influence on it. Green entrepreneurship is a driver for change, especially in the energy industry, according to (Galindo Martín et al., 2020). Green businesspeople spur innovation and guide us toward the use of cleaner, more effective renewable energy. (Joensuu-Salo and Saari, 2020) defines green entrepreneurship as the process of addressing environmental concerns and bringing about social change via the application of entrepreneurial drive. (Pacheco and others, 2010). believes that green entrepreneurship, which encourages cleaner and more effective methods, is a driving force for innovation and sustainability, especially in the energy industry. The higher scholarly expectations may thus be justified, therefore it is logical to draw the conclusion that, contrary to normal operations, there is a difference between new environmentally friendly company activities and sustainable development. In their research from 2022, Nursih and MN examine how Green Entrepreneurship (GE) fits within a sustainable economic paradigm that reduces environmental risks and fosters economic expansion. Focusing on innovation, resource efficiency, and economic advancement, (Chandel, 2022) investigates the function of green entrepreneurship in attaining a green economy. (Foss, 2019) offers a solid basis for comprehending the ways in which entrepreneurship in general might impact economic expansion. Green companies often concentrate on cutting waste and making better use of resources, which may save money and perhaps result in cheaper costs for customers. Create new markets and employment possibilities by developing innovative technology and solutions for environmental problems. Green enterprises can address the rising demand for sustainable goods and services as customers become more environmentally concerned. As far as the author is aware, there are no macro-level empirical analyses or forecasts that look at whether green companies promote human development, increase economic growth, or lessen environmental deterioration.

Environmentally conscious companies and green entrepreneurship have grown in popularity in billions of countries worldwide. Data from the Global Entrepreneurship Monitor (GEM) shows that in 2020, the number of new companies that focused on sustainability and environmental problem-solving increased significantly in many of these nations, including Brazil, Kenya, and India. In an attempt to bridge the existing research gap, this study use

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Econometric research to assess the relationship between green entrepreneurial activities and the three pillars of sustainable development at the national level. Eradicating global poverty, emphasizing the requirements of low-income nations, is a crucial component of sustainable development. 'Low-income' is a word that is consistent with the United Nations' categorization of countries: United Nations, 2015. Many solutions for global sustainable development have been put out by Spangenberg (2016), however low-income countries need customized approaches. This is due to the fact that these nations' interests diverge greatly from those of established and growing economies, particularly with respect to socioeconomic and infrastructural development programs. Notably, the number of individuals in Sub-Saharan Africa who live in severe poverty has been relatively constant over the last several decades, despite a decline in the world average of extreme poverty (DESA, 2020) (Ozturk, 2017). Significant declines in China and India are the main causes of the worldwide decline in severe poverty. Moreover, countries with varying economic levels may need rather diverse approaches to accomplish the Sustainable Development Goals (SDGs). In low-income nations, sustainability is accomplished by addressing a number of critical issues, such as the elimination of poverty, the development of jobs, the training of unskilled laborers, and the supply of clean drinking water and safe housing, among others. Complex connections between poverty, climate change, fast urbanization, and food insecurity are emphasized as the primary elements that may either help or impede sustainable development in low-income countries (Robert, K.H., 2000).

Others argue that green growth and sustainable development fall short of satisfying low-income nations' important socioeconomic demands (Spangenberg, J.H., 2016). According to this argument, low-income countries cannot engage in green growth and sustainable development projects since poverty affects the vast majority of their people. Poverty and unplanned urbanization have been highlighted as two of the most significant hurdles to sustainable development in economically disadvantaged nations (Broman, G.I., & Robert, K.H., 2017).

This article presents three significant achievements in economics, entrepreneurship, and environmental management. The absence of substantial datasets hinders empirical research in these fields (Demirel et al., 2019). Moreover, impact assessments are obstructed by complex interrelations at the meso, micro, and macro levels (Johnson and Schaltegger, 2019). Green entrepreneurship may have considerable indirect impacts on stakeholders and established enterprises, complicating the evaluation of its total sustainability impact at the individual level (Mair and Martí, 2006). The GEM annual special issue on social entrepreneurship offers a valuable chance to examine the sustainability implications of green entrepreneurship across the meso, micro, and macro levels (Johnson & Schaltegger, 2019). The GEM's annual report offers a comprehensive analysis of the sustainability results of green entrepreneurship at the macro level, while considering the complex interconnections among the meso, micro, and macro levels.

Econometric models use "Gross Domestic Product (GDP), the modified Human Development Index (MHDI), and CO2 emissions" as metrics to independently analyze the relationship between entrepreneurship and the three principal attributes of sustainability. An increasing volume of research is comparing nations at various levels of economic development. Carree et al. (2007) and Omri (2018) identified substantial differences in entrepreneurial activity, features, and overall impact across industrialized and developing countries. Consequently, research findings from prosperous nations may not be readily adaptable or transferable to less developed countries (Anand et al., 2021). The potential disparities across countries at different levels of development must therefore be considered when doing cross-national research on green entrepreneurship, particularly as emerging and BRICS countries gain prominence. Using an income-stratification lens, this research examines how low-income nations are doing in terms of meeting the SDGs at the national level.

Literature Review

Economics Impact

Over the past two decades, more than 100 empirical studies have been done to investigate the economic consequences of entrepreneurship. The GEM selected TEA to evaluate the impact of entrepreneurship across different countries as the core criterion for quantifying entrepreneurship. This body of empirical data has been the subject of several literature reviews, which have come to the conclusion that entrepreneurship promotes economic growth. However, creative, opportunity-driven businesspeople with aspirational development goals are mostly responsible for this beneficial impact (Urbano et al., 2020; Versloot and van Praag, 2007). Many studies have been conducted on the economic consequences of entrepreneurship and its many forms, but no empirical research has

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been done on the economic benefits of green entrepreneurship. However, four factors affect the likelihood that environmentally conscientious businesses will have a discernible economic impact. First, new green companies find lucrative and sustainable possibilities that may otherwise be overlooked. Environmental market imperfections, according to research, provide significant potential for new technologies and business models. Dean and McMullen (2007) and Cohen and Winn (2007) has shown this. In order to accelerate economic growth, new green businesses take use of these opportunities to expand their current markets and creating new ones (Schaltegger, 2002). Furthermore, green entrepreneurship is very successful at transforming new information into innovative solutions and lucrative commercial possibilities when compared to other developing technologies. Dechezlepr ̆et al. (2013) claim that "clean" technologies increase the number of tiers at which information is disseminated, hence increasing the marginal economic value. Recent studies have confirmed this conclusion, proving that new eco-friendly company efforts exhibit enhanced characteristics regarding creativity, advancement, and level of worldwide integration (Hoogendoorn et al., 2020). Furthermore, research shows that new environmentally aware businesses are more likely to participate in open networks and idea sharing (Zahraie et al., 2016).

As a result, the development of new innovations and innovations with higher economic value is not the only factor contributing to the growth of new environmentally conscious business efforts; open networking also helps spread these innovations. Consequently, this enhances their positive influence on the overall growth of the economy. Businesses that practice environmental responsibility are more likely to outperform their conventional counterparts, according to the Porter hypothesis, which was initially put out by Porter and van der Linde in 1995. The resource-based natural approach strategy, which holds that businesses must include environmental factors into their planning in order to prosper, is in line with this idea (Hart, 1995). Ambec et al. (2013) did a thorough study of empirical literature that looks at the relationship between greening practices and business success. The researchers found evidence of better success in green initiatives in addition to identifying the basic principles behind this favorable link. These mechanisms include the following: (i) a wider variety of goods; (ii) improved access to niche markets; (iii) improved risk management techniques; (iv) improved stakeholder interactions; and (v) reduce labour and resource expenses. According to recent studies, green practices improve the financial performance of both new and existing enterprises (Leoncini et al., 2019; Tamvada, 2019). Moreover, in comparison to their traditional equivalent, green initiatives are more likely to be better quality (Gagliardi et al., 2016), endure prolonged (Serio et al., 2020), and produce many employment (Horbach, 2018). New environmentally conscious companies also face several challenges, including financial and ethical limitations, obstacles in market formation, and uncertainties and administrative red tape in the extrinsic and legislative settings (Linnanen, 2002; Melay et al., 2017).

These supplementary difficulties may restrict the potential of new environmentally friendly enterprises to thrive, lowering their overall worth. This essay, on the other hand, assumes that the positive characteristics of newly founded eco-friendly enterprises reduce these hurdles. These characteristics include exceptional financial performance and work success, greater innovation capacity, and the ability to find and capture new sustainable business prospects, all of which lead to higher survival rates. The hypothesis in this context is that larger percentages of green entrepreneurship lead to better macroeconomic outcomes. (Guo, 2022) discovered a relationship between a nation's GDP and Human Development Index and a greater rate of Green Entrepreneurial Activity (GEA). Green companies improve public wellbeing and promote economic growth. Green entrepreneurship also stimulates innovation and opens up new markets for environmentally friendly goods and services, which results in employment prospects. (J.N. Kimengsi and S.A. Gwan, 2017) Their findings suggest a favorable correlation between green enterprises and economic growth, including elements such as market diversity and employment generation. The importance of green entrepreneurship to understanding Indonesia's economic growth is examined in (Lusseau, D., Mancini, F., 2019). According to the study, green entrepreneurship significantly improves the achievement of sustainable development objectives.

Green entrepreneurship often entails developing innovative sustainable methods, goods, and services. According to study by Farooq et al., this may result in new markets and financial prospects. (K.H. Robert, 2000) "Green Entrepreneurship's Contribution to the Study of Indonesia's Economic Development" Young adults' commitment to sustainability. This study focuses on how green education and values may encourage green entrepreneurship, which in turn can spur economic growth. Chen (2007) emphasizes the idea of "green value" in addition to conventional economic metrics. Green companies often place a high priority on waste reduction and resource efficiency, which may save money and perhaps result in cheaper costs for customers. Economic activity may be stimulated by this. According to (Zeigermann, U., Böche, M., 2020), green entrepreneurship supports sustainable

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development, which is essential for long-term economic viability. Green companies may help reduce risks like resource depletion and climate change by tackling environmental issues, which will strengthen the economy. New sustainable goods and technology are often developed by green entrepreneurs. As shown by studies by (Suseno Hendratmoko, 2023), this may result in more competition, product variety, and economic development.

Hypothesis 1. ***Green entrepreneurial activity favorably promotes economic growth.***

Social effect

improves life quality and lessens the impact of emergencies (Itri et al., 2015). According to a recent body of study that empirically examined this potential contribution and found a positive connection, green businesses may improve societal well-being (Jabbar et al., 2021). Additionally, countries with more green businesses also often have better social outcomes. Rupasingha and Goetz (2011) argue that self-employment considerably improves income disparity and poverty. Additionally, the MHDI has been employed in two studies to assess social development. Dhahri and Omri (2018) discovered that entrepreneurship improves society. However, Gu et al. (2020) found no significant impact on the MHDI. Dhahri et al. (2021) did a comprehensive research to evaluate the link between entrepreneurship and social development. Dhahri et al. (2021) contend that opportunity-driven entrepreneurial activity is inextricably linked to social development as described by SDG-based principles. However, need-driven businesses have less of an impact. Ndzabandzaba (2015) says that social factors are crucial in green business. It emphasizes the possible social and environmental benefits of promoting a sustainable culture. Businesses that care about the environment may support larger societal objectives such as environmental growth (Mustunsir, M., 2015). (Wackernagel, M., Lin, D., Evans, M., Hanscom, L., Raven, P., 2019) investigates theoretically and empirically, green entrepreneurship is linked to the economic, social, and environmental pillars of sustainable development. It implies that green initiatives may have a "double advantage" that benefits both the economy and society. the contribution of green businesses to societal stability via sustainable practices (Schaltegger, S., & Wagner, M., 2011). (Prokopenko and colleagues, 2024) By encouraging ecologically responsible behavior and fostering a more sustainable future, green business may have a good societal influence. In 2022, Chen, X., and Lee, T. J. favorable relationship between social development and green business, maybe as a result of economic opportunity and employment creation, especially in environmentally aware enterprises. (Wagner & Schaltegger, 2011) This research emphasizes how societal stability is aided by green entrepreneurship, especially in emerging nations. Green companies may improve resource management, provide employment, and instill a feeling of environmental responsibility. (P. Ahi and C. Searcy, 2013) . promoting the beneficial social effects of green entrepreneurship via green ideals and education. (Fritsch, M., Mueller, P., 2004) discussed "green value" and how it affects the social effect and motives of entrepreneurs. Although necessity-driven entrepreneurship may have unfavorable effects, theory (Alberti, F., & Garrido, M. A., 2017) and empirical data (Dhahri et al., 2021; Pinkse, J., Groot, K., 2015) suggest that new opportunity-driven businesses are essential to macro-level society progress. Through its beneficial effects on consumer and employee health and safety, potential incentives, and indirect environmental social effects, green entrepreneurship significantly benefits society. According to this research, a higher percentage of entrepreneurial engagement advances societal progress.

Hypothesis 2. *Social development is favorably impacted by green entrepreneurship*.

Environmental effect

In high-income countries, it is less clear how much entrepreneurship contributes to environmental damage (Omri 2018). Some scholars (Dean and McMullen, 2007; Hall et al., 2010; York and Venkataraman, 2010) argue that creative and environmental entrepreneurship may assist address environmental issues despite proof of the negative environmental consequences of entrepreneurship. These three main justifications back up this stance. The literature claims that environmentally friendly businesses provide answers for problems. Influence consumption and production patterns (Vickers and Lyon, 2014; Belz, 2014; Dean and McMullen, 2007; Choi and Gray, 2008; Pastakia, 1998); function as role models for present companies, communities, and customers. Green entrepreneurs thus should be able to preserve the ecosystem, mitigate the effects of climate change, slow down environmental degradation, stop deforestation, and improve agricultural practices and freshwater availability (Cohen and Winn, 2007; Shepherd and Patzelt, 2011). Furthermore, (green) prospects are more likely to start new environmentally friendly firms, which may be beneficial to the environment. Furthermore, early empirical data suggests that a green

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entrepreneurial approach improves environmental performance at the micro level (Meirun et al., 2020). Green entrepreneurs may create and disseminate new solutions that reduce greenhouse gas emissions, according to study (Basiago, 1999). This has the potential to significantly lessen the consequences of climate change. Green entrepreneurs play a crucial role in attaining economic development while reducing environmental harm, according to the OECD. An investigation on the relationship between environmental development and green entrepreneurial activity was conducted by Lumpkin, G., and Pidduck, R. J. (2021). Although their results point to a favorable relationship between green business endeavors and social and economic advancement, further research is necessary to fully understand how they affect environmental growth. (Nawas, W., & Koc, M., 2017) investigates the connection between environmental development and green entrepreneurship. The environmental effect needs further research, even if they show a good association between green initiatives and social and economic progress. Wang, S., Abbas, J., & Sial, M. (2022) examine the connection between environmental development and green entrepreneurship. According to their findings, green initiatives and social and economic advancement are positively correlated. Green entrepreneurs create innovative technology and solutions that reduce their negative effects on the environment. This may include topics like waste reduction tactics, sustainable materials and industrial methods, and renewable energy sources (wind, solar). Green entrepreneurship is typically good, but it may have problems. For example, the initial cost of certain green goods may be higher, which would restrict their market reach. This topic is examined in research by Ozturk, I., Aslan A., and Kalyoncu H. (2010), which demonstrates a favorable association between economic growth and green entrepreneurial activity. According to (Kasseeah, H., 2016), green innovation may result in good environmental performance when green entrepreneurial motive is present. Environmental entrepreneurs stimulate innovation and redirect investment toward a greener economy, eventually promoting sustainable development (Atems, B., Shand, G., 2018). Green businesses have the ability To raise the quality of the surroundings. According to this study, there are beneficial environmental developments when the percentage of new green businesses rises.

Hypothesis 3. *Environmental development is favorably impacted by green entrepreneurship*.

Method

A scientific method for making data-driven administrative and financial decisions is quantitative research. It is important to know that quantitative research has two parts: (a) checking theories and (b) trying to apply the results to the whole population. The study framework says that the main steps of the quantitative method are defining the problem, making a model, gathering data, choosing a solution, trying it, analyzing the results, and putting the results into action. In addition, Widarjono (2018) presents panel data, which mixes cross-sectional and time series data.

Types and Data Sources

Cross-sections are the kind of secondary data employed in these investigation. Supomo and Indriantoro (2018) define secondary data as information obtained indirectly from earlier research, usually from third-party sources or documentation created by other parties. This study's data was obtained indirectly from the finished research item and was collected by many organizations using a variability of commercial and non-commercial methodsCross-sectional data is composed of a single object, but it also requires other sub-objects that are linked to or contained inside a single parent object at a time. The most comprehensive source of statistics on entrepreneurship in the world is the GEM, which collects data globally each year from a sample of around 2000 people. Individual environmental orientation data from GEM is also included in this research. The macroeconomic impact of entrepreneurship is frequently quantified using distinctive cross-country datasets (Neumann, 2021). A comprehensive manual on the GEM sample techniques, survey designs, and topics was provided by Bosma et al. (2012). In 2009, GEM became the first global database on green entrepreneurship that facilitated econometric analysis by incorporating a survey that was specifically designed for social entrepreneurship. It is often used in studies on green entrepreneurship, according to Hörisch et al. (2017), Hechavarría et al. (2017), and Hoogendoorn et al. (2020). 180,000 adults from 53 sources were analyzed in a 2009 survey. According to these criteria, the environment is very important to these business owners. Additionally, while the data is gathered at the national level, it focuses on information at the individual level. A nation's green-oriented (GEA) environmental activities describe the group of early-stage entrepreneurs who are considered ecologically conscientious. Every nation included in GEA represents a single observation, and the independent variable is specified at a macro-level. 53 observations make up the overall sample size as a result. Macro-level information from the WDI, which are supplied by the World Bank

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and the UNDP, was added to the GEM data. This additional information made it easier to evaluate GEA's effects on the economy, society, and environment. Table 1 provides detailed information on the variables used, the data sources, and the numbers that describe the years that are part of the base model.

Empirical Analysis

To look into the link between GEA and environmental, social, and economic growth, three separate regression models were created. Ordinary least squares regression (OLS) was used in the models. This is a method that is often used in similar cross-country studies (e.g., Méndez-Picazo et al., 2021; He et al., 2020; Albulescu & Drăghici, 2016). The first model, which is based on the method suggested by Urbano et al. (2020), is used to measure economic growth. This builds on the institutionally-aware approach that Audretsch and Keilbach came up with in 2004. This study's panel data analysis employs a fixed-effect methodology. Because it is assumed that the intercept varies but the slope stays the same across nations, fixed effect is employed. Consequently, the following is the generic fixed effect model.

$$ln\ y_{it} = \beta_{01} + \beta_1\, ln\, X_{1it} + \beta_2\, ln\, X_{2it} + e_{it}$$

Table 3.1 Level in Country

Level C
<$25,000
Brazil
China
Colombia
Egypt
Guatemala
India
Indonesia
Iran
Morocco
South Africa

These investigation simultaneously employs three models. GDP is the Y variable in the first model, while GEA, or government consumption, export, and capital, are the X variables.

$$ln\ GDP_{it} = \beta_{01} + \beta_1\, lnGEA_{1it} + \beta_2\, lnGC_{2it} + \beta_3\, lnExport_{3it} + \beta_4\, lnK_{4it} + e_{it} +$$

GDP is the total output of production quantified in constant 2010 US dollars. L is a measure of labor input that represents the whole workforce. One often used measure of economic progress is labor productivity, which is determined as GDP per unit of labor (GDP/L) (Urbano et al., 2020). K is the constant gross domestic capital creation in 2010 US dollars, which is a measure of physical capital. The government consumption rate is denoted by GC and the export rate by E. The estimated parameters are denoted by the coefficients b0 through b5, whereas the statistical error term is denoted by e. Every variable is explained in depth in the operational definitions that follow.

Table 3.2 Operational Variables in the First Model

Variable	Mean	S.D	Description
LnGDP/L	9.360	0.418	A common critical measure of economic advancement is labor productivity.
GEA	14.37	7.01	The amount of early-stage business owners in each nation is reflected in eco-entrepreneurial activity.
InGC	3.16	6.495	Government consumption

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InExp	4.09	8.004	Export rate
InK	0.7007	0.7007	The steady accumulation of gross domestic capital is the measure of physical capital.

The second approach evaluates societal growth using the Human growth Index (HDI). The UNDP figures out the HDI every year. The HDI is found by taking the geometric mean of three important measures: life expectancy, life schooling, and GNI. Following the suggestions of Dhahri and Omri (2018) and Gu et al. (2020), the MHDI is used to lessen the effects of multicollinearity. These study's model is as follows:

$$ln\ MHDI_{it} = \beta_{01} + \beta_1\, lnGEA_{1it} + \beta_2\, lnPOP_{2it} + \beta_3\, lnGDP_{3it} + e_{it}$$

Table 3.3 Operational Variables in the Second Model

Variable	Mean	S.D	Description
MHDI	46.92	2.449	HDIM
GEA	14.37	7.013	The amount of early-stage business owners in each nation is reflected in eco-entrepreneurial activity.
POP	1.17	0.4996	Population growth in per cent
GDP	28.42	4.735	GDP in constant prices 2014-2023

The third model shows that the environment is getting worse and measures it in metric tons by finding the amount of CO2 emissions per person (lnCO2pc). Carbon dioxide emissions per capita are often used as a measure of environmental quality in cross-country studies because they are easy to find across countries and don't limit the number of observations (ben Youssef et al., 2018) (Dia et al., 2020; Dhahri & Omri, 2018; Omri, 2018). The regression model used to look at the link between GEA and natural growth is explained below:

$$ln\ CO2_{it} = \beta_{01} + \beta_1\, lnGEA_{1it} + \beta_2\, lnGDP_{2it} + \beta_3\, lnMHDI_{3it} + e_{it}$$

Table 3.4 Operational Variables in the Third Model

Variable	Mean	S.D	Description
CO2	0.98	0.717	Instead of lnCO2pc, total greenhouse gas emissions, measured in kilo tons of CO2 equivalent per capita, are used to judge the health or decline of the environment.
GEA	14.37	7.01	" The quantity of early-stage business owners in every nation" is represented by eco-entrepreneurial activity.
GDP	28.42	4.735	GDP in constant prices 2014-2023
MHDI	46.92	2.449	HDIM.

4. Empirical Analysis

4.1. Correlation and multicollinearity analysis

Table 2 displays the Pearson correlation coefficients for each of the variables that were examined. The ln(CO2pc) measure and GEA have a negative and substantial correlation, suggesting that as eco-friendly entrepreneurial activity rises, environmental deterioration falls. There was no significant correlation between GEA and the other dependent variables. All of the control variables showed a substantial correlation with the corresponding dependent variables. Multicollinearity is not an issue in models 2 and 3, as shown by the extra variance inflation factor (VIF) computation being much lower than 10 (VIFmax = 3.66).

4.2. Regression Analysis

The results of OLS regression for equations (1), (2), and (3) are shown in Table 3's columns (1), (2), and (3). With the exception of GEA, which was shown to be statistically significant ($p < 0.001$), all three models explained a large a $0.326 <= R2 \leq 0.525$ is the range of the dependent variable's variation. Each of the three main regressions was significantly affected by each of the control variables. The results of hypotheses 1, 2, and 3 show that green business practices are good for the earth, the economy, and society. Figure 1 and 2 of Table 3 show that the GEA values are positive and not statistically significant ($p > 0.001$). Because of this, there is no proof

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to back either assumption 1 or assumption 2. It's still true that the data in column (3) show that lnCO2pc and GEA are statistically significantly linked. Based on the data, it seems likely that the positive relationship between GEA and lnCO2pc is due to the direct link between economic growth and environmental impact, as shown in Table 2. Consequently, H3 is approved.

Table 2 Correlations.

	1	2	3	4	5	6	7	8	9
ln(GDP/L)	1								
MHDI		1							
ln(CO2pc)		.442**	1						
GEA	.121	-.004	-.431**	1					
lnK	.019			.752	1				
GC	.323**			-.180	.422**	1			
Export	.592			.028	.002	.987**	1		
POP		-.319**		.081				1	
lnGDP		.472**	.509**	-.128				-.015	1

*p <.05; **p<.01.

[a] Correlations are not relevant, as variables are not used together in any regression model

Table 3 OLS regression results

	ln(GDP/L)	***MHDI***	***ln CO2***
	(1)	(2)	(3)
Independent variables			
GEA	.082	.030	.008
	.061	.328	.000
GC			
EXPORT	.030		
	.079		
LnK	.126		
	.006		
POP		.412	
		.000	
LN GDP		.044	.013
		.000	.000
MHDI			.025
			.001

Statistics:

Durbin-Watson	.235	.219	.397
R2	.106	.326	.460
F Statistic	1.376	15.493	27.211
Max VIF	1.166	1.023	1.313
Observations	100	100	100

*p<.05; **p<.01. Exact significance levels in parentheses

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4.3 Robustness tests & additional analyses

In Table 4, the regression results from equations (1), (2), and (3) can be seen in columns (1), (2), and (3). This is done using robust regression. With the exception of GEA, all three models explained a large amount of the variance in the dependent variable (0.326 <= R2 ≤ 0.525) and were statistically significant ($p < 0.001$). The three main regressions were significantly impacted by each of the control variables. Green entrepreneurship has a favorable impact on social, economic, and environmental development, as per assumptions 1, 2, and 3. Both columns (1) and (2) of Table 3's GEA coefficients are positive and statistically insignificant ($p > 0.001$). As a result, neither assumption 1 nor assumption 2 has received any evidence. However, the results in column (3) show that lnCO2pc2010 and GEA have a statistically significant relationship. The findings support the hypothesis that the positive connection among GEA and lnCO2pc, as seen in Table 2, is due to the direct relationship between environmental degradation and economic development. Consequently, H3 is approved.

Table 4 Robustness tests

	ln(GDP/L)	*MHDI*	*ln CO2*
Independent variables			
GEA	.004	.032	.006
	.054	.369	.000
GC	4.483		
	.000		
EXPORT	3.735		
	.000		
LnK	.048		
	.000		
POP		.383	
		.000	
LN GDP		.031	.010
		.000	.000
MHDI			.025
			.001

Statistics:

DW	.235	.219	.397
R2	.106	.326	.460
F Statistic	1.376	15.493	27.211
Max VIF	1.166	1.023	1.313
Observations	100	100	100

Result and Discussion

Recent years have seen the emergence of preliminary empirical data about the connection between sustainable development and entrepreneurship, but they have also brought up new issues. This research contends that the characteristics of entrepreneurship, which vary depending on economic, social, and environmental advancement, are crucial in determining the results of this association. According to earlier studies, conventional entrepreneurship promotes economic expansion but may also have detrimental effects on the environment. Nonetheless, this study makes the strong assumption that there is a a favorable correlation between rising "entrepreneurial activity and GDP, MHDI, and CO2 emissions." More studies show how consistent these findings are across a spectrum of economic development levels and green entrepreneurship measurements (including varying

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environmental orientations), alternative environmental progress indicators, and time-lag scenarios. The regression findings make it abundantly evident that economics plays a major role in sustainable development, implying that the anticipated environmental advantages are outweighed by more financial support for green entrepreneurship. However, as mentioned in the section's last paragraph, the small sample size and ensuing statistical analysis restrictions may also be to blame for this apparently conflicting outcome. In particular, the absence of environmental repercussions might be explained by three criteria. First, the degree of economic development in the nations under study may mitigate the environmental effect as Omri (2018) notes, the The effects of green entrepreneurship are about the same as those of regular entrepreneurship. Creating smaller subgroups within the sample according to national income levels is a popular study design strategy to counteract this moderating impact. The sample size in this instance, however, could not be lowered any more. Furthermore, even though green entrepreneurship has a direct impact on social and economic progress, it's crucial to understand that Long-term processes are climate change and other urgent environmental concerns.

Consequently, it takes a long time for environmental initiatives especially those requiring technology advancements to have a discernible effect on the climate and environment. Empirical studies on the periods linked to the financial impacts of creative entrepreneurship support this. In accordance with Schumpeter's 1942 theory of "creative destruction," new company endeavors lead to crowding-out effects and changes in the market, which ultimately produce a more efficient economy. It typically takes five to ten years to finish this process, in accordance with Fritsch and Mueller (2004). The results don't show how green business really affects the environment because they only looked at one, two, and three years. They didn't look at the long-term effects. Furthermore, it's critical to acknowledge that carbon dioxide (CO2) emissions are a worldwide problem rather than only a domestic one. In order to overcome inefficiencies in the global market, entrepreneurs often create technology solutions (Neumann, 2022). However, this method ignores environmental changes impacted by nations other than the entrepreneur's native country when CO2 emissions are taken into consideration at the national level. As a result, the actual environmental impact of green entrepreneurship is probably understated by the present results. It may be concluded that more GEA supports sustainable development by producing notable economic and social advantages, even if the evidence does not fully support the concept that GEA has a beneficial environmental effect.

The results of the OLS regression show that GEA considerably enhanced the environment by 0.008, meaning that a 1% increase in the GEA variable would result in a 0.008 increase in the Co2 variable. These results contradict prior research showing a detrimental relationship between environmental consequences and entrepreneurship. In low-, middle-, and high-income nations, entrepreneurship has been shown to degrade environmental quality (Omri, 2018). Through innovation, commercial methods, and strategic choices, entrepreneurs have a significant influence on the environment. More eco-friendly items, including recyclables, organic products, or clean technology that lower carbon emissions, may be produced by entrepreneurs. The GDP variable has a 0.013 positive influence on the environment, meaning that a 1% increase in the GDP variable will result in a 0.013 increase in the environmental variable. These findings align with research conducted by Gu et al. (2021), Omri (2020), and Dhahri and Omri (2018). Future research may include other indicators of sustainable development, such as those related to pollution, resource depletion, poverty, and well-being. Instead, it may look at comprehensive approaches like tailored total savings (e.g., Ben Youssef et al., 2018) or SDG-based techniques (e.g., Dhahri et al., 2021).

A rise in GDP is often associated with higher levels of consumption and output. Increased output often results in greater use of natural resources, which may harm the environment by causing pollution, deforestation, and the depletion of water supplies. In the meanwhile, the environment benefited significantly from the MHDI variable by 0.025. MHDI indicates that a 1% rise in MHDI will also result in a 0.025 increase in the Human Development Index (HDI), or that environmental consequences are highly influenced by the HDI. The HDI evaluates a nation's development according to three primary criteria: knowledge, a respectable quality of living, and lifespan and health. Consumption is often greater in nations with high HDI. additional garbage is produced and natural resources are often used in tandem with this increasing consumption, which may put additional strain on the ecosystem. Stricter natural control and more important teaching. With better control and more effective legal restrictions, this might help reduce adverse environmental effects. The positive impact of green corporate social initiatives, as exemplified by the research conducted by Xie et al. (2016) and Chuang & Yang (2014), on the overall development of society is suggested by the correlation between the MHDI and these initiatives. The influence of corporate organizations on macro-level economics has been consistently denied by financial specialists societal development, despite the fact that they may be crucial for financial progress (Gries & Naudé, 2011). The process of expanding personal "choices" is the definition of social or human progress, as per the United Nations Progress Report (1990). This process mainly entails teaching people how to lead healthy lives and acquire the resources required for a better quality of life. According to this research, corporate entities are improving human capacities, including the capacity to work, earn

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money, and amass riches (Gries & Naudé, 2011). This significantly affects improving the general quality of life and resolving the current welfare problem (Itri et al., 2015). Therefore, businesses have the potential to make a significant contribution to the evolution of humanity. Additional empirical research has looked at the possible effects of entrepreneurship and found that it successfully eradicates poverty and lessens economic disparities (Atems & Shand, 2018). Additionally, there are two things to think about while using the MHDI to approach social transformation. Companies were shown to have positive social consequences (Dhahri and Omri, 2018). Gu et al. (2021) were unable to find any significant impact on MHDI, however. A thorough examination of the relationship between commercial enterprises and societal progress was carried out by (Dhahri et al., 2021). The researchers found that Granger's entrepreneurial endeavors, driven by possibilities rather than requirements, aided in social development by using SDG-based buildings as a yardstick (Dhahri et al., 2021). For three reasons, we argue that green entrepreneurship has a different societal effect than conventional entrepreneurship. First and foremost, green organizations put their customers' and workers' safety and wellbeing first. A safer workplace (Xie et al., 2016) and health goods (Chuang & Yang, 2014) lessen the responsibility placed on the medical system by avoiding hazardous compounds and reducing harmful emissions. Second, since social advancement and environmental deterioration are closely related, this research argues that green entrepreneurs that concentrate on environmental concerns are also likely to help alleviate social issues (Grossman & Krueger, 1995). Secondary advantages of enhancing regional air and water quality (e.g., by providing electromobility, filtration systems, or renewable energy) include lowering respiratory ailments and restoring local fish supplies. Additionally, this will help achieve the "Zero Carbon Social Goals." It will also combat "hunger" and encourage " wholesome livelihoods." The third characteristic that distinguishes eco-conscious entrepreneurs is their dedication to addressing ecological issues (e.g., Dean & McMullen, 2007; Cohen & Winn, 2007; Wilson & Taylor, 2002). As a result, pressure from unfavorable employment opportunities increases the likelihood that the (green) opportunities will support their new green endeavors. Venâncio and Pinto (2020), Dhahri et al. (2021), and Gries and Naudé (2011) have provided empirical evidence that these opportunity-oriented enterprises are essential to the macro-level growth of society. It could be riskier to launch a firm that is motivated by a need. Environmental acts that have indirect socioeconomic repercussions, opportunity incentive, and the advantages for employee and customer safety and health are a few examples of the important contributions that green entrepreneurship makes to society. Therefore, this study makes the argument that increasing entrepreneurial activity is good for society's progress.

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