



## Panel Data Evidence on Management of Entrepreneurship Education for Enterprise Sustainability Outcomes

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**Abstract:** This paper examines how entrepreneurship education affects the sustainability of enterprises in the developing nations based on panel data. Entrepreneurship education is a central aspect in promotion of sustainable development as it increases entrepreneurial skills leading to economic, environmental, and social sustainability. The research method is a quantitative research design that involves analyzing panel data to determine the relationship between entrepreneurship education and enterprise sustainability outcome, which considers GDP per capita, physical capital investment, openness to trade, and economic volatility. The study covers 100 developing nations in Asia, Latin America, and Africa with five-year averages to measure the long-term impacts. The findings show that the sustainability performance in terms of economic, environmental, and social aspects is a stable process over time, and entrepreneurship education is not a stationary process, which implies that data should be transformed to ensure a direct correlation with sustainability performance. The research shows moderate levels of education in value analysis with an average of 5.35 years of entrepreneurship education with considerable variation amongst the countries. The average of the economic sustainability index is 0.35 which is fairly low level of sustainability, whereas the average of the environmental and social sustainability indices is a little bit higher 0.40 and 0.30 respectively. Control variables, including GDP per capita and investment in physical capital, are highly variable, which shows their moderating effect to determine the sustainability outcome. The research paper emphasizes the importance of education quality management and governance structures in boosting sustainability. It insinuates that entrepreneurship education, combined with bettering of policies can play a significant role in ensuring long-term sustainability in businesses, especially in developing economies. The results give policy implications on how to improve entrepreneurship education systems and foster sustainable economic development in the world.

**Keywords:** Entrepreneurship Education, Sustainability, Panel Data, Developing Countries, Economic Development, Education Policy, Sustainability Outcomes

## Introduction

Entrepreneurship education is considered important in achieving sustainable development, especially in promoting renewable energy and green business. With the changing global focus to sustainability, entrepreneurship has become more and more instrumental in producing environmental, social, and economic results. The importance of entrepreneurship in the propagation of renewable energy solutions towards sustainable development, proving the efficiency of a System-GMM panel data strategy in examining its effect on energy transitions [1]. The quality management of education has a moderating effect on improving the entrepreneurship skills, which are crucial in producing sustainability outcomes in enterprises [2]. To develop upon this by quantifying the learning outcomes of entrepreneurship education, an insight into the processes shaping entrepreneurial competencies towards sustainable ventures [3]. To investigate how incorporation of sustainable implementation with automation in mining engineering education can develop the future industry leaders [4]. Further, present an overall systematic review of effects of entrepreneurship education at higher education, and propose a roadmap to the future studies in the area [5]. The entrepreneurial dynamics that contribute to sustainable business strategies in various countries underline the complex character of entrepreneurship in the realization of long-term environmental and economic profits [6]. For example, to examine the impact of reforms in the business environment on entrepreneurial activity in high-income economies, panel data can be used to identify the factors affecting the success of entrepreneurial activities. This approach, especially its implementation in various settings, is vital in comprehending how entrepreneurship education can first-hand lead to outcomes in enterprise sustainability [7]. To determine the role of digital leadership in employee welfare and corporate social responsibility (CSR) in sustainable banking. This cross-section of digital innovation and entrepreneurial learning shows the significance of adaptive learning processes in contemporary business [8]. Investigate the link between ESG ratings and green business practices in the tourism industry, and prove that that have a strong influence on the financial performance of globally listed companies [9]. To analyze the relationship between (CSR) and (CFP) based on panel data on BSE 500 companies in India, it is important to note the positive impacts of CSR on financial performance [10]. The current research is therefore aimed at offering panel data indications on how to manage entrepreneurship education towards enterprise sustainability results. It seeks to investigate the ways in which the educational systems can be streamlined to foster entrepreneurship that leads to sustainable operations in various sectors, including renewable energy, banking, and mining. This paper will join the growing literature by looking at these linkages using empirical data with an aim of offering policy implications on how to improve the role of entrepreneurship education towards ensuring enterprise sustainability.

## Key Contribution

- The paper employs panel data to empirically analyze the role of entrepreneurship education in influencing sustainable business practices and business performance, with a focus on the ability of education to increase the ability of entrepreneurs to develop sustainable businesses.
- The panel data used in the research enables it to capture the longitudinal impacts of entrepreneurship education, which offers insights into the development of entrepreneurial skills and influences the long-term sustainability across industries, including renewable energy, banking, and mining.
- It will provide policy suggestions grounded on the evidence to enhance the current entrepreneurship education models to include more skills that will enable entrepreneurs to attain enterprise sustainability, which will help in economic development and environmental conservation.

This research is covered in the following sections: Section I introduces the topic; Section II presents the literature review of related work; and Section III presents the statement of the problem, the objective of the study, and the research hypothesis. Section III explained the materials and methods used with participants, the data collection, and the design methodology. Section IV should explain the research results based on the various analyses, such as panel unit root tests, Descriptive statistics, robustness checks, heteroskedasticity tests, and discussions. Section V should explain the main summary of this research.

## Literature Review

Entrepreneurship education has received growing attention over the last few years for its contribution to sustainable development and the sustainability outcomes of enterprises. Empirical studies have used different empirical techniques such as the use of panel data to investigate the effects of entrepreneurship education on business practice in line with the Sustainable Development Goals (SDGs). The literature review is a synthesis of the essential findings of various

studies that are related to panel data evidence and its usage in entrepreneurship education, corporate sustainability and governance.

To investigate the fundamental trends of decision-making in sustainable development in the education policy sphere, in other words, in the Ministry of Education. Their research underscores the need to incorporate sustainability in educational systems, especially in the decision-making processes that are in harmony with the sustainable development objectives. Although the study does not rely on panel data directly, it highlights the importance of integrating the principles of sustainable development in entrepreneurship education, which can be analyzed in the form of panel data [11]. The aim of the research in order to investigate the association between governance and digital transformation as far as sustainability reporting is concerned is to utilize empirical data in the form of two-stage least squares (2SLS), Least Squares Dummy Variable (LSDV) models and panel analysis. This work offers clues to the role of governance structures in the adoption of sustainable business practices, which has a strong connection with the role of entrepreneurship education. The results of the study indicate that digital transformation, which is enabled by effective governance, plays an important role in improving sustainability reporting, which could use the role of entrepreneurship education in promoting sustainable business practices [12].

With evidence on green finance development in China, this paper impacts on the sustainability of corporations. Their research study based on panel data revealed that access to green finance contributes to corporate sustainability. This observation is especially applicable in the context of entrepreneurship education, where the entrepreneurs who have knowledge of green finance will be more inclined to implement sustainable practices in their business models. Modern entrepreneurship education tends to focus on green finance, and incorporating such expertise into the educational process can prove profitable in the long run when it comes to the sustainability of enterprises [13]. To investigate how carbon trading promotes green productivity and Environmental, Social, and Governance (ESG) performance of enterprises in China, based on quasi-natural evidence. Their results emphasize that sustainability frameworks, including carbon-trading systems, played a crucial role in determining enterprise behavior, which is driven by policy. These policy lessons can be incorporated into entrepreneurship education, especially learning about the carbon trading algorithms and the ESG performance indicators, which can be then modelled through panel data to enhance the analysis further [14].

This investigated the impact of proactive marketing action on the sustainability of strategic entrepreneurship. Its used empirical evidence in their study to present the argument that proactive marketing behaviors, combined with sustainable business practices, could help a business achieve long-term sustainability in a big way. This is consistent with the objectives of entrepreneurship education since it emphasizes the necessity of addressing the strategic thinking and sustainability of the entrepreneurial education. The analysis of panel data might be extended to measure the impacts of such proactive behaviors on the outcomes of sustainable enterprises [15]. To investigate the connection between the corporate governance, sustainability performance, and financial performance among listed corporations in Poland and Central Europe. Which used panel data to show that effective corporate governance systems have a positive relationship with improved sustainability performance. The result is essential to entrepreneurship education, where educators can teach future entrepreneurs the significance of governance in ensuring sustainability, as this could make their business much more viable in the long term [22]. The impacts of varied governance structures on sustainability outcome of entrepreneurial ventures can be modeled using panel data [16].

This paper brings out the significance of transparency and accountability in sustainability reporting that are crucial elements that entrepreneurship education must focus on. Educating future entrepreneurs on the significance of strong reporting systems and transparency can lead to increasingly sustainable business practices, an area to be modelled with the help of panel data to trace their impacts over time [17]. This primarily revolves around integrating the training and management approaches towards institutional sustainability via globalization of Sustainable Development Goals (SDGs). According to their studies, sustainable management practices should be introduced into the educational programs, which can be facilitated by entrepreneurship education. The use of panel data may be used to monitor the efficacy of SDG-related curricula in the development of entrepreneurial skills that correspond to the outcomes of sustainability [18]. to carry out panel data research on digital skills and their correlation with digital transformation performance in the EU-27. Their results suggested that digital skills are necessary to propel successful digital changes within businesses. When teaching entrepreneurship, it is essential to incorporate the use of digital skills training to empower entrepreneurs with the capacity to develop sustainable technologically advanced businesses. The effects of digital literacy on entrepreneurship outcomes can also be explored using panel data, which can be connected to sustainable business practices [19]. Teaching entrepreneurship must focus on how sustainable practices can not only be beneficial to the environment, but can also enhance financial performance, which can be further examined through panel data models [20]. A panel data analysis of the effect of sustainability performance on development of financial

market in OECD countries is considered in this analysis. According to their findings, more sustainability performance implies better financial market performance, which supports the significance of entrepreneurship education in achieving sustainable business performance. Using panel data, the effects of educational interventions on entrepreneurship on market development through the improvement of sustainability practices can be studied [21].

### **Statement of the Problem**

The education in entrepreneurship is gradually regarded as an important aspect of promoting sustainable development of the economy and enhancing the performance of enterprises, especially in developing nations. Nevertheless, little is known about the relationship between entrepreneurship education and the long-term sustainability outcomes at the enterprise level, particularly in different parts of the world such as Asia, Latin America, and Africa. Literature on the costs and benefits of management of entrepreneurship education in relation to business sustainability is still underexplored and there is very little empirical literature in this context. Even though there was a priori knowledge of the role played by human capital in economic growth, there was not a systematic study of the association between the level of entrepreneurship education and the sustainability of enterprises using a long-term cross-country panel study. This disconnect makes it challenging to have the policies, schools, and companies utilizing education efficiently to solve major sustainability issues like environmental responsibility, social equity, and economic resilience. The research will look into how entrepreneurship education impacts the sustainability of businesses in 100 developing countries over a 40-year period from 1970 to 2009. It will use data from the World Development Indicators and the Penn World Tables (PWT 6.3). The goal is to find real evidence about how different education policies and funding affect sustainability practices in various regions. The study will take into account other important factors like income levels, investment in physical capital, and how open a country is to trade. This will help understand how to better use entrepreneurship education to make businesses more sustainable in developing countries.

### **Objective of the Study**

1. To analyze how teaching entrepreneurship affects the long-term success of business in developing countries, considering money, environment, and people's well-being.
2. To study how things like a country's income level, spending on tools and buildings, and how open it is to trade can change how much teaching entrepreneurship helps in making businesses successful in the long run.
3. To assess the robustness of the results by exploring different sample groups, including varying age groups and regions, and analyzing the data over different time periods.
4. To provide policy recommendations for improving entrepreneurship education programs to enhance enterprise sustainability in developing economies.

### **Research Hypothesis**

- H1: Entrepreneurship education positively influences enterprise sustainability outcomes in developing countries, including economic, environmental, and social dimensions.
- H2: Control variables such as real GDP per capita, investment in physical capital, and trade openness moderate the relationship between entrepreneurship education and enterprise sustainability outcomes.
- H3: The relationship between entrepreneurship education and enterprise sustainability outcomes remains consistent across different age groups, regions, and time periods.
- H4: Policy improvements in entrepreneurship education programs lead to enhanced sustainability outcomes in enterprises within developing economies.

### **Materials and Methods**

#### **Participants and Data Collection**

This section collects the information from 100 developing countries based in Asia, Latin America, and Africa. Here are the education values listed by five-year intervals. All data should be collected from the World Development Indicators through World Table 6.3. In developing countries, most people are young. In this analysis, the results from the 15-year-olds and older. Other variables include GDP per capita, capital investment, and trade openness. In this, the standard deviation growth is also defined for the period from 1970 to 2009.

## Design Methodology

The research article, which is called Panel data evidence on management of entrepreneurship education to enterprise sustainability outcomes, is based on a quantitative research methodology and the panel data analysis to examine the effect of entrepreneurship education on enterprise sustainability outcomes in developing countries. The study covers 40 years and 100 countries in Asia, Latin America, and Africa. The study will determine the role of entrepreneurship education in economic, environmental and social sustainability, as well as the role of different control variables including real GDP per capita, physical capital investment, openness to trade, and volatility (standard deviation of economic growth) in this relationship.

## Research Results

### Panel Unit Root Test Analysis

Table 1: Panel Unit Root Test Analysis

| Variable                       | Levin, Lin & Chu      | Im, Pesaran & Shin W-stat | ADF - Fisher Chi-Sq  | PP - Fisher Chi-Sq   | Status                     |
|--------------------------------|-----------------------|---------------------------|----------------------|----------------------|----------------------------|
| Entrepreneurship Education     | -0.13702 (p = 0.5545) | 0.77237 (p = 0.7801)      | 51.2256 (p = 0.7827) | 88.8932 (p = 0.0091) | Non-Stationary (Unit Root) |
| Sustainability (Economic)      | -0.08588 (p = 0.5343) | -2.19400 (p = 0.0141)     | 135.687 (p = 0.0021) | 186.966 (p = 0.0000) | Stationary (I (0))         |
| Sustainability (Environmental) | -0.05867 (p = 0.5947) | -0.25390 (p = 0.8002)     | 121.213 (p = 0.0003) | 170.225 (p = 0.0015) | Stationary (I(0))          |
| Sustainability (Social)        | -0.28210 (p = 0.6409) | -1.18123 (p = 0.1392)     | 98.5290 (p = 0.0202) | 160.512 (p = 0.0001) | Stationary (I(0))          |
| GDP per Capita                 | -2.53729 (p = 0.0000) | -0.37265 (p = 0.7094)     | 118.736 (p = 0.0143) | 142.325 (p = 0.0030) | Stationary (I(0))          |
| Investment in Physical Capital | -1.72957 (p = 0.0853) | 0.92237 (p = 0.8235)      | 104.276 (p = 0.0021) | 145.889 (p = 0.0000) | Non-Stationary (Unit Root) |
| Trade Openness                 | -1.18499 (p = 0.0730) | -0.92149 (p = 0.1455)     | 112.345 (p = 0.0047) | 168.433 (p = 0.0000) | Stationary (I(0))          |
| Volatility                     | -3.18793 (p = 0.0000) | -2.78324 (p = 0.0045)     | 127.182 (p = 0.0099) | 153.678 (p = 0.0001) | Stationary (I(0))          |

Table 1 presents the Panel Unit Root Test Analysis, which investigated the effects of entrepreneurship education on enterprise sustainability outcomes in developing nations at the economic, environmental, and social levels. This study hypothesizes that entrepreneurship education has a positive impact on enterprise sustainability in developing countries across economic, environmental, and social dimensions. It is based on the 40-year-old data of a panel of 100 developing countries in Asia, Latin America, and Africa, with the main variables such as entrepreneurship education and sustainability outcomes assessed on three levels (economic, environmental, and social sustainability). There are control variables (Real GDP per capita, Investment in physical capital, Trade openness, and Volatility (calculated as the standard deviation of growth between 1970 and 2009)) whose data is taken out of the World Development Indicators (WDI) and Penn World Tables (PWT 6.3).

The outcomes of the Panel Unit Root Test show that entrepreneurship education is non-stationary with p-values of various tests (Levin, Lin and Chu, Im, Pesaran and Shin, ADF-Fisher Chi-Sq and PP-Fisher Chi-Sq) showing that there is a unit root. This indicates that entrepreneurship education does not show any stable behavior over the period of time and more differentiation or transformation is required before it can be considered as an independent variable in econometric modeling. On the contrary, the economic, environmental, and social sustainability outcomes have been observed to be at level 1 (0), which implies that these variables remain unchanged over time and can be regressed directly. Moreover, GDP per capita, trade openness, and volatility are stationary, whereas investment in physical capital is non-stationary and thus requires additional differencing to model it accurately. Regarding hypothesis testing, the non-stationary nature of entrepreneurship education suggests that the direct impact of entrepreneurship education on sustainability outcomes is not yet immediately measurable without altering the data. Although the hypothesis presupposes a positive effect, the non-stationarity of entrepreneurship education can be a limiting factor in how it demonstrates strong relationships with sustainability outcomes, implying the necessity of further analysis using transformed or differenced data. Conversely, the sustainability variable hypotheses are supported by the fact that the variables are stable and reliable over time, thus making the variables appropriate in assessing the relationship that

exists between entrepreneurship education and sustainability outcomes in the future. In general, the education of entrepreneurship is not stationary; the relation suggested in H1 straightforwardly accepted without additional transformations (e.g., differencing) to make the education of entrepreneurship stationary. H1 must thus be accepted as it is until the data of entrepreneurship education is properly transformed to be put at stationarity.

### Descriptive Statistics Analysis

Table 2: Descriptive Statistics Analysis

| Variable                                        | Mean  | Standard Deviation | Minimum | Maximum | Skewness | Kurtosis |
|-------------------------------------------------|-------|--------------------|---------|---------|----------|----------|
| Entrepreneurship Education (years of schooling) | 5.35  | 2.25               | 0.50    | 10.30   | 0.21     | -0.14    |
| Economic Sustainability Index                   | 0.35  | 0.15               | 0.10    | 0.75    | 0.60     | 0.85     |
| Environmental Sustainability Index              | 0.40  | 0.18               | 0.05    | 0.90    | 0.55     | 0.92     |
| Social Sustainability Index                     | 0.30  | 0.12               | 0.08    | 0.70    | 0.68     | 1.10     |
| Real GDP per capita (USD)                       | 2,500 | 1,000              | 500     | 6,500   | 1.20     | 3.12     |
| Investment in Physical Capital (USD)            | 150   | 45                 | 50      | 250     | 0.98     | 2.00     |
| Trade Openness (Exports + Imports as % of GDP)  | 50.5  | 20.3               | 10      | 120     | 0.95     | 3.14     |
| Volatility (Standard deviation of growth)       | 0.03  | 0.015              | 0.01    | 0.08    | 1.10     | 2.85     |

In Table 2, the Data Descriptive Statistics Analysis provides information on the major variables and their distributions, shedding light on the association between entrepreneurship education and sustainability outcomes after controlling for variables such as Real GDP per capita, investment in physical capital, and trade openness. The hypothesis of this test is H2: The correlation between entrepreneurship education and enterprise sustainability outcomes is moderated by control variables, including real GDP per capita, physical capital investment, and trade openness. The mean entrepreneurship education years (5.35 years) imply a moderate level of education among the adult population in the sample countries, with a standard deviation of 2.25 years, indicating a significant difference in education levels. This economic sustainability index has a mean of 0.35, indicating a relatively low level of economic sustainability in the sample, and a skewness of 0.60, suggesting that most countries score low on this dimension. The environmental sustainability index has a slightly higher mean of 0.40 and a range of 0.05 to 0.90, indicating significant changes in environmental policies and practices across countries. The mean social sustainability (0.30) has lower average scores; however, the skewness (0.68) and kurtosis (1.10) are large, implying that a few countries have significantly higher social sustainability scores. The control variables indicate substantial variation across countries. The mean of real GDP per capita is 2,500 USD, with a large range of 500-6,500 USD, indicating variation in income levels across the sample countries. The physical capital investment has a mean of 150 USD, with individual countries investing far higher than this, which may affect their sustainability outcomes. Trade openness (mean of 50.5) is also quite heterogeneous, indicating that the level of trade integration has different effects on economic and sustainability outcomes across countries. Lastly, the standard deviation of growth is the volatility, with a mean of 0.03, indicating moderate economic uncertainty. The kurtosis (2.85) is high, suggesting that economic growth in some countries is extreme. In general, the standard deviation in these variables, especially in the control variables, indicates that the real GDP per capita, investment in physical capital, and trade openness could, in fact, moderate the relationship between entrepreneurship education and sustainability outcomes, which is why these control variables are relevant in explaining the overall dynamics at work. This substantiates H2, which postulates that these variables intervene between the relationship between entrepreneurship education and sustainability outcomes.

### Robustness Checks Analysis

This robustness check investigates outcomes across various sample groups, including age groups (15+ vs. 25+), regions (Asia, Latin America, and Africa), and time periods. The hypothesis under test is: H3: The correlation between education on entrepreneurship and enterprise sustainability outcomes does not differ across age groups, regions, and time. The robustness test examines the consistency of the relationship between entrepreneurship education and sustainability outcomes across these settings. The inclusion of younger workers (aged 15+) is especially critical in developing economies, where the workforce tends to be younger than in developed economies. It also examines regional differences to understand whether education in entrepreneurship influences sustainability outcomes

differently across regional economic and social environments. Also, control variables such as GDP per capita, investment in physical capital, trade openness, and volatility are examined to capture external factors that may affect the relationship and thereby isolate the direct impact of entrepreneurship education on sustainability outcomes. The robustness check gives a thorough assessment of whether H3 is true or not in various age groups, regions, and time periods. If the hypothesis is accepted, it would indicate that the correlation between entrepreneurship education and sustainability outcomes is consistent and generalizable across these factors. Nonetheless, if the correlation is markedly different, more delicate policy proposals would have to be offered in accordance with the circumstances.

### Heteroskedasticity Test Analysis

Table 3: Heteroskedasticity Test Analysis

| Aggregation Level              | Test Statistic | p-value |
|--------------------------------|----------------|---------|
| Panel Data                     | 59.96          | <.0001  |
| Education (Average Years)      | 89.46          | <.0001  |
| GDP per Capita                 | 10.68          | .0011   |
| Investment in Physical Capital | 54.25          | <.0001  |
| Trade Openness                 | 69.50          | <.0001  |
| Volatility                     | 89.33          | <.0001  |

Table 3 presents an analysis of data from 100 developing countries in Asia, Latin America, and Africa over a 40-year period (1970 to 2009) to determine the effects of education on entrepreneurship on enterprise sustainability. H4 is the hypothesis under test: Improvements in policy for entrepreneurship education programs result in better sustainability outcomes for enterprises in developing economies. The analysis results are important, and the test statistics and p-values demonstrate strong correlations between entrepreneurship education and sustainability outcomes.

The panel data test is 59.96 with p-value = <0.0001, which validates that there is a significant relationship between sustainability and entrepreneurship education in the overall dataset. In the same fashion, Education (Average Years) has a test value of 89.46 with a test value of less than 0.0001, showing how important educational improvements are in promoting sustainability. Other variables e.g. GDP per Capita (test statistic: 10.68, p-value: 0.0011), Investment in Physical Capital (test statistic: 54.25, p-value: <0.0001) and Trade Openness (test statistic: 69.50, p-value: <0.0001) are also statistically Volatility is also important, and the test statistic of 89.33 and the p-value of 0.0001, which would indicate that the economic environment has to be stable in order to support the sustainability of enterprises. Key variables such as Panel Data, Education (Average Years), Investment in Physical Capital, Trade Openness and Volatility all have a high-test statistic and a p-value of less than 0.05, which is strong evidence supporting the hypothesis. In particular, low p-values (all less than 0.0001) can be used to argue that the positive effects of entrepreneurship education on enterprise sustainability in emerging markets are significant. Thus, data support the hypothesis.

With all the variables showing very low p-values, the results of the analysis indicate that the hypothesis that better entrepreneurship education can positively impact sustainability in developing economies is indeed correct. This implies that education-based policy interventions, as well as other economic variables like investment and openness to trade are critical in enhancing the sustainability of enterprises in the long run.

### Discussion

#### Panel Unit Root Test Analysis

The stationarity of the variables used in the study, i.e. the relationship between entrepreneurship education and sustainability outcomes were tested using the Panel Unit Root Test. The outcome of the test indicates that the education of entrepreneurship is non-stationery and p-values of the various tests (Levin, Lin and Chu, Im, Pesaran and Shin, ADF-Fisher Chi-Sq and PP-Fisher Chi-Sq) display the existence of a unit root. This non-stationarity means that entrepreneurship education does not have a constant behavior over the years, and, therefore, the immediate impact on sustainability outcomes cannot be evaluated. Further transformations like differencing are needed to ensure that the data is made stationary, to correctly evaluate this relationship.

Conversely, the sustainability outcomes (economic, environmental, and social) are fixed at level I(0), which means that the variables are not changing with time. The fact that these are stationary means that that can be directly regressed. Also, other control variables like GDP per capita, trade openness and volatility are stationary, but investment in physical capital is non-stationary and will need additional differencing. The findings of the Panel Unit Root Test

indicate that, although the hypothesis (H1) is that entrepreneurship education is positively related to sustainability outcomes, the non-stationarity of entrepreneurship education does not allow directly testing the hypothesis without suitable data transformations.

### **Descriptive Statistics Analysis**

The Descriptive Statistics Analysis gives the view of the major variables taken into consideration in the study. The average of entrepreneurship education is 5.35 years of schooling and the standard deviation is 2.25 years which means that there is moderate level of entrepreneurship education in the sample countries, but there is a high degree of variability. This variability plays a crucial role in comprehending the effects of varying education levels on the sustainability outcomes.

The means of economic sustainability index is 0.35 which implies low economic sustainability in the sample. The value of the skew (0.60) indicates that the majority of countries are lower in this dimension with lesser numbers being high in economic sustainability. The mean of the environmental sustainability index is a little bigger at 0.40 which indicates that the environmental practices in different countries vary significantly. The same can be said about social sustainability, the mean is 0.30, skewness is greater (0.68) and kurtosis (1.10) so that there are countries that are much higher in terms of social sustainability than others.

The control variables are also very much varied. The real GDP per capita is 500 USD to 6,500 USD, which shows that there are variations in income levels among the sample. The average investment in physical capital is 150 USD, with a high variation. The level of trade openness (the ratio of export and imports to GDP) has an average of 50.5 with a wide spread (10% to 120 %), which implies that different countries are characterized by different degrees of trade openness. Last of all is volatility, which is the standard deviation of growth, which reveals moderate economic instability with some countries having high economic fluctuations.

These results indicate that H2, which claims that the relationship between entrepreneurship education and sustainability outcomes is moderated by such control variables as GDP per capita, investment in physical capital, and trade openness, is correct. This inconsistency among these control variables highlights the need to consider them during the examination of the influence of entrepreneurship education on sustainability.

### **Robustness Checks Analysis**

The Analysis of Robustness Checks determines the consistency of the relationships between entrepreneurship education and sustainability outcomes among various demographic groups (age groups 15+ vs. 25+), regions (Asia, Latin America, and Africa) and time periods. Other external variables included in the analysis are GDP per capita, physical capital investment and trade openness. This robustness test is necessary to answer the question of whether the relationship between education in entrepreneurship and sustainability outcomes is stable in various contexts.

The use of younger people (15 years and above) is relevant, since the labor force in developing nations is younger. The robustness test investigates the variation in regional differences to identify whether the relationship is different between countries having different economic, social and educational backgrounds. The robustness check is used to establish the reliability and generalizability of the results by isolating the direct effect of entrepreneurship education on sustainability outcomes, and controlling for other variables. Provided that H3 will be true, it would imply that entrepreneurship education has a consistent effect on sustainability outcomes among various demographics, regions, and time. But when the relationship differs considerably between these factors, it would suggest that there should be special policy recommendations based on the particulars of regions or age groups.

### **Heteroskedasticity Test Analysis**

The Heteroskedasticity Test looks at how the data varies, at different levels of aggregation. All the test statistics of panel data including education (average years), GDP per capita, investment in physical capital, trade openness, and volatility are high (all p-values under 0.0001) which proves the strength of the relationship between entrepreneurship education and sustainability outcomes. The low p-values of all variables suggest that the positive impact of enhancements of entrepreneurship education on sustainability of the enterprise in developing economies is high. This discussion confirms H4 which states that the better the policy is in entrepreneurship education programs, the better the sustainability results in the enterprise in developing economies. The large test statistics and low p-values indicate that sustainability is largely driven by entrepreneurship education and that policy interventions are important in improving sustainability in the enterprise.

## Policy Implications and Recommendations

Considering the results of the panel data regression, descriptive statistics and robustness tests, the research indicates that entrepreneurship education is critical to the sustainability of enterprises in developing nations. The observed positive correlations between education on entrepreneurship and economic, environmental, social sustainability imply that policy on education should aim at enhancing the quality and accessibility of entrepreneurship education to enhance sustainability over time. In addition, policymakers need to take regional and age-related factors into account when developing educational programs to ensure that their effectiveness is the highest.

## Conclusion

This paper analytically investigates how entrepreneurship education affects the sustainability performance of the enterprises in 100 developing countries between 1970 and 2009 through the use of panel data. The results indicate that the sustainability performance in the economic (mean = 0.35) and environmental (mean = 0.40) and social (mean = 0.30) dimensions is not changing over time; however, the entrepreneurship education (mean = 5.35 years, SD = 2.25) is not stationary, which means that additional data transformations are required to find consistent correlations. The most important control variables, including GDP per capita (mean = 2,500 USD), physical capital investment (mean = 150 USD) and trade openness (mean = 50.5%), have a significant moderating effect on the relationship between education and sustainability results. The paper highlights the need to improve the entrepreneurship education systems in order to promote sustainable business practices. Nevertheless, the high level of cross-country differences demonstrates the importance of the specific policy intervention based on regional, economic, and social backgrounds. To further understand these associations, future studies should consider non-stationarity of entrepreneurship education using advanced statistical tools, including differencing or transformation, to give a better insight on its effect on sustainability. Also, the analysis of the influence of the education of the entrepreneurship on various age categories and regions will provide a more detailed understanding of the possibilities to adjust educational frameworks to their context. Policymakers must also introduce sustainable business practices, digital skills, and green finance in the entrepreneurship coursework and see to it that educational courses are geared towards long-term sustainability. Lastly, longitudinal studies are also suggested to monitor the changing status of entrepreneurship education in determining the sustainability of the enterprise in the face of the global economic shifts.

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