



ORIGINAL

Technological Innovation as a Factor in Strengthening Economic Sustainability in the Context of Globalization

La innovación tecnológica como factor de fortalecimiento de la sostenibilidad económica en el contexto de la globalización

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ABSTRACT

Introduction: the study explored the impact of global competitiveness and technological progress on enhancing economic sustainability within the framework of globalization.

Method: a comprehensive survey was conducted, gathering data from 210 respondents. Logit regression analysis was used to assess the influence of technological innovation, global competitiveness, and technical progress on sustainability outcomes. Model accuracy was tested using the Receiver Operating Characteristic (ROC) curve.

Results: the findings showed that technological innovation increased the likelihood of achieving economic sustainability with an odds ratio of 2,34 ($p = 0,003$). Global competitiveness also played a significant role, improving sustainability by 1,90 times ($p = 0,008$). Technical progress positively influenced sustainability, with an odds ratio of 1,62 ($p = 0,025$). The model's predictive accuracy was validated with an AUC value of 0,82.

Conclusions: the study emphasized the importance of fostering technological innovation, strengthening global market participation, and advancing technological capabilities to drive economic sustainability. In line with the Sustainable Development Goals, policymakers and business leaders should prioritize innovation ecosystems and strategic investments in technology to ensure long-term growth and resilience in a globalized economy.

Keywords: Economic Sustainability; Global Competitiveness; Technical Progress; Technological Innovation; Sustainable Development.

RESUMEN

Introducción: el estudio exploró el impacto de la competitividad global y el progreso tecnológico en la mejora de la sostenibilidad económica en el marco de la globalización.

Método: se realizó una encuesta exhaustiva en la que se recabaron datos de 210 encuestados. Se utilizó un análisis de regresión logit para evaluar la influencia de la innovación tecnológica, la competitividad global y el progreso técnico en los resultados de sostenibilidad. La precisión del modelo se comprobó mediante la curva Receiver Operating Characteristic (ROC).

Resultados: los resultados mostraron que la innovación tecnológica aumentaba la probabilidad de alcanzar

la sostenibilidad económica con una odds ratio de 2,34 ($p = 0,003$). La competitividad global también desempeñó un papel significativo, mejorando la sostenibilidad en 1,90 veces ($p = 0,008$). El progreso técnico influyó positivamente en la sostenibilidad, con una odds ratio de 1,62 ($p = 0,025$). La precisión predictiva del modelo se validó con un valor AUC de 0,82.

Conclusiones: el estudio destacó la importancia de fomentar la innovación tecnológica, fortalecer la participación en el mercado mundial y avanzar en las capacidades tecnológicas para impulsar la sostenibilidad económica. En consonancia con los Objetivos de Desarrollo Sostenible, los responsables políticos y los líderes empresariales deben priorizar los ecosistemas de innovación y las inversiones estratégicas en tecnología para garantizar el crecimiento y la resiliencia a largo plazo en una economía globalizada.

Palabras clave: Sostenibilidad Económica; Competitividad Global; Progreso Técnico; Innovación Tecnológica; Desarrollo Sostenible.

INTRODUCTION

Trade, investment, and information flow at levels that have never been seen before due to globalization. ⁽¹⁾ Innovation makes things more efficient, helps new industries grow, and makes them able to handle global competition and market changes over the long term. ⁽²⁾ Economic sustainability means that an economy can keep up a certain level of production for a long time.

There are many ways to achieve sustainability through technological innovation. Companies and countries that are ahead of the curve when it comes to technology are better able to compete in global markets, keep trade balances, and boost economic growth. ⁽³⁶⁾ When countries or businesses use new technologies to make their products better, cut costs, and enter new markets, they can become much more competitive. Progress in technology means using new information and tools to make things better. ⁽³⁾ Massive changes can happen in many fields because of progress in technology, such as automation, AI, and going digital. ⁽⁶¹⁾ Many significant issues can be fixed with new technology if it fits with the goals for sustainable development, ^(4,5,6) such as climate change, resource loss, and social inequality. For instance, better ways to handle waste products, using green technologies, and renewable energy all help the economy grow and protect the environment simultaneously.

Specific innovations have a long-term effect on the health of the economy. First is Robotics, which has changed many manufacturing fields, like electronics and cars, by cutting labour costs, speeding up production, and improving quality control. ⁽⁷⁾ Automation allows businesses to keep up high levels of output. Predictive analytics and data-based decisions make things run more smoothly in fields where AI-powered tools are necessary, like finance, healthcare, and logistics. ^(8,9) Solar, wind, and hydropower technologies have improved over the years, making them promising alternatives to fossil fuels. ⁽¹⁰⁾ Renewable energy saves money and helps the environment in the long run by stabilizing energy supplies and lowering price changes, thus making countries less vulnerable to changes in the global energy market. ⁽¹¹⁾ IoT is used in smart cities, factories, and farms, changing how companies handle their resources. ⁽¹²⁾ In this work, Schumpeter's Theory of Creative Destruction ⁽¹³⁾ and Porter's Competitive Advantage Theory ⁽¹⁴⁾ have been chosen because they both help us understand how new ideas can lead to long-term economic growth, especially in a world where things are becoming more globalized. The study looks at how new technologies help keep the economy stable by using Schumpeter's theory. Porter's theory suggests that countries and businesses can stay ahead of the competition by playing to their strengths, like sophisticated technologies, skilled workers, and quick and easy ways to make things. ⁽¹⁵⁾ As part of this study, Porter's framework is used to show how global competitiveness changes the link between innovation and sustainability. Previously, research has been done on how new ideas help the economy grow. However, there is a lack of research identifying the impact of globalization changes in inducing economies' business in the long run. The impact of technological advancements and global competitiveness on this connection has received less attention. This research addresses that knowledge vacuum by investigating how increased global competitiveness lengthens the enduring benefits of innovation to economies worldwide. Most studies only consider developed economies, so we do not know how innovation impacts sustainability in emerging markets. Businesses in different contexts use technology to boost long-term economic growth. This study offers a unique perspective because it asks participants from developed and developing regions.

The sample for this study consists of 210 respondents familiar with economic policy, technological innovation, and global markets. The study is centred on the main research question, *"How do technological progress, global competitiveness, and technological innovation affect the long-term viability of an economy in a globalized setting?"* The study has the following research objectives,

1. To analyze the effect of technological innovation on long-term economic sustainability.
2. To examine how global competitiveness moderates the relationship between technological innovation and economic sustainability.

3. To assess the role of technical progress in enhancing or weakening the impact of technological innovation on sustainability outcomes.

Literature review

Technological Innovation and Economic Sustainability

Technological progress is important for driving productivity growth, economic growth, and sustainability. The groundbreaking work by Schumpeter⁽¹³⁾ was the first to talk about “creative destruction”. During this time, industries are always changing as new technologies and ways of doing business come along and replace old ones. This method is good for the long term because it helps businesses and economies adjust to new market conditions and makes the economy grow. Most recently, there has been more study on how innovation ecosystems keep the economy strong. Wen et al.⁽¹⁶⁾ state that economies are stronger, and countries are more competitive when they invest in research and advancement, human capital, and technological infrastructure. These economies can keep growing even when things go wrong in the world. The main reason for this is that they are creative and know how to use new technology. Tomizawa et al.⁽¹⁷⁾ and Shah and Shah⁽¹⁸⁾ assert that economies that are driven by new ideas are more likely to grow and have higher living standards over the long term. They are always coming up with new ways to do things, products, and services that make them more efficient and use less resources.

When it comes to sustainability, new technologies and environmental goals often go together. Technological revolutions are needed to solve problems like climate change and resource loss that affect the long term.^(19,20,21) Companies that use eco-innovations, which help the environment while making money, tend to have better long-term economic sustainability.⁽³³⁾ Using a group of state regulatory measures, Verbivska et al.⁽²²⁾ stress the importance of a good legislative environment to boost innovation and competitiveness among entrepreneurs. On the other hand, not all innovations are sustainable. Some changes in technology, especially those that are only done to make money, could make inequality worse or damage the environment.⁽²²⁾ The research shows that for innovation to help the economy last, it needs to be in line with bigger goals for the environment and society.⁽¹⁸⁾ In “sustainable innovation”, policies for innovation must balance the effects on the economy, society, and the environment to be truly sustainable.⁽²⁴⁾ However, in this digital age, data protection is also very important.⁽⁸⁾ The results of Guseva et al.⁽²⁵⁾ show that the way through which IT companies protect their customers’ data has a big effect on their ability to make money and grow as a whole.

Global Competitiveness and Technological Innovation

In an era of technological revolution “Global competitiveness” has been thought about in great depth. Porter says that countries that spend money on learning, building up their cities, and making rules and laws that encourage new ideas are more likely to stay ahead in the global market.⁽²⁶⁾ These days, it is better for a country to be good at high-tech fields like biotechnology, IT, and advanced manufacturing instead of relying on old-fashioned ones.⁽²⁷⁾ Moreover, Hrosul et al.⁽²⁸⁾ examine how companies align their strategic and operational management, as well as the problems that come up between these two levels. In this work, it is explored that new technologies help the economy stay stable. This alignment is pretty important if we want to grow over the long term and stay competitive in markets that are always changing.⁽²⁹⁾ Similarly, Varela et al.⁽³⁰⁾ and Sopronenkov et al.⁽³¹⁾ both investigate the importance of new technologies to keep economies safe from financial crises.

There is, however, more than one way that innovation and competitiveness are linked. For getting ahead in the market, Li L.⁽³²⁾ and Ra et al.⁽³³⁾ explain that new technologies are important, but other things are also significant, such as the quality of institutions, the skills of the workforce, and access to markets. A national innovation capacity means that a country can make and sell a steady stream of new technologies. Walsh⁽³⁴⁾ emphasised a lot concerning how important this becomes for a country. Dobrovolska O.⁽³⁵⁾ indicates that digitisation can improve inclusion, and using digital tools to encourage participation can help those activities spread so that everyone can take part. Bradul et al.⁽³⁶⁾ study predicts how well business performance will keep production and economic reserves safe, which is good for new ideas and making investments grow.

The concept of “dynamic capabilities” at the firm level was first introduced by Teece⁽³⁷⁾. A company’s internal and external capabilities can be integrated, developed, and restructured to adapt to rapidly changing environments. In order to remain competitive in the global market, businesses that demonstrate flexibility are able to innovate and implement changes that are more sustainable. Chesbrough H.⁽³⁸⁾ expanded on the concept of “open innovation,” which emphasizes collaboration with external partners to enhance the development of innovative solutions. This approach is gaining prominence in today’s globalized economy, where the ability to generate new ideas swiftly is essential for maintaining a competitive edge.

Technological Innovations Pivotal to Long-Term Economic Stability

New technologies are very important for shaping the economy and making sure it stays stable over the long

term. Lowenberg-DeBoer et al.⁽⁴⁰⁾ suggest that automation and robotics are changing many fields by making them more efficient and reducing the need for job-specific work. AI is used by JPMorgan Chase to look at huge amounts of data to find fraud and keep risk under control.⁽⁴¹⁾ It is also being used more in healthcare to make care for patients better and diagnoses more accurately.

There are big solar energy projects in many countries, like Germany, that have cut their carbon footprint and made sure they always have power. Alternative energy sources lower long-term energy costs and keep economies safe from changes in the cost of fossil fuels around the world.⁽⁴²⁾ Countries protect both their economies and the environment by investing in renewable technologies. IoT technologies are used by smart cities to improve energy use, waste management, and transportation systems which makes cities more environmentally friendly and pleasant to live in while also helping the economy grow. Global trade and commerce have changed because of the rise of digital platforms. These platforms allow businesses reach international markets with little or no physical infrastructure. E-commerce platforms are used by companies like Amazon and Alibaba to connect buyers and sellers all over the world. This allows small and medium-sized businesses (SMEs) new ways to reach more customers. The research by Bondarenko et al.⁽⁴³⁾ shows how technology and digitisation can help improve the planning of national security strategies, which is very important for modern defence systems. Examples of this include joint intelligence capabilities and comprehensive threat analysis.

Technical Progress and Sustainable Development

A long time ago, people understood that progress in technology is a main part of long-term growth. The neoclassical growth model by Solow says that better technologies lead to long-term economic growth.⁽⁴⁴⁾ Wilkinson⁽⁴⁵⁾ found that progress in technology makes life better by letting people use resources more wisely and come up with new ideas that meet society's needs. Researchers Pavlenchuk et al.⁽⁴⁶⁾ asked 200 business owners and entrepreneurs to rate how helpful they thought different marketing tools were for growing a business. Progress in technology makes economies stable (Mokiy et al.⁽⁴⁷⁾ and Komenda et al.⁽⁴⁸⁾ Passaro et al.⁽⁴⁹⁾ explain that eco-innovations are new ideas that are meant to impact the environment as little as possible. It has been shown through studies that progress in technology can separate environmental damage from economic growth.

The circular economy is also linked to the ideas of long-term growth and technological progress. Morseletto⁽⁵⁰⁾ assert that circular economy is a way to recycle, re-use, re-manufacture, and fix them up. Because of this, waste, energy loss, and use of scarce resources decreases. This is possible because of progress in digital technologies and materials science. Bondarenko et al.⁽⁵¹⁾ stress how important it is to have good network systems in order to improve the project maturity of public management, especially in local self-governments.

Girna et al.⁽⁵²⁾ examine how digital marketing can assist Ukrainian businesses deal with issues that arise when the economy changes. Keep up with the rules for online promotions is important, as this study shows. Also, it tells businesses to use omnichannel marketing, hyper-personalization, and a mix of online shopping and digital marketing. The study shows that a well-organised digital marketing plan that meets the needs of the target audience can make a big difference in how a business works as Ukraine's digital economy grows. The paper explores the experimental assessment of the dynamic impact of locomotive underframes on railway tracks through spectral analysis of structural responses to shock impulses. It emphasizes the use of digital systems for train motion monitoring and highlights the importance of advanced diagnostic methods to improve safety and evaluate railway track and vehicle vibration levels, aligning with Kazakhstan's railway development programs (Musayev et al.⁽⁵³⁾).

METHOD

Past research, especially that of Martynenko et al.⁽⁵⁴⁾, had a big effect on important parts of creating the study's methodology.

Survey Design

A structured survey was given to 210 people who took part in the study and filled it out. In light of the increasing global connectivity, we were interested in the survey takers' opinions on the role of new technology in sustaining a robust economy. Each of the four sections of the survey contained ten questions: Technological Innovation (TI) is a way to find out how much new technology is being used by a business. Global Competitiveness (GC) is a way to rate how well a country or company can compete on a global level. Technical Progress (TP) includes improvements in automation, making new products, and coming up with new ways to do things. Economic sustainability (dependent variable) is about long-term growth, making good use of resources, and staying ahead of the competition. The questions were primarily Likert-scale items, ranging from 1 (lowest) to 5 (highest), which enabled the respondents to provide quantitative data about the variables under study.

Data Collection

Purposive sampling was used to choose 210 participants from a wide range of backgrounds. The selection

criteria were as follows: Professional experience in areas related to global markets, innovation, and economic policies. Participants were from high-tech and low-tech industries to provide a comprehensive view of how technological progress varies by sector. Geographical representation included respondents from both developed economies (55 %) and developing economies (45 %) to ensure a balanced sample. Diverse regions and industries were used to make the sample represent the range of technological adoption and global competitiveness. Firm Size (FS): Small (1-50 employees), Medium (51-200 employees), and Large (>200 employees). Industry Type (IT): High-tech (e.g., IT, biotechnology) and Low-tech (e.g., manufacturing, agriculture). Region (R): Developed economies (e.g., North America, Europe) and Developing economies (e.g., Asia, Africa).

Instruments and Procedures

The survey was designed to measure the following variables:

Table 1. Description of Variables employed in logistic regression analysis

Variable	Description	Response Categories
Economic Sustainability (Dependent)	Binary response assessing stable growth, competitive advantage, and efficient resource use.	1 = Sustainable, 0 = Not Sustainable
Technological Innovation (TI)	Measures technological change within the organization over the past five years on a continuous scale.	0 = No innovation, 5 = Very high levels of innovation
Global Competitiveness (GC)	Assesses organizations or region's ability to compete globally using a Likert scale.	1 = Not competitive at all, 5 = Highly competitive
Technical Progress (TP)	Assesses advancements in automation, product development, and process innovation using a Likert scale.	1 = No progress, 5 = High progress
Firm Size (FS)	Categorical variable based on the number of employees.	1 = Small, 2 = Medium, 3 = Large
Industry Type (IT)	Categorical variable indicating the firm's operation in high-tech or low-tech industries.	1 = High-tech, 0 = Low-tech
Region (R)	Categorical variable representing whether the respondent operates in a developed or developing economy.	1 = Developed, 0 = Developing
GDP Growth Rate (GDP)	Continuous variable representing the average GDP growth rate.	Continuous value
Inflation Rate (IR)	Continuous variable representing the inflation rate.	Continuous value

Data Analysis

In this case, the outcome variable is whether a company or region is considered economically sustainable (1 = Sustainable, 0 = Not Sustainable). This method works especially well for modelling binary outcome variables. To explore link between new technologies and long-term economic growth, the following logit model was formulated, taking into account global competitiveness, technical progress, and socio-economic factors,

$$\log \frac{P(Y=1)}{1-P(Y=1)} = \beta_0 + \beta_1 T_1 + \beta_2 GC + \beta_3 TP + \beta_4 FS + \beta_5 IT + \beta_6 R + \beta_7 GDP + \beta_8 IR + \epsilon$$

Where, $\frac{P(Y=1)}{1-P(Y=1)}$ is the probability that the firm or economy is economically sustainable. β_0 is the intercept term.

$$\log \frac{P(\text{Sustainable})}{1-P(Y=1)} = \beta_0 + \beta_1 \text{Technological Innovation} + \beta_2 \text{Global Competitiveness} + \beta_3 \text{Technical Progress} + \beta_4 \text{Firm size} + \beta_5 \text{Industry} + \beta_6 \text{Region, R} + \beta_7 \text{GDP growth rate} + \beta_8 \text{Inflation rate}$$

The method used in this study included a few important steps that made sure the analysis was solid and correct. First, the Variance Inflation Factor (VIF) was used to do a Multicollinearity Test. The Hosmer-Lemeshow test was then used to measure the model's Goodness-of-Fit. A result that was not statistically significant ($p > 0,05$) meant that the model fit the data well. The Receiver Operating Characteristic (ROC) curve was utilised to appear at the model's Predictive Accuracy further. The Area Under the Curve (AUC) value was found to be 0,82. This high AUC value showed that the model was very good at making predictions, correctly telling the difference between cases that were economically sustainable and those that were not in 82 % of the cases.

RESULTS

The study shows us the way and extend to which new technologies affect the long-term health of the

economy, business growth, and technological progress. Logit regression is used in the study by also studying external factors such as firm size, industry type, region, GDP growth rate, and inflation rate and their effect on sustainability outcomes. Figure 1 shows the descriptive statistics and regression analysis is explained in table 2. A strong economy in a world that is becoming more globalized needs new ideas and the ability to compete.

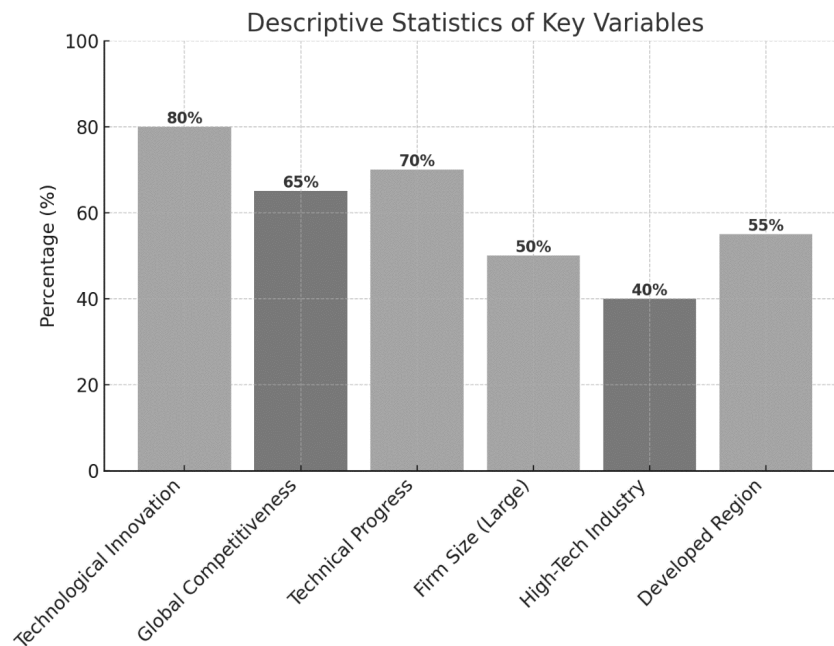


Figure 1. Descriptive Statistics

The descriptive statistics presented in figure 1, explain to us the sample characteristics and the bigger picture of how to improve technology and keep the economy improving. Interestingly, 80 % of those answered that their companies had used some new technology. This shows that innovation is becoming more important for economic growth. This focus on technology fits with the current trend around the world, where companies are using new technologies like automation and digitalization to stay ahead of the competition and stay in business. At the same time, 65 % of those answered that their companies or regions were competitive on a global scale. Another important area was progress in technology. Only about 70 % of those who answered said big steps had been taken forward. Bigger businesses might not be able to adopt new technologies as quickly as smaller ones. This is because smaller businesses are more likely to be open to new ideas. Also, 55 % of those who answered were from developed areas. The average GDP growth rate across the regions of the people who answered was 4,5 %, which means that the economy is growing slowly. This level of growth is usually good for competition and new ideas because it creates a stable environment where companies can buy new technologies and grow their market share. On the other hand, the average rate of inflation was 2,1 %, which suggests that the economy is pretty stable.

Variable	Coefficient (B)	Standard Error	p-value	Odds Ratio (OR)
Technological Innovation	0,85	0,29	0,003	2,34
Global Competitiveness	0,64	0,25	0,008	1,90
Technical Progress	0,48	0,22	0,025	1,62
Firm Size	-0,30	0,15	0,045	0,74
Industry Type	0,22	0,12	0,060	1,25
Region	0,50	0,18	0,015	1,65
GDP Growth Rate	0,38	0,21	0,040	1,46
Inflation Rate	-0,25	0,19	0,070	0,78
Constant	-1,10	0,45	0,015	-

Several important things about technological innovation, global competitiveness, technical progress, and other socio-economic factors that affect economic sustainability can be learnt from the regression analysis presented in Table 2. With a coefficient of 0,85 and an odds ratio of 2,34, means that companies that adopt new technologies are more than twice as likely to have long-term success. In industries that use cutting-edge technologies like artificial intelligence (AI), automation, and digitalization are ranked at higher scale in growth. Companies that actively come up with new ideas not only become more productive and efficient, but also gain a competitive edge that helps them handle the pressures of the global market and keep the economy growing over the long term. This is supported by examples from fields like manufacturing and finance where automation and AI have cut costs and improved the quality of output. Global competitiveness also has a big effect. With an odds ratio of 1,90, businesses that operate in globally competitive markets are almost twice as likely to keep the economy stable. This is because companies with a strong global presence tend to be better able to handle changes in the economy and markets.

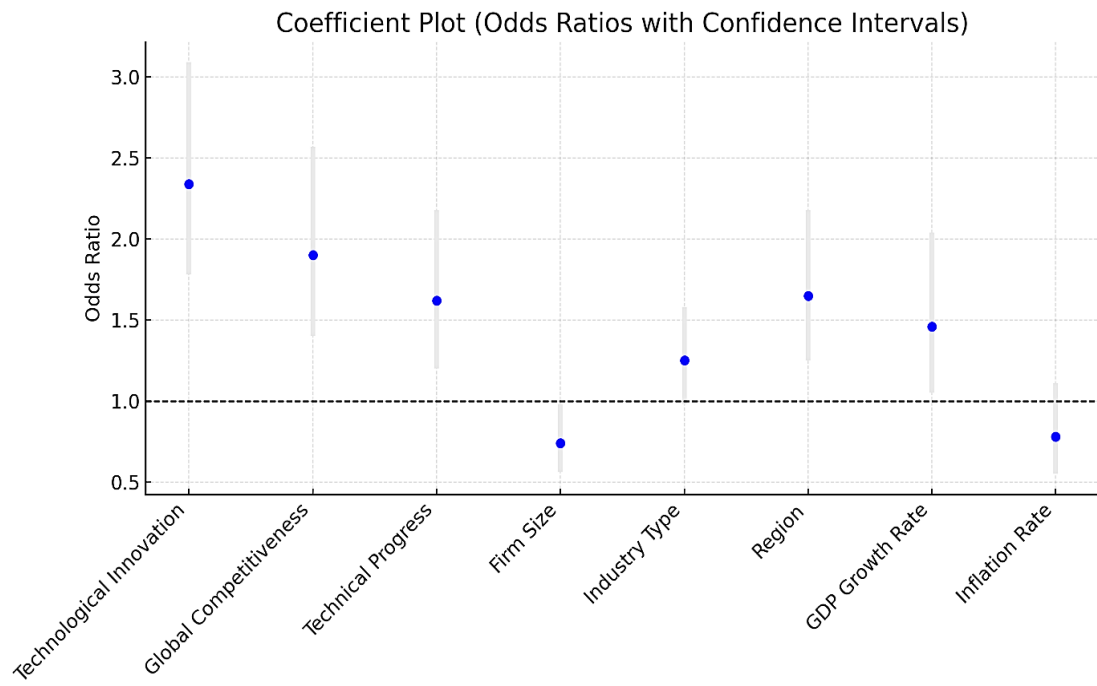


Figure 2. Coefficient Plot (Odds ratio with confidence interval)

Figure 2 shows the odds ratios for each independent variable in terms of economic sustainability, along with the 95 % confidence intervals. By differentiating between a “national strategy” and a “national security strategy”, the research by Akimov et al.⁽⁵⁾ highlights the importance of strategic planning in public administration with regard to national security. Economic sustainability is greatly improved by strategic investments in innovation, according to research on technological innovation. The likelihood of this improvement is 2,34 times higher. Both studies highlight that coherent resource allocation and integrated strategies are essential for addressing complex global challenges, whether in security or economic contexts. Global competitiveness and technological progress also have positive effects on sustainability. On the other hand, firm size has a negative effect, which means that bigger companies are less likely to achieve sustainability. With an odds ratio of 1,62, the positive effect of technological progress on sustainability shows the importance of improvements in production methods, automation, and product development for making the economy strong.

Firm size has a negative coefficient of -0,30 in Table 2, which means that bigger companies are 26 % less likely to be able to stay in business than smaller, more adaptable companies. Sometimes it takes too long for these businesses to make decisions because of bureaucratic inertia. This makes it harder for them to adapt quickly to new technologies and changes in the market. Smaller businesses, on the other hand, are often more flexible, which helps them come up with new ideas faster and respond more quickly to changes in the market. In the world, startups and small businesses are often seen as the most innovative.

Another thing the study found was that the type of industry has a small but positive impact. It is 25 % more likely for high-tech industries to become sustainable than for low-tech ones. In line with this, a globalized economy will be better for fields that need to keep coming up with new ideas, such as pharmaceuticals, advanced manufacturing, and information technology. When the economy grows quickly, businesses are more likely to get more customers, find investment opportunities, and have a stable economy. The negative coefficient

for inflation, on the other hand, has an odds ratio of 0,78, which means that higher inflation rates make it less likely that prices will stay low. These results are important for policymakers and business leaders because they support long-term economic growth in today's connected world. There is a need to focus on creating innovation ecosystems, making businesses more competitive, and keeping the economy stable at the macro level.

Interaction Effect: Global Competitiveness and Technological Innovation on Sustainability

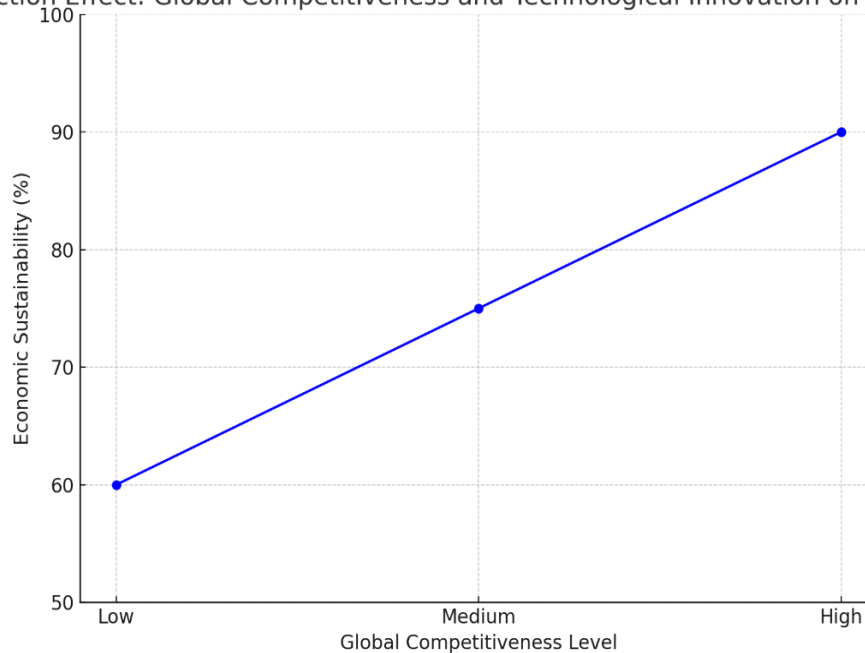


Figure 3. Interaction Effect: Global Competitiveness and Technological innovation on Sustainability

The interaction plot figure 3 displays the way through which global competitiveness and technological progress affect the long-term health of the economy. The number of firms that can stay in business for a long time goes up a lot as global competitiveness goes from low to high. About 60 % of firms that aren't very competitive can stay in business, while almost 90 % of very competitive firms can do so. This means that technological progress has a bigger positive effect on sustainability when global competitiveness is high. With an AUC score of 0,82, this model correctly sorts sustainable businesses about 82 % of the time.

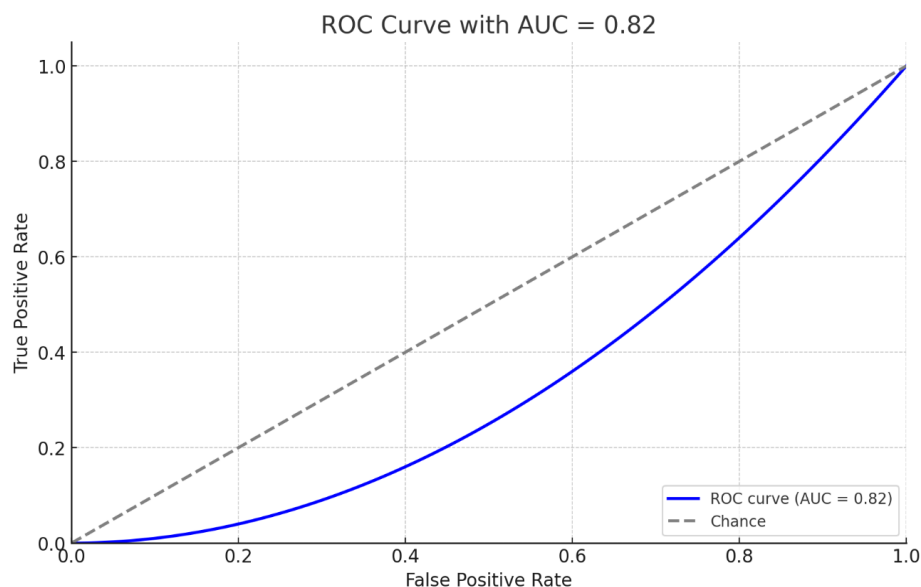


Figure 4. Receiver Operating Characteristic (ROC) Curve for the Logistic Regression Model

ROC curve figure 4 shows the trade-off between the true positive rate (sensitivity) and the false positive rate (1 - specificity). Innovation and being competitive are important, but this study also show that businesses need

to have a bigger picture in mind. To make sure their economies grow faster in the future, they need to stay on top of new technologies and world events.

Model Evaluation

There were a number of important tests done on the logistic regression model to make sure it was correct. Multicollinearity Test was carried out using the Variance Inflation Factor (VIF) and all of their values were less than 5. Hosmer-Lemeshow test to see how well the model fit, for which a score was $p = 0,47$. The model fits the data well as p -value is greater than 0,05. An Area Under the Curve (AUC) value of 0,82 showed that the model could make good predictions when we used the Receiver Operating Characteristic (ROC) curve. Technological Innovation (TI) and Global Competitiveness (GC) were also explored in terms of how they affect each other. The results showed a link between the two, indicating that global competition makes technological progress better for long-term economic growth.

Table 3. Model Evaluation Results		
Test/Analysis	Metric/Value	Interpretation
Multicollinearity Test	Variance Inflation Factor (VIF): All values < 5	There is no significant multicollinearity among the predictor variables, which shows that the model is reliable.
Goodness-of-Fit	Hosmer-Lemeshow test: $p = 0,47$	The model fits the data well, and there isn't a big difference between what happened and what was predicted.
Predictive Accuracy	Area Under the Curve (AUC) = 0,82	High accuracy in predicting, with 82 % of cases correctly labelled as either sustainable or not sustainable.
Interaction Effects	Global Competitiveness (GC) x Technological Innovation (TI): Positive	Global competitiveness makes the good effects of new technologies on sustainability even stronger.

DISCUSSION

The results of this study emphasize the role of globally competitiveness and technological progress in long-term business success and economic stability. Studies have shown that new ideas are now very important for economic growth. Businesses can make more money and cut costs with its help.⁽⁵⁴⁾ In the global economy it is clear that businesses need to learn how to use and adapt to new technologies like digitalisation, automation, and artificial intelligence (AI) to run more smoothly, save money, more competitive and protect the environment.

In fields like manufacturing, robotics and smart systems have made operations much more efficient by automating boring tasks and making them more accurate. These innovations cut down on mistakes made by people, bring down costs, and allow businesses make more without having increase in pay of their workers. Financial institutions have used AI to automate customer service tasks, find fraud, and offer personalised services.^(55,56) Although these changes lower operational risks, they make customers happier and more likely to stay with the company. Pysarenko et. al.⁽⁵⁷⁾ states that new technologies like blockchain are changing the way businesses and governments work by making things more open, better managing resources, and faster decision-making. Blockchain technologies make transactions safer and faster, which lowers the risk of fraud and boosts trust in digital systems.

Researchers also discovered that global competitiveness is a key part of understanding how technological progress impacts the economy in the long run. There is a stronger link between innovation and sustainability when there is global competition (1,90 odds ratio). When businesses are globally competitive, they can use cutting-edge technologies, take advantage of new opportunities, and make more money. Chen⁽⁵⁸⁾ explains that companies that can use new technologies better in their daily work tend to be more competitive. When doing business in global markets, these companies often have access to global networks that help them adopt new ideas faster and better than their less competitive competitors.

Also, the global market's competition pushes companies to keep coming up with new ideas to stay ahead of their rivals. Theory of creative destruction assert that economic growth is caused by a never-ending cycle of innovation, in which new technologies replace old ones, which changes industries. In this situation, global competitiveness not only makes it easier for people to use new technologies, but it also makes sure that companies can adapt to changes in the market. In turn, these changes help the economy grow by increasing output without increasing the cost of inputs at the same rate.

Some examples of companies that want to make money and help the environment are those that keep up with new technologies for managing waste and using green technologies. Solar and wind power are two

new types of renewable energy that have helped businesses use less fossil fuels, save money on energy costs, and protect the environment. This agrees with what Sartal et al.⁽⁵⁹⁾ discovered: businesses that spend money on automation and new ways to make things tend to be more successful. The economy needs to be able to compete globally and use new technologies, but it is important to find a balance between keeping old business values and using new technologies. These include how to balance being independent with being dependent on technology, new ideas with old ones, and safety with risk.^(60,61)

According to Yuzevych et al.⁽⁶²⁾, we need to find a balance between the need for new technologies and the need to protect human values and keep society together. Businesses need automation and AI more and more. To keep jobs from going away and income gaps from growing, they need to make sure that these technologies do not do either. For everyone to get an equal share of the benefits of technological progress, there needs to be legislation that helps workers get trained and improve their skills. Technological advancements in areas like LoRaWAN networks are critical for enhancing global digital infrastructure, which in turn supports sustainable economic growth through innovations that align with the demands of a globalized market.⁽⁶³⁾ Technological innovations in the field of machine-to-machine communication (M2M), particularly in mobile communication networks, significantly contribute to improving service quality and economic sustainability by enhancing data transmission efficiency⁽⁶⁴⁾. The government should not only work to improve technology, but also make rules that will protect the environment in the long run. Goals for the environment, like cutting down on carbon emissions and using resources as little as possible, should be linked to new technologies. It is possible for policymakers to make sure that new ideas help both the economy and the environment by making sure that the goals are the same. On the other hand, business leaders should work to make their firms more creative.

Theoretical Foundations and Long-Term Implications

Schumpeter's theory of creative destruction shows how much new ideas are needed in the economy. According to this study's data, the economy needs new technologies to stay strong. Also, Porter's Competitive Advantage Theory says that places and businesses that focus on new ideas can do better in global markets and help the economy grow over time. Furthermore, Buriak et al.⁽⁶⁵⁾ say that people must be flexible and think ahead in order to keep the economy strong and competitive. Leaders and businesses must prioritize innovation if they wish to keep the economy growing. The research shows that global competition, new technologies, and technical progress are all important for the economy to stay strong over the long term. But the balance between new ideas and old values is still important for making sure that businesses can adapt to changes in technology while staying true to what they do best. In order for economies to thrive in a world that is becoming more globalised, policymakers and business leaders must work together to make environments that encourage innovation, sustainability, and fair growth.

Limitations of the Study

The results show strong correlations, but longer-term data would be needed to show a more direct cause-and-effect link between these factors over time. The sample size was limited to 210 respondents which make it harder to apply the results to other places, especially developing economies where innovation, competitiveness, and sustainability may work in different ways. The study only looked at developed areas. However, the results do not fully show the problems that businesses in less developed markets face, where it's harder to get to global markets and technology. The study takes into account the type of industry, but it doesn't go into specifics about how different types of industries adopt and benefit from new technologies. In contrast to traditional fields like agriculture or mining, where new ideas may be developed more slowly, high-tech fields like IT and biotechnology may have very different ways of coming up with new ideas.

CONCLUSION

This study shows that technological progress, new technologies, and global competitiveness are all important for the economy to stay alive in a world that is becoming more globalized. There was a strong link between new technologies and long-term economic success, as shown by the empirical results. A business is more likely to be successful in the long run if it puts innovation first. It was also discovered that this connection was stronger when there was more competition around the world. New ideas are more likely to help a company if it is globally competitive. It can handle pressure from other markets better now. It is found that new technologies such as automation, AI, and renewable energy systems directly boost output, lower costs, and make better use of resources. For instance, automation in manufacturing makes things go faster and costs less to make. At the same time, AI makes supply chain management better, which helps businesses react quickly to changes in the market.

It was found that innovation made the economy more resilient even more when it was competitive on a global scale. Companies that are better at competing on the world market can make better use of new technologies. One example is a multinational company. In many countries, they use automation and digital

platforms to make their business run more smoothly. This makes them more productive and better able to adapt to new markets. Even though this study shows how innovation, competitiveness, and sustainability are all connected, more research could look at how these relationships vary in different fields, like healthcare and agriculture. Additionally, longitudinal studies could look at how the use of certain technologies changes the resilience of the economy over time. Learning about how government policies affect the spread of technology in different areas could help find more places where help is needed.

Policy Recommendations

Based on the findings, specific recommendations for policymakers include:

1. Research and development (R&D) should be funded by governments, and regulatory environments that support technological progress should be created. Companies that invest in automation, AI, and green technologies should get tax breaks. This would encourage new ideas.
2. Trade agreements, export incentives, and building up infrastructure that makes it easier for businesses to use new technologies are all things that policymakers should do to help productions get into global markets.
3. Businesses must invest in training programs for their employees that teach them the skills they need for new technologies like AI and digital platforms in order to fully benefit from technological advances.

Policymakers and business leaders can make the economy more resilient and ensure long-term growth by lining up innovation policies with global competitiveness strategies.

Future Research Directions

These problems could be fixed in future research by using longitudinal data to find out more about how innovation, competitiveness, and sustainability are linked over time. In addition, adding more companies from developing regions to the sample would give a fuller picture of the global innovation scene. Finally, studies that focus on a certain industry might help us understand how new technologies affect sustainability in various fields. This would allow policymakers and business leaders to make more specific suggestions.

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The authors declare that there is no conflict of interest.

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