

SOCIO-ECONOMIC AND INSTITUTIONAL DETERMINANTS OF SUSTAINABLE DEVELOPMENT: A PANEL DATA ANALYSIS (2000–2023)

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Article History:

- received 28 September 2025
- accepted 23 March 2026
- first published online 5 August 2026

Abstract. The purpose of this research is to identify and analyse the impact of socio-economic, technological and institutional factors on countries performance in terms of sustainable development. It presents a study of the structural factors that influence sustainable development using panel data from 165 countries between 2000 and 2023. The UN SDG Index Score has been modelled as a dependent variable, incorporating World Bank predictors related to access to information technology, the labour market, institutional quality, per capita income and economic inequality. Five progressive models have been estimated, applying fixed effects methodology and validating the basic assumptions of linear regression with panel data. The results are partial and subject to revision as new controls and methodological improvements are incorporated in later stages, but it has been observed that access to communication technologies and good institutional quality favour sustainable development goals, while a high level of inequality has a negative impact on these goals.

Keywords: sustainable development, equity, justice, inequality, technological change: choices and consequences, measurement of national income.

JEL Classification: Q01, D63, O33, E01.

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1. Introduction

The objective of this research is to analyse the relationship between the Sustainable Development Goals (SDG) Index and a series of independent variables selected from socio-economic indicators provided by the World Bank (n.d.). Sustainable development (Sachs, 2015) is a goal that pursues a future of shared prosperity by ensuring a decent life for all. It is compatible with promoting economic growth but respecting the planet's resources in such a way that they can be maintained in the long term, but in the most inclusive way possible. In 2015, the United Nations (UN) established a 2030 Agenda setting out seventeen goals based on three pillars: economic, social and environmental. Among these goals, the following stand out: ending poverty (Sachs, 2013) and hunger, promoting responsible production and consumption through clean energy, achieving quality education and healthcare, promoting

gender equality (Pérez-Rico et al., 2025) and ensuring peace, justice, and democratic institutions (Echarte, 2023). These goals represent a more far-reaching update of the well-known Millennium Development Goals, which were intended to be achieved by 2015 but, for the most part, were not. The Sustainable Development Goals (SDGs) represent a viable and ambitious plan by the UN, but they require a commitment from all member countries, and it is necessary to establish indicators and controls to measure the degree of compliance. Since 2016, the Sustainable Development Solutions Network (SDSN), a network promoted by the UN and led by economist Jeffrey Sachs, has produced an annual sustainable development report (SDG Index) (Kynčlová et al., 2020; Schmidt-Traub et al., 2017) that assesses member states' compliance with these goals. The latest report highlights some areas for improvement (United Nations, 2025). On average, progress has been limited, with only 16% of the targets set for 2030 likely to be met, and many of them showing stagnation or even regression.

The COVID-19 pandemic and the most recent geopolitical conflicts, notably the Russian invasion of Ukraine (Guijarro, 2022) and tensions in the Middle East, are some of the causes of the setback in some SDGs (Gómez, 2018; Pes & Castiñeira, 2021), such as number two (zero hunger) and number sixteen (peace, justice and strong institutions). The economic situation in recent years, characterised by high inflation rates (Echarte et al. 2022; Shinkarenko et al., 2022) and trade tensions, has also contributed to a shift away from goals related to economic variables. On the other hand, there has been a perceived regression in some democratic countries on issues such as freedom of expression and the separation of powers. Some indicators, however, show more positive trends, but there is considerable inequality in compliance between countries. The Nordic countries top the list of the most committed countries, while the BRICS countries are also making some progress, but this contrasts with countries with lower per capita incomes that are not meeting sustainable development goals. The latest Sustainable Development Report points out that the international financial system needs to be reformed through a series of strategies to facilitate the financing of educational and other investments in low-income countries. It also points out that, given that the challenges are global, a boost in international cooperation and multilateralism is required (James, 2018). It establishes a classification of countries according to their greater or lesser support for joint decisions through a series of variables: ratification of international treaties, voting in the UN General Assembly, use of unilateral sanctions, financing of international organisations, participation in armed conflicts, etc.

In addition to the SDG Index, there are World Bank (n.d.) statistics that reflect the international socio-economic situation and serve to determine the level of sustainable development based on a series of factors such as access to new technologies, per capita income, levels of inequality, and the youth unemployment rate. The original contribution of this research is based on the incorporation of macroeconomic indicators and institutional quality using a panel data methodology for a broad set of countries and over several decades to explain the causes of sustainable development.

According to various authors (Piketty, 2015; Rodrik, 2021), high levels of inequality or unemployment are related to low levels of socio-economic development, while broad access to new technologies fosters long-term economic growth and promotes sustainable development (Alonso, 2023). The following section provides a literature review to reflect the main

themes of this research, drawing on the contributions of other authors. Subsequently, the methodology used is outlined, the results are presented and compared with other studies. Finally, the conclusions section summarises the main contributions of the article.

2. Literature review

Economic theory on economic growth and development processes is very broad and varied. Since the emergence of the classical school of economics, different economic schools have considered the factors that contribute to higher per capita income growth by analysing how this growth is distributed among different social groups (Skousen, 2022). Adam Smith believed that the wealth of nations was due to the specialisation of labour (the theory of absolute advantage) and a free-market environment that overcame the restrictions of the mercantilist era. David Ricardo expanded on the idea of absolute advantage with his theory of comparative advantage in international trade, although he established that growth was limited by the diminishing returns of land in an economy where agriculture continued to play a major role in national income. Another notable classic is the Englishman Robert Malthus, who argued that the population was growing faster than resources, which would lead to a subsistence crisis (Hunt, 2002). However, empirical evidence shows that since the Industrial Revolution there has been a large increase in population in parallel with significant economic growth, interrupted only by a few economic crises, such as the Great Depression, the oil crisis and the international financial crisis of 2008 (Sabry, 2024).

Modern theories of economic growth emerged in the 20th century and can be classified as exogenous or endogenous theories. Within the first group, the neoclassical Solow-Swan model of 1956 stands out, in which, in addition to labor and capital, growth is explained primarily by exogenous technological progress. Subsequently, from the 1990s onwards, several endogenous growth theories emerged, with renowned authors such as Romer (1990), Chandra (2021), Lucas (1990) and Barro and Sala-i-Martin (2004). Human capital theory argues that investments in education and health improve labor productivity (Hanushek, 2002) and promote economic growth. On the other hand, institutional theory (North, 1990) considers that growth is driven by the stability and quality of institutions (Gonzalez & Nishiuchi, 2018; Kararach et al., 2015), such as a consolidated rule of law, legal certainty and the protection of private property, among other factors. Pedraza Rodríguez (2023) analyses these theories and presents empirical examples that demonstrate how good institutional quality promotes economic growth. Acemoglu and Robinson (2012, 2019) distinguished between inclusive and extractive institutions. The former promote growth, while the latter discourage it. Inclusive institutions include the recognition of property rights and a market economy, together with a state that provides security and intervenes moderately. Extractive institutions include authoritarian governments and extractive elites. The Nobel Prize in Economics was recently awarded to Philippe Aghion, Joel Mokyr and Peter Howitt for his studies on how innovation and technological disruptions affect economic growth (Aghion & Howitt, 2017; Mokyr, 2023). Just like the 2025 Nobel Prize awarded to Joel Mokyr, Philippe Aghion, and Peter Howitt for studying economic growth driven by innovation. Mokyr (2023) contributed a historical

perspective, highlighting the cultural, and institutional prerequisites necessary for innovation. Meanwhile, Aghion and Howitt (2017) developed the mathematical model related to “creative destruction”.

Some current theories of sustainable growth are based on ecology and environmental protection to ensure the long-term sustainability of the system (Urteaga, 2009; Ahlerup & Olsson, 2023). A precedent for these theories is the report *The Limits to Growth*, published by The Club of Rome in 1972, which argued that unlimited growth is unsustainable. Subsequently, Jackson and Webster (2017) updated this report from a macroeconomic perspective with the aim of promoting dialogue between parties on the possible environmental and social limits to growth. In recent years, a radical but minority group of authors has emerged who even propose the need to promote economic degrowth (Fitzpatrick, 2025). These theories take a negative view of the ability to combine economic growth and environmental sustainability.

There is another school of thought within academic literature that has not focused on explaining the causes of long-term economic growth but has been more concerned with understanding the causes of underdevelopment in some regions such as Latin America or Africa. Development theories study the historical and structural factors that prevent certain regions from prospering (Frank, 1967). In the case of Latin America, some authors (Chávez, 2013; Mallorquín, 2019) have argued that there are relationships of dependency with other powers and have proposed protectionist models based on import substitution as a form of development. These theories had their heyday in the 1970s and had a notable influence on the Economic Commission for Latin America and the Caribbean (ECLAC) (Prebisch, 1949).

The SDG are not based on a single theoretical framework (Ament et al., 2020), but rather take into account many theories and economic approaches. Within development economics, the human capital theory (Becker, 2009) and endogenous growth models stand out. In the field of environmental economics, Pigou and Coase’s approach to negative externalities is noteworthy, while institutional economics highlights the importance of the quality of institutions and government effectiveness (Guerrero & Castañeda Ramos, 2021). For the selection of variables, a sample representing this variety of approaches has been chosen.

Traditionally, long-term economic growth has been measured using GDP per capita, and although some authors have questioned this approach, which is not without its limitations, the fact is that it is the most widely used indicator. It has a strong positive correlation with another broader indicator, the Human Development Index (HDI). This index, created in 1990 by the United Nations Development Programme (UNDP), reflects three dimensions: life expectancy at birth (as a health indicator), literacy level (as an educational indicator) and per capita income, adjusted for Purchasing Power Parity (PPP). The results of this index show that countries with higher income levels also have better health and education levels (Sušnik & van der Zaag, 2017; Stewart et al., 2018; Elistia & Syahzuni, 2018; Singh et al., 2025).

There are numerous studies analyzing the UN SDGs. Mukherjee (2017) studies the transition from the Millennium Development Goals to the SDGs. Meanwhile, Jacob (2024) conducts a historical review of these development goals, analyzing the evolution of the concept of development from its link to external aid towards a model based on four pillars: environment, economy, society and governance. The sustainable development indicator is more comprehensive than the HDI as it incorporates more variables from different dimensions (economic, social, environmental).

Martín-Blanco et al. (2022), Chen et al. (2024) analyze the effects of the COVID-19 pandemic on the SDGs through a comprehensive review of the academic literature. The health and economic crisis generated by the pandemic slowed down the performance of many countries in terms of socio-economic indicators. According to United Nations (2022) report:

The coronavirus disease 2019 (COVID-19) pandemic has put steady progress in poverty reduction over the past 25 years into reverse, with the number of people in extreme poverty increasing for the first time in a generation. Now, rising inflation and the impacts of the war in Ukraine may derail progress further (United Nations, 2022).

Indeed, the disruption of global supply chains caused by the measures taken to tackle the pandemic led to many bottlenecks and contributed to cost inflation, with rising prices for agricultural products and other goods and services, which affected the incomes of many people, especially in lower-income countries (Headey & Martin, 2016; Abdi & Nor, 2025; Hu et al., 2025).

On the other hand, in recent years there has been renewed discussion of the need to relocate certain industries that provide essential goods for national economies (Yakovlev, 2023; Vásquez Galán, 2024). This process could partially reverse some of the effects of the economic and financial globalization that has characterized recent decades. Financial globalization has allowed for great capital mobility and an international division of knowledge that enables many companies to move their production to countries with more lax regulations or lower taxes. This reduction in costs has contributed to lower prices for many products, such as technology, but there is a risk of dependence on other powers for the supply of energy sources (gas, oil) or important inputs, such as semiconductors. In general, globalization has been positive for economic growth and development in recent decades (Deaton, 2015; Norberg, 2017). However, there has been a certain degree of stagnation in some European countries that were affected by the 2008 international financial crisis (Canterbery, 2011), which lasted for several years. However, some authors have criticized the process of financial globalization. Economist Stiglitz (2003) questions some of the decisions taken by the main international economic organizations, the World Bank (n.d.) and the International Monetary Fund (IMF). According to Stiglitz (2003):

“While I was at the World Bank, I saw firsthand the devastating effect that globalization can have on developing countries, and especially the poor within those countries. I believe that globalization – the removal of barriers to free trade and the closer integration of national economies – can be a force for good and that it has the potential to enrich everyone in the world, particularly the poor. But I also believe that if this is to be the case, the way globalization has been managed, including the international trade agreements that have played such a large role in removing those barriers and the policies that have been imposed on developing countries in the process of globalization, need to be radically rethought (Stiglitz, 2003)”.

On the other hand, Rodrik (2012) argues that there is a conflict between global markets and national democracies that creates a paradox in the globalization process, as shown by the lack of institutional quality in some countries compared to their wealth of natural resources. Furthermore, it highlights the importance of demonstrating the real value of companies compared to their market value for the sustained development of society and to prevent economic crises from arising periodically (Kaczmarek & Náñez, 2025).

3. Methodology

This study is based on a retrospective quantitative analysis (Cabrera-Tenecela, 2023) using panel data models to explain countries' levels of sustainable development over time. The dependent variable used is the SDG Index Score, an indicator developed by the UN and the SDSN, which measures countries' progress in achieving the SDGs. This index synthesises multiple dimensions of development on a standardised scale, providing a robust comparative assessment between countries and regions (Sachs et al., 2022).

Figure 1 shows the degree of compliance of countries with the SDGs up to 2023, which is the final year covered by the panel data analysis.

The map created using RStudio – an Integrated Development Environment (IDE) – shows the percentage of compliance with all seventeen SDGs, although the Sustainable Development Report database also shows specific compliance with the SDGs in each of the 165 countries included in our study sample. As can be seen, the countries lagging furthest behind are those in sub-Saharan Africa, which have the lowest per capita income levels. The United Nations report also provides a ranking with points, as each goal has its own metrics for measuring performance. Currently, the top 18 positions are occupied by European countries, which are leading the way in their commitment to these SDGs. It is also worth noting that China and India, the two most populous countries, have been climbing the rankings in recent years. Specifically, China has improved in socio-economic indicators (digitalization of the economy, better healthcare system, etc.) but lags in environmental issues despite having made a significant effort to invest in renewable energy. Something similar is also happening in India, which has environmental gaps compared to other regional and global powers. In general, this pattern is seen in many Asian countries, but there are some that have fallen significantly behind, such as Afghanistan, Pakistan, Syria and Yemen, because of their political regimes or the wars in which they are embroiled. Several studies analyze the negative impact of armed conflicts on the achievement of SDG targets. According to Wang et al. (2024), wars delay the achievement of SDGs, especially those related to infrastructure and industry (SDG 9)

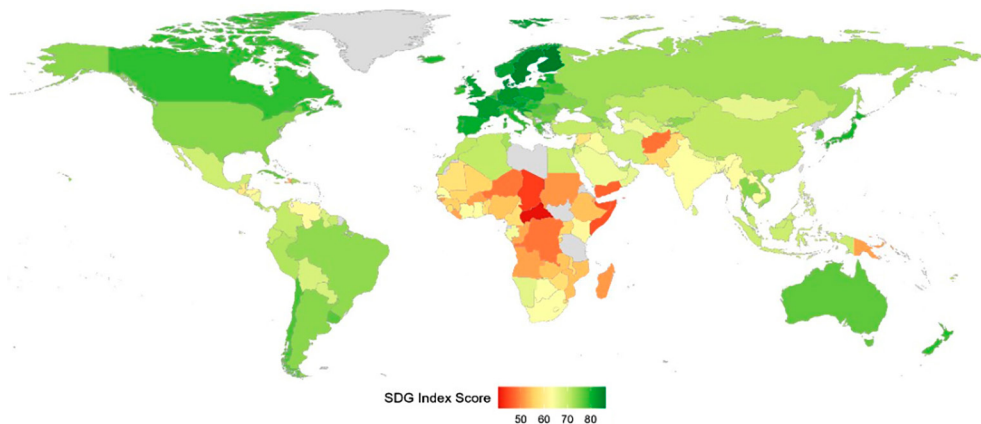


Figure 1. Map of SDG compliance until 2023 (source: prepared internally using data from the Sustainable Development Report, United Nations, 2025)

and education (SDG 4). On the other hand, Pereira et al. (2022) study the impact of the war between Russia and Ukraine on the socio-economic SDGs (2, 3, 4 and 8) and environmental SDGs (6, 13 and 15). It should be noted that the countries colored grey on the map is those that are excluded from the classification because they do not have information on sustainable development in the database analysed.

The independent variables were selected from socioeconomic indicators provided by the World Bank (n.d.) and are as follows: the percentage of individuals who use the Internet (as a measure of the digitisation of the economy and access to communication technologies), the logarithm of gross domestic product per capita adjusted for Purchasing Power Parity (PPP) at constant 2017 prices, and the youth unemployment rate and the GINI coefficient (as a measure of economic inequality). Table 1 shows the definitions provided for each indicator or variable by the agency from which the data originate.

The inclusion of this set of variables seeks to offer a comprehensive and multidimensional view of the structural factors that affect countries' performance in terms of sustainable development, as measured by the SDG Index Score. This approach not only allows for the identification of significant correlations but also provides useful empirical evidence for the design of public policies aimed at achieving the SDGs. All independent data comes from official and open databases, ensuring its international comparability (World Bank, n.d.).

To build the database, an unbalanced panel design was chosen, comprising 165 countries with annual observations between 2000 and 2023. No imputations were applied; each model was estimated solely with actual data available by country and year. This decision sought to avoid distortions arising from missing value estimation procedures, prioritizing the empirical integrity of the information (Little & Rubin, 2019).

Since this is a mixed panel regression (Moon & Weidner, 2014), a two-way fixed effects model was used, which simultaneously controls for country-specific unobservable heterogeneity (α_i) and time effects common to all countries (λ_t), specifying a panel structured by country and year using `index = c('Country', 'year')` in the `plm` function. The analysis strategy was then organized around five staggered models, all estimated using fixed-effects linear regression, using the `plm` function from the `plm` package in R (Croissant & Millo, 2008). This methodological choice responds to the need to control for unobservable heterogeneity between countries, under the assumption that there are factors that are constant over time and simultaneously affect the dependent and independent variables. The fixed effects model thus reduces bias due to omitted variables, strengthening the internal validity of the study (Allison, 2018; Wooldridge, 2010). In all cases, the Hausman test (Hausman, 1978) confirmed the relevance of this approach over the random effects model, as a correlation was detected between the regressors and the unobserved individual effects.

To ensure the statistical validity of the results, the estimation of the coefficients is complemented by robust standard errors of the Driscoll and Kraay type (Driscoll and Kraay, 1998), which simultaneously correct for heteroscedasticity, serial autocorrelation and cross-sectional dependence, without requiring the panel to be balanced (Hoechle, 2007; Setyowati et al., 2020). This additional robustness reinforces the consistency of the inferences, especially in panel structures that are broad in temporal dimension and with possible correlations between units.

Table 1. Description of variables used (source: prepared internally, adapting the definitions provided by the source of the data)

Variable	Description
SDG Index rating (dependent variable)	The overall score measures total progress towards achieving the 17 SDGs. This value can be interpreted as a percentage of SDG achievement: 100 points = means that all SDGs have been fully achieved. Less than 100 = reflects the level of partial progress towards those goals.
GDP (log)	GDP per capita based on Purchasing Power Parity (PPP). GDP is gross domestic product converted to international dollars using purchasing power parity rates. One international dollar has the same purchasing power over GDP as the US dollar in the United States. GDP at purchaser prices is the sum of the gross value added of all producers' resident in the country plus taxes on products and minus subsidies not included in the value of products. It is calculated without making deductions for depreciation of manufactured assets or for depletion and degradation of natural resources. The data are in constant 2017 international dollars. This variable was transformed to a logarithmic scale to reduce skewness, stabilize variance, and allow for a more linear relationship with SDG variable.
Youth unemployment	This refers to the percentage of unemployed young people aged between 15 and 24 in the economically active population in that age group.
Gini index	The Gini index measures the degree to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equitable distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of beneficiaries, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.
Internet users (% of total population)	Internet users are people who have used the Internet (from any location) in the last three months. The Internet can be accessed via a computer, mobile phone, personal digital assistant, games console, digital television, etc.
Government effectiveness: percentile rank	This indicator reflects the quality of the institutions that exercise authority in a country. This includes the process of selecting, overseeing and replacing governments, respect for citizens and adequate control of corruption. On the other hand, it quantifies the quality of public services and the separation of powers within a country. The percentile rank has been used. According to the World Bank, the percentile rank indicates the country's position among all countries included in the aggregate indicator, with 0 being the lowest position and 100 being the highest. The percentile ranks have been adjusted to correct for changes over time in the composition of the World Governance Indicator (WGI).

The general specification used was as follows:

$$Y_{it} = \alpha_i + \lambda_t + \sum_{k=1}^K \beta_k X_{kit} + \varepsilon_{it},$$

where, α_i is the country fixed effect; λ_t is the time fixed effect; β_k represents the coefficient associated with explanatory variable k ; X_{kit} denotes explanatory variable k for country i at time t ; ε_{it} is the idiosyncratic error term; i indexes countries, t indexes years, and k indexes explanatory variables.

Post-estimation diagnostics confirmed the validity of the models. The Breusch-Pagan test was applied to assess heteroscedasticity, the Wooldridge test was used to detect autocorrelation in fixed-effects panels, and the Durbin-Watson statistic was used to check for serially correlated errors. Recent methodological contributions have also discussed the interpretation and limitations of the traditional Durbin-Watson critical value tables (Wang & Lee, 2024). In no case were substantial violations of the classical regression assumptions identified. Likewise, multicollinearity was verified through the Variance Inflation Factor (VIF), with no problematic values recorded. The staggered structure of the analysis allowed for the gradual incorporation of different blocks of explanatory variables, observing the increase in explanatory power at each stage based on the change in the adjusted R^2 . This logic not only responds to statistical criteria but also allows us to observe the marginal contribution of each new set of predictors in explaining sustainable development. It is important to note that some of the results are presented through graphs generated with the ggplot2 package, which allows for the construction of customized visualizations through the aggregation of layers, under the Grammar of Graphics approach. This made it possible to clearly and comparatively represent the behavior of the different models and the trajectory of the variables analysed.

4. Results

Table 2 presents descriptive statistics for the central tendency, dispersion, and 95% confidence intervals for the variables used. The ODS index score has a mean of 64.35 points, with a standard deviation of 10.68, while Internet use shows large variations between countries. These statistics show that there is structural heterogeneity between the countries analysed and form the basis of the panel data model applied.

The estimation of the model with fixed country and year effects underwent specific tests to assess compliance with the classical assumptions of regression for panel data. No evidence of severe collinearity was found among the regressors included, with VIF values below 5 in all cases. However, the results of the Wooldridge test ($F = 229.54$, $p < 0.001$) and the modified Breusch-Godfrey test ($\chi^2 = 467.5$, $p < 0.001$) show serial autocorrelation of the errors. Likewise, significant heteroscedasticity was detected in both the Breusch-Pagan test ($p < 0.001$) and the LM test for effects ($p < 0.001$), as well as cross-sectional dependence between units (Pesaran CD test: $z = -2.52$, $p = 0.0116$), implying that countries may have

Table 2. Descriptive indicators (source: own elaboration)

Variable	Average	Median	SD	Min	Max	IC 95% inf	IC 95% sup	N
SDG Index Score	64.35	65.43	10.68	34.7	86.42	64.01	64.69	3803
GDP (log)	9.437	9.536	1.191	6.55	11.889	9.399	9.475	3728
Youth Unemployment	17.66	16.54	9.21	2.97	79.55	17.24	18.07	1887
GINI index	37.09	35.15	8.36	23.2	64.8	36.67	37.5	1554
Internet Usage	38.45	31.5	32.26	0	100	37.43	39.48	3803
Government Effectiveness	65.05	69.524	25.454	0.94	100	63.601	66.502	1183

common problems or coincidences in certain years. Based on these results, the use of robust Driscoll-Kraay standard errors (HC1 type) were adopted as the main inference strategy, since this correction allows valid estimates to be obtained even in the simultaneous presence of autocorrelation, heteroscedasticity, and contemporary dependence between panels. This choice allows the consistency of standard errors to be maintained without requiring strict assumptions about the structure of the disturbances.

Furthermore, as shown in Table 3, it was decided to use fixed-effects models (two-way FE: country and year) after verifying that the random effects were not consistent in any of the specified models. To evaluate this, the Hausman test was applied to the five estimated models, from the simplest (model 1, with only GDP (log) to the most complete (model 5, with five predictors). In all cases, the χ^2 statistic was high and with p-values significantly lower than 0.001. For example, model 1 yielded a χ^2 of 71.8 (gl = 1, $p < 2.2e-16$), and model 5 yielded a value of 1019 (gl = 5, $p < 2.2e-16$). The intermediate models (2, 3, and 4) showed equally conclusive results, with χ^2 values ranging from 120 to 916. This consistency indicates that the effects that have not been specifically observed are correlated with the regressors included in the models, which invalidates the assumptions of the random effects model. Therefore, it is necessary to work only with fixed-effects models, which allow for control for unobserved differences between countries that do not change over time.

Table 3. Hausman test results by model (source: own elaboration)

Model	Specification	gl	χ^2	Valor-p
1	GDP (log)	1	71.82	<2.2e-16
2	GDP (log) + Youth Unemployment	1	120.62	<2.2e-16
3	GDP (log) + Youth Unemployment + GINI	3	230.24	<2.2e-16
4	GDP (log) + Youth Unemployment + GINI + Internet Usage	4	916.42	<2.2e-16
5	GDP (log) + Youth Unemployment + GINI + Internet Usage + Government Effectiveness	5	1019.00	<2.2e-16

Some predictors have missing data for certain countries or years, which is why the number of observations varies between models, as shown in Figure 2. Rather than forcing a reduced base common to all models, it was decided to maintain the maximum number of observations possible in each specification to preserve statistical power. This means that in the first model, which only includes the logarithm of GDP per capita, there are 3,728 cases with 162 countries, and that in more complex models, such as model 5, estimates are made on smaller subsets of the panel due to the lower availability of data on variables such as governance, which only has 1,183 cases for 114 countries. For this reason, model 5 is considered the most complete.

The five estimated models presented in Table 4 allow us to observe the relative weight and consistency of different predictor variables of the SDG index, controlling for fixed country and year effects. The main comparative criterion has been the R^2 within and its adjusted version. However, because the models differ in their number of observations, comparison via ANOVA is not feasible. Let us see what happens in each model. Model 1 includes only the logarithm of GDP per capita [GDP (log)], which shows a significant positive association ($\beta =$

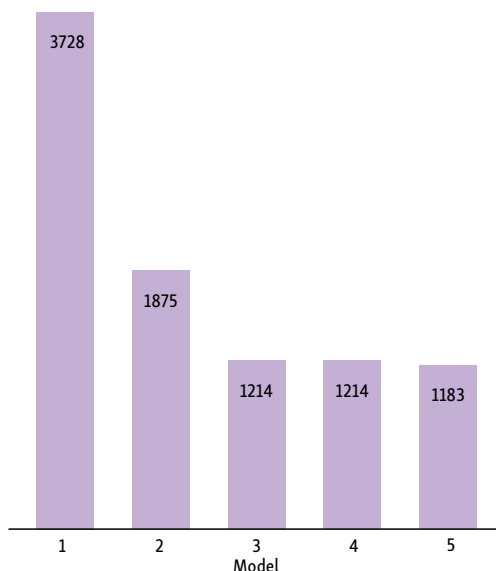


Figure 2. Amount of data in the model (source: own elaboration)

3.066, $p < 0.001$). However, the model explains only 11.4% of the variance within countries, with an even lower adjusted R^2 (6.8%), revealing a limited explanation. However, when we add a variable in model 2, the youth unemployment variable, which is also significant ($\beta = 0.023$, $p < 0.001$), the explained variance improves slightly (13.6%, adjusted 4.7%). Nevertheless, the fit remains poor, indicating that both predictors capture only a fraction of the variation in the index. Then, in model 3, we incorporate the GINI index, and the model takes a notable leap in explanatory power ($R^2 = 38.4\%$, adjusted 30.3%). The inequality coefficient is negative and highly significant ($\beta = -0.228$, $p < 0.001$), while GDP and youth unemployment maintain significant effects.

This model shows that inequality has a significant impact on progress in sustainable development, reducing the SDG score. Next, in model 4, the variable Internet Usage was added, which is also positive and significant ($\beta = 0.021$, $p < 0.001$). Although the increase in R^2 is modest (from 0.384 to 0.413), the adjusted model improves by up to 33.5%. The inclusion of this variable indicates that connectivity also plays an important role in the SDG index, albeit to a lesser extent than the GINI index.

In model 5, we incorporate the government effectiveness indicator (Government Effectiveness), whose coefficient is positive and marginally significant ($\beta = 0.020$, $p \approx 0.1$). The R^2 reaches its highest point (41.7%, adjusted 33.9%), although the gain over the previous model is minimal. Government effectiveness seems to contribute a marginal improvement but consistent with the expected direction. As we have seen, only model 5 remains consistent with the data, and the model maintains an explanatory level for each value. For this reason, model 5 is considered to offer the best explanation for the SDGs.

Table 4. Estimated coefficients with Driscoll-Kraay errors (vcovSCC, type HC1)
(source: own elaboration)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
GDP (log)	3.066***	3.802***	2.327***	2.026***	1.470*
Youth Unemployment	–	0.023***	0.019*	0.017*	0.018*
GINI Index	–	–	–0.223***	–0.215***	–0.213***
Internet Usage	–	–	–	0.021***	0.022***
Government Effectiveness	–	–	–	–	0.020°
R ² inside	0.115	0.136	0.384	0.413	0.417
R ² inside tight	0.068	0.048	0.303	0.335	0.339

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$.

The Standardised Coefficients Chart (Figure 3) shows more clearly the comparative magnitude of the effects of each predictor in the final model (model 5), controlling for country and year. As can be seen, the GINI index has the highest standardised coefficient in absolute value (standardised $\beta = -0.17$), confirming its negative and prominent role over the SDG index in relation to the other variables. The logarithm of GDP per capita maintains a significant positive effect (standardised $\beta \approx 0.16$), but we can see its instability and large variability related to each model, however it would imply that economic growth remains a robust factor, although not sufficient on its own. The youth unemployment rate also has a positive effect, which is smaller but significant. On the other hand, internet connectivity and government effectiveness contribute with small positive coefficients. Figure 3 presents the standardized coefficients and their confidence intervals for the different models, allowing a comparison of the magnitude and direction of each predictor. As shown, the GINI index has a negative effect, while GDP (log) exhibits the strongest positive impact, and the remaining variables show smaller coefficients close to zero.

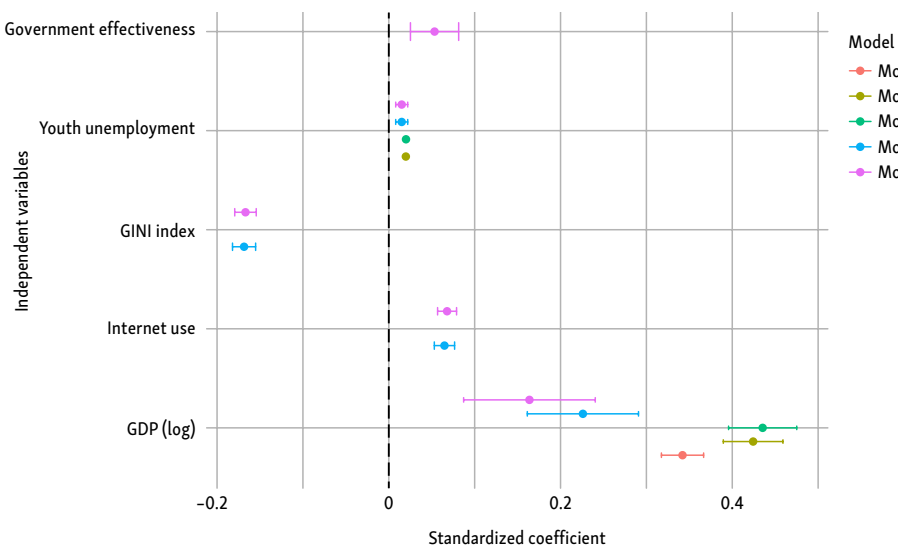


Figure 3. Standardised coefficients (Driscoll-Kraay SE) (source: own elaboration)

5. Discussion of results

The results of the study show the positive effect of Internet use and the quality of government institutions, as well as the negative impact of inequality (GINI) and youth unemployment. Several studies demonstrate the positive effects of information technology and the digitisation of the economy, especially in lower-income countries. Hjort and Poulsen (2017) use the difference-in-differences method to analyse the impact of the arrival of high-speed internet in a sample of African countries. According to the article: "To show how fast Internet affects employment in Africa, we exploit the gradual arrival of submarine Internet cables on the coast and maps of the terrestrial cable network. Robust difference-in-differences estimates from 3 datasets, covering 12 countries, show large positive effects on employment rates – also for less educated worker groups – with little or no job displacement across space. The sample-wide impact is driven by increased employment in higher-skill occupations, but less-educated workers' employment gain less so. Firm-level data available for some countries indicate that increased firm entry, productivity, and exporting contribute to higher net job creation. Average incomes rise" (Hjort & Poulsen, 2017).

According to Suri and Jack (2016), access to financial services such as digital payments through M-Pesa electronic money in Kenya has reduced the number of people living in extreme poverty. In countries where there are few bank branches, the use of mobile applications promotes financial inclusion (Náñez Alonso et al., 2025). Financial technology (Fintech) is growing in other regions such as Asia and Latin America (Ernest et al., 2019; Fenwick et al., 2020; Hsu & Li, 2020) due to the increase in start-ups using mobile applications to provide financial services. These applications make remittances cheaper, allow instant transfers and facilitate non-bank financing for some local ventures. These companies are subject to less regulation than the traditional banking industry and are more flexible in their operations because they have lower structural costs. Bahia et al. (2020) analyse the impact of mobile broadband on household consumption in Nigeria, using a longitudinal study. According to this research: "The estimates show that mobile broadband coverage had large and positive impacts on household consumption levels which increased over time, although at a decreasing rate. Mobile broadband coverage also reduces the proportion of households below the poverty line, driven by higher food and non-food consumption in rural households. These effects are mainly due to an increase in labor force participation and employment, particularly among women" (Bahia et al., 2020).

The government effectiveness indicator is related to the quality of countries' government institutions. Poor institutional quality negatively affects development. Several studies demonstrate the negative effects of corruption on countries' growth and development. Sarabia et al. (2019) use a statistical model to analyze the relationship between the HDI and the Corruption Perceptions Index (CPI) in European countries, studying how populist parties are emerging because of the weakening of democratic institutions and the impact of economic crises. On the other hand, Castillo et al. (2024) study the effects of corruption using the HDI and its sub-indices for a sample of 135 developed and developing countries during the period 2005–2021, employing a dynamic estimation method with correlated panels. According to this research: "The findings show that corruption, in any of the indices, serves as a human development constraint for both the overall country sample, and for the countries grouped by

income level. An interesting result is that the education index in the lower-income countries is more sensitive to corruption, while corruption affects the income index to a greater extent in the higher-income countries" (Castillo et al., 2024).

As inequality increases (higher GINI), performance in sustainable development decreases. According to United Nations Development Programme (2024), inequality in the HDI between high- and low-income countries is growing, and it warns that climate change may widen this gap between countries. Several countries in Latin America and Africa are among those with the highest income and/or wealth inequality, so it is not surprising that they rank lowest in the Sustainable Development Report, among other things because one of those goals, SDG 10, seeks to reduce income inequalities. Lusseau and Mancini (2018) analyse how economic inequalities generate conflicts between the achievement of different SDGs. Lakner et al. (2020) conclude that, to reduce extreme poverty (SDG 1), it is more efficient to reduce the Gini Index by one percentage point than to increase economic growth by one point. On the other hand, several studies (Khan & Yahong, 2021; Uzar & Eyuboglu, 2022; Che et al., 2023) show that greater inequality also affects the ecological footprint and CO₂ emissions, aspects related to SDGs 7 and 12 (Moinuddin & Olsen (2024).

Although several studies (Gago-Cortés & Alló, 2021; Señoiret et al., 2022) show the negative effects of job insecurity and problems with labour market integration among young people in many developed countries, the results of this study indicate that there is a positive effect in relation to the SDGs, which may seem paradoxical. However, this social problem affects developed countries more due to phenomena related to economic stagnation, an ageing population, low birth rates, excessive regulation in the labour market and the role of trade unions. Some authors Jimeno and Rodriguez-Palenzuela (2002), Sachs and Smolny, (2014), Gaffney and Millar (2025) have analysed the high rates of youth unemployment in several OECD countries, such as Sweden, Spain, Italy, France, Greece, and Portugal. However, these countries compensate for this situation with better results in terms of the environment and institutional quality (Har et al., 2023; Bisogno et al., 2025).

The same can be said of the per capita income variable, where the results show great variability (see the length of the lines in Figure 3, compared to the other variables). In other words, it is true that low-income countries perform poorly in relation to the SDGs, but among high per capita income countries, there are some that do meet all SDG standards, such as the Nordic countries, while others, such as the United States, are at an intermediate level of compliance. Asadikia et al. (2022) and Liu et al. (2024) present empirical evidence on the difficulties faced by low-income countries in addressing the SDGs. On the other hand, Soto (2023), Qi et al. (2024) show how there is a strong imbalance in the fulfilment of the SDGs by countries in the Global North, which are those with the highest levels of per capita income.

6. Conclusions

The results of this research could represent a significant advance in identifying socio-economic and institutional factors that explain the performance of developing countries in terms of sustainable development, as measured by the UN SDG Index Score. By applying fixed-effects panel data models, we seek to control for unobservable heterogeneity between countries and strengthen the internal validity of the findings.

The results show that access to communication technologies and good institutional quality are positive and relatively robust factors in explaining higher levels of sustainability. On the other hand, high levels of inequality (measured using the GINI index) appear to be negatively associated with SDG performance. These findings are consistent with those of other studies that apply the same or other methodologies.

The progressive incorporation of variables into stepwise models showed steady growth in explanatory power, reaching 41.3% of the variance (R^2 inside). This finding could be interpreted as evidence that technological, economic and governance factors contribute in a complementary manner to sustainability performance. Furthermore, it is important to note that variables with multicollinearity have been discarded to avoid redundancies and autocorrelations.

From a methodological standpoint, we chose to work exclusively with actual data available for each country and year, without applying imputation techniques for missing values. This should reinforce the empirical credibility of the analysis, although it could also limit the effective sample size and potentially affect the representativeness of some countries or periods. In addition, a robust method such as that of Driscoll and Kraay was applied.

Among the limitations of the study, we can point out that some countries have not been included in the sample, especially as new variables are added, reducing the number of countries involved significantly from 3,728 to 788 data points. Future research may consider adding additional databases to those of the World Bank to complete the missing information.

Acknowledgements

This paper is supported by the research project "Socioeconomic and Business Challenges in the Era of Digitalization" (Ref. 2024/SOLCON-135776; Internal Ref. V1568), funded by Universidad Rey Juan Carlos, 2025.

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